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Kristin Ystmark Bjerkan

The contents and shaping of transition work

Lessons learned from Norwegian ports

Doctoral thesis

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of
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Preface

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) in fulfillment of the requirements for the degree of Philosophiae Doctor (PhD).

The research for this thesis has been performed at the Department of Interdisciplinary Studies of Culture (KULT), Faculty of Humanities, NTNU, Trondheim. Professor Marianne Ryghaug has been the main supervisor, while Professor Tomas Moe Skjølsvold has been the co-supervisor.

The research has been undertaken as part of the research project Transition towards Zero Emission Ports (TRAZEPO) (2018–2022), which is funded by the Research Council of Norway's program EnergiX. The aim of TRAZEPO is to provide relevant decision-makers with knowledge of technologies and opportunities that may accelerate ports' transitions to zero-emission energy hubs. This involves understanding the prerequisites for transition work and dynamics between the microlevel (i.e., specific ports) and the macrolevel (i.e., the broader energy and transport system).

Abstract

To counter the increasingly visible effects of climate change, societies are forced to rethink the ways in which they function. To accelerate towards net zero emissions, policymakers should not only focus on technological innovation and technological diversity, but also stimulate non-technological change processes. Further, it is increasingly clear that societal transformations occur at the intersections of many different technologies and many different sectors. Thus, ports, which are located amidst many actors, sectors, and markets, could play a key role in societal transformation.

This thesis therefore addresses the need for knowledge and understanding of the ways in which ports can drive sustainability transitions. To do so, it turns to the content and shaping of transition work in three Norwegian ports. Transition work is here understood as all forms of deliberate and purposeful activities aiming to progress sustainability transitions. This understanding is based on perspectives on socio-technical stability and change expressed in the field of sustainability transitions and its theoretical lineage within science and technology studies (STS). I propose a conceptualization of transition work that I believe contributes to active narratives around applied agency, induces directionality onto agency in studies of sustainability transitions, provides empirically applicable constructs, and lead to explicit definitions of transition work.

This conceptualization of transition work has been applied to investigate the transition work of the Port of Narvik, the Port of Kristiansand, and the Port of Oslo. This investigation encouraged a conceptual framework for transition work that distinguishes between six types of such work: technological work, visionary work, governance and policy work, political work, reflexive work, and relational work. These groups serve to simplify the many facets of transition work and provide one way of collecting and gathering different activities that are dedicated to progress transition.

This thesis has further studied how different types of transition work emerge. Specifically, it has discussed ways in which transition work emerges within socio-technical configurations, which reflect transition dynamics typically expressed in the multi-level perspective (MLP). These discussions provide examples of the ways transition work is shaped by the unique socio-technical systems of which ports are part, the ways actors and technologies direct and influence transition work, they ways that landscape pressure contest rationalities and determine the need and scope for transition work, and the ways normative expectations of ports urge them to take on roles as intermediaries.

As particularly potent sites for deep transition and whole-system transformations, ports could play a cardinal role in society's quest for sustainable futures. However, this calls for ports and policy alike to recognize the potential transformative effect of the transition work of ports and the need to encourage such work through transformative policy mixes.

Acknowledgements

I never dreamed of becoming a doctor, at least not the philosophical kind. For someone who has never held high academic aspirations, studying for a doctoral degree might seem a peculiar choice. Still, this journey has shown me how useful apparently floating and evasive perspectives could be for engaging also with real world problems, and I am happy to have experienced that the work I have undertaken has made me better equipped to understand and deal with empirical problems in the practice fields I encounter.

My thanks go to Sigrid and Adrian for discussions in FME MoZEES, which led us to TRAZEPO. Thanks are also owed to my other TRAZEPO colleagues, Truls, Assiya, Hanne, Markus, and Lillian, for their excellent collaboration and engaging discussions. Especially, thanks are due to Hanne for all venting and debriefing sessions—it has been good knowing you had my back. Also, I thank our committed TRAZEPO partners: Ports of Norway, the Norwegian Coastal Administration, and the ports of Narvik, Oslo, and Kristiansand. Their time spent sharing knowledge and experience allowed us to gain a real understanding of ports as transition sites.

During my research for this thesis I have entered scholarly fields I had never heard of, with academic cultures and norms that are quite different from the ones with which I was already familiar. Therefore, getting into transition studies has been like learning an entirely new language for talking about issues I had already researched for some time. This has been by far the most challenging part of my doctoral research. However, somehow, I have ended up incorporating transition lingo into much of my research. Getting to this point is a huge win, and I would not have accomplished it without NTNU.

My fellow PhD students, in STS classes I had never thought I would ever sign up to, have demonstrated how incredibly useful and versatile STS is. Above all, I would like to thank my brilliant supervisors, Marianne Ryghaug and Tomas Moe Skjølsvold, for their enduring belief in, and patience with, an STS novice. I appreciate their calm and constructive approaches, their sociable and productive collaboration, and our interesting discussions. Their steady guiding hands definitely calmed my nerves when I was digging into the world of transitions.

I would also like to thank Timo von Wirth for a very useful critical reading of my thesis. His constructive insights helped to clarify many unfinished logics. I also appreciate the work of Roar and Unn Karin to get the practicalities in place so that I could do conduct my doctoral work as a SINTEF researcher. Also, I would like to highlight the general support and inspiration provided by my SINTEF colleagues. They are the main reason why I am excited to go to work every day. Special thanks go to "the persistent few," Astrid, the Ninas, and Kroken, who persevered in our offices during lockdowns.

Last, but most importantly, I wish to express my endless love and gratitude to my bunch at home, Magnus, Marius, Mali, and Gazi, for reminding me how unimportant degrees really are.

Trondheim, April 2022 *Kristin Ystmark Bjerkan*

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Part A: Introduction and overview

1 Introduction

To counter the increasingly visible effects of climate change, societies are forced to rethink the ways in which they function. Although sustainable futures are multifaceted and require attention to numerous social, economic, and environmental challenges, policy, research and development (R&D), and public debate all tend to revolve around needs to cut global emissions. The sixth assessment report from the International Panel on Climate Change (2021, 2022) clearly demonstrates the severity of climate change and the obvious need to cut emissions to limit further escalation. However, despite a series of global policy efforts to counter climate-related developments—from the first World Climate Conference in 1979, the United Nation's Framework Convention on Climate Change in 1995, the Kyoto Protocol's entry into force in 2005, to the adoption of the Paris Agreement in 2015—CO_2 emissions have continued to increase (Figure 1). Therefore, it is clear that the latest acts of the world community, exemplified by the UN's Climate Change Conference (COP26) held in Glasgow in 2021 and the European Green Deal, a new growth strategy of the European Union (EU), need to significantly accelerate counter efforts.

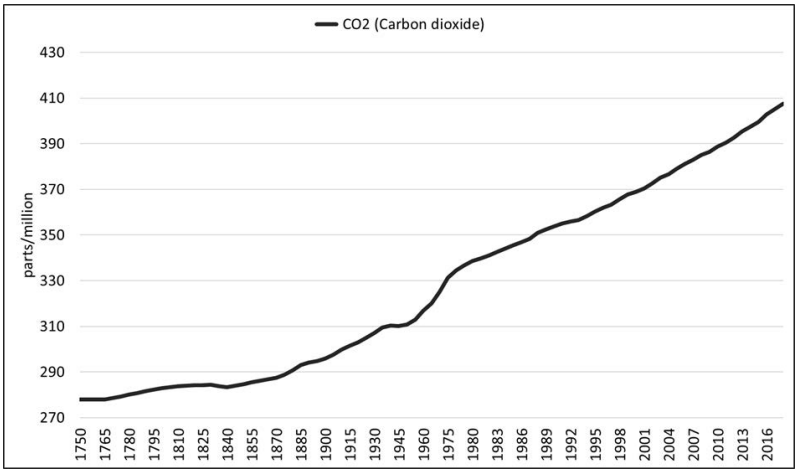

Figure 1. Trends in atmospheric concentrations of CO_2 (Carbon dioxide) (parts/million) 1750–2016
Source: European Environment Agency (2017)

The Science Advice for Policy by European Academies (SAPEA 2021) consortium suggests that to accelerate towards net zero emissions, policymakers should not only focus on technological innovation and technological diversity, but also stimulate non-technological change processes. Both SAPEA and a growing community of scholars consider that such acceleration is essential in order to succeed with sustainable transformations of contemporary society. In parallel, research on energy and sustainability transitions is mounting, and is concerned with how societal functions could be maintained in a more sustainable manner, assuming that transitions depend on the breakthrough of sustainable niche innovations that are supported by renewed regulation, science, culture, norms, and economic structures. Scholars have typically focused on transitions in the energy system, (e.g., Erlinghagen & Markard 2012, Kern & Howlett 2009, Raven & Verbong 2007, Solomon & Krishna 2011), but increasingly they are finding themselves working within a research field dedicated to transitions also in sectors that

converge or interact with energy systems, such as the transport sector (Geels 2012, Ghosh & Schot 2019, Mullen & Marsden 2016, Sopjani et al. 2019, Sovacool 2017). Common to much research on transitions is the focus on single technologies that could usher in transformative processes within a given sector. For instance, in transport-related research, scholars have so far focused mainly on the rise of electric automobiles (e.g. Figenbaum 2017, Sovacool 2017).

However, it is increasingly clear that societal transformations occur at the intersections of many different technologies and many different sectors, leading some scholars to focus on interactions between sectors and systems (e.g., Brown et al. 2018, Rosenbloom 2020). In recent years, this has led to discussions on *deep transitions* or *whole system transformation*. McMeekin et al. (2019) draw attention to interdependencies between subsystems, arguing that "whole system transition involves multiple changes that unfold over decades and may involve knock-on effects or innovation cascades" (p. 1219). Furthermore, Schot and Kanger's notion of deep transition (2019, 2018) covers the intersectoral nature of societal transformation more explicitly. They argue that transformations of a wide range of socio-technical systems occurs over the course of centuries, unfolding in waves, with each wave contributing to "broadening and deepening" the transition. Schot and Kanger build their conceptualization on a review of the history of industrialization, in which developments within mechanization and mass production spurred and strengthened transitions across different sectors, such as agriculture, transport, and housing.

Thus, recent transition studies have recognized the need to focus on how multiple niche innovations could diffuse in order to accelerate sustainable transformations of interconnected systems. One type of transition site that connects several systems is ports. Ports are particularly useful cases for exploring and understanding transitions that unfold between different sectors, as well as between different levels of regulation and government. Ports are nodes in transport systems and potential nodes in future energy systems. They connect road, rail, and sea transport, and can produce and provide low-emission energies and operations for various actors on sea and land. Thus, port organizations,[1] which are located amidst the many actors, sectors, and markets that intersect in ports, could play a key role in transitioning different sectors. However, the central position of ports has yet to be fully recognized, as expressed by the efforts of the European Sea Ports Organisation (ESPO) to obtain recognition of the role of ports in transitioning mobility systems. ESPO highlights that transport policies should recognize port organizations as facilitators in the ecosystem of ports, that such ecosystems are crucial elements in value chains, and that ports should be considered key partners in implementing ambitious environmental policy (ESPO 2020c). ESPO further contends that port organizations "can act as catalysts by including tools to facilitate, promote, raise awareness and encourage the decarbonization and greening of their stakeholders in their port strategies" (ESPO 2020c:2).

Also in Norway, the main function of ports has not been to facilitate sustainability and emission reductions among its users. Rather, the role of ports in regional production, supply and value chains has primarily made them centers for labor and economic activity, with a

[1] Publicly or privately owned enterprises responsible for managing the port.

commercial raison-d'être. This has been the case for private and public ports alike, and the many public port enterprises have mainly taken a laissez-faire approach to port governance, in which the port board and the port management have been granted a large degree of autonomy by public owners. However, ports are reorienting their roles and increasingly focusing on their own potential in moving port actors and activities towards more sustainable functioning.

A growing volume of research has addressed the sustainability efforts of ports and different governance approaches that port organizations can undertake to deal effectively with global and local emissions (e.g. Lim et al. 2019, Verhoeven 2010). This research field has focused on specific technologies and innovations that port organizations could implement to reduce emissions from their own and their users' operations. However, to date the research has generated little empirical knowledge about the actual implementations and applications of technologies and innovations, and has mainly comprised hypothetical, conceptual, and modelling studies pointing to the potential of solutions (Bjerkan & Seter 2019). Consequently, current research has informed little about how ports may drive transformations in other sectors as well as their own transformations. A first step towards understanding the transformative potential of transition sites such as ports is to increase our knowledge and understanding of how ports address sustainability, meaning what specific actions and interactions they take in response to the many different sustainability challenges they face.

In this thesis I address the need for knowledge and understanding of the ways in which ports can drive sustainability transitions. Studies of sustainability transitions provide many different understandings of how transitions could be furthered. Transition Management (e.g. Loorbach & Rotmans 2010) and Strategic Niche Management (e.g. Schot & Geels 2008) focus on ways in which transition processes or particular niches could be deliberately fostered and promoted. Scholars of Technological Innovation Systems (e.g. Bergek et al. 2008) seek to understand how sustainable technologies evolve amidst actors, networks and institutions. Also prominently placed in transition studies are understandings inherent in the multi-level perspective (MLP), which assumes that transitions emerge through interactions between socio-technical regimes, landscapes, and niche innovations. More specifically, the MLP asserts that transitions develop when established ways of maintaining societal functions (e.g., transport) are placed under pressures that reduce the legitimacy and ability of existing social and technical system elements to uphold specific functions.

Different understandings of how change processes emerge and progress also contain different perspectives and emphases on the role of actors and agency in those processes. Although the MLP has been criticized for insufficiently recognizing the role of agency in transitions, many scholars in science and technology (STS) and sustainability transitions have highlighted the roles of actors and users. They refer to active expressions of agency, such as institutional entrepreneurialism (e.g. Duygan et al. 2019), strategic niche management (e.g. Schot & Geels 2008), and intermediation (e.g. Kivimaa et al. 2019b). However, agency could also be associated with the *potential* to act, expressed through, for example, actor roles and resources. In this sense, agency could be understood as something that someone has, and that *could* be purposefully applied. In my perspective, this understanding represents latent expressions of agency in which agency is not necessarily followed by action.

In studying the ways in which ports engage with their sustainability challenges, I wish to emphasize the active dimension of agency more fervently. Therefore, I seek an operationalization of agency that allows for identifying specific activities or practices in ports that are deliberately and purposefully executed to progress sustainability transitions. As such, I also engage explicitly with transitions-in-the-making (e.g. Elzen et al. 2011), which, in contrast to many studies focusing on historical transitions, orient towards currently evolving sprouts of transition. As elaborated in Chapter 3, I do so by introducing my conceptualization of the term *transition work*.

In this thesis, I discuss transition work as an enabler in processes of socio-technical change. By focusing on socio-technical changes that enhance sustainability in and around ports, as potential sites of whole-system transformations, the thesis finds obvious place within studies of sustainability transitions. However, in building my conceptualization of transition work, which rests of different understandings of agencies on socio-technical change process, I also lean on some of the lineage of sustainability transitions that is found in science and technology studies (STS). Like sustainability transitions, STS also engages with socio-technical change, and ideas of socio-technical systems – which are key in understandings of sustainability transitions – developed in the forming years of STS. Thus, its focus on transition work as a driver to change socio-technical systems, also places this thesis within one of the core STS perspectives identified by Hess & Sovacool (2020). However, as elaborated in Chapter 3, the STS connection of this thesis is downplayed by its lack of emphasis on the agency of things, although it is recognized. Further, in this thesis I will not go into the black box of socio-technical matters to the same extent as STS scholars would, i.e. to investigate how "socio-technical matters are defined, constructed, maintained and shaped" (Hess & Sovacool 2020:14).

Finally, this thesis departs from STS in its orientation towards layered structuration. I seek to understand under what conditions active expressions of agency, in this thesis understood as transition work, emerge. Accordingly, I address the embeddedness of transition work, highlighting that transition work (like other forms of agency) occurs within particular structures. The three papers on which this thesis is based all demonstrate that transition work is not separable from structure, but rather emerges and evolves as proactive and reactive responses to the socio-technical contexts of which they are a part.. As elaborated in Chapter 3, I discuss the structuring of transition work with reference to its embeddedness in socio-technical configurations, implying that the configurations represent ways of enabling, directing, or limiting transition work.

1.1 Purpose and objectives

Thus far, I have pointed to certain theoretical and empirical observations that remain fundamental throughout this thesis. First, despite the substantial amount of attention paid by transition scholars to dynamics and processes that drive sustainability transitions, and despite the recognized role of actors and agency in those processes, transition studies have yet to provide a comprehensive understanding of the active dimensions of agency that deliberately and purposefully propel transitions. Second, despite of ports being an obvious example of transition sites that could unite transition work across different sectors, scholars who focus

on sustainability transitions and port governance alike have yet to examine dedicatedly and comprehensively the activities that port organizations and port actors initiate to enhance sustainability.

Thus, by applying perspectives from sustainability transitions to investigate the sustainability efforts of the port sector, this thesis seeks to operationalize active dimensions of agency as transition work and to increase our knowledge and understanding of the content and shaping of transition work. More specifically, this thesis addresses the research questions listed in Table 1. The first question represents a response to what I consider is a gap in the operationalization of agency in transition studies, and which I mainly address with reference to established understandings of agency and change processes in studies of sustainability transitions, as well as science and technology studies . The second and third questions allow for an exploration of what transition work ports are doing, and how the transition work emerged. The three research questions are related to the empirical work described in this thesis, which is focused on the three Norwegian ports of Narvik, Kristiansand, and Oslo.

Table 1. Research questions concerning the concept, contents, and shaping of transition work.

Transition work		
	Concept	*RQ1: How could agency be operationalized to capture more fully the active dimensions that promote sustainability transitions?*
	Contents	*RQ2: How are actors in the port sector working to promote and accelerate transitions in and around ports?*
	Shaping	*RQ3: How do particular forms of transition work emerge?*

1.2 Structure of thesis

To increase our conceptual understanding of transition work, what transition work contains, and how it emerges, this thesis draws on empirical investigations of the port sector. The next chapter provides an overview of current knowledge about the sustainability efforts of ports and aspects that might encourage or discourage ports from explicitly engaging with sustainability issues. Drawing on literature from research on port governance, Chapter 2 also demonstrates the need for more deliberate investigation of not only what technologies and innovations ports are directing their attention towards, but also the *ways* in which ports deal with sustainability and the specific activities they engage in to realize sustainability strategies. Considering how the lack of attention to the actual practices of ports has been identified as a gap in research on port sustainability (Bjerkan & Seter 2019), conceptualizations of transition work could also facilitate further empirical investigations of sustainability efforts in the port sector.

The operationalization of active agency as transition work, and hence the first research question of this thesis, is covered in Chapter 3. As Chapter 3 shows, my understanding of transition work relates strongly to its potential for progressing sustainability transitions. As sustainability transitions are typically considered the products of change processes surrounding socio-technical systems, it follows that transition work could also be considered

a component of such change. Thus, Chapter 3 starts with an overview of existing notions of socio-technical change processes, as understood by research on sustainability transition and science and technology studies. Specifically, the ways in which these understandings of change processes account for and understand agency are crucial to my conceptualization of transition work. Although agency is a prominent feature in much of the theoretical lineage of this thesis, there is a need to move towards understandings of agency that more explicitly emphasize *applied agencies*, rather than latent agencies inherent in, for example, power and resources. For this reason, I present four arguments that demonstrate the need to conceptualize transition work, which relate to agency applied, the directionality of agency, epistemological understandings of agency, as well as existing use of the concept of transition work in the literature.

Chapter 3 further elaborates on understandings in the multi-level perspective that are particularly instrumental in framing discussions on the shaping of transition work. In Chapter 7, the shaping of transition work is discussed with reference to socio-technical configurations, the elements of which derive from understandings of transition dynamics primarily described by Geels (2004). In Chapter 3 I show how the different elements of such dynamics—socio-technical systems, actors, and sociotechnical regimes—and their interactions with niche and landscape pressures could all be expected to shape transition work in different ways.

Chapter 4 presents the empirical basis of this thesis. It gives an overview of the Norwegian port sector and the three ports that have been studied. It also describes how document studies and qualitative expert interviews (i.e., interviews with experts) have been applied to explore transition work, including what documents and actors were included in data collection, as well as strategies for data collection and analysis. The chapter ends also includes a short discussion of the transferability implications of data and methods. Considering that this thesis is anchored within the highly constructivist tradition of science and technology studies, Chapter 4 ends with some reflections on the naturalist character of the data collection.

Chapter 5 provides an overview of the three published papers included in this thesis. Specifically, the overview describes the transition work identified in the studies presented in the papers, as well as what elements of socio-technical configurations could have contributed to the emergence of specific transition work. Thus, Chapter 5 addresses the second and third research questions of this thesis, regarding the contents and shaping of transition work.

These research questions are discussed more fully in Chapter 6 and Chapter 7. Chapter 6 provides a thorough discussion of what types of activities (i.e., transition work) have been identified in the empirical investigations. More specifically, it distinguishes between six types of transition work—technological, visionary, policy and governance, political, reflexive, relational—that might be interconnected and/or induce other types of transition work. With reference to Papers 1–3, as well as understandings of socio-technical configurations presented in Chapter 3, Chapter 7 discusses what might have shaped the transition work described in Chapter 6. This is done with reference to eight claims about the shaping of transition work (as shown in Figure 2), concerning how transition work emerges in relation to socio-technical

systems, actors, technologies and innovations, intentional landscape pressures, and normative rules.

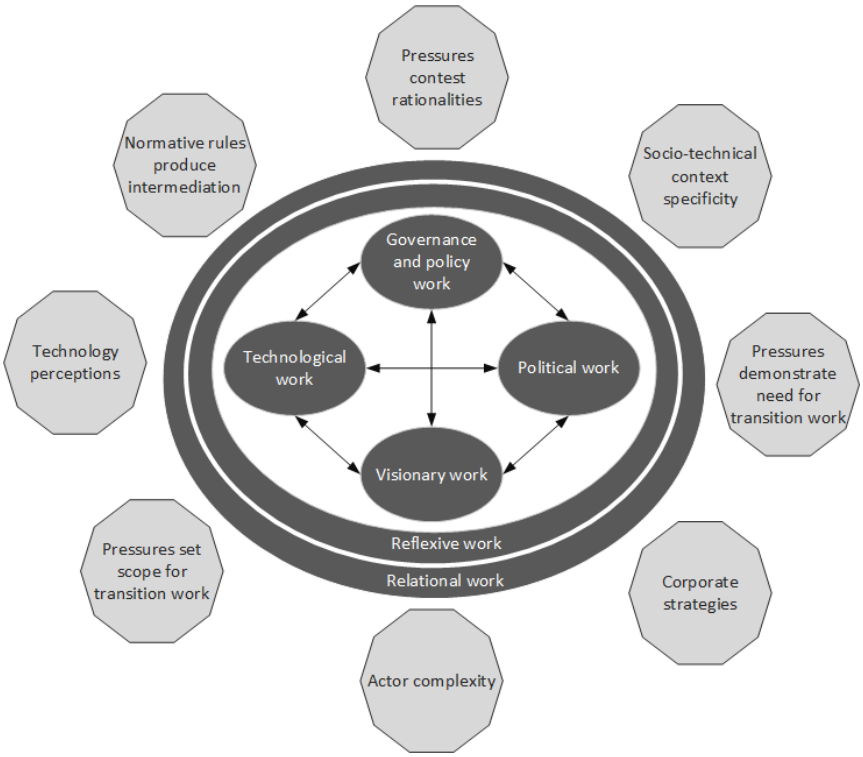

Figure 2. Types of transition work and socio-technical elements that shape transition work.

Finally, Chapter 8 presents the conclusions relating to the three research questions (listed in Table 1). The chapter also presents reflections on the potential of the port sector to drive deep or whole system transformations, and ways in which transition work could provide linkages between systems or socio-technical configurations in such transformation processes. It also includes some critical reflections on the motivations and transformative nature of transition work. Chapter 8 is concluded with some thoughts on the future of ports both as sectors and as the subject of research.

2 Previous research: decarbonization efforts in the port sector

Ports are facing increasing pressure to reduce emissions and negative impacts on their surroundings. In accordance with the European Green Deal (European Commission 2019b), "transport should become drastically less polluting" and the policy initiatives highlight efficient multimodal transport as a crucial element in achieving net zero greenhouse gas emissions from the EU member states within 2050. As nodes in transport, industry, and energy sectors, ports could be strategic partners in realizing such ambitions (ESPO 2020b, ESPO 2020d) because (1) they are potential producers, suppliers, and facilitators of clean energy solutions, (2) they can create synergies between industries, and (3) they are potential centers of circularity (ESPO 2020c).

Hence, the strategic importance of ports rests on their role in connecting several sectors and thus their ability to impact transition endeavors in those sectors. When referring to sustainability efforts in ports, one might readily think of activities aimed at the many operations taking place at the physical premises under the jurisdiction of the port authority or the port company. These typically comprise the lifting, stacking, and shifting of containers, the collection of port fees and waste, customs and security clearances, vessel repairs, and industrial production, all of which are carried out by terminal operators, goods owners, industrial companies, and providers of maintenance services. However, sustainability efforts in ports may also include activities aimed at the transport systems that intersect in ports. Sustainability efforts related to sea transport could, for example, be directed at the arrival, departure and (un)loading of vessels, fuel bunkering, and naval services linked to piloting and tugboat operations. By contrast, sustainability efforts related to land transport could be directed at the arrival, departure and (un)loading of trains and vehicles, as well as fueling. Furthermore, sustainability efforts aimed at both types of transport systems could involve shipping and transport companies, shipping and forwarding agents, owners of vessels and vehicles, fuels providers, and infrastructure owners.

Thus, port sustainability issues concern a number of different activities carried out by a range of different actors. Given that ports are located amidst these many actors and activities, they potentially play a crucial role in moving entire transport systems towards zero emissions.

The ways in which systems boundaries of sustainability activities are reflected in ports is also a central issue to be addressed in research and practice. This has generated a growing and substantial body of research on port sustainability.

2.1 The scope of decarbonization efforts in ports

Although transition studies have previously paid limited attention to the port sector, the practice field itself and scholars who study port governance provide valuable insights into port approaches to environmental sustainability. One valuable source of information on the sustainability efforts of ports are the environmental reports of the European Sea Ports Organisation, which provide regular, self-reported accounts of the environmental

performance and priorities of European ports.[2] In 2021, the five most prominent environmental priorities of European ports were air quality, climate change, energy efficiency, noise, and relationship with the local community. Figure 3 shows how the prominence of these priorities has evolved since 2004, demonstrating how air quality, energy efficiency, and noise have become stable focus areas in the European port sector. However, the importance of efforts targeting climate change has increased significantly. To some extent, this contrasts with environmental priorities in Norwegian ports, which still give lower priority to global emissions and energy use than to emissions to water and noise reduction (Bjerkan et al. 2021c).

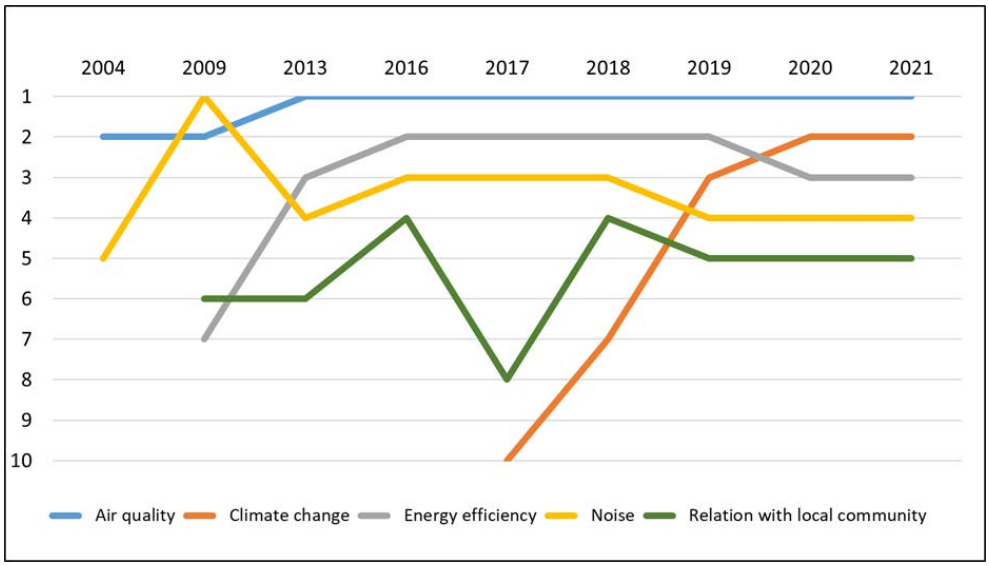

Figure 3. Ranking of the top five environmental priorities in European ports 2004–2021. Source: ESPO Environmental Report 2021 (ESPO 2021).

The scope of sustainability efforts in the port sector can also be understood from the many scientific studies that address the environmental performance of ports (e.g. Di Vaio et al. 2018, Puig et al. 2014). Environmental issues in ports cover the many dimensions of port activity, ranging from local and global air emissions from vessels, vehicles, and machinery to emissions to water and consumption, waste generation, and recycling (Table 2). This multitude of environmental issues, arising from the multitude of activities taking place in port areas and adjacent transport systems, also renders relevant a range of innovations and technologies that can improve port sustainability.

Research on port sustainability has focused mainly on how the sustainability efforts of ports could be aided by port policies and managerial solutions, such as port plans, concession agreements, monitoring, port dues, and energy management (e.g. Acciaro et al. 2014a, Acciaro et al. 2014b, Bergqvist & Egels-Zandén 2012, Ferrari et al. 2015, Schipper et al. 2017).

[2] The reports are based on self-reported data from member ports in ESPO, and thus comprise only a limited part of the European port sector. For instance, the *Environmental Report 2021* (ESPO 2021) is based on responses from 97 ports.

Researchers have also focused on the many ways ports can reduce emissions by producing and providing energy from renewable sources, such as wind, solar, wave, tidal, and geothermal, or by providing alternative fuels (e.g., hydrogen, LNG, methanol) or fuels with low sulfur levels (e.g. Calderón et al. 2016, Gibbs et al. 2014, López-Aparicio et al. 2017, Ramos et al. 2014, Styhre et al. 2017). In addition to supplying port users on sea and land with different types of fuels, port authorities could seek emission reductions in sea and land activities by promoting speed reductions for vessels approaching/departing the port areas (e.g. Jia et al. 2017, Linder 2018), by increasing the efficiency of port operations (e.g.Johnson & Styhre 2015, Moon & Woo 2014, Torkjazi et al. 2018), by promoting modal shifts (e.g. Bergqvist et al. 2015, Gonzales-Aregall et al. 2019), and by reducing emissions from industrial activities in ports (e.g. Fenton 2017).

Table 2. Environmental issues in ports and relevant innovations and technologies. Sources: Di Vaio et al. (2018), Bjerkan & Seter (2019).

Environmental issues	Air emissions	Environmental quality	Light emissions	Water consumption
	Air quality	Environmental policy	Noise	Water management
	Combustion	Environmental management	Pollutant emissions	Water quality
	Eco-efficiency	Environmental training	Port development	
	Effects on local ecosystem	Greenhouse gas emissions	Recycling	
	Emission control	Knowledge management	Resource consumption	
	Energy consumption		Shipping emissions	
	Environmental accidents		Waste generation	
	Environmental costs			
Relevant technologies and innovations	Automation	Electrification	Methanol	Shore power
	Biofuels	Geothermal energy	Modal split	Solar energy
	Clean industrial activity	Hydrogen	Monitoring	Speed reduction
	Collaboration	LNG	Concessions	Tidal energy
	Efficient vessel handling	Low-sulfur fuel	Port dues	Wind energy
	Efficient trucking	Management of environment and energy	Port plans	Wave energy
	Efficient loading/unloading			

Although significant research has been done on technologies and innovations that might reduce emissions from ports and connected transport systems, it has tended to emphasize potentials and opportunities associated with these solutions rather actual implementations and empirical experiences. Thus, research has provided limited knowledge about actual, practical sustainability efforts in ports (Bjerkan & Seter 2019), which is necessary to assist decision-makers in ports and policymakers in identifying and specifying potential and promising avenues for continued transition efforts.

However, in recent years there has been an increasing focus on the actual sustainability endeavors of ports. In a recent study of 93 ports worldwide, Sornn-Friese et al. (2021) examined ports that did and did not adopt solutions to reduce air emissions, while Ashrafi et al. (2019) conducted a survey to investigate sustainability efforts and approaches to corporate social responsibility in Canadian and US ports. Canadian ports were also targeted by Hossain et al. (2019), who particularly investigated their use of administrative and managerial measures. Other studies have taken qualitative approaches to understand the scope and content of sustainability efforts in ports. Poulsen et al. (2018) conducted interviews with port

representatives to learn about their experiences and assessments concerning specific solutions for reducing emissions from port activities, such as shore power, LNG, virtual arrival, and traffic management. Similarly, Lozano et al. (2019) interviewed representatives of a Swedish port and its users to study how organizational change management in ports could promote port sustainability. The above-mentioned studies have provided a first glimpse into factors that shape sustainability efforts in ports. For instance, the authors found that economic costs and financial concerns outweighed environmental concerns. They also suggest that ports engage in sustainability issues when they are located close to urban populations, and when emissions are visible, when there is governmental push, and when potential solutions are easily implemented and financed.

Most research on port sustainability relates to the practices of large, front-runner ports. Hence, small and medium-sized ports, which comprise the majority of ports in Norway and worldwide, have received less attention. The sustainability efforts of Norwegian ports have recently been examined through a survey of 96 Norwegian private and public ports, and the findings revealed what technologies and innovations that the ports were orientated towards, as well as the scope and character of their sustainability efforts (Bjerkan et al. 2021b, Bjerkan et al. 2021c). As shown in Figure 4, 82% of Norwegian ports had implemented at least one measure to improve sustainability, and shore power was the most frequently implemented measure (Bjerkan et al. 2021b). The finding corresponds with the finding in the latest ESPO environmental report (ESPO 2021), which shows that 57% of the European ports in the sample had implemented shore power in 2021. The report also shows that 31% of ports had implemented LNG, and 53% had implemented differentiated port fees for vessels with greener fuels. Furthermore, in Norwegian ports, the most prominent drivers in implementing solutions to improve sustainability relate to support and pressure from owners and the surroundings, as well as political governance and steering by port owners. Economic conditions also represent primary barriers, followed by access to and demand for low-emission technologies (Bjerkan et al. 2021b).

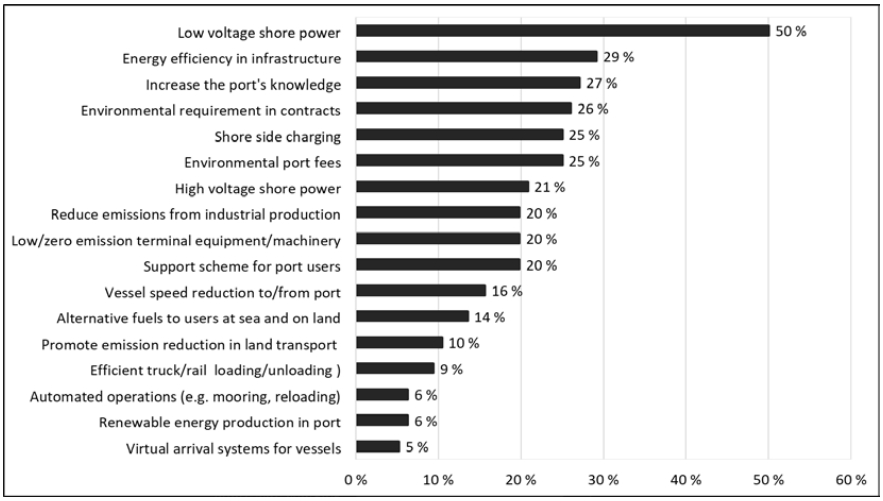

Figure 4. Technologies and innovations implemented by Norwegian ports.
Source: Bjerkan et al. (2021b:12).

2.2 Renewed port functions and implications for sustainability

Research on Norwegian ports shows significant variation in whether and how ports address sustainability. For example, there are clear differences in the approaches followed by private and public ports, ports with dissimilar traffic volumes and characteristics, and ports that take either more or less active roles in facilitating sustainability endeavors in the entire port area (Bjerkan et al. 2021b, Bjerkan et al. 2021c). Damman and Steen (2021) discuss how opportunities for enabling energy transitions in ports relate not only to exogenous landscape pressures and the involvement with niche innovations, but also to place and geographical contexts, to the networks and institutions each port belongs to, and the opportunities provided by each port's role and functions. Port functions have received substantial attention in the literature on port governance and go a long way in describing the contexts within which ports execute their sustainability efforts.

In recent years, the literature on port governance has increasingly discussed how port functions have evolved in response to structural changes in the port sector. Historically, ports have been considered engines of economic growth in coastal areas and the hinterland through creating jobs, providing cheap and effective transport, and enabling exchanges of goods and materials (Cheon 2017, Dwarakish & Salim 2015). In Norway, the primary activity of ports has been to facilitate maritime transport (Ports of Norway 2017). Hence, the functions of ports have been geared to facilitating and enabling flows of information, materials, resources, and people within and between countries, and across seas and oceans (Fenton 2017:271).

Scholars who have studied port governance have typically distinguished between three main functions that port authorities have sought to uphold: the landlord function, the regulator function, and the operator function (Acciaro et al. 2014b, Poulsen et al. 2018, Verhoeven 2010). As landlords, ports act as owners responsible for port areas and the port's estate, infrastructure, and facilities. This implies ensuring that they are maintained and developed in an appropriate and efficient manner, and in line with policies and plans established to ensure responsible management of physical resources (Verhoeven 2010). The landlord function is still quite prominent in Norwegian ports, and approximately 80% of ports work with the administration, maintenance, and development of property (Bjerkan et al. 2021c). By contrast, the responsibilities inherent in the regulator function are more immaterial and include controlling, surveillance, and policing (Verhoeven 2010). Depending on the types of activities and operations that characterize the individual port, ports need to comply with and uphold different regulations related to the handling of goods, passengers, and vessels, such as regulations concerned with environmental protection, health, and safety issues. This also includes ensuring that port users and tenants abide by the same regulations. Many ports are highly focused on environmental security and complying with regulations to protect against spills and emissions to water. In some cases, the ports themselves also issue and enforce own regulations, for example when they include environmental scores as a basis for calculating port fees for vessels. Overall, most Norwegian ports are dedicated to the regulator function, and over 90% claim to impose requirements, rules, and fees on their users (Bjerkan et al. 2021c).

Historically, ports have also taken on the role as operator, which implies that the port organization itself is responsible for carrying out port services, such as handling goods and waste in the port area and technical-nautical services such as pilotage, towage, mooring, and anchor services (Verhoeven 2010). However, the operator function has been increasingly outsourced and ports are less often involved in practical port operations and services. In Norway, only 25% of ports provided port services themselves in 2020, while 42% were involved in the practical handling of goods and passengers (Bjerkan et al. 2021c). However, while the operator function has diminished throughout the port sector, another function has emerged and become vital to the continued development of ports, namely the community manager function.

Community management is "a coordinating function, meant to solve collective action problems in and outside the port area, such as hinterland bottlenecks, training and education, ICT, marketing and promotion as well as innovation and internationalization" (Verhoeven 2010:257). It also involves lobbying on behalf the port community, as well as aligning interests (Verhoeven 2010), and ensuring good relationships between port actors (Chlomoudis et al. 2003). This aspect of the community manager function relates to the position of ports as links in global supply chains, allowing and catalyzing also global economic growth and development (Becker et al. 2013). The position fits with the increasingly global character of the port sector, in which increasing disconnection between the port and economic actors discourages the latter from binding their operations and investments to their local port. This requires ports to find new ways to uphold relationships with existing users and customers and to establish relationships with potential users and customers (Verhoeven 2010). Another aspect of the community manager function relates specifically to increasing pressures regarding environmental sustainability. The environmental dimension of port sustainability has received less attention in the past than social and economic dimensions. The economic dimension of port sustainability (Sislian et al. 2016), which highlights returns on investment, efficient land use, and facility provision, could be considered a core dimension in the landlord function of ports. The social dimension of port sustainability, which highlights labor in port areas, relations with local communities, and the livability of neighboring areas (Sislian et al. 2016), has been prominent in the operator function of ports, but has also been strengthened as ports have moved towards community management.

Ports have a dual nature as public bodies with corporate characteristics that are "deeply rooted in the local normative and social context" (Acciaro 2015:293). This suggests that ports need to acknowledge their own impacts on the development of local communities in order to maintain their license to operate (Verhoeven 2010). Thus, the environmental dimension of port sustainability has arisen from the need to seek legitimacy from local communities and public opinion, as well as from customers and users (Acciaro 2015). Also, pressure from markets and governments to address the societal and environmental dimensions of ports has fostered the prevalence of the community manager function (De Langen 2007), and has increased ports' stake in environmentalism, urban development, labor conditions, and the interests of neighboring communities (Verhoeven 2010).

Conventional port authority functions could enable sustainability efforts through, for example, including environmental concerns in port development projects (landlord function),

monitoring and regulating pollution (regulator function), or reducing emissions in the port authorities' own activities (operator function) (Acciaro et al. 2014b). In private ports in particular, port authorities could also engage port users in sustainable behavior by drawing on the mechanisms available to the port through the landlord and regulator function (Verhoeven 2010). However, even more explicitly, the community manager function encourages multilateral engagement with the different sets of users that inhabit and comprise port operations and activities. Ports that attend to the community manager function actively seek to promote sustainability efforts also among port users and stakeholders by promoting the use of technologies and practices that reduce emissions, and by demonstrating marketing opportunities associated with showcasing green profiles and specific sustainability efforts (Acciaro et al. 2014b). Furthermore, the sustainability efforts of community managers are characterized by collective action, the alignment of interests, and lobbying on behalf of the port community, as the ability to demonstrate environmental performance is a strategic effort to ensure the legitimacy of entire port clusters (van der Lugt et al. 2013).

The degree to which different port authority functions correspond to sustainability efforts has not received substantial attention in research on port governance. One exception is a Norwegian study that found community management to be prominent among port authorities that were progressive in their sustainability efforts (Bjerkan et al. 2021c), for example by reducing energy use, working strategically to become low- or zero-emission ports, and implementing more technologies and practices to improve port sustainability.

In sum, this chapter has shown that the functions of ports are evolving in ways that make ports orient more actively towards their communities and towards environmental sustainability. However, the chapter also highlights a lack of empirical research on sustainability efforts in ports, specifically how port organizations and other actors in ports engage to facilitate and promote environmental sustainability. The gap in knowledge highlights the need to pay more direct attention to port practices and activities aimed at sustainability. In the next chapter I seek to accommodate this need by conceptualizing transition work, thus responding to the first research question in this thesis, about the conceptualization of transition work.

3 Transition work for systemic change

To provide an elaborate and theoretically grounded understanding of transition work, I will in this chapter present and discuss theoretical underpinnings that I consider useful to conceptualize transition work. I will also exemplify insights from sustainability transitions and STS that can inform about the transition work of ports. Additionally, I present my approach to discuss the shaping of transition work.

My conceptualization and understanding of transition work is closely related to notions of change, as transition work could per se be considered efforts to induce change. Studies of sustainability transitions are concerned with dynamics of stability and change. More specifically, they are dedicated to understanding change processes that lead towards sustainability, and they rely on understandings of socio-technical systems to study such processes. Therefore, I start with an introduction to the concept of socio-technical systems, before presenting a selection of perspectives on socio-technical change and stability. These theories—placed within both studies of sustainability transitions and within science and technology studies —all provide perspectives on the nature of change processes in which actors, users, and other agents are all prospective executors of transition work.

3.1 Socio-technical systems

Transition scholars typically consider socio-technical systems to encapsule societal functions, which are upheld and reproduced by the socio-technical systems that constitute them (exemplified in Table 3). According to Sorrell (2018:1269), a socio-technical system comprises "the dominant technologies, infrastructures, industries, supply chains and organizations associated with delivering a particular function." Such societal functions may be water supply, housing, energy provision, and transport. Performing these societal functions depends on linkages and alignment between "tangible and measurable elements," which are reproduced, maintained, and modified by social groups and actors (Geels 2005, Geels 2012, Geels & Kemp 2007). Transition scholars also highlight the cohesion provided by institutions, as they embed or produce certain values and beliefs that guide actor behavior (Fuenfschilling & Truffer 2016, Genus 2016). In addition, transition scholars particularly emphasize the core technologies of socio-technical systems (Sorrell 2018), the strength and position of which is shaped by their co-evolution and interdependence with other elements in the socio-technical system (Geels 2004).

One vital societal function of ports is facilitating the shifting of goods between land and sea transport, in which cranes and stackers are core technologies. The operation of these technologies depends on infrastructure for refueling or recharging, and on networks for repairs and maintenance. Furthermore, ports relate to a range of other artifacts, such as containers, ships, trucks, and the goods themselves. The technologies and the artifacts are operated by dock laborers and sailors, who incorporate their usage into their own practices and develop knowledge about them accordingly. The operation of technologies and artifacts is also bound by regulations related to health, safety, and environment, and regulations concerning air emissions and noise levels. Thus, following understandings of socio-technical systems, the successful shifting of goods (i.e., the societal function of ports) emerges from smooth and mutually supportive interaction between core technologies, infrastructure,

maintenance and repair networks, other artifacts, user practices, and regulation. It could also rest on norms and routines following historical cultural practices associated with transporting particular types of goods in particular ways or along particular routes.

Table 3. Elements of socio-technical systems
Source: Geels (2004, 2005, 2011), Geels & Kemp (2007)

Artifacts	Knowledge	Regulation
Consumption practices	Maintenance networks	Science
Cultural meaning	Markets	Supply networks
Cultural discourse	Production networks	Technology
Infrastructure	Public opinion	User practices

Socio-technical systems enable societal functions because they have become stable over many decades (Geels 2018a). Transition scholars argue that the stability of socio-technical systems is preserved by their material, economic, and social characteristics. The materialist component of socio-technical systems (e.g., in the form of cranes, docks, and containers) produces stability because it is hard to abandon, while sunk investments in infrastructure, production lines, and skills reduce willingness to invest in new technologies that could also uphold the societal function covered by the socio-technical system (Geels 2004). In the port sector, stability is also provided by existing market structures, in which fierce inter-port competition imposes a great risk for ports that, for example, wish to introduce alternative fuels for vessels. Additionally, stability is provided by regulations that define the autonomous nature of public ports, allowing them to emphasize the commercial aspects of their mandates rather than societal aspects. Equally importantly, socio-technical systems are stable because they are inherently tied to social actor groups, the interactions of which not only produce, maintain, and modify the socio-technical system, but also introduce interests, perceptions, values and norms, preferences, strategies, and resources (Fraedrich et al. 2015:2). Geels (2012) argues that the socio-technical systems themselves also impact social practices, as "people adapt their lifestyles to artifacts" (Geels 2004:911).

3.2 Socio-technical stability and change

The stability of socio-technical systems is at the core of understandings of socio-technical change. This applies to research in sustainability transitions and STS alike, as understandings of socio-technical change connects to a series of perspectives typically located within these (Sovacool & Hess 2017, Sovacool et al. 2020a). Sustainability transitions are considered to occur when socio-technical changes lead for example ports to uphold their societal function in a more sustainable manner. The ways in which socio-technical changes occur have been subject to extensive scholarly discussions, and in this thesis, I contribute to the discussions by suggesting that transition work is an accelerating force in developing and altering socio-technical systems. However, this understanding of transition work builds on several notions of socio-technical stability and change, as represented by transition scholars, as well as understandings from science and technology studies (STS).

3.2.1 Perspectives from science and technology studies

Three perspectives from science and technology studies (STS) are particularly useful in understanding socio-technical stability and change: large technical systems (LTS), social

construction of technology (SCOT), and actor-network theory (ANT). These discuss how systems, technological artifacts, and networks could achieve dominance and preference by becoming stable and competitive vis-à-vis other systems, artifacts, and networks. In each perspective, the roles of actors and agency are central in establishing such stability and enhancing competitiveness. Thus, although the perspectives are not very explicit about change processes, they point to how actors orient towards systems, artifacts, and networks, and how actors relate to the socio-technical arrangements of which they are part.

The idea of large technical systems (LTS) was originally introduced by Thomas P. Hughes (1983, 1987), who considered such systems to consist of "messy, complex, problem solving components" (Hughes 1987:1), such as technological and physical artifacts, social organizations, natural resources, scientific components, legislation, research, and teaching programs. The core focus of LTS has been the construction and development of systems (i.e., the networks of technical and non-technical components), which Hughes considered to evolve through interactions between their different components and through the systems' interaction with their surroundings. Furthermore, LTS were perceived to evolve through "patterns of evolution," referring to the different stages through which technical systems mature and gain momentum. Momentum emerges with the accelerated alignment of volumes of interconnected social and technical system elements, thereby increasing the system's influence on other systems, groups or individuals (i.e., soft determinsism, Hughes 1987). Paramount to the successful evolution of LTS, i.e. their ability to exert soft determinism, was therefore the building of strong, aligned LTS. Such *system building* involved solving technical and social issues that might keep system components and functions from being arranged in ways that would "maximize efficiency of a given technique, process or goals" (Sovacool & Hess 2017:716). For instance, in the port sector, port organizations' increasing orientation towards the community manager function, as discussed in Chapter 2, could reflect an increasing orientation towards system-building, in which ports work to identify and implement low-emission technologies and create dialogue between users and providers to incorporate technologies in daily port operations. Thus, Hughes (1987) considered technical systems to be socially constructed, which is one expression of how actors could influence change and stability in LTS.

Another STS perspective that sheds light on the role of actors in socio-technical stability and change is social construction of technology (SCOT). While LTS has typically been applied in studies of large systems like power grids and district heating, SCOT has primarily been applied to studies less systemic artifacts, such as bikes. First formulated by Pinch and Bijker (1984), SCOT emerged as a response to deterministic perspectives on technology, which assumed that technologies existed independently of where, when, or by whom they were constructed. Like the way LTS was concerned with the competitiveness of technological systems, SCOT has been concerned with the competitiveness of technological artifacts and selection processes in which new technological artifacts or specific variations of artifacts prevail because of their perceived superiority. According to SCOT, the superiority of technological artifacts derives from the meaning that relevant social groups ascribe to them, particularly meanings relating to the artifacts' ability to solve problems and provide solutions.

One example from the port sector of how technological artifacts are ascribed problem-solving capabilities relates to the introduction of shore power: Although emissions from sea transport occur mainly *between* ports, local protests about visible air pollution in Norwegian fjords have contributed to frame shore power technology *in ports* as a solution to emission problems in the maritime transport sector. This could also be regarded as an example of how one particular group (e.g., local protesters) attributes meaning to a given technological artifact. SCOT holds that technological artifacts might be perceived differently by different social groups with regard to their differing potential for solving problems and providing solutions. SCOT assumes that different perspectives could produce conflicts and controversies around what technological artifact should be selected over others. Thus, following SCOT, actors contribute to (de)stabilizing technological artifacts through contestations between social groups' perception, interpretation, and sensemaking of technological artifacts.

Yet another set of thoughts on socio-technical stability and change exists in actor-network theory (ANT), which focuses on the strength of reciprocal relationships between artifacts and actors. As different understandings within ANT have evolved and diverged over time, it is challenging to present a simplified idea of ANT. Therefore, I highlight a few core concepts that inform about how socio-technical stability and change could be perceived through the lens of ANT. Originally introduced by Callon (1986), Latour (1987), and Law (1992), ANT has been concerned with understanding processes that produce stability and support around technologies or facts, but has also been oriented towards processes that produce "societal stability and order" (Skjølsvold 2015:87). At the core of these processes are human and non-human actors who act and interact to pursue their own goals and objectives. In contrast to SCOT, the original thinkers behind ANT emphasized that there is reciprocal shaping between humans and artifacts. For example, in ports, artifacts could shape humans through the introduction of electric and automated cranes, which change planning procedures and work processes among port administrators and stevedores. This emphasis on non-human actors (actants) is particular to ANT and expresses ANT-related perceptions that objects, artifacts, and technologies themselves have agencies that impact their relations and interactions with other actors. ANT thus diverges from SCOT theory and other sociological understandings by placing symmetrical emphasis on what human and non-human actors do, and by opening the black box of social structure (Latour 1999). Following a highly empiricist orientation, ANT assumes that social structure can only be observed by studying how structure is enacted. Thus, the flat ontology of ANT perceives structure as only observable if we can observe what actors do.

Thus, following ANT, stability is maintained by networks of human and non-human actors, which seek to solve controversies and enroll actors into their networks. Crucial to network building is *translation* (Callon 1984), which could increase the coherence and durability of actor-networks by developing shared understandings, ideas, and interests. More specifically, translation could strengthen *relations* between actors, by aligning them and making them more equipped to promote the establishment of a particular fact, technology, or worldview. As I show in Chapter 6, the Port of Oslo's work on uniting its users around a shared vision for the future zero-emission port could be considered one example of such translation efforts.

The above-presented STS perspectives all suggest that stability and change relate to socio-technical processes: in LTS socio-technical change appears in the social construction of technical systems, in SCOT it appears in social perceptions of technological artifacts, and in ANT it appears in networks that include actors (social) and actants (technical). These strands of thought have evolved in close relation to each other, and all three perspectives are concerned with interactions between the social and the technical. These perspectives are also foundational aspects in assumptions that guide studies of sustainability transitions, which are devoted to understanding how societies transform in sustainable directions.

Although transition scholars do not necessarily make explicit connections with STS, the research field of sustainability transitions is considered to lend an ear to "STS inspired socio-technical perspectives" (Sovacool et al. 2020a:2). This is apparent in overviews of main trends in transition studies (Hess & Sovacool 2020, Köhler et al. 2017, Köhler et al. 2019, Loorbach et al. 2017, Sovacool et al. 2020a), which clearly display their STS legacy. This legacy relates primarily to shared emphasis on socio-technical change processes, but it is also apparent in how transition studies increasingly study actors as "active players in socio-technical change" (Köhler et al. 2019:24), in ideas of windows of opportunity (Geels 2007b) and transition pathways that originated in LTS understandings of "momentum" (Sovacool et al. 2020a), and in perspectives tending to the arrangements of actors and networks around emerging innovations and technologies (e.g. Hekkert et al. 2007, Rip & Kemp 1998).

Current approaches to understanding sustainability transitions build on concepts and ideas that started to develop in STS during the 1980s. Approaches to sustainability transitions also represent a continuance of early transition research, which focused on understanding technological innovation and historic technological transitions, as represented by shifts in transport from horse-drawn carriages to automobiles (Geels 2005), shifts in water management (Van der Brugge et al. 2005), and shifts in sewage systems (Söderholm 2013). Although they have a shared understanding of the socio-technical and ways in which socio-technical systems are (de)stabilized, studies focused on sustainable transformations depart from STS and the thinking of early transition scholars on one crucial point, namely, the focus on changes towards sustainability, which gives this line of research a specific directionality. While traditional STS theories are equally concerned within maintaining stability (e.g., through strong actor networks or technical systems), and while early transition research aimed to understand any technological transition, studies of sustainability transitions are specifically geared to understand the socio-technical prerequisites for sustainable changes. As such, studies of sustainability transitions also bear more normative connotations, related to the different pathways that societies might follow towards sustainability. In the following (Subchapter 3.2.2), I give brief accounts of how (the promotion of) socio-technical change is understood within the field of sustainability transitions.

3.2.2 Perspectives from sustainability transitions

In addition to their STS lineage, studies of sustainability transitions draw on a range of scholarly disciplines, providing a well of approaches to researching, analyzing, and understanding societal change. Studies of sustainability transition are typically considered to consist of four main frameworks, all of which provide perspectives on how socio-technical

change occurs or could be induced. Scholars following ideas of *strategic niche management* (SNM) assume that change occurs through the emergence, build-up, and breakthrough of new niche innovations that are better equipped to uphold societal functions than existing socio-technical configurations. Therefore, SNM is dedicated to understanding how emerging niches could gain traction, for example through establishing protective spaces in which innovations are empowered, nurtured, and shielded from competition with more mature technologies (Smith & Raven 2012). Also, the ability to create visions and expectations, build resourceful actor-networks, and deep learning are essential for promoting niche innovations that propel change (e.g. Geels & Smit 2000, Markard & Truffer 2008, Naber et al. 2017).

The development and strength of emerging technologies is also key among scholars who study *technological innovation systems* (TIS), and who consider change to result from the strength of systems that support emergent technologies. In short, TIS scholars consider the prospects of technologies to derive from interactions between actors, networks, institutions, and technologies that impact innovation processes surrounding emergent technologies (e.g. Bergek et al. 2008).

Following understandings of *transition management*, socio-technical change can be governed. Transition management is typically referred to as experimental governance (Loorbach 2007), and prescribes strategic, tactic, operational, and reflexive activities that actors can engage in to promote, initiate, or accelerate change (Loorbach 2010, Loorbach & Rotmans 2010, Wittmayer & Loorbach 2016). Transition management suggests that economic, technological, and institutional barriers and lock-ins impede sustainable problem-solving, and that such lock-ins could be destabilized when front-runner networks with shared understandings and agendas engage in (transition) experiments to learn and adapt continuously (Loorbach & Shiroyama 2016).

The final framework within studies of sustainability transitions is the *multi-level perspective* (MLP), which scholars have sought to integrate with numerous theoretical perspectives and research traditions (e.g. Coenen et al. 2012, Lawhon & Murphy 2012, Vähäkari et al. 2020). Scholars have also pointed to convergences with LTS, SCOT and ANT (Geels 2010, Genus & Coles 2008). Understandings of multi-level change dynamics were first described by Rip and Kemp (1998), and were later conceptualized further through Frank Geels' development of the multi-level perspective. The MLP emphasizes three dimensions of change (Geels 2005:449): socio-technical systems, socio-technical regimes, and social groups. These concepts are at the core of discussions relating to the third research question in this thesis, about how particular forms of transition work emerge. Therefore, in the following (Subchapter 3.2.3) I provide more elaborate accounts of MLP understandings of socio-technical change.

3.2.3 Multi-level perspectives on socio-technical change

In Subchapter 3.1 I have shown that societal functions, such as those maintained by ports, are upheld by socio-technical systems comprising, for example, technologies, industries, infrastructures, regulation, and science. In line with the MLP, socio-technical change occurs when socio-technical systems are no longer able to uphold societal functions in their current form, and when systems are forced to adapt or replaced by new socio-technical systems. Thus, socio-technical change is the product of destabilization in socio-technical systems.

Furthermore, according to the MLP, the stability of such systems is provided by actors and socio-technical regime, which are intangible and underlying deep structures. Some of the central elements of socio-technical regime, as described in transitions literature, are listed in Table 4 (i.e., the list is not comprehensive). Geels (2011:27) describes the regime as a "semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems." More specifically, he describes socio-technical regimes as sets of normative, cognitive, and regulative rules that provide stability in the socio-technical system by guiding the perceptions and actions of actors. In turn, these rules are reproduced by the very same social groups that are abiding by them (Geels 2004).

In his much-cited paper on the nature and functioning of socio-technical systems, Geels (2004:905) suggests that socio-technical regimes are comprised of a number of subregimes (e.g., technological regimes, policy regimes, science regimes, markets regimes) that collectively and coordinately provide strength and support for elements in the socio-technical system. Therefore, the strength and durability of the socio-technical regime is a product of how strongly rules in different subregimes align; whereas strong socio-technical regimes are characterized by specific dominant rules, weak socio-technical regimes are characterized by competing rule sets that "threaten the overall structure of the system" (Fuenfschilling & Truffer 2014:776).

Table 4. Elements of socio-technical regimes
Sources: Geels (2002, 2004, 2005), Geels & Kemp (2007), Sorrell (2018)

Capabilities/competences	Legally binding contracts	Regulation	Symbolic meanings
Cognitive capital	Lifestyles	Regulatory rules	Technical standards
Cognitive routines	Normative rules	Role perceptions	Technology
Cognitive rules	Norms	Rules of thumb	Techno-scientific knowledge
Engineering beliefs	Markets	Routines	Understandings
Guiding principles	Policy	Shared meanings	User practices
Heuristics	Policy paradigms	Social expectations	Visions
Identities	Problem agendas	Standardized ways of doing	Ways of life
Industry structure	Promises	Subsidy rules	
Infrastructure			

In line with the MLP, transitions occur when regime rules no longer support and reproduce the socio-technical system, implying that socio-technical systems change when regime rules are altered (Geels 2011:26). Such alteration occurs when pressures from niche innovations and the socio-technical landscape causes cracks and instability in the rule sets of regimes, leading to reorientations in perceptions and behaviors (illustrated in Figure 5). From a niche perspective, transitions occur when "successful niche innovations (…) trigger a series of interrelated technical, economic, social and cultural changes that may eventually combine to create a new and different sociotechnical system based around a different set of core technologies" (Sorrell 2018:1270). New technologies and innovations that could cater to a societal function evolve and start diffusing outside the socio-technical system, in so-called niches. Niches could either represent a particular market segment with other demand criteria than markets in the socio-technical system, or they could represent specific technologies that are protected by subsidies, public policy, or strategic investments (Geels & Kemp 2007). The

niches protect emerging innovations from competition with established technologies (Geels 2004), allowing new innovations to increase their support from social networks, and to develop relationships and mutual expectations with actors. Arguably, such niches could be considered underdeveloped and unstable socio-technical systems themselves, with their own actors and tangible elements, albeit connected to less articulated and clear-cut rules (Geels 2004, Geels & Kemp 2007). They could also become so stable that they begin interacting with incumbent regimes, altering regime characteristics altogether.

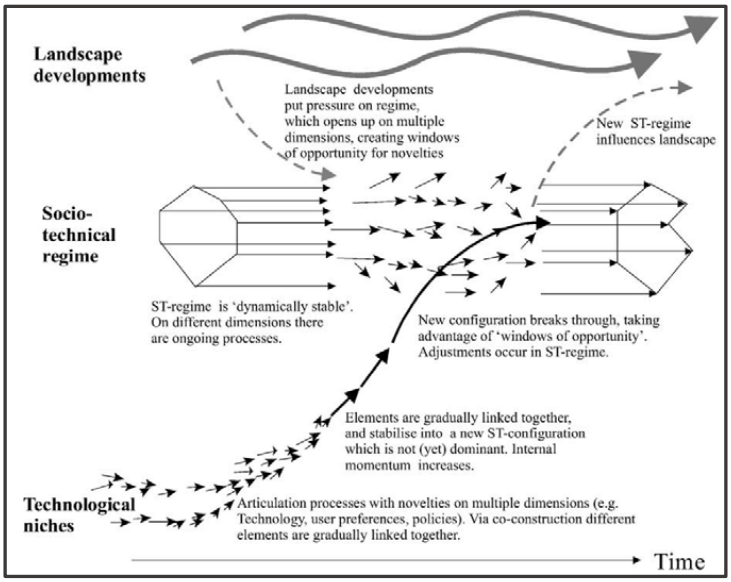

Figure 5. Overview of transition dynamics in the multi-level perspective
Source: Geels (2004:915).

As articulated by the MLP, transitions are also ushered in when landscape developments place pressure on the socio-technical regime. The concept of landscapes was originally introduced by Rip & Kemp (1998), who described them as deep structural gradients of force that make some actions easier than others. In the MLP, the concept has been used to define external heterogenous factors on the macrolevel that are harder to change than the regime elements, and that are beyond the direct influence of actors (Geels 2002, Geels & Kemp 2007). The landscape provides a structural context for the regime, niches, and actors, and could provide intentional pressures, as well as unintentional pressures (Morone et al. 2016). Typical examples of landscape pressures include oil prices, economic growth, demographic change, war, migration patterns, political coalitions and ideologies, cultural, societal, and normative values, social movements, emerging scientific paradigms, and environmental problems. Landscapes also include material and spatial arrangements and contexts, which tend to change more slowly than, for example, political landscapes (Geels & Kemp 2007).

Although the MLP has provided transition studies with a range of widely used tenets, it has also been subject to extensive criticism. Some criticism relates to its originally hierarchical approach, while other criticism concerns methodologies and applications. Critics have particularly pointed to unclear conceptual and empirical boundaries between the regime and

the socio-technical system, and that the regime concept is difficult to specify and operationalize empirically (Berkhout et al. 2004, Genus & Coles 2008, Markard & Truffer 2008, Smith et al. 2005, Sorrell 2018). In response, Geels (2011) advocates the MLP as an open framework that guides our attention to "relevant questions and problems" and to the processes of transition. He labels the MLP a "global model," in contrast to rigorous and statistical models that are unable to capture the complexity of phenomena. As such, he argues, vague and imprecise methodologies pose less of a problem to the MLP, as understanding transition by necessity requires an element of creative interpretation.

Another set of criticisms relates to the MLP's take on change processes. The landscape level has been criticized for its inadequate nuance regarding different types of landscape pressures and for its dual relationship with the regime level, as landscapes can stabilize regimes while themselves also being destabilized by regime shifts. Critics have further argued that the MLP assumes socio-technical change to emerge bottom-up from the niche level, thus insufficiently recognizing the potential of changes in the regime and landscape to induce transition too. Hence, the MLP is criticized for disregarding that specific change agents are not necessarily fixed at one level, and that the timing of transitions dynamics is not necessarily linear (e.g. Raven et al. 2012, Skjølsvold & Ryghaug 2020). Geels and Schot (2007) counter such criticism by referring to a set of pathways that transitions might follow, and in which landscape pressures and the destabilization of regimes might precede the emergence and penetration of niche innovations.

One of the original criticisms of the MLP also concerned its lack of agency. Conceptualizing and understanding transition work, which is at the core of this thesis, calls for understanding the role of agency in socio-technical change. In my understanding of transition work, which is elaborated further in Subchapter 3.4, the ability of actors to induce socio-technical change is essential. Moreover, in the preceding subchapters 3.1 and 3.2 I have demonstrated that the roles of actors and agency in producing stability and change are already addressed by perspectives on sustainability transitions and STS alike. To conceptualize transition work and add to the theoretical foundations upon which transition work rests, I next account for how agency is currently understood in STS and transition studies.

3.3 Agency for systemic transformation

The STS heritage of studies of sustainability transitions is filled with agency, and could as such hint towards the contents of transition work. For instance, understandings of large technical systems (LTS) emphasize *system building*, in which actors seek to make and change LTS in ways that allow them to solve problems effectively, and thereby to progress LTS through different phases of development (Hughes 1987). In SCOT, agency is apparent in how *users* contribute to the development of technology through interpreting and attaching meaning to technology, and through establishing user practices that (re)shape user perceptions (Pinch & Bijker 1984). Also, ANT stresses agency quite significantly by highlighting the equal agency of humans and artifacts that engage in "relations of alliance and conflict" (Sovacool & Hess 2017:720) and seek to solidify the networks that they are associated through translation (Callon 1984, Callon 1986). As elaborated below, understandings of agency that are expressed in STS depart from understandings in sustainability transitions in several regards, which is also reflected the way

I conceptualize transition work in this thesis. In the following subchapter, I review more fully how agency is understood in studies of sustainability transitions, as well as what specific activities such studies raise as expressions of agency. In addition to guiding the operationalization of active agencies as transition work (RQ1), the review directly informs about the potential content of transition work (RQ2).

3.3.1 Agency and structure

In seeking to conceptualize agency in sustainability transitions, scholars have relied on different theoretical outsets. For example, Kern (2015) discusses the role of agency in understandings of technological innovation systems. Seyfang et al. (2010) rely on grassroots innovation theory, and new social movement theories to emphasize the potential agency of civil society in sustainability transitions. Others have discussed agency as expressed in intermediation (Bergek 2020, Kanda et al. 2020, Kivimaa et al. 2019a) and users (e.g. Hyysalo et al. 2017, Schot et al. 2016). Many scholars also discuss how agency relates to the contexts within which it is executed. For instance, Pesch (2015) relates agency in sustainability transitions to "discursive fields," which are bodies of meaning that actors rely on when engaging in social action. He argues that changes emerge when discursive fields are altered, thereby altering actor behavior altogether. Pesch further claims that agency problems in studies of sustainability transitions are a consequence of highly structuralist approaches to transitions: as structuralist approaches seek to understand social order and stability, they are less equipped to explain social change. This has produced an institutional turn in transition studies, which considers transitions to be processes of institutional change (Fuenfschilling & Truffer 2016:298), in which "institutionalization is a process of increasing structuration" (Fuenfschilling & Truffer 2014:775).

Thus, the originally sociological dichotomy of structure and agency seeps through the makings of transition theory as well. It is especially prominent in studies that discuss agency in light of institutional sociology, emphasizing how agency in sustainability transitions appears in the form of institutional work and institutional entrepreneurialism (Duygan et al. 2019, Fuenfschilling & Truffer 2016, Hassink et al. 2018). Institutional work refers to the actions taken by actors to construct, maintain, or disrupt institutions (Fuenfschilling & Truffer 2016), which can be observed in the form of activities such as experimentation, building narratives, forming networks, lobbying, mimicry, valorizing, or demonizing (Duygan et al. 2019). Furthermore, institutional entrepreneurialism involves both institutional and entrepreneurial tasks directed at the institutionalization of new practices, such as developing business propositions, pulling resources, devising strategies, and networking (Hassink et al. 2018). Thus, ideas of institutional work provide obvious value to the conceptualization of transition work, as exemplified by Löhr et al. (2022), who extend dynamics of transition work to propose a similar understanding of transition work.

The structure and agency dichotomy is also prominent in ideas of "embedded agency" (Fuenfschilling & Truffer 2016:299), which implies that agency takes place within highly institutionalized system structures. This could be considered a fundamental paradox in social science, as agency is shaped by institutions, while also changing and maintaining the institutions themselves. Giddens (1984) referred to this paradox as the "duality of structure."

In an attempt to break with the idea of structure and agency as inseparable entities, Svensson and Nikoleris (2018) introduced critical realism theory to discuss the role of agency and structure in the MLP. They argue that in order to study contextualized practices, which transition work could be one example of, there is a need to recognize that the actions of actors are enabled and disabled by the actor's position in the system and the influence of structure on each actor. As such, agency is performed under differentiated systemic conditions (ibid. p. 470.

Although agency is evident in how both scholars of sustainability transitions and STS scholars perceive of socio-technical change, they depart in their perspectives on the relationship between agency and structure. This contrast is particularly evident in ANT, which finds structural categories such as class and gender to be redundant. Understandings of distributive agency, which assume agency to flow between humans and non-humans (e.g., Michael 2017), point to how social and material network elements relate and interact. However, ANT maintains that these different elements do not exist in layered structures, thereby demonstrating the flat ontology of ANT. This ontology could reflect perceptions that collective arrangements are "so fluid that to think of social structure is obsolete" (Elder-Vass 2008:464), and that structural influences are understood better by investigating free associations between actors and actants. Hence, ANT does not consider agency to follow structure, but rather to be distributed and to manifest in relations between actors and actants.

This understanding of structuration contrasts with understandings in sustainability transitions. Transition scholars which have criticized STS for shattering so severely divisions between the social and the material, the human and the non-human, structure and agency, that STS approaches are merely left with empirical descriptions of complexity and local situatedness, disabling them from providing general lessons (Geels 2007a). In response to the so-called messiness of flat ontologies, the MLP describes a layered structure in which structuration dynamics occur on several levels, with different degrees of force. Socio-technical change occurs, it argues, "through the alignment of processes at different levels [of structuration]" (Geels 2007a).

I recognize the value of following actor relations in my quest to understand transition work, and the contribution of ANT is especially prominent in the foundational role of relational transition work, as described in Chapter 6. However, my discussions of transition work as agency applied will throughout this thesis orient by understandings of structuration inherent in sustainability transitions. This is elaborated further in Subchapter 3.5, in which I describe my understanding of transition work as embedded in socio-technical configurations.

3.3.2 Agency in actors

The discussion in the preceding subchapter shows that understandings of agency in transitions could rest on several theoretical backdrops, and that agency has come to be recognized as a potent force in sustainability transitions. Transition scholars have mainly studied agency by investigating the role and involvement of actors. Thus, agency could manifest in purposive actor behavior attempting to prevent or generate change (Fischer & Newig 2016). Sustainability transitions have been considered "multi-actor processes" in which a variety of actors and social groups, whether deliberately or not, apply their "resources, capabilities,

beliefs, strategies, interests [and] agencies" (Köhler et al. 2017:5) to promote or obstruct systemic change. Although studies of sustainability transitions have been criticized for ignoring the role and agency of actors (Fischer & Newig 2016), studies of actor involvement have greatly enhanced understandings of agency. Much research has attempted to define and categorize different types of actors (e.g. Avelino & Wittmayer 2016, Fischer & Newig 2016, Haan & Rotmans 2018), providing typologies that indicate to what degree and what kinds of agency different actors can apply. Transition literature has also sought to understand agency by investigating the plurality of roles that actors can take in sustainability transitions (Fischer & Newig 2016, Schot et al. 2016, Wittmayer et al. 2017).

To date, research on sustainability transitions has focused on the involvement of many different actor groups, all of which could hold different forms of agency. Some scholars have been particularly interested in intermediaries (e.g. Barnes 2019, Gliedt et al. 2018, Kivimaa et al. 2019a, Stewart & Hyysalo 2008), whose agency manifests in facilitating, conjuring, and brokering. Others have studied incumbents (e.g. Berggren et al. 2015, Kungl 2015, Lindberg et al. 2019, Penna & Geels 2015, Steen & Weaver 2017, Wells & Nieuwenhuis 2012), not only to learn about how they obstruct transformative change,[3] but also to learn how they can accelerate transitions by applying their agency to "reorient their strategies and resources towards niche-innovations" (Geels 2018). Also, niche actors have been a prominent feature in studies of sustainability transitions, as they can "create a starting point for a systemic change" (Fischer & Newig 2016:6). Furthermore, agency can be expressed in attempts by civil society to shape governance, politics, and policymaking that ushers in transitions (Seyfang et al. 2010), either as social grassroots movements (e.g. Haukkala 2018, Hossain 2016), or as activists and pioneers (e.g. Gernert et al. 2018, Hamann et al. 2021), as users (Rohracher 2003e.g. , Schot et al. 2016) or third sector organizations (e.g. Allan & Hadden 2017, van Welie & Romijn 2018).

Understandings of actors as driver of socio-technical change highlight the agency of human and non-human actors (actants) alike. The is especially evident in how ANT attributes agency to artifacts and technologies, but it is also reflected in material lock-ins that obstruct regime alterations at the core of MLP understandings. As becomes evident in coming chapters, the agency of the material is also less prominent in my discussion of transition work, although it clearly manifests in how transition work in ports is shaped by for example vessels and infrastructure. As such, although recognizing the potential for transition work to also encompass the work of actants, this thesis reflects the orientation of transition scholars towards studies of human actors.

Their many studies of actors, whether taking actor-centric or role-centric approaches, have demonstrated the specific activities that different types of actors engage in to deliberately impact transition processes. Such activities are the essence of agency in sustainability transitions (Fischer & Newig 2016), undertaken by a multitude of actors, and aimed at

[3] Transformative change refers to how the development path of society is fundamentally changed through social, cultural, regulatory, and economic transitions that align with transitions to green technologies and artifacts. Such development paths also depend on fundamental alterations of actors and governance approaches, and the values toward which they are oriented (Burch et al. 2014). Whereas 'transformation' typically refers to large-scale changes in whole societies—whether local, national, or global—'transition' is mainly used to "analyse changes in societal sub-systems (e.g. energy, mobility, cities)" (Hölscher et al. 2018:2).

landscapes, regimes, or niches. Thus, it is an overly daunting endeavor to provide a full overview of activities that could impact transitions. However, in the following subchapter I discuss activities that have received particular attention from transition scholars, some of which are already mentioned in Subchapter 3.2.

3.3.3 Agency in activities

The range of activities that transition researchers have focused on when investigating change processes and agency is shown in Table 5. Central to sustainability transitions is the development of innovations and technologies, which includes not only the design and engineering of the solutions themselves, but also creating support and momentum around them. This is the particular dedication of strategic niche management (SNM), in which the building of social networks, learning, and the articulation of visions and expectations are considered key activities (Naber et al. 2017, Schot & Geels 2008). In creating protective spaces, it is necessary to build trust and legitimacy around emerging innovations, among other by presenting and framing issues and problems, and by marketing and diffusing information about innovations. To encourage use and ensure widescale adoption, niches also depend on successfully incorporating user preferences that embed innovations into new or existing practices, such as through experimentation and learning.

However, acceptance of emerging innovations depends not only on their appropriate design, function, and marketing, but also on their anchoring in wider society. Therefore, studies of sustainability transitions have emphasized the role of governance in ensuring the transitioning of socio-technical systems. Governance refers to "interactions in which public and private actors participate [to solve] societal problems or [create] societal opportunities (Kooiman 2003:4), and is expressed through transition management (TM). As shown in Subchapter 3.2.2, transition management prescribes strategic, tactic, operational, and reflexive activities that actors can engage in to promote, initiate, or accelerate transitions (Loorbach 2010, Loorbach & Rotmans 2010, Wittmayer & Loorbach 2016). Strategic activities aim at establishing a cultural basis for relevant social systems, and include vision development, strategizing, and defining goals and norms. Tactical activities aim at establishing structures and contexts within which actors operate. Such activities may include establishing rules and regulations, institutions, organizations, networks, infrastructure, and routines (Loorbach 2010). Operational activities are typically everyday decisions and actions related to innovation in societal, technological, institutional, and behavioral practices (Loorbach 2010, Loorbach & Rotmans 2010). Finally, reflexive activities serve to enhance knowledge and learning, for example through monitoring, assessing, and evaluating the status quo, which allows for structuring, (re)framing, and managing societal issues (Loorbach & Rotmans 2010).

Another line of research dedicated to the active steering of transition processes relates to intermediation (e.g. Barnes 2019, Gliedt et al. 2018, Kivimaa et al. 2019a, Stewart & Hyysalo 2008). Intermediaries contribute to promote transitions through facilitating, conjuring, and brokering transition processes, and many of the activities listed in Table 5 relate specifically to intermediation. Kivimaa et al. (2019a) refer to intermediaries as actors and platforms that link actors and activities by aligning visions and creating collaboration. Research has paid substantial attention to actors that engage in intermediation and different typologies of

intermediaries, such as innovation intermediaries (e.g. Gliedt et al. 2018, Stewart & Hyysalo 2008), niche intermediaries (e.g. Smith et al. 2016), and systemic intermediaries (e.g. Kanda et al. 2020, van Lente et al. 2020).

Kivimaa et al. (2019b) specifically discuss what activities intermediaries engage in during different phases of transition, which indicates that also transition work might change and evolve as transition processes mature. In the *pre-development and exploration* phase, activities include developing ideas and incorporating visions and expectations. At this stage, intermediaries also initiate and manage pilots, experiments, and projects to allow learning exchange and network formation. In Norway, DNV's Green Shipping Programme (GSP), a public-private partnership, may represent an example of intermediation that involves ports in the pre-development and exploration phase of transition. In the *acceleration and embedding* phase, activities typically advance. The articulation of visions becomes more specific, networking and experimentation become more targeted, and efforts to promote diffusion of new innovations intensify, for example through circulating knowledge, creating new standards and rules, and articulating needs and demand. As innovations gain momentum, intermediation further involves lobbying for resources and political attention. Also. translation—the harmonization of visions and interests between actors (Skjølsvold et al. 2018:253)—becomes a more prominent activity in this phase.

Table 5. Agency as expressed in activities identified in studies of sustainability transitions.[4]

align	create market	foster acceptability	motivatenegotiate
advise	create narrative	frame issues	participate
adoption	create rules	gain permission	plan
advocate	create standards	governance	protest
articulate demand	create symbolic variety	imagine	provide information
articulate visions	develop policy	initiate	provide meaning
articulate user preferences	develop innovations	inspire	provide rationale
assess risk	develop knowledge	institutional work	push
broker	develop strategies	intermediate	raise awareness
build coalitions/alliances	develop technologies	invent	resist
build expectations	devise agendas	involve	search
build legitimacy	diffuse ideas/practices	learn	set goals
build networks	diffuse knowledge	lobby	set rules/regulations
build system	embed	manipulate	share experiences
build trust	empower	mediate	shield
coerce	encourage	mitigate uncertainty	structure problems
configure	endorse	mobilize claims	technological learning
consult	evaluate	mobilize resources	translate
cooperate	experiment	modify practices	
coordinate	facilitate	monitor	

[4] The activities are examples collected from, but not limited to, the following sources: Allan & Hadden (2017), Avelino & Rotmans (2009), Brown et al. (2013), Fischer & Newig (2016), Geels & Verhees (2011), Haan & Rotmans (2018), Haukkala (2018), Hess (2014), Hossain (2016), Jasanoff (2015), Kern et al. (2019), Kivimaa et al. (2019b), Kivimaa & Kern (2016), