

The Sustainable Brazilian Blue Economy: A Blue Powershoring and Blue Watershoring Strategy

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Abstract

The Blue Economy offers a new paradigm and a new virtuous cycle of sustainable economic growth and development. The Blue Economy's equitable, inclusive, intergenerational perspective on sustainable growth and development has the potential to grow considerably in the next decades. Thus, addressing a number of the Sustainable Development Goals established in the 2030 agenda. This paper addresses the Brazilian Blue Economy and its economic, social, and environmental potential. Brazil's Blue natural capital assets offer Brazil a unique opportunity to capitalize on its Blue Powershoring and Blue Watershoring natural competitive advantages. Moreover, Brazil's Blue Powershoring and Blue Watershoring competitive advantages position Brazil as a premier location for the production of Green Hydrogen, which will allow Brazil to enhance its global economic competitiveness by expanding its exports of green hydrogen and green hydrogen-intensive products and services.

Keywords

Blue Economy, Blue Powershoring, Blue Watershoring, Green Hydrogen, Brazil, Sustainability

1. Introduction

In 2023, countries around the globe are paying heed to the economic, social, and environmental benefits and potential of their Blue Economies. The Blue Economy is composed of rivers, lakes, aquifers, and oceans. Oceans account for 72% of the planet's surface, and rivers and lakes for an additional 1%. The Blue Economy is a vital source of food, energy, minerals, and a vital source of non-market services, such as environmental services. The 2023 United Nations Climate Change

Conference, COP 28, stressed the role of the Blue Economy in combating climate change (Pauli, 2010, 2015, 2017; Henderson, 2023; Packard, 2023; UNEP 2023a, 2023b).

Blue Economy's ecosystems play a vital role in global climate health, regulating global climate, CO₂ sequestration, oxygen production, and absorption of carbon dioxide, amongst other environmental services and benefits. The global Blue Economy's rivers, lakes, aquifers, and oceans can be approached as engines of sustainable, equitable, inclusive, growth and development, assisting the global economy in making the transition from a brown economy towards a green and blue economy. The United Nations 2030 Sustainable Development Goals, SDG 14, explicitly observes and points out the conservation and sustainable use and development of rivers, lakes, aquifers, and oceans. The Sustainable Development Goal 14, Life Below Water, addresses the pressing issues of sustainability of the Blue Economy. It is also important to stress that if the Blue Economy is to grow and develop, it must be based on healthy rivers, lakes, aquifers, and oceans. Thus, the Blue Economy is an important component of this larger global sustainable, inclusive, equitable, development and growth strategy (UNDP, 2023a, 2023b; World Bank, 2016; Biber, Knodt, & Visbeck, 2022; Morgan, Huang, Voyer, Benzaken, & Watanabe, 2022; Paysant & Miville, 2023).

The global Blue Economy is valued at US\$ 2.4 trillion, creating close to 350 million jobs, and also accounting for 80% of all global transportation. In the coming decades, it is expected that the global Blue Economy will expand faster than the overall global economy. However, the traditional approach to harnessing rivers, lakes, and ocean resources must change. If the Blue Economy is to have a long-term, intergenerational impact, we must pay attention to the sustainable harnessing, preservation, and regeneration dimensions of these natural capital assets. How to better achieve SDG 14 is a major concern of countries around the globe (Alam, 2023; ASEAN, 2023; Attri, 2023; Blue Resources, 2022; Yashiro, 2022).

Moreover, the Blue Economy must pay heed to the inclusive and equitable dimension of its sustainability architecture and governance. It is important to guarantee and foster the resilience of these Blue Economy's resources and ecosystems, in order to extend the longevity and also ensure that current and future prosperity is warranted. Thus, as stated by the Brundtland Report back in 1987, the Blue Economy is also attentive to intergenerational justice, i.e. future generations can keep on benefiting from the Blue Economy's natural capital assets and social, economic, and environmental potential (Bramley, Rogers, Hamflett, Turner, Howell, Giannoumis, Matthew, & Lambert, 2021; United Nations, 1987; Global Environment Facility, 2018).

The preservation of Blue Economy's natural capital assets is a vital dimension of the Blue's Economy intergenerational, inclusive, and equitable goals and objectives. Billions of people around the planet depend on rivers, lakes, and oceans for their livelihood, food security, and employment opportunities (Bennett, Cis-

neros-Montemayor, Blythe, & Silver, 2019; BAPPENAS, 2021; Bocci & Mancini, 2022).

After the 1992 United Nations Conference on Environment and Development, a number of global environmental initiatives and conferences reinforced the increasing importance of the global Blue Economy. In the last two decades, several global conferences have addressed the need to address the health and sustainability of rivers, lakes, aquifers, and oceans. The 2012 United Nations Conference on Sustainable Development, the Rio + 20 Earth Summit, forwarded a number of proposals related to the sustainable production and consumption of fish and related products from rivers, lakes, and oceans, in addition to food security and sustainable energy. The main focus was on the conservation of rivers, lakes, aquifers, and oceans, in addition to the sustainable harnessing of their resources (Martinez-Vazquez, Milan-Garcia, & Valenciano, 2021; European Investment Bank, 2021; European Commission, 2022).

In 2015, during the UN Sustainable Development Summit, 17 Sustainable Development Goals (SDGs) were introduced. The 17 SDGs covered issues such as poverty, gender equality, clean water and sanitation, sustainable consumption and production, and climate action, among other sustainable development goals. SDG 14, “Life Below Water” explicitly stated and stressed the increasing importance of rivers, lakes, aquifers, and oceans in the global sustainability effort. In addition, it also stressed the crucial importance of the Blue Economy as a vital source of food, resources, and services to the global economy, society, and global environment (Bryan, Neumann, & Patterson, 2015; UNCTAD, 2023; Fisheries and Oceans Canada, 2022).

In 2017, the United Nations declared the beginning of the ocean decade from 2021-2030, when global attention and efforts would be directed toward the creation of a policy-science interface addressing a number of SDGs that interface with the Blue Economy. The 2018 Nairobi, Sustainable Blue Economy Conference, the 2021 United Nations Climate Change Conference, and the 2022 Second United Nations Ocean Conference—“2022 United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development”, reinforced the increased importance of the global Blue Economy in any discussions related to global inclusive, equitable, and sustainable growth and development (Commonwealth, 2016; Denis & Fix, 2018; United Nations, 2021b; European Commission, 2022).

The United Nations COP 26 and the United Nations COP 27 further reinforced the role of the Blue Economy in addressing food security, renewable energy, and climate regulation. Both UNs COP 26 and COP 27, stressed that the role of the Blue Economy is addressing and solving these pressing global issues. The Blue Economy plays a key role in carbon sequestration, food security, and economic prosperity for billions of people around the planet (Ebarvia, 2016, 2022; Drew, Barsky, Gifford, Yang, Erdman, Stettler, Ludwig, & Ribet, 2020; Economic

Advisory Council to the Prime Minister Government of India, 2020; UNDP, 2023b; UNCTAD, 2023).

