



# Actors in energy transitions: Transformative potentials at the intersection between Norwegian port and transport systems

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## ABSTRACT

Although actors are of central importance in the progress of energy transitions, their roles and contributions have received limited attention by transition scholars. This article aims to fill this gap by taking a 'role-centric' approach to actors and by expanding existing user role typologies to include the variety of actors involved in such transitions. This allows for a more comprehensive grasp of the potential role of actors in accelerating energy transitions. To explore how particular constellations of actor roles can shape energy transitions, we turn to an under-addressed transition site, namely ports. As nodes in transport systems, ports may shape and potentially transform the energy use and practices in the three domains that intersect in ports: the port domain, the sea transport domain, and the hinterland transport domain. We find that port actors' fulfilment of their roles differs between the three domains, which differ according to whether actors are united by an uncontroversial innovation, and whether there is a strong intermediary role. We also find that port actors are collectively more able to shape energy transitions in ports than in related transport systems. We conclude that studying the complex and context-laden realities of ports is a useful exercise for exploring the variety of role constellations that could shape energy transitions.

## 1. Introduction

With alarming reports from the Intergovernmental Panel on Climate Change (IPCC) [1] and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [2], society-wide sectors, systems and actors have been urged to become more sustainable. Scholars have noted that what they call 'deep transitions' require fundamental shifts in directionality and logic across sectors, with sustainability as a guiding principle [3]. However, energy transition studies have been criticized for focusing too strongly on systems of production and distribution, and energy transition researchers have been challenged to study such transitions in new and more diverse ways [e.g. 4]. Among other, scholars have responded by, for example, studying and acknowledging the multiple roles of actors in energy systems and [5–7] and exploring the many roles and strategies that actors can mobilize to advance transition [e.g. 8–10].

To date, energy transition research has taken a broad approach to actors, encompassing organizations, industries, citizens, consumers and other representatives of civil society, culture and social movements, and as agents holding and representing different geographies, power, agency

and resources [11]. A growing number of studies have sought to understand and conceptualize actor involvement in transition [e.g. see 8], and have mainly attempted to categorize different types of actors that shape transition processes. To provide a more united perspective on actor roles, Schot, Kanger and Verbong [12] present a categorization of users in different phases of transition, which has been lacking in transition studies [13]. In our study, we extend Schot et al.'s description of roles [12] to the variety of actors involved in energy transitions, and not just end-users of technologies. Accordingly, we emphasize the functions inherent in the roles described by Schot et al. rather than focusing on the actors who carry those functions. As such, we engage with a relatively new focus in transition studies – one that stresses the multiple roles of social actors in energy systems [14]. We address the following question: *How can actor roles and the constellations they constitute shape energy transitions?*

To extend the typology presented by Schot et al., we draw on a transition case characterized by large actor complexity, and where actors can shape transition in different domains. Ports represent hubs in transport systems in which sea and land transport intersect with port operations. This intersection encompasses a broad range of actors,

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including port authorities, terminal operators, wholesalers, forwarders, carriers, shipping companies, rail and barge operators, industrial businesses, port service providers and many more. This heterogeneous mass of actors suggests that ports serve as particularly useful cases in research when taking a role-centric approach to demonstrate how actors can shape energy transitions. To demonstrate how role constellations can shape such transitions, we studied the roles of actors in the Port of Oslo and how that particular role constellation shaped energy transitions in domains that intersected in the port.

Through interviews with port actors in Oslo we examined the port actors' activities and perceptions regarding transition work, and reviewed them in light of the roles suggested by Schot et al. [12]. As all of the roles introduced by Schot et al. could be considered essential for successful energy transitions, one could assume that the potential for such transition is higher in cases where all roles exist and are strong. From our investigation of the role constellation in the Port of Oslo we have been able to indicate whether the potential for successful transition in the studies case was high or low. In turn, this finding may enhance our understanding of the roles that different actors take in energy transitions, as well as ports as transition sites.

This article contributed to the field of transition research in two ways. First, and unlike most studies on energy transitions, we do not examine in depth a particular transition, niche or innovation. As the central position of ports in transport systems allow port actors to shape transitions in several domains, we wished to focus on their potential reach and not limit our study to single innovations. Second, we believe that functions inherent in the roles described by Schot et al. are important in transition processes regardless of what actors attend to them. Therefore, we extend Schot et al.'s typology of roles to the variety of port actors, independent of whether they are end-users of a specific innovation.

## 2. Actor roles in energy transitions

Actors play pivotal roles in sustainability transitions, which have been considered 'multi-actor processes' whereby a variety of actors and social groups, whether deliberately or not, apply their 'resources, capabilities, beliefs, strategies, interests [and] agencies' [15:5] to promote or obstruct systemic change. However, transitions studies have for long been criticized for ignoring the role and agency of actors in transition processes [16], and for conceptual ambiguity in references to actors [17]. Consequently, scholars have responded to the call for greater representation and conceptualization of actors within sustainable transition studies.

Many authors take an 'actor-centric' approach by focusing on the actions and approaches of specific actors, such as incumbent actors [e.g. 18–20], niche actors [e.g. 21,22], and actors in social movements [e.g. 23,24]. Others take 'role-centric' approaches in their efforts to understand actors. For example, in a review of transition studies' perspectives on actors, Fischer and Newig [16] distinguish between four actor types (systemic, institutional, governance and intermediary), but stress the ability of actors belonging to different types to have similar functions (i.e. roles). Further, Haan and Rootmans [25] suggest a typology of what roles actors take as transformative change agents, namely frontrunners, connectors, toppers, and supporters.

By contrast, however, Wittmayer et al. [26] aim to provide transition scholars with a vocabulary for understanding actors in transition processes, by highlighting the transition roles' of such actors. They argue that hitherto transition scholars have not presented an analytical framework for understanding roles in transition, which they describe as 'as a set of recognizable activities and attitudes used by an actor to address recurring situations' [26:49]. Wittmayer et al. further argue that examining actor roles in depth allows for systematic descriptions of how

actors engage and relate to each other, and that understanding actor roles in transition requires an understanding of all individual roles as well as constellations of roles, which they refer to as a 'web of roles which interact, interrelate and co-evolve' [26:50].

