CONGRESSO NACIONAL DE EXCELÊNCIA EM GESTÃO & INOVARSE
ISSN 1984-9354
Rio de Janeiro, Brasil, 23, 24 e 25 de novembro 2023

XVII CNEG _ Congresso Nacional de Excelência em Gestão / INOVARSE _ Simpósio de Inovação e Responsabilidade Social
&
ESD _ Economic and Social Development Conference

ENERGY TRANSITION AT PORTS: A COMPARISON BETWEEN AÇU (BRA) AND ANTWERP-BRUGES (BEL)

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ABSTRACT: *Renewable energy sources are frequently deemed the foremost and better choice to mitigate the climate change issue. Although transitioning away from the existing energy system in the port industry and transportation networks is of utmost significance, as they represent great consumers of energy and generators of emissions, the green port rhetoric is not always aligned with actions being taken by port authorities. At the core of this concern, ports have been expected to prioritize designing a sustainable strategy for energy transition, while investing in the development of technologies and innovative solutions for more efficient logistics, infrastructure, and operations. The purpose of this paper is to analyze the issue of energy transition from the perspective of a contrasting assessment between two major ports in the international context (i.e. Port of Açu in Brazil, and Port of Antwerp-Bruges in Belgium) using their latest sustainability reports. The results found an overall consonance between the narrative from port authorities and their publications and delved into their considerations surrounding sustainability and green alleviation initiatives. Further research on the role of policies and legislation as well as thorough financial planning is recommended.*

Keywords*: Energy Transition, Energy, Port, Sustainability, Green Port.*

1. Introduction

Energy poverty may be described as the lack of either availability or access to safe, dependable, affordable, appropriate, good-quality, and environmentally friendly energy services to aid both human and economic development (Goldemberg et al., 2000). By 2019, nearly 90% of the global population was estimated to have some form of access to electricity, however limited or costly (Lee et al., 2020). Yet at that same point in time, a third of the world's population still used inefficient, unclean, and unsafe cooking systems (The World Bank, 2021).

It is more challenging for underprivileged populations to amass the primary capital needed to invest in more energy-efficient, economical renewable sources of energy and appliances, as they usually pay more for daily energy needs (Reddy et al., 2000). Economically, smaller-scale renewable energy solutions are becoming more appealing, potentially very positive news for the world in general and emerging countries in particular, these energy trends provide swift scalability and adaptability to address expanding energy demands (Bhattacharya et al., 2016). There exists a plethora of activities aimed at financing and investment in promoting access to modern energy services, and these can serve as sources for funding energy access and interventions to help formulate future actions. (Bazilian et al., 2012).

Income inequality fosters power disparities, which play a critical part in the determination of environmentally-related policies, thus the promotion of renewable energy consumption is an imperative goal of climate policy (Awaworyi Churchill et al., 2021). The trade-offs between meeting renewable energy targets and relieving energy poverty must be taken into account, especially when strategizing and legislating in favor of ending energy poverty and its implications (Arndt et al., 2019). That is why policy makers should also ponder on establishing policies that account for reducing social inequality as well as emissions stemming from energy use, which would safeguard the groups of people who are geographically and financially most vulnerable to the perils of energy poverty while simultaneously encouraging the use of renewable energy sources (McGee & Greiner, 2019)

Although legislations may pose barriers for decarbonization efforts, the availability of space in the port area, and the accessibility of investment and human capitals are also key factos that port authorities need to plan out for energy transition towards climate neutrality on vessels as well as port area, as they are recognized as operators, landlords, regulators and community managers (Hendriks & Gooyert, 2023). Moreover, on port sustainability, Armani Aguiar at al. (2023) explore the issue of ecoefficiency concluding that the main determining variables on economic, social and environmental issues are centered around pollution, regional development and operational costs, respectively.

