How Should Asian Ports Approach to Build the Supply Chain for New Energy: A Comparison to European Ports

Keigo OKANO [a], Yumei MINAMI [b], Tadasuke ISOYAMA [c], Tomoya FUJIKAWA [d], Jun KIMATA [e], Masaki MIMURA [f], Mikio TAKEBAYASHI [g]

[a,b,c,d,e] *Chuo Fukken Consultants Co., Ltd., Osaka, 533-0033, Japan*
[a] *E-mail: okano_k@cfk.co.jp*
[b] *E-mail: minami_y@cfk.co.jp*
[c] *E-mail: isoyama_t@cfk.co.jp*
[d] *E-mail: fujikawa_t@cfk.co.jp*
[e] *E-mail: kimata_j@cfk.co.jp*
[f] *Waterfront Vitalization and Environment Research Foundation, Tokyo, 105-0001, Japan; E-mail: mimura@wave.or.jp*
[g] *Graduate School of Maritime Sciences, Kobe University, Kobe, 658-0022, Japan; E-mail: takebaya@kobe-u.ac.jp*

Abstract: This study aims to reveal the direction of port management to follow the "Net zero Policies" of some representative ports in East Asia and Europe. We select some ports in Japan and Taiwan to compare with European ports, which are acting as the leading role for promoting the Euro type "Net zero Policies." The results suggest that ports in Japan and Taiwan just show the way of reducing carbon emission, while ports in Europe build up the concrete direction for becoming the "gateway" for new energy distribution, i.e. hydrogen. For Asian ports to play a role in the new energy supply chain, it is important to position it as industrial policy, not environmental policy. In addition, port authorities should have a clear initiative and strongly promote efforts by involving private companies.

Keywords: Net Zero Policies, Port Management, New Energy

1. INTRODUCTION

Climate change is a critical issue that the international community must address immediately and collectively. At the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, France, in 2015, the COP decision, including the Paris Agreement, was adopted as a new international framework for reducing greenhouse gas emissions from 2020 onwards (UN, n.d.). The Paris Agreement, which came into effect in 2016, is the first fair agreement in history in which all countries participate, and concrete actions towards net zero are accelerating worldwide.

In Japan, the government has set a target to reduce greenhouse gas (GHG) emissions by 46% compared to FY2013 levels by 2030. This reduction is being pursued through rigorous energy efficiency measures, the Feed-in Tariff (FIT) scheme for renewable energy, and the operation of nuclear power plants. As a result, the share of non-fossil fuel power sources has been increasing, and by FY2023, Japan had achieved a reduction of approximately 24% compared to the base year.

Meanwhile, when looking at major countries and regions participating in the Paris Agreement, Europe's net-zero initiatives are generally more ambitious than Japan's, and are considered valuable references for future policy development. For example, the United

Kingdom has set a target of 68% reduction by 2030 compared to 1990 levels, and the European Union aims for a 55% reduction over the same period. As of 2022, the UK and EU had already achieved reductions of approximately 50% and 33%, respectively, indicating both ambitious targets and substantial progress. Furthermore, in addition to FIT and the operation of nuclear power plants, the UK declared in 2015 its intention to phase out coal-fired power generation within a decade, and successfully eliminated coal power plants by September 2024. In the EU, coal phase-out efforts and support for renewable energy deployment under the Renewable Energy Directive (RED) have led to a non-fossil fuel power share of 61% as of 2022 (Ministry of Economy, Trade and Industry, Japan, 2025).

Greenhouse gases (hence, GHG) include CO_2, CH_4 and NOx, but currently, carbon dioxide (CO_2) would be the hottest target for reducing emissions. In Japan, energy-related CO_2 accounts for 85% of greenhouse gas emissions (Ministry of the Environment, Japan (MoE), 2022). Therefore, the "Net zero Policies" are understood to shift energy consumption from "dirty (fossil)" sources to "clean (non-fossil)" sources.

One of the most notable candidates for replacing "dirty" energy would be hydrogen. Hydrogen can be produced from various resources; water, fossil fuels, methanol, ethanol, and waste plastics. Needless to say, hydrogen does not emit CO_2, that means "completely clean." Hydrogen can be produced through the electrolysis of water; The electricity by renewable energy sources (solar panels, windmills, etc.) also can be used for this electrolysis.

Regarding the supply of such new energies, ports could act as very important role; in particular, the role of "gateway" connecting between the source of new energies and hinterland. On the other hand, ports themselves should be getting "clean" in terms of the general meaning of "Net zero"—reduce the fossil energies. These two directions could have a gap; each port would have its own direction for following the Net zero Policies, but its policy could be positioned between "being the gateway" and "just reducing the fossil use."

Since the Net zero Policies was launched by the International Energy Agency (IEA, 2021), we have seen so many plans of port development and management for following the Net zero Policies. However, we did not organize such plans that each port could have so far. At a minimum, categorizing the policies at each port would be meaningful to promote the plans for following the Net zero Policies efficiently. This is our motivation for research.