### 2.1. A typology of actor roles

By applying the role typology suggested by Schot et al. [12] in our study of actors in the Port of Oslo, we aspired to follow Wittmayer et al.'s perspective on actor roles in transition [26]. Although Schot et al.'s discussion of end users could be considered as taking an actor-centric approach, unlike many scholars, they also take a role-centric approach by defining what roles end-users play in key transition processes. Extending Schot et al.'s typology beyond end-users allowed us to place greater emphasis on the roles and functions that could be enacted in energy transitions. Thus, by targeting actor *roles* instead of actor *types* we recognized the agency the former might hold in actively (re)shaping and/or reshaping and replacing regimes [27], and thus aimed to contribute to an understanding of how energy transitions at the intersection between ports and transport systems may be stimulated.

Schot et al.'s typology of actor roles distinguishes between five roles: producers, legitimators, intermediaries, citizens and consumers [12]. *Producers* contribute to innovation and evolution of emerging niches. Given the array of innovations available to port users, producers can have a prominent role in ports. User-producers design, modify and test transformative technologies, present solutions that atone to user preferences and that foster new practices [12]. This resembles von Hippel's term 'lead users' [28], which refers to those who seek innovations that cover needs not already met by the market.

*Legitimators* install meaning in niche activities, ensure values and interpretations that support niches and promote their spread and legitimacy [12]. Perception and meaning are crucial for continued diffusion of innovations and must be continuously maintained [29]. Thus, legitimators are central in enrolling actors to networks around niches, which in the case of ports may be an important but challenging role, given the heterogeneous group of actors whose connections to different economies and realities might call for different types of innovations.

Conceptualizations of *intermediaries* are continuously evolving [e.g. 30–32], but the literature has traditionally emphasized their efforts to broker between actors [e.g. 33] and instigate change among others. Schot et al. [12] describe 'user-intermediaries' as those who create and strengthen support structures in order to transform socio-technical systems, such as infrastructures and regulations. Intermediaries work to establish and shape the system within which niches are to gain ground and they engage actors to align technologies, regulations, expectations, and use. Intermediaries can have a crucial role in ports because they are complex structures populated with a range of actors with different priorities.

According to Schot et al. [12], intermediaries are considered to be involved in transitions through three key processes - facilitating, configuring and brokering - that are contextually, spatially and temporally dependent [34]. The many references to these processes have led scholars to criticize transitions studies for not fully acknowledging the independent agendas and wills of intermediaries. Parag and Janda [35,36] argue for a broader conceptualization of so-called 'middle actors' that recognizes their capacity and agency to a greater extent. Janda and Parag's middle actors are granted endogenous existence and *raison-de-vivre* beyond their brokering role. This could be, for example, the case for port authorities that need to balance their (social) role as community managers with their roles as regulators or operators [e.g. 37]. Similarly, Haan and Rotmans [25] describe actors in transition processes as 'transformative change agents' whose intentional acts derive from specific value sets. The question of whether intermediaries in ports are

primarily preoccupied with brokering, facilitating, or configuring, or whether they act as transformative change agents with the intention to drive energy transitions, is explored further in this article.

Through a range of activities, spanning from lobbying to social movements, *citizens* actively progress niches at the expense of the prevailing regime or competing niches [12]. In ports, citizens in the sense of private individuals are not expected to be a prominent feature. Hence it will be interesting to see whether any of the actors discussed in this article attend to functions typically carried by user-citizens.

Finally, *consumers* incorporate niches and innovations in their daily lives, thereby creating or modifying established practices. They shape transitions through their consumption power [13], but also attach symbolic meaning to niches that confirm their values and identities [6,12]. Given the heterogeneity of port users and the vast number of innovations available to them, one could expect to identify consumers that are in a position to influence port transitions, for instance through purchasing transport services or investing in low-emission machinery. In contrast to previous research, our understanding of user-consumers in the context of ports implies the need to study organizations that either implement or could implement innovations rather than studying individual household consumers.

## 2.2. Existing research on user roles in energy transitions

Schot et al.'s typology of actor roles [12] is a valuable conceptualization in presenting users as more than passive adopters of new technologies, in that they can actively encourage (or discourage) the diffusion of such technologies. This approach is in contrast to most research on energy transitions, which has mainly focused on users as technology adopters, often related to energy practices in households [38–42] or as adopters of electric vehicles [e.g. 6,43–46] and bio-energy [27].

Few studies have thus far applied Schot et al.'s categories to empirical cases. Some exceptions are studies that have used them to study transitions in mobility [43,47] or to describe the involvement of users in grid connected solar PV [7]. These studies have predominantly supported the usefulness and validity of the categories, although more research is needed to show their transferability to other domains and to advance our understanding of user roles in energy transitions. This study constitutes a contribution in this direction because we applied Schot et al.'s typology to a new empirical field, namely ports. Further, the study contributes to energy transitions research by emphasizing the *functions* inherent in the roles described by Schot et al. We argue that these functions are cardinal to transition processes and that they could be fulfilled by others than end-users. Accordingly, in this article we stress the way the categories could be translated into functions that actors fulfill in energy transitions. As an example, for an innovation to materialize, someone must take responsibility for testing and conducting a pilot study of the innovation to allow for learning and modification, and thereby function as a producer. As a further example, there is a need to coordinate and align actors and interests in order to promote the innovation – a task typically carried out by intermediaries. Moreover, for transitions to happen, there is need for someone to create positive narratives and legitimize framings of new innovations and directions, and thereby function as a legitimator. As a last example, for a transition to materialize and spread someone must take the innovation into use (i.e. act as a consumer) and the innovation must have broad, general support (i.e. by citizens).

In this article, we use Schot et al.'s typology [12] to define roles that are considered essential for progressing energy transitions. We then identify port actors who take on these roles in the three domains that intersect in ports: sea transport, hinterland transport, and port operations. The actors' fulfillment or lack of fulfillment of these roles is used to indicate in what domain the potential for transition is greater and what role functions should be complemented to progress transition.

We argue that functions that must be fulfilled for transitions to take

place can be revealed by taking a 'role-centric' perspective. In this article we demonstrate how these functions can be taken on by a variety of port actors. By focusing on the constellation of roles and the functions that these roles may serve in the port and related sectors we can identify where the port stands in terms of transition progress and what niches prospective transitions could be expected to center on.

## 3. The complexity of ports as potential transition sites

This article draws on the Port of Oslo to explore how role constellations can shape energy transitions. Apart from a few studies on the port of Rotterdam [48–50], transition research has largely overlooked the sustainability potential of ports. Exploring the potential of ports to accelerate energy transitions relies on an understanding of their complexity as expressed through the intersecting of the many different actors, activities, and sustainability issues in ports. These are found in the port area as well as at the port-sea interface and at the port-land interface [51], implying that ports are in a strong position to influence energy transitions in all three domains that connect in the port node (i.e. port operations, sea transport and hinterland transport).