Port authorities face a growing demand for energy-efficient transportation systems, port operations and equipment, in line with increasing legislation promoting alternative sources of energy (Oloruntobi et al., 2023). For green port development, key factors are the monitoring of emissions and energy consumption, besides investiments on port logistics information system, and technology innovation towards energy conservation and environmental protection. Nevertheless, the importance

of the practical aspects of green port concepts via training and promotional activities should not be ignored, as a means to ensure its concept does not fall under a mere formality (Hua et al., 2020).

From a world perspective, it is a time of immense challenges to sustainable development, while it is also a time of immense opportunity. Building on the 2000's Millennium Development Goals, the 2030 Agenda for Sustainable Development came into effect on 1 January 2016, seeking to achieve what the MDG's did not, proposing 17 Sustainable Development Goals with 169 associated targets which are integrated and indivisible, via which the United Nations collectively commit to the pursuit of global development (United Nations, 2015). Within the 2030 Agenda for Sustainable Development, Goal 7 states "Ensure access to affordable, reliable, sustainable and modern energy for all".

It is made clear that energy transitions offer solutions to certain sustainability-related world problems, extending to efforts linked to climate change, as well as the achievement of environmentally-friendly development (particularly associated with the Sustainable Development Goal 7) by reducing pollution to air and water, besides land contamination (United Nations, 2021).

Located in the municipality of São João da Barra in the northern region of Rio de Janeiro state, Brazil, and sanctioned by the municipal law 035/06, extending for 130 square kilometers in area and comprising 10 world-class private terminals, Port of Açu is a result of 20 billion Brazilian reais in investments and is currently managed with a partnership with the Belgian Port of Antwerp-Bruges and is a privately owned logistics and industrial complex where 20 businesses operate (Hora et al., 2021).

Given its sheer size and degree of operations (over 57 megatons of cargo moved in 2022), and despite being a fairly new seaport in operations since 2014, it is responsible for nearly 30% of the oil exports in the country. Port of Açu has been aware of its increasing energy consumption demands from both port operations and the enterprises located therein, local energy supply instabilities, Port of Açu has been strategically investing in alternative sources of power to hydroelectricity in two main fronts: First, by building the largest gas-powered thermoelectricity generating plant in Latin America, expected to generate 3 gigawatts of power, and secondly by investing on the development of solar and wind power supply structure as a greener source of power expected to generate 2.4 gigawatts (Porto do Açu, 2021). Regarding its ecological impact in the region, incumbents at Port of Açu want to integrate social and environmental projects towards the preservation of regional flora and fauna by keeping an area of 40 square kilometers as the green belt Caruara environmental protection area, which is the largest private reserve of restinga ecosystem in Brazil. (Porto do Açu, 2020). Moreover, efforts in favor of relieving the effects of climate change are in place, through the restoration and protection of both shoreline and maritime ecosystems, besides extensive investments in Research and Development work on biodiversity conservation (Porto do Açu, 2021).

The partnership between the Port of Açu and the Port of Antwerp-Bruges, has aggregated the European experience on innovation commitment towards circular economy and energy transition, as the Port of Antwerp-Bruges is striving to limit its impact on the climate, planning to become Europe's leading import hub for green hydrogen and be climate neutral by 2050. Such partnership promotes the exchange of expertise and the placing of Port of Açu as a pioneer in better energy practices in Latin America (Porto do Açu, 2020).

As nearly 85% of products traded worldwide are transported by ship, maritime transportation plays a major role in the global supply chain modality, whilst still being heavily reliant on fossil fuels (Eades & Pepper, 2019).

At the crossroads of innovation, technology, and economics studies lies the issue of shifts in energy systems which has been broadly researched in the field of energy transition, and has never before been more relevant to the maritime transportation industry (Schot et al., 2016). Given the global tendency towards sustainability in seaports, this research is duly justified as Port of Açu is the largest (in area) seaport in Latin America and carries relevance both nationally and internationally.

Be it due to environmental awareness, social pressures, or investment attractivity, ports worldwide have started the structuring and execution for the transition towards more sustainable energy. Following on these lines, the objective of this study is to investigate the question of energy transition in the context of a comparison between Port of Açu (in Brazil) and Port of Artwerp-Bruges (in Belgium), where the latest sustainability reports from both entities are contrasted in regards to planning, feasibility, and alignment, via the application of a text processor software, and later a breakdown analysis of the results.