This paper aims to reveal the direction of port management to follow the "Net zero Policies" of some representative ports in East Asia and Europe. We identify certain features that indicate variations in the plans of each port and use them to categorize the ports in the future works.

Our research would contribute to enhancing Net zero Policies at Asian ports and help encourage the motivation to reduce fossil fuel use at ports that are ambitious about developing new energy utilization methods.

2. LITERATURE REVIEW

In the last two decades, the issue due to the climate change has been one of the most serious issues in the transport sector. Many research articles including the maritime sector has focused on the reduction of GHG emissions by vessel operation (Bouman *et al*, 2017; Gritsenko, D., 2017; Chen, Y., 2021). These studies highlight the importance of a multifaceted approach involving close collaboration between the public and private sectors, given the diverse international stakeholders in the maritime field. Bouman *et al* (2017) pointed out that combining multiple technical and operational measures rather than relying on a single solution. Gritsenko, D. (2017) proposes that promoting a multipolar approach to governance based on institutional

diversity rather than uniform regulation. Additionally, Chen, Y. (2021) addressed the conflict between developed and developing countries regarding GHG emission reductions in international shipping, suggesting that developed countries should be obligated to provide extramural funding assistance to developing countries. However, these studies focus on initiatives in the international shipping sector and do not primarily address the roles, plans, or international comparisons of ports.

Subsequently, the role of ports has gained more attention through the International Energy Agency's (IEA) "Net zero by 2050" strategy. This strategy positions ports near industrial areas as ideal hubs for low-carbon fuels, designating them as production and supply centers for hydrogen and ammonia (IEA, 2021).

In this context, particularly in Europe, research on port comparisons related to net zero and the construction of new energy supply chains has emerged. Schodler, K., & Saraceni, A. (2024) found that European ports place more emphasis on climate change mitigation measures compared to ports in West Africa and the United States. Through a comparison of 33 European ports, they demonstrated that the size of the port, population density, and the GDP of the host country influence investment in GHG reduction measures. Additionally, Notteboom *et al*. (2023) discussed the impact of green hydrogen on European ports and the role of port managers, highlighting the development of Antwerp and Rotterdam ports amid hydrogen competition among major economic countries. In Asia, Hong, X. *et al*. (2021) study the economic analysis of hydrogen supply chain construction using Singapore as a case study.

However, there is insufficient accumulation of research on port comparisons across international regions, including Asia, regarding the construction of new energy supply chains associated with net zero. Schodler, K., & Saraceni, A. (2024) mentioned the need to expand analysis to ports in other continents and regions to comprehensively understand the impact of ports on environmental measures, noting the lack of sufficient comparisons between European and other regional ports. Furthermore, as pointed out by Sifakis, N., & Tsoutsos, T. (2021), there is an imbalance between the increase in research on port sustainability and the research on strategies and technologies. Particularly in Asia, there is a lack of studies focusing on the strategies and implementation frameworks under which net zero initiatives are undertaken in various national ports.

Thus, while prior research has organized the initiatives, roles, strategies, and impacts of ports in each country and region, there has been no study like this one that compares European and Asian cases focusing on the three points of "purpose," "development method," and "promoting organization," and compiles recommendations for Asia. This aspect can be considered the novelty of this research.

3. METHOD AND SOURCES

3.1 Overview

The following are key factors to considering how Asian ports should approach the creation of new energy supply chains.

1) The purpose of building new energy supply chains.
2) The status of the projects.
3) The promotional system of the projects.

In order to capture the variations across multiple ports concerning these factors, we will conduct narrative investigation. Given that efforts toward building a new energy supply chain remain in their nascent phase, it is important to uncover the underlying context of each port’s

approach by narrative investigation.

Let us start the analysis by comparison of the efforts to build new energy supply chains in ports across multiple countries and regions based on review of port-planning documentation. Then, through on-site surveys of each port and semi-structured interviews with managers and operators, we will analyze the policies behind the projects undertaken by each port. From these results, we will compare the direction of each port from multiple dimensions, by means of cluster each port based on the project's status and purpose. In addition, by comparing the promotion system of the projects, we will consider the direction of port management and real actions to follow the "Net zero Policies."

3.2 Review of port-planning documentation

For comparative analysis, we will focus on Japan, which was the first country in the world to formulate a national hydrogen strategy, Taiwan, which has similar geographical conditions to Japan, and Europe, where efforts to construct new energy supply chains are said to be progressing according to previous research. Specifically, we will target the six ports shown in Table 1, the investigation is based on publicly available documents obtained from the official websites and other online sources of each port, with the aim of analyzing their efforts toward the development of new energy supply chains.

3.3 Interview

To understand the policy background behind the projects undertaken by port authorities — specifically, their motivations for engaging in the development of new energy supply chains— interviews were conducted with the respective port management organizations.

The investigation employed a semi-structured interview format, focusing primarily on the following questions:

- What projects are being implemented in relation to new energy and net-zero goals?
- What are the underlying motivations for pursuing these projects?