The three domains are characterized by different *activities*. In the sea transport domain, activities typically relate to the handling of vessels, either at port or as they are approaching or leaving port. The activities include the provision of fuel and services that allow safe passage for vessels. By contrast, a core activity in the port domain is the shifting of cargo and passengers between, for example, vessels, trains, trucks, public transport. However, port operations also include administrative activities relating to the collection of fees, as well as customs and clearances. Furthermore, industrial production and shipyards are prominent in many ports. In the hinterland transport domain, activities mainly relate to logistics operations for intermodal connections with rail, barge, or truck transports, as well as fuel provision for them.

All of the above-mentioned activities are subject to framework conditions and operational prerequisites provided by policy and regulation, trade and business interests, infrastructure, research, and social interests and communities. Furthermore, the different activities are carried out by different *actors*, which interact across the three domains. Whereas the port authority and terminal operators are prominent in the port area, along with actors conducting their business and engaging in production in the port, the actors in the transport domains typically enable transport services, as goods owners, vessel and/or vehicle owners, transport agents and forwarders, or as fuel providers. All such actors have increasingly become oriented towards reducing *emissions* from their respective activities, be they emissions from vessels or vehicles, cranes, trucks, and excavators during their respective activities. Further, noise pollution and visual pollution associated with ports are high on the actors' agenda for ensuring peaceful co-existence with neighboring communities.

Moreover, various tools and technologies are available to reduce emissions associated with activities in ports [for an overview see 52]. In all three domains that connect in the port node, promoting alternative fuels and establishing a more sustainable energy system for the port area could enhance sustainability. Furthermore, emissions could be reduced by increasing efficiency in operations in all domains, such as vessel handling, goods handling, and truck loading, and replacing the fossil fuel technologies used to conduct these operations.

An overview of the three domains, energy issues, and innovations and technologies, is presented in Table 1, which shows the realities that port actors are part of, and which shape their transition endeavors. The complexity of ports as potential transition sites, which comprises many different actors, activities and markets, dealing with different types of energy issues and oriented towards a variety of innovations, suggests that a range of different energy transitions can occur in the different domains, and that actors have different opportunities for, or interest in, progressing transition in the three domains. Therefore, when studying

**Table 1**  
Overview of port dimensions, energy issues and innovations and technologies. Authors' compilation.

	Sea transport domain	Port domain	Hinterland transport domain
Activities	Vessel arrival/departure Vessel loading/unloading Fuel bunkering Piloting Tugboat operations	Container lifts Stacking/shifting containers Fee collection Waste reception Customs Security clearances Vessel repair Industrial production	Vehicle/train arrival/departure Container pick-up/delivery Fueling
Actors	Shipping agents Ship owners Shipping companies Fuel providers  Local, regional and national authorities National and international port associations Trade and industry associations International Maritime Organization Environmental organizations Energy suppliers Research, development and innovation Consultants Local communities	Port authority Terminal operators Goods owners Industrial companies Service and maintenance providers	Transport companies Forwarding agents Vehicles/train owners Infrastructure owners Fuel providers
Sustainability issues	Emissions from vessel on arrival/departure and at berth (SO <sub>x</sub> , NO <sub>x</sub> , CO <sub>2</sub> , CH <sub>4</sub> )	Emissions from cranes, trucks, tractors, excavators etc. Noise Visual pollution	Emissions from vehicles Congestion Noise
Innovations and technologies	Shore power Speed reduction Efficient vessel handling  Alternative fuels (LNG, biofuels, methanol, hydrogen, ammonia, low-sulfur fuel) Alternative power sources (wind, solar, wave, tidal, geothermal)	Electrification of terminal operations Efficient goods handling Automation Clean industrial production Port management	Efficient loading/unloading Modal shift Technological shift in trucks and drayage

how actor roles shape transition it is therefore important to keep in mind that the potential reach and influence of actors could be limited to certain domains. Accordingly, in the remaining part of this article we distinguish between the three domains when analyzing and discussing the prominence and contribution of role constellations.

#### 4. Methods

##### 4.1. The port of Oslo

The Port of Oslo is Norway's busiest port and a hub in the national transport system. Port traffic is dominated by bulk and container transport, as well as local and international passenger transport. The port has a variety of users with permanent operations in the port area, including the terminal operator, users in warehousing and storage, vehicle import, construction and building materials (sand, gravel, and cement), other dry bulk (salt and grain), material processing (coffee and cement), iron and metals scrapping, and wet bulk storage (petroleum).

In a Norwegian context, the Port of Oslo has a large and specialized port organization, which has been working increasingly more closely with its owner, the City of Oslo. The city aims to cut 95% of citywide CO<sub>2</sub> emissions by 2030 [53] and this has compelled the port to set its own ambitious reduction objectives. To facilitate an emission free port, the port and the city have jointly launched an action plan with 17 measures that are estimated to reduce CO<sub>2</sub> emissions by 85% [54], including shore power, environmental differentiation of port fees, goods transfer from road to sea, and electrification of local passenger services.

The Port of Oslo is a useful case for exploring how role constellations can shape energy transitions, for mainly two reasons. First, as one of the largest ports in Norway it demonstrates the complex web of actors and activities that characterize ports. Second, the Port's ambitious emission reduction goals and its strategic and encompassing approaches to

transition make it a forerunner in port sustainability both nationally and internationally. For this reason, it is more likely that complete role constellations can be identified in the Port of Oslo than in ports that are less dedicated to sustainability.

##### 4.2. Interviews

Our case study on the Port of Oslo enabled us to investigate how actor roles and the role constellations they constitute can shape energy transitions. To do so, we relied on interviews with actors in and around the port. Before the interviews, we reviewed regulation and policy documents, as well as public and corporate strategies in order to familiarize ourselves with the interviewees and their current work with energy issues. We also visited the port and some of the actors to learn about their operations and the realities they operated under. Document reviews and port visits represented important backdrops when developing the interview guide. The interviews served to provide greater detail and nuance regarding the transition efforts already identified in

**Table 2**  
Interview sample.

Organizations (N)	Actors	Interviews (N)
1	Port of Oslo	3
1	City of Oslo	1
1	The Norwegian Ports Association	1
1	The Norwegian Coastal Administration	1
1	Terminal operator	1
2	Energy companies	3
3	Goods owners/transport buyers	3
7	Transport providers	6
17	Total	20



the document reviews and port visits. As such, the interviews served to systematize knowledge about the actions, experiences and practices of the port actors, and allowed us to obtain systematic and complete information [55].