2. Methodology

The variables used in this research are the most recent and available sustainability reports from both Port of Açu and Port of Antwerp-Bruges. Such documents report on the operational as well as the economic-financial performance of said ports, while also giving an overview of the businesses' ethics, corporate governance, strategic management performance, safety and security, infrastructure and digitalization. Within the same reports, those points are pondered against topics of sustainability relevance such as environmental and climate change management, conservation of biodiversity, the businesses' commitment to shareholders, environmental externalities, and relationship with communities.

The references for this research were the latest available sustainability reports for Port of Antwerp-Bruges and Port of Açu (Port of Açu, 2021; Port of Antwerp-Bruges, 2019).

In order to assess the similarity between reports, the text processor software WORDij was used. It is a suite of data science programs capable of automating many aspects of natural language processing from a set of unstructured texts. Also, by using an "include list", the opposite of "drop list", one can analyze networks among the included words. The program computes the similarity of pairs of networks from different sets of texts using Quadratic Assignment Procedures (QAP) that produce a correlation coefficient for the comparison of whole networks (Danowski, 2013). The output from WORDij is then processed in Gephi, which is an open-source software for graph and network analysis, that uses a 3D render engine to display large networks in real-time and to speed up the exploration. Gephi generates a pajek-style graph for analysis and visualization of large networks having numerous vertices and varying sizes of nodes (Bastian et al., 2009).

Two separate analyses were performed. First using the full text available, in its entirety, where the frequency of appearance of word or pair was set to no less than 6 times, besides the

application of a standard drop list file provided by software default. The second analysis used a list file of word thesauri of terms related to energy transition.

Every single analysis used the setting Porter Stemming Algorithm, which reduces the variations of words to their syntaxis stems.

The parameters for the analyses are (1) Node size: represented by a circle, which denotes the word frequency; (2) Edge thickness: represented by a link between nodes, which displays how all nodes are related or connected; and (3) Modularity: measures the strength of the network graph's division into clusters.

3. Results

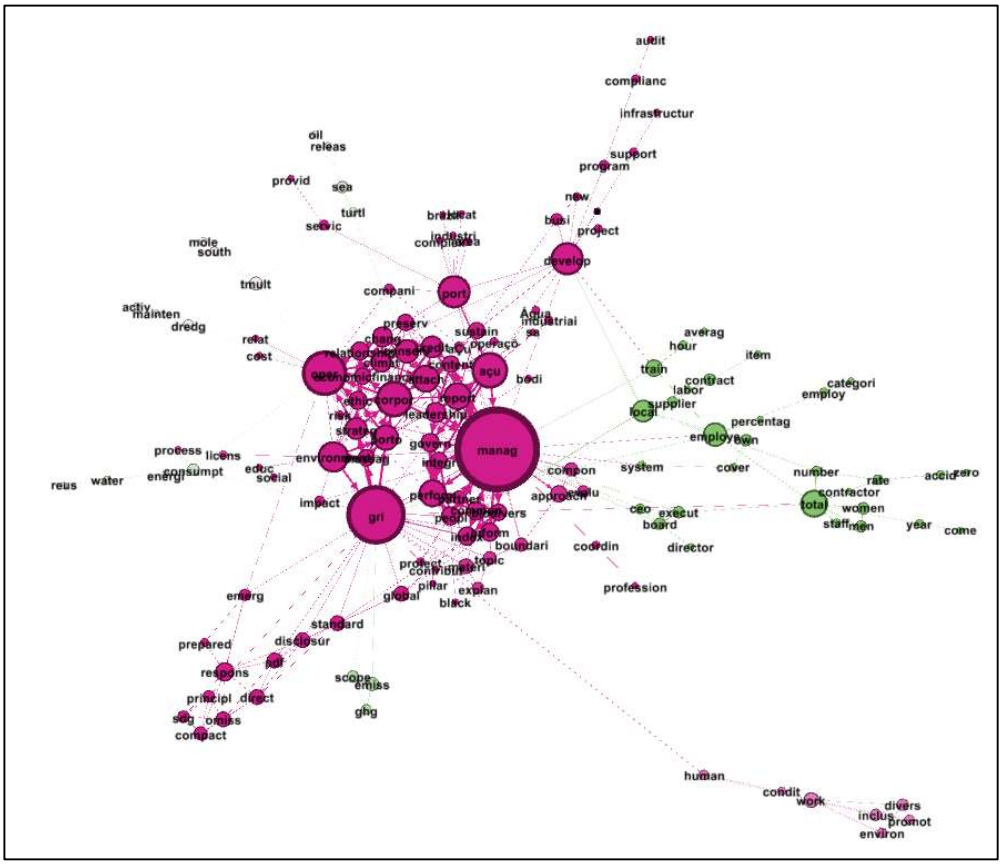
Figure 1 presents the analysis from the full text of the sustainability report of Port of Açu in 2021.

Based on the frequency of appearance, represented in the graph by the nodes from large to small, the ten most frequent word stems were: 1) Manag, 2) GRI (Global Reporting Initiative), 3) Oper, 4) Açu, 5) Perform, 6) Corpor, 7) Port, 8) Total, 9) Environment, 10) Commun. Keywords related to energy transition rank between the 20th and 30th places, while the word energy itself ranks at 66th place. Only rarely did the word transition appear in this report.

The most prominent node manag is strongly related to report, açu, corporate, integration, diversity, performance, partnership and people. Its connections to environment, preservation and impact are only slight. GRI, however, is strongly linked to port, environment and strategy.

On modularity, the cluster of scope/emission/GHG (greenhouse gas) is only related to GRI, while the micro cluster of energy/consumption/water/reuse is connected to both the macro nodes operation and GRI.

Figure 1 - Full Analysis: Port of Açu 2021.



Source: Own elaboration.

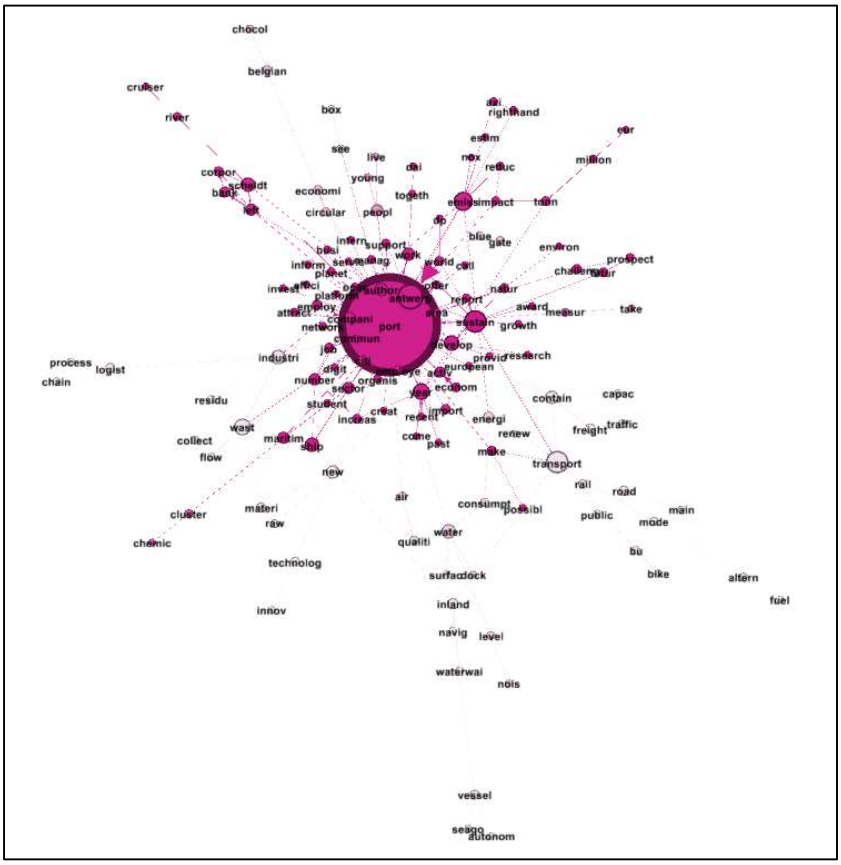
Figure 2 shows the analysis from the full text of the sustainability report of Port of Antwerp-Bruges 2019.

The ten most frequent word stems were, in terms of appearance throughout the report: 1) Port, 2) Antwerp, 3) Sustain, 4) Ship, 5) Transport, 6) Year, 7) Compan, 8) Work, 9) Author, and 10) Develop. The word emissions, water, and waste raked at the 11th, 14th, and 18th positions, respectively, whilst energy ranked at the 66th. The word transition itself ranked at 125.

As Port is the one node that distinctively surpasses all others, it is related to the most words in the report. Markedly, the strongest connections were to Antwerp, world, work, sustain, year, authority, and company.

On the modularity aspect of the analysis, a cluster of modes of transportation and fuels is directly related to sustainability, which is then connected to the main node.

Figure 2 - Full Analysis: Port of Antwerp-Bruges 2019.



Source: Own elaboration.

Figure 3 displays the duality of energy transition thesauri analysis against the sustainability reports of both Port of Açu 2021(left) and Port of Antwerp-Bruges 2019 (right).

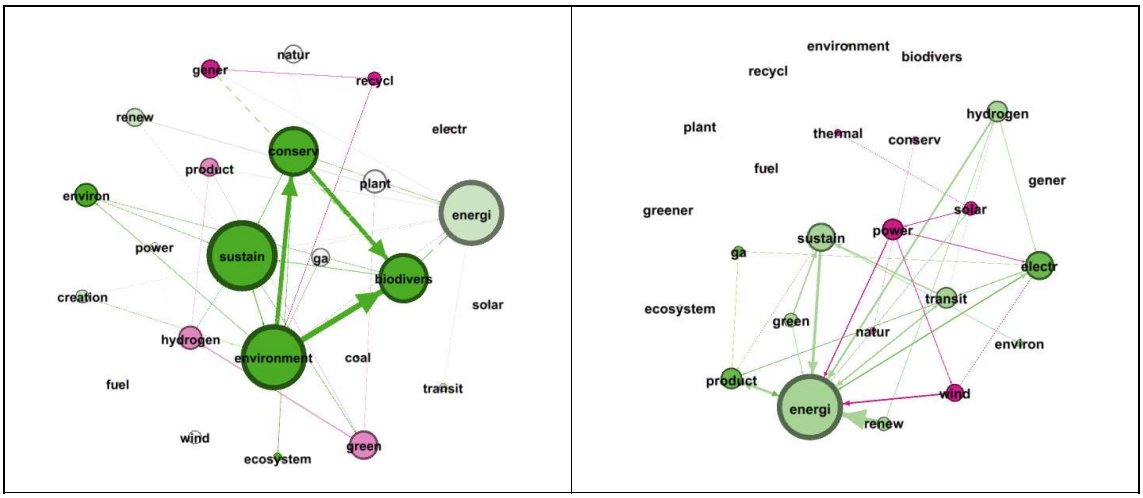
The visualization of such graphs is more straightforward as the analyses are established in contrast to a defined set of words.

The graph to the left evidences Port of Açu's clear focus on sustainability related to the conservation of biodiversity and the environment, and their connections are noticeably marked. The energy node is prominent, yet it is only slightly linked to the node transition, and it is weakly or not at all linked to terms such as green, hydrogen, coal, or wind. Action words like reclycle, generate, creation and plant are present and linked to the main nodes.

The graph to the right demonstrates Port of Antwerp-Bruges' obvious emphasis on energy. This main node is most strongly associated with the terms renewable, sustainability, electricity, production, hydrogen, wind and power. Words related to biodiversity, ecosystem, recycling and conservation do appear, but with either weak or no link to the main nodes.

On the modularity aspect of the analyses, Açu's report shows secondary clusters on generation/recycling/production/hydrogen/green, and also nature/power/wind/plant. Meanwhile, Antwerp-Bruges' report presents a secondary cluster on power/wind/solar/nature/conservation/thermal/fuel/biodiversity.

Figure 3 - Energy Transition Thesauri Analysis: Port of Açu 2021(left) and Port of Antwerp-Bruges 2019 (right).



Source: Own elaboration.

4. Conclusion

The objective of this research was to use the sustainability reports from the Port of Açu (in Brazil) and the Port of Artwerp-Bruges (in Belgium) and explore the issue of energy transition from the perspective of a contrasting assessment between both entities. The results of this research were found to successfully bring insight into the practicality and alignment aspects of the energy transition issue, however, it was not adequately sufficient to touch on the planning portions of the reports, as they are more focused on what is being done, rather than what could be.

The results found were consonant with the overall narrative of the port authorities and their publications. The main nodes on the graphs are concurrent with the topics most strongly regarded by both ports in their concerns around green alleviation initiatives and solutions.

As a comparatively young entity, Port of Açu's focus revolves mostly around the conservation of native fauna and flora, as well as the communities affected by the port installation and operations. The emphasis on the preservation of the biome is backed by their investments in maintaining the Caruara reserve, along with environmentally-sound awareness programs for all levels of stakeholders. However, performance and corporate results are markedly relevant, as this port still needs to justify its business, attract new investors and seek out further capital for future investments. Port of Açu's endeavors towards investing in greener operations and progressively

switching to low-carbon energy sources are strong and ongoing. This too is an investment-oriented strategy directed at energy transition.

Conversely, dating back to the 12th century, the Port of Antwerp-Bruges has been long recognized. The results speak to how its impacts on the landscape, society, and logistics are well integrated. The more recent topic of green port initiative and energy transition does transpire on its reports when sustainability is posed as one of the most prominent issues to the entity. At this point, the role of port authority confronts how work performance relates to sustainability, where digitalization and automation are also mentioned to help improve port productivity and support fleets' energy transition.

Despite the term energy transition itself not ranking very high, the reports point to the actions already being put in place in the direction of shifting to cleaner energy sources, with the establishment of its green energy hub which already produces much of the renewable energy locally with solar panels and wind farms at land and sea, besides the green energy in use at the port from locally-generated hydrogen. It is important to mention that this know-how is designed to be transferred to Port of Açu in due time, although legislations in each country are at dissimilar levels of alignment and commitment to the global agenda concerning climate change and the environment.

The results found by this research are in line with considerations from Oloruntobi et al. (2023) on their considerations on the relevance of the integration of information and communication technology to moderate the requirements for energy efficiency in transportation systems, where the implementation of lower energy systems benefit future maritime services. Platias and Spyrou (2023) highlight that mainstreaming ecological goals and sustainability in port operations do affect strategic choices when it comes to energy-related projects eligible for funding, which is corroborated by the findings from this research especially concerning the Port of Antwerp-Bruges. Topics regarding ports as significant energy users and polluters and their part in environmental degradation that led to the concepts of green port, energy conservation, and transition were found in agreement to the discoveries from Hua et al. (2020) on green port policies and the establishment of an effective methodology system.

Although the role of policies and legislations concerning environmental preservation, and governmental financial aid are of central importance, this could not be explored further based on the analyses of the results achieved by this research as this theme was not directly implicated in the reports from either port studied. Further research on this topic is recommended, as these are means to enhance technology innovation and strengthen the development of digitalization, infrastructure, logistics, and operations; all of which are fundamental when considering the mitigation of the impacts caused by energy consumption and pollution emissions, turning the issue of energy transition in ports all the more justified and pressing. It is suggested that financial reports of these same ports be also taken into account in such future research as they might provide supplementary information onto the planning portion that this present research was unable to accomplish with solely the environmentally-focused reports.

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