This paper will address the main promises and challenges permeating the global Blue Economy, with an emphasis on the Brazilian experience. This paper also introduces two new concepts that will help to contextualize the increasing importance of the Blue Economy for nations such as Brazil's overall social, economic, and environmental goals and objectives. This paper introduces two novel concepts: the concept of Blue Powershoring and Blue Watershoring. This paper introduces the idea that renewable energy endowments and fresh water endowments are the new paradigms permeating the future location of global manufacturing and how global supply valued added chains will be located globally wide. Countries that are competitive on both dimensions, such as Brazil, will be able to further benefit from the global Blue Economy virtuous cycle of equitable and inclusive sustainable economic growth and development, achieving competitive advantages over countries that have much smaller endowments of renewable energy and fresh water resources. Moreover, this paper also elaborates on the nexus of Green Hydrogen and the Blue Economy, and how countries like Brazil have a differentiated natural competitive advantage in the global green hydrogen industry as a result of its Blue Powershoring and Blue Watershoring economic and environmental competitive advantages.

2. The Blue Economy

In this century, rivers, lakes, aquifers, and oceans are becoming major drivers of global sustainability, economic growth and development. It is expected that the global Blue Economy will grow faster than the global mainstream economy. The Blue Economy is expected to surpass the global mainstream economy on two basic dimensions: employment creation and value-added activities and sectors. More than 3 billion people depend on food from rivers, lakes, and oceans for food, employment, and livelihood. Fish alone accounts for 16% of our planet's population consumption of animal protein. In Senegal, 75% of all animal protein comes from fish (Biber, Knodt, & Visbeck, 2022; European Investment Bank, 2021; European Commission, 2022; UNDP, 2023a, 2023b).

There isn't a single definition for the Blue Economy. Still, several definitions emphasize the inclusive, equitable, and sustainable nature of economic activities linked to the harnessing of rivers, lakes, aquifers, and ocean resources, paying heed to the ecologically regenerative preservation of these resources, and the intergenerational-minded nature and perspective of these Blue Economy activities. For instance, one of the Blue Economy definitions, mostly addressing oceans, stressed some of these points and issues: "A sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy" (The Economist Intelligence Unit, 2015: p. 7).

SDG 14, "Life Below Water", is related to the Blue Economy, but it also con-

nects to the other 16 Sustainable Development Goals, as rivers, lakes, and oceans interconnect with all the other SDGs. The Blue Economy promotes sustainability by promoting the Blue Circular Economy, by promoting the sustainable production and consumption of Blue Economy's related products and services. In addition, by promoting the creation of blue jobs, blue entrepreneurship, blue venture capitalists, blue innovation and blue R&D, and blue financing (United Nations, 2017, 2021a, 2021b; UNDP, 2023a).

In the next decades, the global Blue Economy is expected to grow at twice the rate of growth of the global traditional, or mainstream economy. The value of the global Blue Economy is assessed to be around US\$ 2.4 trillion, what in 2023 would rank the global Blue Economy amongst the world's top ten economies. The global Blue Economy employs close to 350 million people in economic activities such as fishing and fisheries, aquaculture, and sea and river related tourism and ecotourism, energy, mining, among other sectors and industries. It is important to highlight that the Blue Economy has strong backward and forward linkages connecting traditional Blue Economy sectors and non-Blue Economy sectors expanding the impact of the Blue Economy. Thus, offering a new cycle of virtuous sustainable growth and development (Keatin-Bitonti & Lipiec, 2022; Biber, Knodt, & Visbeck, 2022; UNEP, 2023a, 2023b).

There are several drivers or inducers of growth for the global Blue Economy. For instance, 1) food security, 2) increasing demand for seafood protein, 3) demand for the development of new pharmaceutical products and cosmetics, leading to additional cycles of R&D development and innovations for the global healthcare industry; 4) demand for minerals—seabed mining, 5) demand for alternative & renewable forms of energy—wave, tide, and offshoring energy generation, 6) demand for fresh water; 7) R&D in rivers, lakes, aquifers, and ocean innovations and technologies, 8) coastal urbanization, 9) conservation activities, policies, and guidelines,, and 10) growth in transportation, amongst other Blue Economy drivers (Keen, Swarz, & Wini-Simeon, 2018; Lupson, Dubois, & Allen, 2021; Karani, Failler, Gilau, Ndende, & Diop, 2022).

The Blue Economy may also be considered a new sustainable emerging business frontier, one that will unleash rivers, lakes, aquifers, and oceans' economic, social, and environmental potential. A number of new emerging sectors and industries are ready to bloom under the auspices of the Blue Economy. For instance, offshore wind farms, tidal and wave farms. Moreover, as a result of declining wild fish stocks and seafood, aquaponics and aquaculture will expand and grow in the future. Seabed mining is also attracting more countries' attention. For instance, in 2023 Norway has found large amounts of strategic minerals such as copper, zinc, magnesium, cobalt, neodymium, yttrium, and dysprosium. These minerals are largely used by the green and blue economies in the production of electric car engines and in wind energy (Lambert, Turner, & Hamflett, 2019; Mancini & Comolet, 2020; Paddison, 2023).

The Blue Economy may be segmented in seven major economic sectors, such as:

- 1) Blue Economy Living resources (rivers, lakes, and ocean): Processing and distribution of seafood, bioeconomy and biotechnology, aquaculture, aquaponics.
- 2) Blue Economy non-living resources (rivers, lakes, and oceans): Oil and gas, seabed mining for products such as copper, zinc, and metals and rare earths.
- 3) Blue Economy Renewable Energy (rivers and ocean): Hydropower energy, tide energy, wave energy, and offshore wind energy.
- 4) Port activities: Cargo and warehousing, infrastructure, submarine cables, robotics, amongst other high-tech sectors.
- 5) Shipbuilding and repair, river and maritime transport, river, lakes, and ocean tourism and ecotourism.
- 6) Infrastructure: Submarine cables, robots and artificial intelligence applied to the Blue Economy.
- 7) Desalination.

Blue Services are an important component of the Blue Economy. Blue Services such as tourism, account for 15% of the Blue Economy global output, close to US\$ 365 billion, trade and shipping for 30% of the Blue Economy output or close of US\$ 700 billion. Activities such as fishing account for 17% of the Blue Economy output or US\$ 400 billion, and new sectors such as wave energy and offshoring wind farms for close to US\$ 890 billion or 38% of the total global economic output of the global Blue Economy (Commonwealth, 2016; Biber, Knodt, & Visbeck, 2022; European Commission, 2022; European Investment Bank, 2021; Lupson, Dubis, & Allen, 2021; Singh, 2022).

The importance of the Blue Economy varies from country to country; however, its global economic, social, and environmental importance is expanding every year. For instance, in China the Blue Economy accounts for 9.4% of its GDP, reaching 28% of Indonesia's GDP and 30% of Thailand's GDP. In the European Union, the Blue Economy employs 4.5 million workers and generates 667 billion Euros output, and 189 million Euros in gross value-added. The U.S. estimates that its Blue Economy is valued at US\$ 361 billion, or close to 1.7% of the U.S' GDP, with coastal and offshore tourism accounting for US\$ 190 billion (Keatin-Bitonti & Lipiec, 2022; European Commission 2022; Ebarvia, 2016, 2022).

Countries willing to develop and foster their Blue Economy have a number of economic and businesses options. Rivers, lakes, aquifers, and oceans offer a number of sustainable business opportunities. For instance, ocean coastal areas are a major source of business opportunities such as tourism, ecotourism, shipping, fishing, aquaculture, aquaponics, mining, oil and gas exploration, as well as transportation, energy, desalination, biotechnology, and bioeconomics, amongst other business opportunities. For instance, the increasing use of algae will potentially unleash a number of applications in the pharmaceutical and cosmetics industries. Marine organisms have the

potential to also be used to produce anti-cancer drugs and antibiotics, Thus, a new generation of pharmaceuticals products are going to be developed in the next few years from the Blue Economy ecosystems (McCann, Poli, Kennedy, O'Neill, Robadue, & Kotowicz, 2020; BAPPENAS, 2021).

Beyond economic activities harnessing the Blue Economy's natural capital assets, the Blue Economy offers a number of environmental services such as climate regulation, 50% of the global oxygen production, Blue carbon, CO₂ sequestration, shoreline protection, mechanical energy related to tides and waves, and offshore wind power (Martens, Moolaert, Pirlet, Losvelt, Overmeire, & Verreet, 2022; Morgan, Huang, Voyer, Benzaken, & Watanabe, 2022; Muller, McGuire, Vidale, & Hawkins, 2023).

3. Challenges & Opportunities

The Blue Economy, despite its sizeable contribution to the planet's sustainability efforts and economy, is under substantial pressure. Rivers, lakes, aquifers and oceans pollution, ocean warming, salinity changes, sea level rise, frequency and intensity of storms, overexploitation of fish resources, lower levels of oxygen production, acidification of oceans, are some of the main threats to the Blue Economy. The Blue Economy aims to promote an inclusive, and equitable economic growth and development, and the same time not losing sight of intergenerational sustainability. Moreover, decoupling blue economy growth and development from environmental impact is one of the main challenges facing the Blue Economy (Brent, Barbesgaard, & Pedersen, 2018; International Institute for Sustainable Development, 2018; Shaw, Kennedy, Quigley, & Coudard, 2022; Juneja, De Souza, Giryan, & Ganeshan, 2021).

Blue Governance: The Blue Economy also calls for local, regional, and global governance structures and frameworks in order to better protect and develop natural capital resources. Here a Quadruple Helix governance structure must be designed, implemented, and audited. The main stakeholders, such as civil society, academic institutions, private sector, and government should be active participants in this quadruple helix governance architecture. This governance is very important in designing and ensuring the goals and objectives of the Blue Economy at the local, regional, and global levels. Each one of these levels will have their own characteristics and specificities that can shared. This governance is an important step in turning the Blue Economy goals, objectives and vision into reality (Karani, Failler, & Gilau, 2023; Martinez-Vazquez, Mila-Garcia, & Valencaino, 2021; UNCTAD, 2023).

Blue Skills Building: It is important to build human capital in order to address the challenges and opportunities created by the Blue Economy. The Blue Economy encompasses a number of fields from managers to biologists. The creation of technical and academic programs and degrees to address the Blue Economy's human capital needs is extremely important. Training to prepare blue managers, blue entrepreneurs, and blue venture capitalists. Moreover, blue pub-

lic-private partnerships are important strategies to channel investments and qualified professionals into the Blue Economy. Moreover, the creation of a Blue Entrepreneurship mindset in universities and technical schools will help to address the shortage of blue entrepreneurs and blue technical professionals (Terra, Lehmann, Resende, Almeida, & Gouvea, 2023; Pauli, 2010, 2015, 2017).

Circular Economy: The circular economy is one of the tenants of the Blue Economy. The long-term sustainability and regeneration of the global Blue Economy is fundamentally connected to the circular and sharing economies (Bocci & Mancini, 2022; Alston & Kan, 2023).

Pollution: Every year close to 12 million tons of plastic are found in oceans from around the globe. Close to 80% of this plastic discharge come from rivers and from land. One million tons of microplastics are mostly found as a result of tire dust and pellets. This plastic pollution reaches 40% of the planet's oceans (Ribeiro & Batista, 2023; Santos, 2021).

Industrial Fishing: Industrial fishing is a major threat to wild fish and seafood stocks. Heavy subsidies from some of the world's leading economies keep these industrial fishing industries profitable. Companies from the European Union, the United States, Japan, China, and South Korea, receive more than half of these subsidies. It is important to mention that the Blue Economy depends on healthy wild fish stocks for its regeneration and long-term sustainability. Aquaculture relies heavily on wild fish stocks (Brent, Barbesgaard, & Pedersen, 2018; Drew, Barksy, Gifford, Yang, Erdman, Stetler, Ludwig, & Ribet, 2020).

“Blue Washing”: Like green-washing, the Blue Economy faces a number of challenges when basic sustainability practices, social practices, and economic practices violates the core foundations of the Blue Economy (Sailer, Wilfing, & Straus, 2022).

Protecting the Blue Economy: Investing in mitigation, adaptation, and regeneration strategies such as pro-active investments to protect and expand existing marshes, mangroves, seagrass meadows, are just some examples. These initiatives may assist to better protect the Blue Economy's regenerative potential in face of an increasing demand for the Blue Economy's natural capital assets (Sepponen, Hjelt, Kuusela-Opas, Pakkala, Suominen, & Varre, 2021; Singh, 2022).

Financing: Financing is one of the backbones of the Blue Economy. Financing the transition from a Brown to a Blue Economy is facilitated by the availability of Blue financing. One option is the use of sustainable Blue bonds, an alternative to traditional debt, and more appealing to investors and supporters of a sustainable Blue Economy. Blue bonds can be used to finance river, lakes, aquifers, and ocean related projects and programs. These projects and programs must have a positive externality on the environment, society, and economy. Blue finance is a vital component in the expansion of a Blue Carbon market. The existence of Blue Venture Capital and Blue Venture capitalists will also foster the development of Blue Startups and expand the role of SMEs in the Blue Economy as re-

sult of financing availability. The sustainable growth and development of the Blue Economy will be determined by investments in sustainable renewable forms of energy, by the sustainable exploitation of natural capital assets and the positive externalities provided by rivers, lakes, and oceans ecosystems (Patil, Virdin, Diaz, Roberts, & Singh, 2016; PEMSEA, 2018; Morgan, Huang, Voyer, Benzaken, & Watanabe, 2022).

Blue R&D and Blue Innovation: SDG 14 provides an architecture for action. The Blue Economy demands a R&D intensive and an innovation-intensive framework and architecture. More science must be applied and developed to better understand and unlock the Smart Blue Economy's potential in a regenerative and sustainable fashion. Moreover, to also ensure that the current and future generations continue to benefit from the Blue Economy, in an intergenerational Blue Economy justice fashion. Thus, blue R&D, blue innovations, in addition to Blue tools and blue technical assistance can benefit Blue Economy participants. A Smart Blue Economy will assist in creating an intergenerational Blue Economy (Martens, Moulaert, Pirlet, Loosvelt, Overmeire, & Verreert, 2022).

BlueDIGITAL: In order to better manage the complex global Blue Economy data must be available. The available data must be digitalized and shared with local, regional, and global stakeholders. Data will support social, economic, and environmental innovation and R&D. Moreover, data will allow the private sector, policy-makers, civil society, and academic institutions to identify gaps that can be addressed in order to develop a more efficient governance structure and framework for the Blue Economy (UNDP, 2023b).

Warmer Rivers, Lakes, and Oceans: The Blue Economy is deeply affected by global climate change. In 2023, the average ocean temperature reached new record highs, deeply affecting marine and freshwater life, affecting the migration of species, and also fostering bio invasion of ecosystems. In the Brazilian Amazon region, 2023 has been marked by an extensive draught in the region, deeply affecting Amazon rivers and lagoons and the local population. This trend is a major threat to fresh water and seafood security, affecting billions of people who depend on these resources for their nourishment, livelihoods, and employment, (Corsini, 2023; Paysant & Mivielle, 2023; Muller, McGuire, Vidale, & Kawkins, 2023).

Transportation: Decarbonization of river, lake, and maritime transportation is a major challenge for the Blue Economy, giving the industry heavy reliance on fossil fuels and contribution to GHG emissions (Castellanos, Roesch, & Sloan, 2021; Maersk Mc-Kinney Moller Center, 2022).

Habitat Loss: Excessive urbanization is affecting a number of the Blue Economy's ecosystems. For instance, the concentration of the global population along the seacoast has been destructing and threatening a number of habitats, deeply affecting feeding and reproduction habitats. For instance, the protection of mangrove forests is fundamental to capture CO₂ and to protect coastal communities from floods and erosion. Moreover, the preservation of rivers, lakes, aqui-

fers, and marine ecosystems must be taken into account when promoting mass tourism and ecotourism activities. Thus, attentions must be paid in order to make sure that these economic activities are inclusive, equitable and sustainable (Bennett, Cisneros-Montemayor, Blythe, & Silver, 2019; The Economist Intelligence Unit, 2019).

Legal Framework: A legal system to address this new cycle of global economic development and prosperity is an important dimension of the Blue Economy. This new economic frontier may have supranational dimensions in some instances, which require legal stability and protection for all of the Blue Economy main stakeholders, from fishing villages to companies investing in the Blue Economy (United Nations, 2021a; World Bank, 2016).

Oil and Gas: Fossil fuel exploration is still a major economic sector for many of the countries that have endorsed and supported the Blue Economy. This is for sure one of the main challenges and contradictions facing the Blue Economy. For instance, Norway has been actively exploring gas and oil in the Barents Sea. The Lula government in Brazil is also following the global and the Norwegian fossil fuel model by proposing to explore for oil and gas near the mouth of the Amazon river (Fusco, Schutter, & Cisneros-Montemayor, 2022; Audi, 2023).

Aquaculture: The Blue Economy has great implications for the access and utilization of ocean space, leading to important questions related to the equitable and inclusive access to the Blue Economy's natural capital and ecosystems. For instance, small-scale, community based fishing activities may be affected by the Blue Economy, if these communities are included in the Blue Economy governance architecture. Moreover, the capture of wild fish is not expected to grow worldwide, reflecting the overfishing of stocks, thus hurting capture fisheries from around the globe. And aquaculture may be largely responsible for an increase in the capture of species such as shrimp, salmon, and anchovies, used to prepare fish meal for fish and seafood farms (Ababouch & Carolu, 2015; Knol-Kauffman, Nielsen, Sander, & Arbo, 2023).

4. The Brazilian Blue Economy

Brazil has close to 8.5 thousand kilometers long of coastline, 12% of all the world's fresh water in the world, and large river basins. Brazil is uniquely positioned to explore and benefit from the Blue Economy. Brazil is in a very unique position to explore the benefits of a vibrant, sustainable, inclusive, and equitable Blue Economy. The country has substantial natural capital assets that warrant the increasing importance of the Brazilian Blue Economy in Brazil's GDP growth and development. The Blue Economy offers a new cycle of virtuous and sustainable growth and development for the Brazilian economy. The Brazilian Blue Economy accounts for 19% of Brazil's GDP, highlighting its present and future importance in unleashing a new cycle of virtuous sustainable growth and development for the Brazilian Economy (Gouvea, 2000, 2015; Gouvea & Kassiech, 2010; Thompson & Muggah, 2015; ABEEolica, 2023; Scangarelli, 2023; Instituto

Oceanografico, 2023).

One of the challenges facing the Brazilian Blue economy is related to building a road map for the Brazilian Blue Economy. This road map would set the overall strategy, policies, incentives, and guidelines for the Blue Economy. In this process, it is important to identify Brazil's economic sectors directly related and linked to rivers, lakes, aquifers, and the Atlantic Ocean, as well as sectors that are indirectly connected to the Blue Economy, via backward and forward linkages. Thus, a Leontief input-output matrix could shed light on the economic multipliers of the main sectors and subsectors linked to Brazil's Blue Economy. Moreover, it will help to identify Brazil's competitive advantages in the global Blue Economy, as well sectors that must be prioritized to comply with the Blue Economy's main tenants of sustainability, inclusivity, and equitability. The creation of the Ocean Work Force (GT GDP) task force aiming to provide subsidies to Brazilian policy-makers to better evaluate the impact, main sectors, and the social, economic, and environmental impact of Brazil's Blue Economy is a fundamental step in establishing a sound and competitive Blue Economy (Castro, Braga, Pradelle, Chaves, & Chantre, 2023; Coelho & Menezes, 2023; Conab, 2022; Regazzi & Procopio, 2023; Scangarelli, 2023).

This approach will also help to identify the main supply valued-added chains, helping to identify the most profitable and competitive sectors, as well as sectors with the highest impact on job creation. It is important to make sure that the Brazilian Blue Economy follows a healthy business ecosystem, one in which not only large companies are present, but also Small and Medium Sized Enterprises (SMEs) are represented. In addition, the creation of a blue entrepreneurial mindset in Brazil will also foster the creation of Blue Startups and Blue entrepreneurs, an integral part of any Blue Economy's successful and sustainable experience (Junqueira, 2023; Klein, 2023; MCTIC, 2023; SENAICETIQT, 2021).

This Blue Mindset can be enhanced and fostered by partnerships between the Brazilian government, universities and technical schools, Brazil's and foreign private sector, as well as Brazil's civil society, including Brazilian NGOs. This functional and effective Blue Economy Quadruple Helix is essential to unlock a number of synergies between these stakeholders. For instance, Blue public-private partnerships are crucial to upgrade and revamp Brazil's Blue Economy infrastructure. For instance, Brazil' logistics infrastructure is not very modern or efficient, penalizing Brazil's private sector overall global competitiveness in global markets. For instance, the 2023 World Bank's Logistics Performance Index (LPI) ranks Brazil in 51st place, out of 139 countries. It is clear that Brazil must pay more attention to its ports, roads, highways, airports, and customs procedures in order to further advance its Blue Economy prospects. Brazil also lags behind other countries when comes to the "Ease of Doing Business" Index. Brazil was ranked in 124th place, out of 190 countries, further indicating that factors outside Brazil's Economy may have a detrimental impact on the competitiveness and effectiveness of Brazil's Blue Economy (World Bank, 2020, 2023; Ribeiro & Batista,

2023; Sochaczewski, 2023).

The Brazilian navy coined the term “Blue Amazon” to define Brazil’s jurisdiction over 5.7 million square kilometers in the South Atlantic Ocean. Brazil’s territorial waters, continental shelf, and its Exclusive Economic Zone (EEZ) are included in Brazil’s Blue Amazon, as well as rivers, lakes, and aquifers. Brazil is implementing the so-called Blue Amazon Management System that will survey Brazil’s coastline, by using satellites, radar systems, drones, submarines, and navy ships. In this region, lies 95% of Brazil’s petroleum reserves, 80% of its natural gas reserves, and 45% of all seafood produced in Brazil (Thompson & Muggah, 2015; Ribeiro & Batista, 2023; Sochaczewski, 2023).