The interviews were based on a semi-structured interview guide that addressed the following topics: the interviewee’s organization and its surroundings, goals and ambitions regarding business, climate and environment, relation to ports and involvement in zero emission activities at the port, as well as preconditions, challenges and barriers in transitions. Prior to the interviews each interviewee was informed about the research project, privacy issues, and procedures for collecting and safeguarding of the interview data.

We conducted interviews with representatives from 17 port actors between October 2018 and March 2019. The interviewees were recruited through purposive sampling [56,57], whereby we explicitly targeted actors that we expected to play important roles in energy transitions in and around the port. These were identified by the researchers and in collaboration with contacts in the port. In addition, a few interviewees were identified through ‘snowball sampling’ [58], whereby interviewees suggested other relevant interviewees. We contacted all interviewees by e-mail or telephone, and all of them agreed to participate. The interviews lasted 30–60 min.

The interviewees represented authorities and users in the Port of Oslo. Each organization represented in the sample might have held several roles and functions in the port and the transport systems connected to the port. For instance, one organization could for instance be a transport company, a forwarding agent, and a terminal operator. The Port of Oslo comprises more than 30 users, whose activities and dedication towards transition vary greatly. In our sample, public actors (the top four categories in Table 2) included those who could directly shape activities in and around the port area and who engaged directly with the port and its users. The private and semi-private actors (bottom four categories in Table 2) were all large actors that had a prominent presence in the port area and whose organizations were reflexive with regard to energy and sustainability issues. They also had an active and productive dialogue with the port authorities.

Thus, our study included representatives of the *main types* of users in the port (i.e. terminal operators, goods owners, transport providers) and from actors more *committed* to energy and sustainability endeavors. Thus, it was not likely that the inclusion of more or other actors would have increased the strength and prominence of any actor roles in the port. Further, by focusing our data collection on port actors that had already started to join forces in their transition work, we were more able to capture the dynamics and synergies between the actors’ roles.

4.3. Data analysis

After the data collection, transcripts were uploaded for coding and

**Table 3**  
Codes used in data analysis.

Code	Code descriptions
Producer	The interviewee talks about own or other organization’s involvement in designing, modifying, testing innovations.
Legitimator	The interviewee talks normatively about innovations and their support/non-support for particular solutions.
Intermediary	The interviewee talks about own or other organization’s involvement in establishing structures and system, infrastructure, regulations to support a given innovation. The interviewee also talks about own organization engaging other organizations to make use of these support structures and work to ensure common perspectives and approaches to innovations.
Consumer	The interviewee talks about own or other organization’s incorporation of innovations in their daily operations and practices.
Citizen	The interviewee talks about own or other organization’s involvement in active, open promotion of particular innovations.

analysis using the qualitative data analysis computer software package NVivo for coding and analysis. The data were analyzed with reference to user categories developed by Schot et al. [12]. When reviewing interview transcripts, relevant text sections were coded through conventional content analysis [59], using the codes listed in Table 3. When all transcripts had been reviewed, all texts assigned to each code (i.e. role) were thoroughly examined to identify and summarize accounts of activities and reflections that corresponded to the role represented by the code. Then, we separated accounts relating to the hinterland transport domain, the sea transport domain, and the port domain. This provided us with a matrix of text data describing all roles in all three domains.

After reviewing the interview data, the categories were modified to capture the operational and practical nature of the Port of Oslo and its transport systems. Whereas much of the literature focuses on households and individuals, in our study the term ‘user-consumers’ referred to port users who had implemented and used a specific innovation or had the potential to do so. Further, we ascribed Schot et al.’s roles to any actor who carried out the functions of a given role, regardless of whether that actor was an end-user or not.

5. Actor roles in intersecting domains

With reference to the Port of Oslo, in this section we analyze and discuss how actor roles and the constellations they constitute might shape the potential for energy transitions in three domains that intersect in ports(i.e. port domain, sea transport and hinterland transport). As elaborated in the following, we found that the three domains differed along two dimensions: (1) the presence of a recognized, uncontroversial innovation, and (2) the prevalence and strength of intermediaries.

5.1. Actor roles and energy transitions in the port domain

As seen in Table 4, the most influential role in the port domain was the intermediary. Through their intermediary role, actors seek to progress an innovation by enabling others to implement and take it into use. Prominent intermediaries have substantial potential to steer, coordinate and drive sustainability in the port domain. As port owners, local authorities hold potentially large sway over port development through active ownership. Furthermore, recent regulation has allowed local authorities to engage directly in port matters. However, historically, local authorities have not considered it their role to steer port developments actively and have not taken on either the brokering role of intermediaries or the agency associated with middle actors. Norwegian ports have a strong autonomy and local authorities have been reluctant to interfere with what they consider the ports’ jurisdiction. Therefore, most Norwegian ports have not been subject to active management by their owners.

However, in the comparatively large coastal cities in Norway, challenges with local pollution have compelled local authorities to incorporate the port in the cities’ strategies. To fulfil its ambitious emission-reduction objectives, the City of Oslo actively engaged The Port of Oslo to progress energy transitions in the port and to align them with the city’s ambitions in other sectors. The local authorities did not take on the role as mediator between port users, but rather used their capacity as port owner to coordinate and align the port’s and the city’s zero emission strategies.

*[The City] can dictate what the Port should do and how to spend their money. We have an exciting role (.) in suggesting good measures for climate and environment that the port should work with and go for. (City of Oslo)*

*“It has been a good experience [to work] shoulder by shoulder with the bureaucrats (.) They have lifted issues politically (.) and [to set low] ambitions would not have been accepted. So, we need to define demanding measures” Port of Oslo*

**Table 4**  
Overview of roles in port domain, with actors, actions and technologies associated with each role.

	Producer	Legitimitor	Intermediary	Consumer	Citizen
Actors	Port authority Vessel owners	All	National energy agency Local authority Port authority	Vessel owners Terminal operator Port authority Vehicle owners	Neighboring communities
Actions and technologies	Shore power Electrification	Electrification	Electrification Zero emission energy system	Shore power Automated cranes Electric machines, vehicles and equipment	Reduce port visibility and audibility

As such, the City of Oslo's active port ownership compelled the Port of Oslo to take an intermediary role in its sustainability work by enabling its users to reduce their emissions and energy consumption. Both the City's and the Port's jurisdiction over the port area provided mandate and an opportunity to actively determine actively the path forward and to align port users.

The port users also emphasized the port's role as a facilitator that structured initiatives among port users. They regarded the Port of Oslo as the epicenter of dialogue between markets and users, which allowed it to coordinate port users' development and implementation of low- and zero emission technologies. On one hand, the port's effort to shape energy transitions related to configuring aspects of the intermediary role, as the port authority engaged port users to develop common visions for the port's future zero emission energy system. On the other hand, the port authority demonstrated agency and an endogenous agenda in spurring sustainability initiatives through project-based cooperation with individual users and through a financial support scheme that funded port users' implementation of sustainable innovations. The port authority itself underlined that its agency depended on dialogue with port users and knowledge about their transition potential. Thus, the port authorities hinted at an interrelation between the agency and capacity as emphasized by Parag and Janda [36] and the facilitatory role stressed in traditional concepts of intermediaries [12]. Through brokering and orchestrating port users the port authority also built capacity to act out its own agency.

*"[The Port] tries to create interaction [and is] an epicenter for dialogue and someone port users can collaborate with to create something positive across markets" Port user A*

Furthermore, the strong intermediary role taken by the Port of Oslo enabled other roles in the port domain. Both the Port and the City provided predictability and direction for port users that translated ambition into actions. This relates to the second dimension that distinguishes the port domain from the other domains: in the port domain, electrification was an obvious and undebated path forward for reducing emissions in port operations. Strong electrification policies at both local and national levels, coupled with the commitment of both the City and the Port to execute these policies, resulted in positive orientations towards electrification among port users and enabled them to act as legitimators, actively championing innovations and promoting their use and diffusion outside own their organizations.

*"[Our Oslo offices] are the ones aiming for zero emission, [among other because of] the strong political focus in Oslo. If you're to be taken seriously in today's [political] climate, you need to follow the environmental trend. [So we have] placed some pressure on our suppliers [of terminal equipment]" Port user B*

Shore power<sup>1</sup> and electrification in general appeared to be a universally accepted approach to promote energy transitions. Port actors

<sup>1</sup> Shore power allows vessels to shut down auxiliary engines and rely on electricity from the shoreside at berth.

promoted electrification of port operations because they assumed it to be a desired pathway, which hints at the essential role of expectations in transition [60–62]. Such expectations could reflect the strong position of electricity in discussions on global energy transitions [63], but could also be a spill-over from widescale incentives for electrification of transport in Norway [64–66]. Along with the millions of grants to shore power, electrification seemed to be the only pathway perceived, with certainty, as legitimate. The certainty was closely linked to the heavy reliance on Norwegian hydropower, which makes electrification a sustainable transition.

Additionally, the direction and predictability provided by strong intermediaries and uncontroversial technologies fostered consumer and producer roles in the port domain by reducing risk perceptions. Consumers implemented innovations and technologies, and they created or modified practices in daily operations accordingly. Above all, port actors in Oslo had started to use and implement shore power. To improve efficiency, improve working conditions and reduce noise, the terminal operator had prepared for automated solutions and had begun the electrification of cranes, small trucks, and tractors. Other port actors had started to replace machinery and equipment with electrical alternatives to the extent possible and applied an incremental approach where existing solutions were replaced as new technologies matured and leasing contracts were renewed or expired. As such, consumer functions were filled by a range of actors.

A strong intermediary role also seemed to foster more prominent producers in the port domain, as the capacity demonstrated in the intermediary role lowered the bar for testing, piloting, and designing solutions with low market maturity. Given the many tools and technologies that can progress port and transport sustainability there is large potential for port actors to actively shape and pilot innovations. In the port domain, the actors' active engagement in testing and developing shore power and electrification of vessels, vehicles and equipment was prominent.

On one hand, this spread was driven by the Port of Oslo itself, which actively engaged its users and technology providers to design a feasible solution for shore power. On the other hand, shore power was introduced by vessel owners, several of which had established shore power on multiple production and/or shipment locations. For instance, in 2011, on its own initiative and expense, and in collaboration with technology providers and R&D, one vessel owner developed a technological solution for shore power in Oslo which arguably became industrial standard. As such, the vessel owner acted as a typical producer, in actively designing solutions that were not already available in the market.

*"We did something long before society did. We showed it was possible and completed at industrial standards even before they existed". Port user C*

The port domain is the only domain in which we found traces of the citizen role (i.e. citizens who encouraged or discouraged particular developments in or of the port). Although none of the interviewees represented citizens directly, several referred to the role and influence of citizens. The interviewees described the periodic engagement of citizens as fierce and persistent, thus making them a visible actor that could

shape sustainable developments in ports. Citizens mainly engaged with the port as neighboring communities, whose main interest was the preservation of community qualities, related to residential environments, recreational spaces, noise levels, and aesthetics.

*“We need to operate 24/7, so we primarily choose shore power because of noise. Today we need to reduce unloading activities because neighbors call and complain” Port user A*

*“We installed shore power (.) to improve our environmental profile; we needed to do something that people can see, since we are so visible and close to the city”. Port user C*

Citizens were perceived to contest the presence of port activities and to pressure port owners (local authorities), port authorities and port users to limit their presence. Hence, citizens could be expected to support innovations that would reduce the visibility and audibility of the port, for example through silent electric equipment, shore power that would reduce local pollution, waste management that would improve water quality, the use of camouflaging colors, and soft flaps on ferries. All of the aforementioned innovations relate to challenges in the port domain, and citizens become engaged when these challenges threaten their interests. The short physical distance between citizens and the port in Oslo increases the visibility of the port’s activities. When addressing activities in the port domain, citizens further connect with familiar ecological perspectives and could therefore be expected to master social and cultural capital in similar way to port actors. This would enable citizens to exert pressure on other roles to develop port operations in order to take their needs into consideration.

5.2. Actor roles and energy transitions in the sea transport domain

In contrast to the port domain, there was no obvious and uncontroversial innovation that united port actors in the sea transport domain (see Table 5). Consequently, it was difficult to identify a single role in this domain that was more prominent than others. Rather, we argue that the lack of a prominent intermediary role in the sea transport domain disables and weakens other roles. The challenge with progressing transition is that the sea transport domain relates to port actors’ ability or inability to take on roles that effectively shape the domain. The global character of shipping suggests that effective intermediaries in the sea transport domain are not necessarily found in Norwegian ports, as jurisdiction and power are located at higher authoritative levels. Given the need for global policy to promote transition in sea transport, port actors have less opportunity to take on intermediary roles. For example, environmental weights in port fees do not apply for vessels under international regulation. Further, port authorities could promote slow steaming on approach to port or virtual arrival systems for ships, although such initiatives would have little effect if they did not account for entire maritime value and supply chains [37]. Furthermore, research suggests that lack of international governance in the maritime sector relate to power divisions between national and international decision-makers [67,68].

Thus, actors could be more successful in taking intermediary roles related to domestic sea transport. ENOVA, a Norwegian government enterprise, provides substantial support schemes for low and zero emission technologies in maritime transport. Furthermore, port

authorities have included environmental performance in port fees for most vessel categories, while national authorities have imposed strict regulations on sea transport fjords designated as world heritage sites by UNESCO. In addition, there is widespread public procurement of passenger services at sea that sets requirements for low- and zero emission operation of vessels.

Port actors in Oslo were also more likely to shape transitions in domestic sea traffic than international sea traffic, although roles in the sea transport domain were fewer and less pronounced than in the port domain. The most prominent intermediary in the former domain was the Green Shipping Program. The Green Shipping Program has joined port authorities, regional and local authorities, goods owners, ship owners, technology providers, R&D, and port and industry organizations to pilot and realize solutions for green and efficient shipping. Our interviewees referred to this program as a nexus for dialogue across domains, which has enabled members to pilot innovations and conduct experiments (e.g. on autonomous transport, shifting cargo from road to sea, environmental port index, alternative fuels). The intermediary position of the Green Shipping Program has therefore enabled more active producer roles among its members.

*“Through the Green Shipping Program we meet, discuss and get a shared understanding of the challenges. There is a model for running pilots quickly and efficiently, which is a good approach. If you wonder about anything, you know who to ask”. Port of Oslo*

Port actors also suggested two other ways for them to take an intermediary role in the sea transport domain. Firstly, transport service agents could seek to shift transport from road to sea through negotiating with transport providers and transport buyers to find solutions for non-road transport that would be acceptable to both parties. Such brokering would also serve to legitimize sea transport over road transport. Secondly, transport buyers engaged in informal forums, which one port actors suggested could be used to place joint sustainability requirements on transport providers. On the one hand, transport contracts could have an intermediary role in establishing structures (i.e. joint requirements) that would enable others to demand and provide sustainable solutions. On the other hand, such forums could align sustainability norms across the markets that transport buyers belonged to, and thereby contribute to legitimize low-emission solutions.

*“The customers of the transport industry can move it in a positive direction. [Many large] goods owners buy transport services from the same shipping companies, and have large potential for influencing these”. Port user A*

Both suggestions demonstrate a potential link between the intermediary role and the legitimator role; in taking on an active, brokering and negotiating role, intermediaries would be in a position to suggest structures or directions that would favor specific technologies or innovations.

As mentioned, the sea transport domain differed from the port domain in that the actors did not recognize a single, uncontroversial innovation, as was the case with electrification. Thus, it was less evident to port actors what innovations to implement or champion in the sea transport domain. In fear of investing in and promoting the wrong technology, they found it safer to remain on the sideline. This was exemplified by one shipowner, who discredited other shipowners who

**Table 5**  
Overview of roles in sea transport domain, with actors, actions and technologies associated with each role.

	Producer	Legitimator	Intermediary	Consumer	Citizen
Actors	Green Shipping Program	All	Green Shipping Program Transport buyers National energy agency	-	-
Actions and technologies	Technology pilots	Technology unspecific Shift from road to sea	Alternative fuels Emission restriction(shore power)	-	-

had lost their LNG investments when the LNG market did not take off in the way that had been expected. The absence of innovation-specific legitimators in the port seemed to relate to the lack of specific expectations of what innovations would be successful, as well as their availability, costs, and climatic impact.

*“Those who installed LNG were considered favorable, but then it wasn’t at all. I am very glad we did not choose LNG. And now hydrogen is on the agenda, although it is not mature enough”. Port user C*

In the absence of an obvious undebated innovation, a prominent trait of the sea transport domain was the port actors’ dedication to legitimate maritime transport as a green transport mode vis-à-vis road transport. Thus, many took on the role as legitimators to shift transport from road to sea, which was expected to reduce emissions greatly. There was a shared perception that the competitiveness of sea transport should be enhanced. For instance, transport service agents encouraged their customers to choose sea transport over road transport in the expectation that it would increase forwarding time but reduce emissions. Also, one forwarding company used centrally managed contracts to ensure that they purchased transport services from companies that performed at an environmentally satisfactory level.

*“We want to keep as much [good] as possible on the seaside”. Port user D*

*“We have hired a guy who works with sea transport and places requirements on vessels, what fuels they use etc”. Port user E*

Whereas the predictability and low risks associated with shore power and electrification allowed port actors to take on roles as consumers in the port domain, the consumer role was less prominent in the sea transport domain. One reason is that few port actors owned the vessels used to transport their goods, which in general gave them little opportunity to act as legitimators, consumers, or producers of specific innovations. As mentioned, transport buyers could place environmental requirements on ship owners or transport agents but given the global character and increasing consolidation of the shipping market (fewer and larger shipping companies) they would primarily impact domestic transports.

Whereas citizens are neighbors to actors, activities and sustainability issues in the port domain, there is a greater physical distance between citizens and the actors and activities in the sea transport domain. First, this implies lower visibility of sustainability issues and hence no (necessary) problem perception among citizens, which is also reflected in little attention paid to sustainable sea transport in politics, media, and public debate in Norway. Second, it implies that citizens may be less able to influence developments in the sea transport domain. In addition to physical distance and unfamiliarity with decision-makers in the sea transport domain, the global character of shipping industry and politics suggests that citizens do not necessarily master the capital (economic, social, cultural) required to have an impact.

### 5.3. Actor roles and energy transitions in the hinterland domain

Transport in the hinterland is diverse, and ports can implement numerous measures to improve its sustainability (e.g. port dues, concession contracts, modal shift, technology shift) [see also 69]. However, it was difficult to identify actors who were taking on roles to progress transition in the hinterland transport domain, as is evident from Table 6. The most prominent efforts in this domain were strategies aiming to shift goods from road to sea, in effect legitimating and

strengthening the position of maritime transport. This could reflect that the hinterland transport domain is often neglected by the port sector, which is oriented strongly towards maritime transport, as was also the case for many port actors in our study.

However, despite the apparent lack of interest in the hinterland transport domain, the potential for taking on intermediary roles was larger in the hinterland transport domain than the international sea domain, as the hinterland transport domain was largely under the influence of national, regional and local authorities. Norwegian policy makers at all levels have for a long time emphasized the need for instruments to accelerate the electrification of personal transport [70,71]. Furthermore, there are numerous examples of prominent Norwegian businesses taking on roles as producers, legitimators, and consumers in commercial land transport. However, their efforts typically relate to distribution activities, which imply shorter distances and more mature and available innovations. As such, these operations do not necessarily connect with the port.

Although there was no marked interest in the hinterland transport domain in the study sample, the Port of Oslo and a few of its users recognized their own responsibility for reducing emissions from transport to and from the port. In developing a concept for the future zero emission port, the Port of Oslo has taken a holistic perspective on the port’s energy system, which includes also non-maritime activities. Therefore, the hinterland transport domain could receive increasing attention in the future, in terms of both technology implementation and intermediary work.

### 5.4. Summarized domain comparison

In Sections 5.1 to 5.3 we have demonstrated the dissimilarities between the three domains in terms of how strong and prominent the different actor roles were. The roles in the port domain quite clearly circled around the strong position of electrification in efforts to decarbonize port operations, for instance through providing shore power for vessels at berth or replacing cranes and machinery with electric models. The presence of an available and uncontroversial innovation – supported by strong and acknowledged policies – allowed intermediaries in the port domain to easily identify a pathway for promoting the innovation and reduced risk perceptions among actors, to the degree that the actors took on roles as producers, legitimators and consumers of the innovation (i.e. electrification).

By contrast, port actors were vague about possible pathways in the sea transport domain. Although they participated in R&D through the Green Shipping Program and were open to the use of alternative fuels, insecurities, unpredictability and risk perceptions relating to alternative fuels lead them to emphasize the shifting of goods from road to sea. Also, considering how port actors had less opportunity to shape the globally bound sea transport domain, the port actors were less able to take on intermediary roles and thereby abate insecurities and directionality failure associated with the international shipping regime.

Similarly, encouraging shifts from road to sea also appeared to be the port actors’ main strategy for progressing transition in the hinterland transport domain. Although the less global character of the domain suggested port actors could take stronger intermediary roles and thereby facilitate port actors to take other roles - we believe that the strong orientation of port actors towards the maritime sector led most to fail to fully recognize their potential impact also on the hinterland transport domain.

In sum, our findings show that the three domains differ as to whether

**Table 6**

Overview of roles in hinterland transport domain, with actors, actions and technologies associated with each role.

	Producer	Legitimator	Intermediary	Consumer	Citizen
Actors	–	all	Port authority	–	–
Actions and technologies	–	Shift from road to sea	Include non-maritime activity in energy system	–	–



the actors could identify a particular pathway towards transition (e.g. electrification) and whether they were in position to produce intermediary capacity.

## 6. Discussion

Thus far in this article we have drawn on a case study on the Port of Oslo to explore how actor roles and the role constellations they constitute can shape energy transitions. More specifically, we have investigated different role constellations in the three domains that intersect in ports: port operations, sea transport and hinterland transport. In the preceding section we have demonstrated how role constellations in the three domains hinged upon two issues in the Port of Oslo. The first was whether actors were united by a recognized, uncontroversial innovation. As demonstrated above, the port domain was distinguished by strong orientation towards electrification, for instance represented by the introduction of shore power, electric cranes and excavators. This aligns with overall strong electrification policies in Norway, which due to the abundance of hydropower have remained uncontroversial. The electrification of port operations have thus extended electrification in road transport [72] and domestic maritime passenger transport, rendering electrification an obvious pathway for any operation that can be electrified. However, this was, less the case in the two transport domains, where battery technologies were not suited for the weight and distance of electrified forms of transport, and where instead alternative fuels were expected to replace fossil fuels, possible in combination with batteries. However, insecurities and disagreement on the maturity of alternative fuels made it difficult to identify an obvious pathway in the two domains, which induced actors to emphasize modal shift to demonstrate sustainability commitments.

Thus, the differences between the sea transport and hinterland transport domains could reflect how close each domain is to identifying a transition pathway. Transition studies typically study transition pathways related to particular niches, emphasizing how sociotechnical, “multiple and interlocking causal processes” [73] shape the evolution of sociotechnical systems [74]. In the case of ports, transition pathways are likely to encompass several niches and can only gain momentum if they are recognized and supported by the heterogeneous actor assemblages to the extent that they take on necessary roles. It could prove a daunting task to align the variety of actors, as well as the potentially contradictory realities and perceptions under which they operate, in support of shared pathways. The task, however, would relate to the internalization of potential pathways in prominent actors, and hence the second issue that distinguishes role constellations in the three domains, namely whether there is a strong intermediary that facilitates and nurtures other roles.

We found that port authorities were decisive in progressing transitions and that initiatives succeeded when port owners and authorities applied agency and capacity to their intermediary roles. Therefore, we emphasize the necessity of intermediaries to master both the brokering function and the agency function. Our findings suggest that successful intermediaries are not only explicitly pushed by their surroundings to take on a neutral brokering role, but also take on the intermediary role to promote own agendas and achieve own objectives. Therefore, the strength of the intermediary role relies on aligning the ends of the transition and the ends of the intermediary. This relates to Kivimaa et al.’s [30] discussion on the ‘emergence of transition intermediaries’, suggesting that the intermediary role can evolve during a transition and that the fulfilment of this role is determined by an intermediary’s normative position vis-à-vis the innovation or technology.

We could also ask whether the intermediary role in our study blended with the legitimator role. In the port domain, the intermediary (i.e. port and port owner) took an explicit, normative position concerning a specific technology (i.e. electrification) which also resonated in their efforts to orchestrate transition work among port users. For instance, when introducing shore power, the intermediary role taken by the port could have been motivated by its own and its owner’s desire to

legitimate this particular solution. Hence, *the intermediary’s inherent motivation and self-interest in progressing a particular innovation or transition altogether, also enhanced its ability and inclination to facilitate other roles*. In this case, intermediaries in the port domain took on this role because of the expectations and role perceptions inherent in local policy. Conversely, the intermediary role in the sea transport domain was less prominent because global policies are more fragmented and less ambitious, leaving little steering direction for potential intermediaries. Thus, a success factor for fostering intermediaries and thereby other roles seems to be *explicit and ambitious policy for port sustainability*.