As will discuss in Section 4.2, the scope of projects at the Port of Kobe and the Port of Kitakyushu, as well as at the Port of Rotterdam and the Port of Antwerp, are relatively similar. Therefore, among the six ports selected for document analysis, the interview survey targeted the Port of Kitakyushu, the Port of Kaohsiung, the Port of Antwerp, and the Port of Aberdeen.

Table 1. List of target ports

Ports	Sources
Kobe, Japan	・ Port of Kobe, Carbon neutral port formation plan. ・ Some press releases from the City of Kobe.
Kitakyushu, Japan	・ Port of Kitakyushu, Port and harbor decarbonization promotion plan. ・ Some press releases from the City of Kitakyushu.
Kaohsiung, Taiwan	・ Homepage of Taiwan International Ports Corporation.
Rotterdam, Netherlands	・ Homepage of Port of Rotterdam.
Antwerp, Belgium	・ Homepage of Port of Antwerp-Bruges (PoAB).
Aberdeen, Scotland	・ Homepage of Aberdeen City Council.

Table 2. Interview information

Interviewee	Date	Participants of Interviewee
Seaport and Airport Bureau, City of Kitakyushu	Dec 7, 2023	Planning Division, Port Planning and Construction Department ・ Manager, Second Planning Section ・ Senior Staff, Second Planning Section ・ Manager, Carbon Neutral Port Section ・ Assistant Manager, Carbon Neutral Port Section
Taiwan International Ports Co. (TIPC)	Jan 25, 2024	・ Senior Deputy Director, Port Business Department ・ Marketing Planning Section, Port Business Department ・ Acting Manager, Sustainable Development Executive Office ・ Sustainable Development Executive Office ・ Senior Supervisor, Occupational Safety and Health Dept. ・ Manager, Field Safety Section, Occupational Safety and Health Dept. ・ Engineer, Field Safety Section, Occupational Safety and Health Dept.
Port of Antwerp-Bruges (PoAB)	Aug 5, 2024	・ Vice President International Relations & Networks ・ International Community Relations manager
Aberdeen City Council	Aug 7, 2024	・ Service Manager ・ Team Leader – Business Support
Robert Gordon University	Aug 7, 2024	・ Vice Principal Economic Development ・ Business Development Manager ・ Business Development Manager ・ Principal Project Manager, Energy Transition Institute

3.4 BASIC INFORMATION OF THE SUBJECTS

3.4.1 CO_2 Emissions by Country

In this section, we summarize the comparison of the way of reducing carbon emissions by countries and reveal the differences. The global CO_2 emissions in 2020 were approximately 31.4 billion tons, with the highest emissions by country being China, the United States, India, Russia, Japan, and Germany, in that order (IEA, 2024). Under the Paris Agreement, which came into effect in 2016, countries are encouraged to formulate and report strategies for long-term low-emission development of greenhouse gases. For example, among the top CO2 emitting countries, China and India have set their 2030 emission reduction targets based on GDP ratios, while the United States, Russia, and Japan have set their targets based on specific base years.

3.4.2 Characteristics of The Ports

In this chapter, we summarize the characteristics of each port surveyed.

1) Port of Kobe (Japan) (City of Kobe, 2017, etc.)
   Since its opening in 1868, it has developed as an international trade port. In the 1970s, it handled the most container cargo in the world, and until 1994, it handled the most container cargo in Japan. The Osaka Bay area, including the Port of Kobe, has long been an industrial hub with heavy chemical industries such as steel, shipbuilding, and chemical plants.
2) Port of Kitakyushu (Japan) (Nippon Steel Corporation, 2024, etc.)
   The Port of Kitakyushu is the site of Japan's first integrated steel mill and remains a thriving center for the steel industry. In Japan, the steel industry is the largest emitter of

Table 3. CO_2 emissions from fuel combustion
& Greenhouse gas emission reduction targets (UN, n.d.)

No	Country	CO_2 emissions (2022)	2030 targets (Based on article 4.19 of the Paris Agreement)
1	China	10,613 Mt-CO_2	・Aim to peak CO_2 emissions before 2030 ・Reduce CO_2 emissions per unit of GDP by over 65% compared to 2005 levels
2	United States	4,608 Mt-CO_2	・Reduce emissions by 50-52% compared to 2005 levels
3	India	2,517 Mt-CO_2	・Reduce emissions per unit of GDP by 45% compared to 2005 levels
4	Russia	1,623 Mt-CO_2	・Reduce emissions to 70% of 1990 levels (a 30% reduction)
5	Japan	974 Mt-CO_2	・Reduce emissions by 46% compared to 2013 levels (with a continued challenge towards a 50% reduction)
18	United Kingdom	309 Mt-CO_2	・Reduce emissions by 68% compared to 1990 levels
22	Taiwan	270 Mt-CO_2	-
34	Netherlands	121 Mt-CO_2	・Reduce emissions by 49% compared to 1990 levels
44	Belgium	79 Mt-CO_2	・Each region, consist federal, sets its own goals ・Ex) Walloon Region: Reduce emissions by 55% compared to 1990 levels

greenhouse gases among manufacturing industries. The area around the Port of Kitakyushu also has a concentration of highways and airports, making it a logistics hub for land, sea, and air transportation.