During the Bolsonaro administration, Brazil created the Blue Economy Resources’ Commission (CIRM), covering 15 ministries to address the potential and challenges facing the Brazilian Blue Economy, in addition to establishing indicators and quantifiers to better measure the size and impact of the Blue Economy. This is a very important step for Brazil to start designing specific policies and actions to unleash the sustainable potential of Brazil’s Blue Economy. Brazil’s Blue Economy accounts for 19% of Brazil’s GDP. Brazil’s Blue Economy covers all the traditional and emerging sectors of the Blue Economy, such as:

- 1) Blue Economy Living Resources: Processing and distribution of seafood, aquaculture, bioeconomy, and biotechnology.
- 2) Blue Economy Non-Living Resources: Oil and gas, minerals.
- 3) Blue Economy Renewable Energy: Hydroelectric power, wave energy, offshore wind, kinetic energy from rivers.
- 4) Port Activities: Cargo and warehousing, logistics, submarine cables, robotics.
- 5) Shipbuilding and Repair: Transportation, mass tourism and ecotourism.
- 6) Desalination.
- 7) Rivers, lakes, aquifers, and ocean infrastructure.

In the Brazilian 5.7 million square kilometers Brazil’s Blue Amazon region lies most of Brazil’s gas and petroleum reserves, Brazil’s shipping and logistic industry, tourism, fisheries, mining, energy, aquatic sports, an important segment of Brazil’s Blue Creative Economy, and water and sewage treatment sectors.

Despite Brazil’s extensive ocean coast, the country only ranked 32nd in the world in wild fish production. China, Indonesia, and Peru are the world’s top three producers, with China accounting for close to 15% of the global production. Brazil produced close to 200 thousand tons of wild fish in 2022, a production well below the country’s potential. Brazil’s lack of a sophisticated fishing fleet, lack of expenditures on innovation and R&D, poor logistics infrastructure, lack of an effective management of Brazil’s fishing resources, poor governance, allied a lack of investments by Brazil’s private sector aggravates Brazil’s ability to increase its production of wild fish. In terms of living resources, the Brazilian aquaculture industry produced 860 thousand tons of fish in 2022. The Brazilian aquaculture industry has expanded by 48%, between 2014 and 2022, showcasing the increasing importance of the aquaculture industry in Brazil. Brazil’s is the

world's fourth largest producer of Tilapia. Aquaculture is also paying attention to native species, other than Tilapia. For instance, the Amazon region is an aquaculture emerging business frontier. Brazil produced 267 thousand tons of native fish species. The Amazon region accounts for 53% of Brazil's total aquaculture production of native fish, with a production of 143 thousand tons. Brazil is also expanding its production of algae, a major food product, and has extensive uses in the biotechnology and bioeconomy industries (Gandra, 2019; Conab, 2022, 2023; Sanchez, 2023).

Brazil is also actively pursuing its Blue bioeconomy. Brazil's Ministry of Science, Innovations, and Technology (MCTI) is developing a number of research and innovation networks around Brazil such as the "BiotecMar". This network will develop basic research related to biodiversity, genome, helping the Brazil's economy via transference of technologies and innovations that can be used to improve Brazil's seafood production, amongst other sectors (Reis & Messeder, 2023; SENAICETIQT, 2021).

Brazil's non-living resource Blue Economy is also a major sector of Brazil's economy. For instance, 98% of Brazil's petroleum production is offshore as well as 87% of Brazil's natural gas production. Brazil is also beginning to explore the potential Deep Sea Mining (DSM). The lack of technology, however, and specific legislation may delay Brazil's deep sea mining operations (Instituto Oceanografico, 2023).

Brazil's Blue Economy renewable energy potential is a very substantial one. Brazil has one of the world's cleanest electricity matrixes, with hydro power accounting for 56.8% of Brazil's total electricity generation. Offshore Wind Energy has increased its share of total wind energy production globally from 1% in 2010 to about 7% in 2022. China is the largest producer of offshore wind energy, with an estimated 31.4 GW production, followed by the U.K. with 13.9 GW production. Brazil has an estimated 700 MG potential for offshore wind production. Brazil, however, is still waiting for a legal framework to be approved by Brazil's congress in order to start the production of off-shore energy. It is expected that a number of domestic and multinational companies will be attracted to Brazil's offshore-wind energy industry (ABEEolica, 2023; Braga, Gouvea, & Gutierrez, 2023; Klein, 2023).

It is important to mention that 95% of Brazil's transportation sector is linked to Brazil's Blue Economy. In 2022, Brazil approved a new law aiming to create economic incentives to Brazil's merchant shipping industry. The "BR do Mar" program aims to expand Brazil's shipbuilding industry and improve Brazil's competitiveness in the freight and logistics global industry (National Secretariat of Ports and Waterway Transportation, 2023).

Brazil has a natural competitive advantage in the tourism industry. Its long seacoast and Brazil's Amazon region are competitive tourism destinations. Brazil has benefited from mass tourism and from ecotourism flows. The Brazilian Amazon region is a prime destination for sport fishing, bird watching, amongst other

ecotourism activities. Brazil's sea shore has been attracting tourists from all over the world. In 2022, Brazil received 3.6 million tourists (Gouvea, 2004; Gouvea, Kassicieh, & Figueira, 2009; Dino, 2023).

The Brazilian Blue Economy also calls for increasing expenditures on blue innovation and blue R&D. The Amazon region for instance would largely benefit from the creation of Water Innovation and Technology Centers, where research institutions, academics, private sector, government, and civil society would engage in advancing the knowledge about Brazil's Amazon region. The digitalization of this knowledge that would include traditional knowledge from Brazilian native communities and river side communities would enhance the capability of policy-makers to better define priorities and gaps, as well as assisting the private sector in directing resources to areas that could benefit from private investments, such as biotechnology and bioeconomics. The research and academic institutions have a substantial role to play in advancing the knowledge about a very important component of Brazil's Blue Economy, the Amazon region. In the state of Amazonas, research institutions such as INPA, FAPEAM, and universities such as the state university of the state of Amazonas—UEA, and the federal university of the state of Amazonas—UFAM, have played a very important and expand the knowledge about Brazil's Amazon region (Gouvea, 1998, 2012, 2015; Gouvea & Kassicieh, 2010; Gouvea & Montoya, 2014; Gouvea, Kassicieh, & Montoya, 2012).

Brazil's petroleum reserves amount to 12 billion barrels of petroleum, with the larger majority located in Brazil's offshore locations. Brazil's is currently producing close to 3 million barrels of petroleum per day, with a forecast of Brazil's reaching 5 million barrels per day by 2030, what would make Brazil one of the world's largest producer of petroleum and exporter (Coelho & Menezes, 2023).

The Fish and seafood farming is still in its infancy in Brazil. The world's largest producers are China, Peru, Japan, India, and the United States. Brazil is ranked 27th in the world. Brazil's Institute of Ocean and Fresh Water Research (INPOH) is another initiative from the Brazilian government to promote innovations and R&D related to Brazilian fresh water and ocean resources (MCTIC, 2023; Reis & Messeder, 2023; Sanchez, 2023; Goncalves, 2023).

The Economist Intelligence Unit publishes the Coastal Governance Index, offering another perspective on how countries around the globe are progressing in balancing coastal sustainability and Blue economic development and growth. The report pays heed to Brazil as well. The report ranks Brazil in 12th place, out of 20 countries when comes to its overall coastal governance index, placing Brazil behind the world's top ranked countries, such as Norway, the United States, and New Zealand. The index also ranks Brazil in 11th place when comes to policy and institutional capacity related to coastal management. When comes to the business environment for coastal activities, comprising indicators such as ease of doing business, corruption, quality of coastal infrastructure, and dispute resolution mechanisms, Brazil ranks in 13th place. Countries like Canada, Norway, New

Zealand, and the United States, offers a much more welcoming business environment for companies doing business in their Blue Economy. When comes to the quality of fresh water, Brazil ranked in 12th place, behind the leading countries, such as Canada. This dimension is very important since most of the Brazilian fresh water flows into the ocean contamination Brazil's sea coast natural capital and creating additional barriers for the sustainable growth and development of Brazil's Blue Economy. Brazil also ranks low on the policies related to protecting its shoreline. For instance, governance guides the tourism and real-estate industries and their environmental impact. Brazil ranked in 13th place, well behind the leading countries: New Zealand and Norway. Brazil also ranked low when comes to the coastal management of living resources such as fisheries and wildlife, ranking in 14th place. Brazil has been showing worsening signs of its ability to manage its fisheries in a sustainable fashion, enforcement, and stock. Brazil must upgrade the quality of its monitoring of and inspection of its fisheries. The U.S. and New Zealand ranked first and second, showcasing their strong policies towards the protection of their marine and coastal species. Brazil on the other hand places in fifth place, on the minerals, energy, and shipping dimension, showcasing Brazil's attention to issues such as monitoring and enforcement. Here the leading country is Norway, followed by China and Japan ([The Economist Intelligence Unit, 2019](#)).

It is important however to mentioned that Brazil's Blue Economy can only be fully developed and exploited if the Brazilian government, private sector, and overall society take firm steps to address a number of bottlenecks and gaps deeply affecting Brazil's economic, social, and environmental performance and competitiveness. The 2023 IMD's World Competitiveness Yearbook summarizes a number of challenges and opportunities facing Brazil's economy. In 2023, the report highlights a number of issues plaguing Brazil's economy such as the need to introduce a tax reform that will enhance Brazil's private sector global competitiveness, a new fiscal anchor that allows for the balance between increasing social and government spending with a responsible fiscal management, increase the quality of Brazil's educational system, and promote measures to induce the private sector to invest again in Brazil's key economic sectors. Moreover, Brazil must pay attention to its poor institutional framework, business legislation, and societal framework. In addition, Brazil lags in its productivity rates, a key ingredient in Brazil's attempt to increase its rates of sustainable economic growth and development. Brazil also lags behind other nations when comes to the quality of its infrastructure, technological infrastructure, scientific infrastructure, health and environment, and education. Brazil has also showed little progress in its digital readiness and competitiveness ([IMD, 2023](#); [Pacheco, 2023](#); [Sardinha, 2023](#)).

The World Economic Forum's Global Competitiveness Index also addresses a number of Brazil's economic, social, and environmental competitiveness challenges. The report ranks Brazil in 71st place, amongst 141 countries, a very low ranking for the 9th largest economy in the world. According to the World Eco-

conomic Forum survey, Brazil ranks very low in the quality of its institutions, low in the quality of its overall infrastructure, low in Brazil's ICT adoption, very low in macroeconomic stability, low in the quality of its health care sector, low in the overall quality and skills of Brazil's labor force, as well as low in the quality of Brazil's product market. The country ranks high in the size of its domestic market and not so poorly in the quality of its financial system. Brazil also shows a dynamic innovation capacity. In sum, Brazil must pay substantial attention to its economic, social, and environmental basic indicators in order to be able to fully exploit its natural blue economy competitive advantages vis-à-vis other nations.

5. Brazil's Blue Powershoring and Blue Watershoring

The Blue Economy has the economic, social, and environmental potential to accrue countries additional competitive advantages. In a sustainable, knowledge-intensive, and inclusive and equitable Blue Economy paradigm, nations can harness their natural capital assets to expand and upgrade their social, economic, and environmental competitiveness. This paper introduces two concepts and approaches related to the Blue Economy, such as: 1) Blue Powershoring, and 2) Blue Watershoring.

Blue Powershoring is related to a country's availability of renewable energy that is related to the Blue Economy, such as hydro power, Off-Shore Wind (OSW) energy, wave energy, and tidal energy amongst other types of Blue energy. These countries can be categorized as renewable energy-intensive economies. Blue Watershoring is related to a country's availability of freshwater reserves, another major pillar of the global Blue Economy. These countries can be categorized as fresh water-intensive economies. Economic activities from agriculture, green hydrogen production, to knowledge-intensive manufacturing, are fresh-water intensive and renewable-energy intensive activities. Thus, companies seeking to design and acquire additional competitive advantages in an ESG environment, will increasingly gravitate towards countries that will allow them to fully exploit these advantages, i.e. they will increasingly relocate and be attracted to countries that are renewable-energy intensive and fresh water-intensive. In other words, countries that showcase Blue Powershoring and Blue Watershoring competitive advantages.

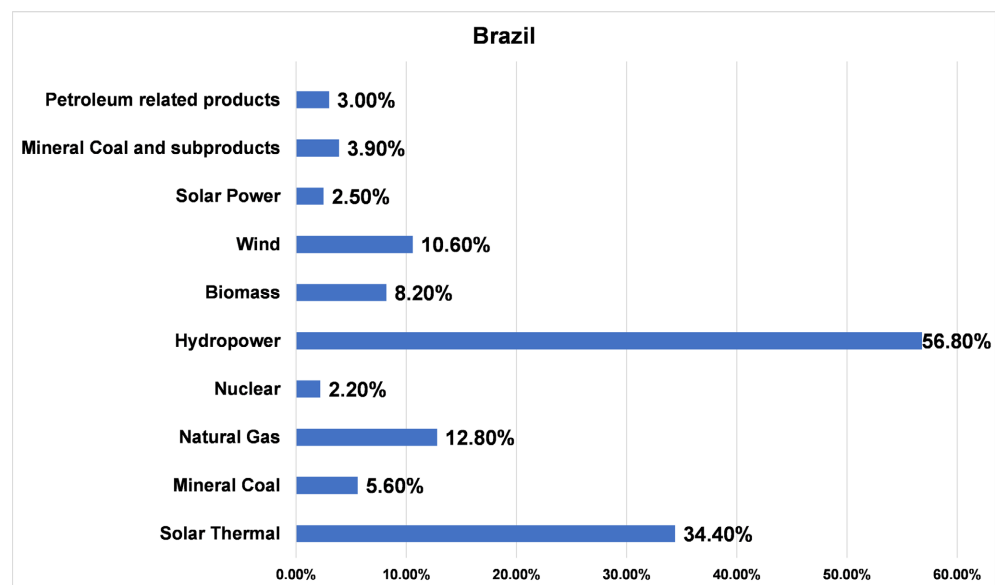
Thus, countries like Brazil that have a clear natural competitive advantage in both fresh-water intensive industries and in renewable energy-intensive industries and economic activities. Thus, Brazil qualifies as having a Blue Powershoring competitive advantage, as well as a Blue Watershoring competitive advantage. Thus, in a factor-endowment approach, Brazil has a competitive advantage in the global Blue Economy by being able to specialize in renewable-energy intensive economic activities as well as in water-intensive economic activities. Thus, allowing companies established in Brazil to benefit from specializing in fresh-water intensive activities as well as specializing in a renewable-energy in-

tensive activity.

Blue Powershoring: Blue energy sources are related to hydropower, wave power, tidal energy, and offshore wind energy, among others related renewable sources of energy. Countries that are blue renewable energy-intensive, such as Brazil tends to benefit companies pursuing sustainable production processes, where their environmentally sustainable goals can be achieved more efficiently and more cost effective. Brazil has one of the most sustainable energy and electricity matrixes in the world, making Brazil a renewable-energy intensive country, and a potential major destination for companies transitioning from the Brown to the Blue Economy, seeking for sustainable strategies to remain competitive, and acquire additional competitive advantages in global market that is increasingly demanding that companies pursue a sustainable strategy and contribute to the global sustainable effort.

Brazil has an electricity matrix that is much more sustainable than many countries around the globe. **Figure 1** showcases Brazil's electricity matrix. The world's electricity matrix relies heavily on non-renewable sources of energy, such as natural gas for close to 24% of its electricity generation output, and mineral coal for close to 35% of its electricity generation output. Thus, close to two-thirds of the global electricity matrix is fossil-fuel intensive. This energy matrix "browns" the agriculture, manufacturing, and service industries of the large majority of countries around the globe, making their production and exports less competitive in a green-led and in blue-led global economy (IRENA, 2020, 2022, 2023).

The Brazilian energy matrix, on the other hand, depends more heavily on renewable sources of energy. For instance, hydropower accounts for 56.8% of Brazil's



Source: Elaborated by the authors from data obtained from *Empresa de Pesquisa Energetica* (2023), <https://www.epe.gov.br/pt>.

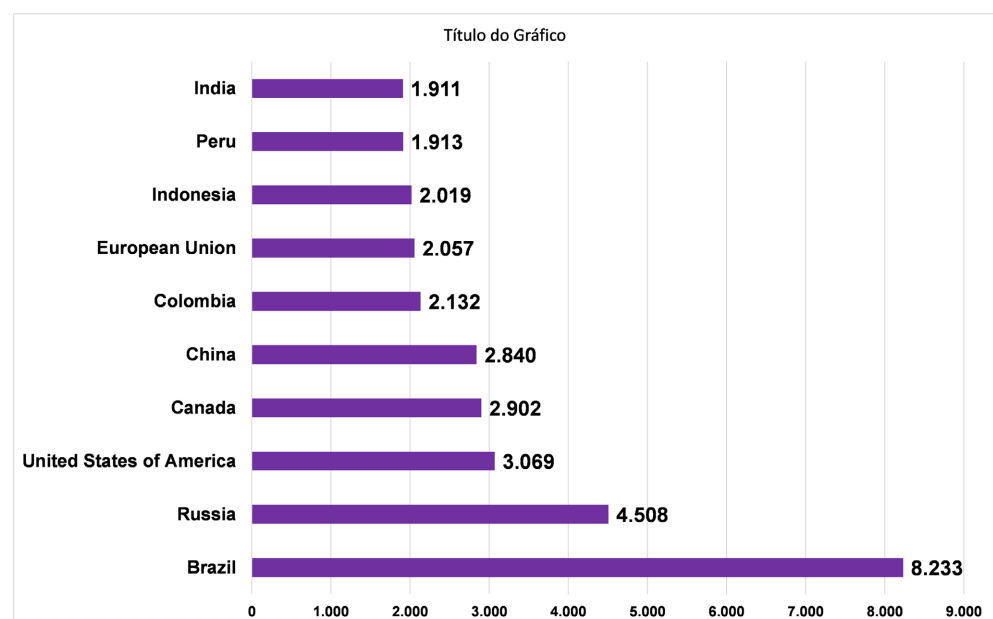
Figure 1. Brazil's energy matrix.

electricity output, solar thermal for 34.4%, wind energy for 10.6%, and biomass for 8.2%. Thus, Brazil has effectively a Blue Powershoring natural competitive advantage when compared to a number of countries from around the world.

Thus, companies pursuing net zero sustainability targets will find Brazil to be a very competitive location. Companies established in Brazil or relocating to Brazil will be able to gain additional competitive advantages in a sustainable-led-global markets vis-à-vis other companies established in “brown” economies.

Blue Watershoring: Brazil is a fresh water-resource-intensive country. Brazil is the world’s leader when comes to freshwater resources. The United Nations’ Environment Programme lists Brazil as the leading country in the world, with an estimated 8.2 cubic kilometers of freshwater resources, followed by Russia with half of Brazil’s resources, close to 4.5 cubic kilometers, and the United States in third place with 3.0 cubic kilometers of freshwater resources. **Figure 2** illustrates the top ten countries in the world with the largest freshwater resources. Thus, Brazil has clearly a fresh water competitive advantage vis-à-vis other countries when comes to water-intensive agriculture, industries, and water-intensive service sectors.

Water is life, and it is a vital component of a country’s society and economy. The modern global society and economy are water-intensive. It is estimated that one-quarter of the world’s population is currently facing water stress, affecting their agriculture, manufacturing and service industries. Countries like India, Mexico, Egypt and Turkey are very vulnerable to experience high levels of water stress. Moreover, in a number of countries, water pollution is also a major issue, hindering the use of their water resources by their agriculture, manufacturing, and services industries (Kuzma, Saccoccia, & Cherlock, 2023).



Source: Elaborated by the authors from data obtained from JagranJosh (2022).

Figure 2. Freshwater resources—top 10 countries.

In Brazil, 58% of all the fresh usage goes to Brazil's agricultural sector, urban centers are responsible for 26%, followed by Brazil's industry and energy generation uses with 16% (Sardinha, 2023).

It is clear from the earlier discussion that the Blue Economy is also made of rivers, lakes, and aquifers. These freshwater resources represent a very important dimension of the Blue Economy. These ecosystems are well interconnected, on a local, regional, and global basis. The health of rivers, lakes, and aquifers has a great impact on the health of oceans around the planet. For instance, close to 80% of oceans pollution comes from land and rivers. It is also important to note that more than 80% of ocean pollution is plastic and microplastic related. Thus, a holistic approach must be designed and implemented in order to warrant the sustainability and regeneration capability of Brazil's Blue Economy. Moreover, close to 49.2% of residual water, i.e. non-treated water is tossed in Brazil's rivers and lakes adding pollutants to Brazil's rivers lakes, and sea-coast, deeply affecting marine ecosystems and economic activities dependent on these ecosystems. Thus, it is important that Brazil pays heed to the four dimensions of water resources, such as safety, quality, security, and availability. Brazil must add more innovation and technology to safeguard its freshwater resources. For instance, the use of biological and chemical sensors in Brazil's lakes and rivers would allow Brazil to establish a network of monitoring systems, creating an early warning system to better manage Brazil's freshwater resources (Gouvea, 2015; Sardinha, 2023).

6. The Nexus Green Hydrogen & the Blue Economy

The hydrogen economy holds the promise to create another cycle of a virtuous global sustainable development and growth. It is projected that by 2050, the global hydrogen economy will be generating US\$ 2.5 trillion in revenues, accounting for 20% of the global energy supply. In Brazil, close to US\$ 27 billion o investments have been announced to invest in Brazil's green energy economy. The expectation is that by 2025, Brazil will be producing 16 million tons of green hydrogen and 2.8 million tons of green ammonia, mostly allocated towards exports (Deloitte, 2023; IEA, 2023; Hydrogen Council, 2023).

Green hydrogen is an important component of the global effort to achieve net zero emissions by 2050. Green hydrogen has a number of applications. For instance, green hydrogen can be used in the transportation industry, aviation, maritime transportation, chemical and petrochemical industry, iron and steel industry, aluminum, cement industry, and decarbonization of the natural gas industry (Castro, Braga, Pradelle, Chaves, & Chantre, 2023).

A hydrogen economy as an energy carrier and as a replacement for fossil fuels may be able to open the door for hydrogen to be used in transportation, heat for manufacturing, on indoor heating applications, and other uses. For instance, hydrogen could be used to replace fossil-fuel internal combustion engines with hydrogen-based fuel cell trucks, ships, and automobiles. Hydrogen could also be

used to substitute natural gas in heating applications, in a blended format with natural gas. Hydrogen has the advantage when comes to emissions, since it does with zero emissions of harmful air pollutants (Offutt, 2023; Pacheco, 2023).

Moreover, green hydrogen, or carbon-free hydrogen, must be produced by using renewable sources of electricity in order to power the electrolyzer. Nowadays, only 3% of all the global production of hydrogen can be classified as green hydrogen (Deloitte, 2023; Offutt, 2023; Fekete & Imogen Outlaw, 2023).

Green hydrogen production, however, is a renewable energy-intensive and water-intensive process. The splitting water molecules process using energy from a renewable energy source, such as hydropower or off-shore wind, is an expensive process. The cost of renewable energy has been dropping steadily for the last decade, however, there is an increasing shortage of fresh water globally. The whole green hydrogen production process is very water-intensive. For instance, each MWh uses five thousand liters of water, when compared to only 20 liters of MWh from solar generation. Thus, only water-intensive and renewable energy-intensive regions, or countries like Brazil, will be able to cost-effectively manufacture green hydrogen. Again, our assumption that Blue Powershoring and Blue Watershoring will become increasingly more important to companies' foreign direct investment decisions and strategies, seems to hold for the Brazilian economy, making Brazil an appealing site for companies seeking to use green hydrogen to address their overall net zero sustainability targets and strategies (Beswick, Oliveira, & Yan, 2021; DiFelice & Vargas, 2022; Braga, Gouvea, & Gutierrez, 2023; Talman, 2023).

The establishment of an efficient and cost effective green hydrogen industry in Brazil would create a virtuous cycle of green sustainable development and growth. Brazil would be able to green its economy by creating a green hydrogen-intensive manufacturing, mining, agricultural, and service industries. Moreover, Brazil could become a major exporter of green hydrogen-intensive commodities, products and services, as well as green hydrogen itself. For instance, in 2023, the Australian company Fortescue has announced investments of US\$ 5 billion to produce green hydrogen in Brazil's state of Ceara (Agencia Brasil, 2023).

In addition, Brazil could become a very attractive site for foreign direct investments, with firms seeking to relocate their manufacturing to a green hydrogen intensive economy. It is important to mention that close to 70% of green hydrogen's production cost is related to the cost of renewable energy. Brazil's Export Processing Zones are already receiving foreign direct investments towards the production of green hydrogen aiming at the foreign market. Brazil's Export Processing Zones legislation allows for foreign companies to bring their hydrogen manufacturing plants exempted of import taxes, making the production of green hydrogen in Brazil, a cost effective and a competitive proposition. Moreover, Brazil can expect a number of firms to set up producing companies in Brazil to take advantage of Brazil's Blue Powershoring and Watershoring competitive advantages in order to comply with their net zero emissions strategies

and ESGs goals and objectives. For instance, Brazil is a prime candidate for the production of Green steel, among other green and blue agricultural, manufacturing, and service products (Braga, Gouvea, & Gutierrez, 2023).

Brazil could also produce green hydrogen close to Brazil's major 201 hydropower power plants, such as Itaipu with a generation capacity of 14,000 MW, Belo Monte with a 11,233 MW generation capacity, Tucuruí hydropower plant with a generation capacity of 8370 MW, and Paulo Afonso with a 4279 MW capacity, among others Brazilian hydropower plants. These hydropower plants established in many regions of Brazil could become major producers of green hydrogen, creating a number of green hydrogen clusters and hubs around Brazil, supplying Brazil's agriculture, mining industry, manufacturing, and service industries, in addition to foreign markets (Ministerio de Minas e Energia, 2023).

In 2023, 93% of Brazil's electricity matrixes were relying on renewable sources of electricity, such as hydropower, sun power, and wind power. Brazil has one of the world's most resilient, reliable, and diversified renewable electricity matrixes. Making Brazil a major player amongst the world's Green Hydrogen Producing and Exporting Countries (HGPCs).

7. Final Remarks

The Sustainable Blue Economy may be defined as providing intergenerational economic, social, and environmental benefits, as well as preserving, protecting, and restoring rivers, lakes, aquifers, ocean ecosystems and natural capital. Blue Economy sectors and industries are characterized as relying on renewable forms of energy, relying on circular production and consumption economic and business models, and relying on local, regional, and global cross-collaboration. Moreover, the global Blue Economy offers the potential to increase climate resilience and foster carbon sequestration.

The equitable, inclusive, sustainable Blue economic growth and development is the new paradigm of a global virtuous cycle of social, economic, and environmental Blue growth prosperity. The blue growth long-term sustainability relies on a paradigm shift away from "business-as-usual" approach to harnessing the environment. For instance, one of the pillars of the Blue Economy is its stress on the Circular Economy approach to production and consumption.

Along these lines, there is an increased need to digitalize and gather data related to the Blue Economy's natural capital inventory, as well as gathering data on the economic, social, and environmental impacts created by the Blue Economy economic sectors and industries. Issues such as rivers, lakes, aquifers, marine protection, waste management, plastic pollution, overexploitation of natural fish and seafood stocks, fisheries growth and development, seabed mining, oil and gas exploration, blue financing, infrastructure, blue innovation and blue R&D, are some of the crucial issues permeating the global Blue Economy.

The future of the Blue Economy is also related to the increasing participation and interaction of the Blue Economy's key stakeholders: 1) governments, 2) pri-

vate sector, 3) academic and research sectors, and 4) civil society, including NGOs. An effective, shared, and dynamic governance must be established in order to better manage and understand the complexities of the Blue Economy in all its forms.

This paper addressed the Brazilian Blue Economy, from Blue Powershoring and Blue Watershoring perspectives. Brazil has a competitive advantage when comes to the Blue Economy. Brazil's vast freshwater resources coupled with a long sea cost, and its blue electricity matrix offered Brazil the possibility of developing a number of Blue Economy economic sectors, from fishing and offshore wind energy production to blue biotechnology. However, in order for Brazil to fully exploit the potential of its Blue Economy, it must pay attention to the fundamental bottlenecks permeating its economy, social, and environmental dimensions. Moreover, it is clear that Brazil's Blue Economy is a mix of successes and missed opportunities. Some sectors are still underdeveloped, limiting the Brazilian Blue Economy's potential social and economic impacts. Still, it also showcases and indicates the enormous potential of Brazil's Blue Economy emerging business frontier.

Very few countries have the Blue Powershoring and Blue Watershoring potential of Brazil. The Blue Economy offers Brazil a new cycle of virtuous growth and development. Brazil's Blue Powershoring and Blue Watershoring and its reflection on Brazil's Green Hydrogen production and utilization in the Brazilian economy, as well as its export potential, further extend the potential benefits that Brazil may accrue from the Blue Economy's new paradigm of sustainable economic growth and development.

Brazil is poised and well-positioned to become the world's premier green hydrogen producer and exporter. Brazil's Blue Powershoring and Blue Watershoring competitive advantages are fostering the establishment and expansion of a green hydrogen-led economy in Brazil. Companies seeking corporate net zero sustainability targets will find the Brazilian economy to be an appealing location proposition. The green hydrogen new global cycle of virtuous economic growth and development will also offer Brazilian companies, from the agriculture sector, manufacturing, and service sectors, additional competitive advantages in a green-blue global economy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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