Norwegian policy has been successful in promoting low-carbon technologies that reduce emissions in a wide range of industries, and has been central in progressing the shift to electrified forms of road transport [6] and low-emission ferry services [66]. However, despite a range of strategies, plans and regulations [75–78] targeting ports, Norwegian port policy has been evasive with regard to introducing specific innovations and has not provided coherent ambitions and directions for sustainability endeavors in ports. Therefore, port actors have called for greater involvement, more attention and specific guidance at the national level. High-level decision makers were generally perceived by our interviewees as uninterested in port issues and as pursuing a *laissez-faire* approach which discouraged ports from developing specific strategies and objectives. Active national engagement to coordinate energy and sustainability issues in ports and maritime transport was considered cardinal for increasing willingness to invest and take risks, reduce long-term insecurity and avoid distortion of competition.

To capitalize on the potential of ports and port actors to shape transitions in connected domains, policies should recognize and nurture the hub position of ports. This in turn would depend on the ability of international maritime policy to deliver joint and ambitious policies that explicitly define the roles of ports in transitioning international shipping. Explicit port policies have also been instrumental in transition work in the Port of Oslo [79], and our findings indicate that progressing transitions in the port sector relies on explicit port ownership strategies as represented by these policies.

This article is one of a few in which Schot et al.’s [12] categories have been applied to an empirical case, and as such it displays the heterogeneity and complexity of active actor-constellations in energy transitions. As stated in the Introduction, we have *extended Schot et al.’s contribution* to a general application suited to describe roles that actors can take to progress transitions. We suggest that not only end-users, but also different types of actors can take on these roles and that the constellation of roles in a particular transition site can inform about transition potential and be used to pinpoint obstructions to transition. We find such an application to be valuable for empirically assessing transition status and defining strategies for acceleration. It enables researchers to ask what functions that are not filled by the actors and how this impacts the transition process, as well as how to deal with deficiencies. Therefore, the approach is useful for exploring how well (or poorly) prepared actors are to progress transition.

As demonstrated by the roles taken by actors in the Port of Oslo, progressing transition also appears to rely on *the dynamic character of the roles* described by Schot et al. (2016). First, the roles are dynamic in that one actor can move between different roles and carry them out in different ways. Second, the roles are dynamic because they comprise evolving role constellations in which changes in one role could produce consequent change in others. In our study, intermediaries appeared to play a triggering role that impacted the presence and prominence of other roles. These inter-role dynamics should be investigated further, and such investigations would add nuance and dynamism to the typology and functions presented by Schot et al. [12]. Although Schot et al. provide valuable discussions of the role of users in different phases of transition, they do not explicitly suggest whether and how roles can provide support and momentum for other roles, and what synergies might be produced by constellations of roles that differ in their prominence. This might be an empirical question to which answers would vary

from one case to another but could also contribute to a more comprehensive theoretical approach to the roles of actors (and users) in transitions.

In this study we have relied on the Port of Oslo to enhance our understanding of role constellations. However, given the strong political ownership of the port [79], and its relatively small size, our results are not necessarily transferrable to other cases. Actors in larger ports can be expected to have larger, more professional organizations that could enable more productive exchange between actors and produce a larger variety of roles. Bigger actors could also have larger impacts on sea and hinterland transport domains. Although actor roles might be more and less prominent in ports of different sizes, we expect their functions, their relations, and interactions to be the most central aspect for transitions in ports. Hence, we expect *port context* to determine sustainability efforts in ports more than port size. Our study should therefore be complemented with studies of the perspectives of a greater variety of ports, domestically and internationally. Understanding roles in the sea transport domain especially should include the perceptions and activities of international actors in order to give a fuller understanding of actors in the sea transport domain that have greater capacity to take on an intermediary role.

We also recognize that the port industry's orientation towards the maritime sector is reflected in the composition of our study sample. We only interviewed 17 actors around the Port of Oslo and paying greater attention to the hinterland transport domain in particular could increase the reliability of our results. Hence, to capture the sustainability potential of ports as *nodes*, future research should focus more dedicatedly on private and public stakeholders in the hinterland transport domain. Such research should explicitly target the connectedness and mutual influence between port, sea transport and hinterland transport domains to truly identify ports' potential for initiating and accelerating energy transitions.

Furthermore, we have focused on actors who are considered more progressive in their sustainability efforts in the port, which suggests that our results might exaggerate the transition work of the ports' actors as a whole, as we have not accounted for the activities and inactivities of all actors. However, as the purpose of our study was to explore what work and roles actors are *currently* engaging in, it made sense to target actors that could actually demonstrate their own endeavors.

## 7. Conclusion

The purpose of this article has been to explore how role constellation can shape energy transitions, by drawing on a case study of actors in and around the Port of Oslo. We find that the port actors took on all the roles conceptualized by Schot et al. [12], but that the degree to which they fulfilled the roles varied between the port domain, the sea transport domain and the hinterland transport domain. The differences were largely the result of the prevalence or non-prevalence of an uncontroversial innovation, as well as different forms of agency and capacity in the intermediary role, which appeared to be decisive to provide direction and reduce risk, thereby promoting the prevalence of other actor roles.

We also found that there was potential for initiating and/or accelerating transitions in all three domains. In the port domain, port actors have already been ushered forward by electrification policies and the Port of Oslo's strong intermediary role. In developing its future energy system, the Port is also increasingly orienting itself towards a similar role that also targets hinterland and sea transport. However, the sea transport domain is challenging, as port actors cannot independently progress transitions that extend outside national waters. Therefore, port users should continue their endeavors to promote sustainability issues through international political bodies, interest organizations and forums that provide direction and predictability for the entire maritime sector.

Related to this is the technological indecisiveness and insecurity that troubles decision-makers. The battle of fuels and technologies is still

undecided, and decision-makers have hesitated to provide direction. Thus, the widescale electrification in Norwegian ports and transport is therefore a remarkable exception, which among other factors has been enabled by a robust power supply and access to hydropower.

We consider the approach we have taken in this article to provide some useful general lessons that could inform future transition research. The central position of the intermediary role found in our study suggests that future research should explore, theoretically and empirically, the relationship between the different roles and how the functioning of one role impacts the functioning of another. Given the complexity and context-specificity of ports, they different roles could provide a useful arena for examining the vast variety of role constellations that could shape energy transitions.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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