3) Port of Kaohsiung (Taiwan) (TIPC, 2024)

The Port of Kaohsiung is the busiest port in Taiwan in terms of cargo volume and is one of the world's leading container ports. It handles about three-quarters of Taiwan's total container volume and about half of its total cargo volume.

4) Port of Rotterdam (Netherlands) (Port of Rotterdam, 2024, etc.)

The Port of Rotterdam is the busiest port in Europe in terms of cargo volume and also handles the most container cargo in Europe (13th in the world). Of the cargo handled, liquid bulk such as crude oil and mineral oil products accounts for about half, containers about 30%, and dry bulk such as iron ore and scrap and coal about 16%. It is also one of the world's largest petrochemical industrial areas.

5) Port of Antwerp (Belgium) (PoAB, 2024)

The Port of Antwerp is the second busiest port in Europe in terms of cargo volume and the second busiest in Europe for container cargo (15th in the world). Of the cargo handled, containers account for about half, and liquid bulk such as petroleum derivatives about 30%. It hosts Europe's largest petrochemical cluster and its pipelines.

6) Port of Aberdeen (Scotland) (Port of Aberdeen, n.d.)

Aberdeen has prospered since the Middle Ages through fishing and trade with the Hanseatic League, and after the discovery of North Sea oil fields, it became a hub for oil extraction. Many companies related to the oil and gas industry are concentrated there. In recent years, the Port of Aberdeen has also functioned as a base port for offshore wind power generation in the North Sea.

4. A COMPARISON OF PORT APPROACHES IN EAST ASIA AND EUROPE

In this chapter, we describe the approach process (4.1), purpose (4.2), and promotion framework (4.3) of the new energy supply chain initiatives in Asian and East Asian ports, and finally compares them (4.4).

4.1 The Approach Process for Net zero and New Energy Supply Chains

4.1.1 A comparison of approach processes for net zero by port authorities

In a net zero society, it is unclear whether hydrogen fuel or ammonia fuel will dominate in the future. Comparing the response policies of port authorities, European ports (such as the Port of Antwerp) (PoAB, n.d.) have roadmaps for the introduction of both fuels. In contrast, many ports in Japan are still considering which fuel to adopt, likely waiting to see which fuel will become dominant.

Regarding the utilization of energy, it is necessary to develop infrastructure to produce

Table 4. Deployment of new energy supply chains by port authorities

	Europe	East Asia
Energy Transition	[Rotterdam] ・ Formation of Hydrogen Hubs and Expansion of Ammonia Terminal Capacity (Port of Rotterdam) [Antwerp] ・ Development of Infrastructure Capable of Handling Both Hydrogen and Ammonia Fuels (PoAB, 2024) [Aberdeen] ・ Commencement of Commercial Supply for the Hydrogen Hub by the City of Aberdeen and BP	[Kobe] ・ Planning hydrogen fuel supply facilities considering ammonia demand, with plans to reassess upon full-scale implementation (City of Kobe, 2023) [Kitakyushu] ・ Many uncertainties, currently under consideration ・ Setting introduction targets for either hydrogen or ammonia fuel (City of Kitakyushu, 2024) [Kaohsiung] ・ No current initiatives
Utilization of New Energy	[Rotterdam] ・ Installation of hydrogen stations for fuel cell trucks on roads spanning the Netherlands, Belgium, and western Germany (MoE, 2021) [Antwerp] ・ Plan to convert the LNG pipeline at the Port of Zeebrugge for liquid hydrogen ・ Plan to construct an open-access hydrogen pipeline with Germany [Aberdeen] ・ Introduction of hydrogen buses and hydrogen stations in the city, development of technology through industry-academia collaboration, and promotion of public understanding of hydrogen	[Kobe] ・ On-site demonstration of introducing hydrogen energy into cargo handling machinery within the terminal (MLIT, 2024) [Kitakyushu] ・ Demonstration of supplying hydrogen from factories to demonstration houses using a 1.2 km hydrogen pipeline in a demonstration area (City of Kitakyushu, 2024) [Kaohsiung] ・ No current initiatives, promoting reduction of existing energy consumption

Note: Information without citation is based on interview surveys.

or import new energy and supply it to port areas and cities. Comparing the response policies of port authorities, European ports have plans such as the installation of hydrogen stations for fuel cell trucks on roads spanning the Netherlands, Belgium, and western Germany (Port of Rotterdam), the conversion of LNG pipelines for liquid hydrogen transport, and the construction of open-access hydrogen pipelines with Germany (Port of Antwerp). Local governments are also actively involved in training technicians to handle hydrogen fuel (City of Aberdeen). Port authorities are defining areas for the actual utilization of hydrogen and advancing plans and initiatives, with cross-border projects being developed.

On the other hand, in East Asia, demonstration projects are being promoted, such as the supply of hydrogen from factories to demonstration houses using a 1.2 km hydrogen pipeline in a demonstration area (Port of Kitakyushu) and the introduction of hydrogen energy into cargo handling machinery within terminals (Port of Kobe). Although technology demonstrations are progressing in limited areas, it is not yet clear where, by whom, and how hydrogen fuel will be supplied in the future.

4.1.2 European and East Asian port authorities' views on net zero

Figure 1 illustrates the roles of ports within the new energy supply chain, along with the specific focus points of each port selected for this study. Since new energy is primarily transported via ships or pipelines, ports are expected to serve as supply bases, receiving and storage bases, and in some cases, secondary receiving bases.

Port authorities in European are steadily advancing infrastructure development based on the premise of new energy proliferation. They are developing extensive cross-border projects, considering who will supply which energy to which areas. Notably, the Ports of Antwerp and Rotterdam are focusing on the entire supply chain, with the aim of positioning themselves as central hubs in the hydrogen supply chain. By leading the establishment of hydrogen supply and utilization infrastructure ahead of other ports, they can play a central role in the international hydrogen supply chain and capture market share from neighboring ports. This demonstrates their intention to lead the net zero society.

In contrast, East Asian port authorities are somewhat skeptical about the proliferation of new energy and are observing societal trends. They are trying to adapt to energy transitions while closely monitoring societal trends. However, regarding the utilization of new energy, they are still in the demonstration phase in limited areas, and it is not clear where, by whom, and how hydrogen fuel will be supplied in the future. Therefore, unlike Europe, which is proactively forming supply chains, East Asian ports are likely to follow successful examples from demonstration areas and gradually develop infrastructure domestically. This approach is effective in obtaining results and identifying challenges in the introduction of hydrogen fuel utilization technology. However, unless specific target areas and participating entities are defined, extensive projects will not be developed. Without such comprehensive initiatives as seen in Europe, the proliferation of new energy may be delayed, and there is a risk of losing international port competition in a future net zero society.

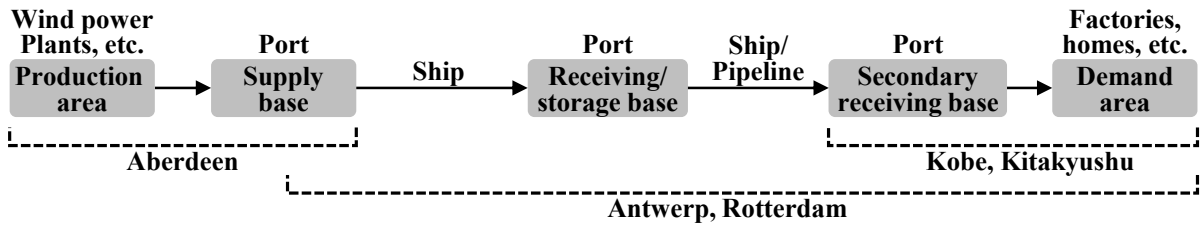


Figure 1. The role of ports in the new energy supply chain and the focus points of each port

4.2 Purpose of Building New Energy Supply Chain

4.2.1 Ports in East Asia

In 2017, Japan became the first country in the world to formulate a national hydrogen strategy (Cabinet Secretariat, 2023). MLIT, Japan is promoting the formation of “Carbon Neutral Port” (CNP, that means Net zero Port) to enhance port functions with consideration for decarbonization and to establish reception environments for hydrogen, ammonia, and other new energies, contributing to the enhancement of port and industrial competitiveness and the realization of a decarbonized society (MLIT, 2025).

The City of Kobe, the port authority of Port of Kobe, formulated the "Port of Kobe, Carbon Neutral Port Formation Plan" in February 2023 (City of Kobe, 2023). This plan sets forth the policy of "strengthening the competitiveness of Port of Kobe and contributing to climate change issues by aiming to achieve net zero greenhouse gas emissions and establishing supply infrastructure for next-generation energies such as hydrogen." It also aims to establish reception environments for new energies to meet the demand for new energy in cargo handling machinery and ships within the terminal.

The City of Kitakyushu, the port authority of Port of Kitakyushu, formulated the " Port of Kitakyushu, Port Decarbonization Promotion Plan" in February 2024 (City of Kitakyushu, 2024). This plan sets forth the policy of "achieving net zero greenhouse gas emissions overall through the establishment of reception environments for new energies, the enhancement of port functions with consideration for decarbonization, and collaboration with industries concentrated in coastal areas." It also aims to promote the construction of new energy supply chains to facilitate the decarbonization of industrial activities in port and coastal areas.

However, these plans formulated by each port are merely plans to realize net zero in port and coastal areas in accordance with the manuals created by the national government.

In Taiwan, the National Development Council (NDC) announced the "2050 Net zero Emission Roadmap" in March 2022 (NDC, 2022). This roadmap clearly indicates the specific paths and policies for achieving net zero by 2050. However, according to interviews conducted with TIPC, which centrally manages major ports in Taiwan, including Kaohsiung Port, it was revealed that while TIPC is leading efforts to achieve net zero in the maritime sector, efforts to achieve net zero for industries located in ports and for ships and vehicles entering and leaving ports have not yet been considered.

4.2.2 Ports in Europe

In Europe, following the formulation of "The European Green Deal" (COM(2019)640final) in 2019, various plans and regulations such as "REPowerEU" (The European Commission, 2022), "The Green Deal Industrial Plan" (The European Commission, 2023), and "The Net zero Industry Act" have been formulated against the backdrop of the European energy crisis caused by the Ukraine issue. As these plans and regulations indicate, net zero investments aimed at enhancing industrial competitiveness are being promoted across the region.

The ports of Rotterdam and Antwerp have significant energy demands within their port areas and hinterlands (industrial regions in Germany, the Netherlands, Belgium, etc.). The Port of Rotterdam aims to strengthen its competitiveness by becoming a hub for new energy supply chains to maintain its position as a crucial energy port in Northwest Europe (Martijn, C. *et al*., 2022). Similarly, the Port of Antwerp aspires to become a major green energy hub in Europe as an active pioneer of a sustainable hydrogen economy. In addition to importing hydrogen, it aims to contribute to the development of the hydrogen economy and a climate-neutral European

economy by producing green hydrogen itself (PoAB, 2025).

The Port of Aberdeen has set an ambitious goal to become the first port in the UK to achieve net zero by 2040. It has identified three main themes for its net zero strategy: reducing port emissions, promoting future fuels, and supporting energy transition. These themes guide its decision-making and financial investments (Port of Aberdeen, 2025). According to interviews with the City of Aberdeen, amid concerns about the decline of the North Sea oil fields that have supported the regional economy, the city sees the transition from oil to hydrogen as a business opportunity. By establishing the Port of Aberdeen as a supply base for new energy supply chains, it aims to maintain and revitalize the regional industry centered on hydrogen.

4.2.3 Policy implications for net zero and new energy supply chains

Table 5 and Figure 2 present the approach and purpose of building a new energy supply chain by each port.

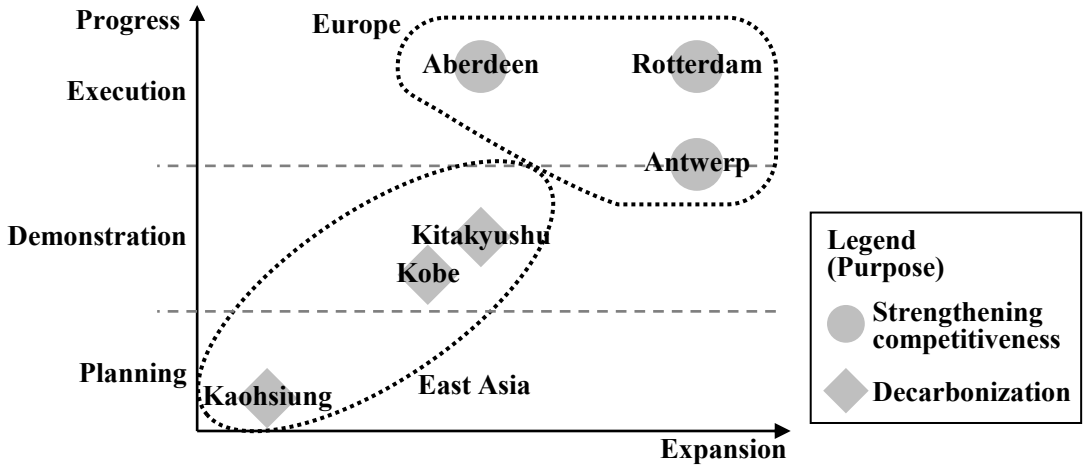
In East Asia, the primary goal is the decarbonization of port and coastal areas. In Japan, the formation of Net zero Ports also aims to "transform industrial structures and enhance competitiveness." However, the "enhancement of competitiveness" here refers to becoming ports chosen by shippers and shipping companies in response to energy transitions, or enhancing industrial competitiveness with an eye on ESG investments. Therefore, the focus is on establishing reception environments in ports as part of the construction of new energy supply chains.

In contrast, the European ports, discussed in this paper, position the construction of new energy supply chains as one of the measures to secure an advantage over other ports. In other words, the goal is not merely to "respond" to the energy transition but to "take the initiative" in the post-transition energy supply chain.

Based on the above, it is suggested that the direction of port management to truly follow "net zero policies" should not be to view net zero as a mere achievement goal, but to position

Table 5. Purpose of building a new energy supply chain

		The purpose	Policy of approaches
East Asia	Kobe	・Reducing greenhouse gas emissions ・Strengthening cooperation as a net zero port ・Contributing to addressing climate change issues	・Development of infrastructure to accommodate new energy sources
	Kitakyushu	・Decarbonization of industrial activities in ports and coastal areas	・Development of infrastructure to accommodate new energy sources
	Kaohsiung	・None	・None
Europe	Rotterdam	・Maintaining own position as a key energy port in North-West Europe	・Development of infrastructure for receiving and supplying new energy
	Antwerp	・Becoming a key import hub for green hydrogen in Europe	・Development of infrastructure for receiving and supplying new energy sources ・Cooperation with hydrogen supplying countries
	Aberdeen	・Developing local industries to replace the North Sea oil fields	・Promoting resident understanding ・Shifting the workforce



Note: "Expansion" is an abstract plot of Figure 1.

Figure 2. The deployment and purpose of building new energy supply chain

the construction of new energy supply chains as a growth strategy for each port and its hinterland.

4.3 Promotion Framework of Approaches for Net zero and New Energy Supply Chains

4.3.1 Port management organizations

Japanese ports are primarily managed by local governments designated as port authorities, responsible for planning, operating, and maintaining the ports. For example, the Port of Kitakyushu is managed by the city of Kitakyushu. However, to provide high-quality services that meet the diverse needs of shipping companies and cargo owners, make quick decisions, and enhance international competitiveness, some ports have established "port operating companies." These companies have been established at key international logistics hubs such as the Port of Keihin (Tokyo, Kawasaki, and Yokohama), the Port of Hanshin (Kobe and Osaka), and Ise Bay (Nagoya and Yokkaichi) (The Ports and Harbors Association of Japan, 2015). For instance, the Port of Hanshin (Kobe and Osaka) is operated by Hanshin International Port Co., whose shareholders include the national government (about 34%), the City of Kobe (about 31%), the City of Osaka (about 31%), and some private companies.

All major ports in Taiwan (Keelung, Kaohsiung, Taichung, Hualien, Taipei, Su'ao, Anping) are managed by the Taiwan International Ports Corporation. This company is a wholly government-owned corporation, but it has high operational freedom, including employment, investment decisions, and asset management. Until 2012, the government itself managed the ports, but the company was established independently from the government to leverage scale advantages and become a hub port in Asia (Japanese Foundation for IAPH, 2022).

The Port of Rotterdam is managed by the Port of Rotterdam Authority, an unlisted public limited company, with shareholders being the City of Rotterdam (about 70%) and the Dutch government (about 30%). Until 2004, the City of Rotterdam managed the port, but political influence was strong as budget approvals required the consent of city council members, who have four-year terms, while ports need long-term plans. Therefore, the port became independent from the city (Japanese Foundation for IAPH, 2016).

The Port of Antwerp has been jointly operated with the adjacent Port of Zeebrugge since April 2022 to strengthen its advantage in the global supply chain and maintain sustainable growth. Both ports are managed by the Port of Antwerp-Bruges, a limited liability company under public law, with shareholders being the City of Antwerp (about 80%) and the City of

Bruges (about 20%) (Port of Antwerp-Bruges, 2024).

Despite differences in the degree of public influence, the overarching framework is common across ports in different countries and regions, where publicly funded private companies (funded by national or local governments) manage, operate, and maintain the ports.

4.3.2 Promotion system of approaches for net zero and new energy supply chains

In Japan, port authorities are required to hold a "Port Decarbonization Promotion Council" with the participation of public and private stakeholders and to formulate a "Port Decarbonization Promotion Plan." Based on this plan, public and private stakeholders advance their respective initiatives. This approach aims to enhance the effectiveness of the plan by involving a wide range of public and private entities, as stipulated by the Port Act (MLIT, 2025).

At the Port of Kitakyushu, in addition to the port authority (the city of Kitakyushu), 59 organizations (including heavy industry manufacturers, steel manufacturers, shipping companies, and port operation organizations) participated. According to an interview with the city of Kitakyushu, the Port Decarbonization Promotion Council is held to build consensus among stakeholders in formulating the port's net zero policy and to match the supply and demand of technology and new energy among participating companies.

In other words, the "Port Decarbonization Promotion Council" serves as a forum for consensus-building towards plan formulation and is not an organization that takes the initiative in building new energy supply chains. Specific initiatives are reflected in the "Port Decarbonization Promotion Plan" based on opinions from private companies. It can be said that the approach is bottom-up, with no specific entity holding the initiative.

Meanwhile, in the Port of Antwerp, the Port Authority (PoAB) is deciding on policies and considering specific initiatives for building a new energy supply chain. It is then collaborating with private companies that have the technology to put the initiative into action. It can be said that the Port Authority has the initiative, and the initiative is being promoted in a top-down manner. As the Port Authority includes the mayors of the hinterlands (City of Antwerp and City of Bruges) as its directors, the Port Authority's decision-making also includes the intentions of the hinterlands as regional strategies, which may enable smooth implementation, including infrastructure development.

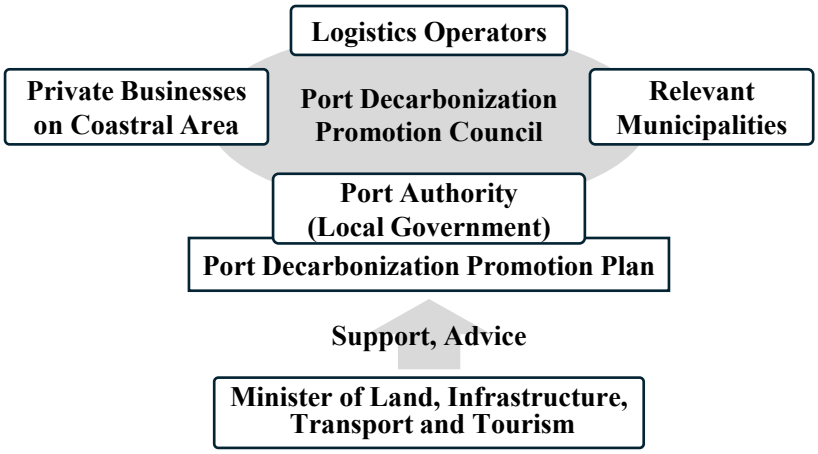


Figure 3. Stakeholders involved in “the port decarbonization promotion plan” (MLIT, 2023)

4.4 Comparison of East Asian and European Ports

Summarizing the comparison between East Asian ports and European ports based on the three perspectives discussed in the previous sections:

1) Japanese and Taiwanese ports are advancing initiatives with the primary goal of decarbonizing the ports themselves, positioning the construction of new energy supply chains as a means to achieve net zero. Consequently, the construction of new energy supply chains is undertaken individually by private companies, with port authorities providing support as needed. In contrast, European ports position the construction of new energy supply chains as a measure to maintain and enhance their competitiveness.
2) In Japanese ports, initiatives are often at the demonstration stage, whereas European ports are more focused on execution.
3) In Japan, councils comprising public and private stakeholders are organized, and plans reflecting the initiatives of private companies are formulated with port authorities acting as coordinators. This approach emphasizes public-private collaboration and consensus-building, without any specific entity holding the initiative. In contrast, at the Port of Antwerp, the port authority (PoAB), with the involvement of the mayor of the hinterland as a director, takes the initiative and executes everything from policy decisions to specific initiatives.

5. CONCLUDING REMARKS AND FUTURE DIRECTION

This study examined the implementation of Net zero Policies in representative ports in East Asia and Europe, highlighting differences in their scope. The key finding is that European ports aspire to become gateways for distributing new energy sources, while East Asian ports primarily focus on reducing carbon dioxide emissions within port and harbor areas. This represents a crucial distinction. In other words, European ports adopt a broader perspective toward achieving the Net zero goal.

If Asian ports are to play a role in future new energy supply chains, a concrete strategy for developing new energy hubs must be established. Additionally, the establishment of a leading organization—or the delegation of leadership to an existing entity—is essential.

Table 6. Comparison of the approaches for new energy supply chain

	The Ports in East Asia	The Ports in Europe
Purpose of Building New Energy Supply Chain	・ Responding to the energy transition ・ Decarbonization of ports and coastal areas	・ Maintaining the port's position by taking the initiative in new energy supply chains
Progress of the approaches	・ Port Authorities are closely monitoring social trends and trying to adapt to the energy transition. ・ Efforts to utilize new energy sources are currently in the demonstration phase in limited areas.	・ Infrastructure development is underway with the assumption that new energy sources will become widespread. ・ Wide-area projects are being developed that target a wide area that crosses borders.
Promotion framework of the approaches	・ No one has the initiative. ・ The port authorities make plans that reflect the approaches of private companies by bottom up	・ The port authority has the initiative. ・ The port authority advances make plan and the execution of approaches by top-down.

Specifically, port management entities should have a clear initiative in constructing new energy supply chains and strongly promote initiatives by involving private companies.

As long as East Asian ports continues to observe the trends of net zero policies in other regions such as Europe, it is unlikely that a net zero society will be realized in the near future. For the realization of a net zero society in East Asia, it is crucial for ports, which serve as international gateways for energy, to take the lead. Port authorities, as the responsible entities, should promote extensive projects based on the premise of new energy proliferation. Instead of merely adapting to the hydrogen supply chain, it is important to develop projects that form the hydrogen supply chain within the Asian region and lead Asia towards a net zero society.

This study is a case study on a limited number of ports. As the situation in Europe and East Asia differs significantly, it is natural that the direction of initiatives in European ports cannot be directly applied to East Asian ports. Thus, we will have further surveys to catch the actual situation that other ports have and analyze the situation based on the statistical information.

In February 2025, during the writing of this paper, the Japanese government revised the "GX2040 Vision: Strategy for Promoting the Transition to a Decarbonized Growth-Oriented Economic Structure." (Ministry of Economy, Trade and Industry, 2025) While decarbonization initiatives have been promoted mainly from the perspective of environmental policy, the aim is to advance decarbonization initiatives with a focus on economic growth as an industrial policy. Policies and initiatives related to new energy supply chains are changing with social conditions and technological advancements, so continuous research is also important.

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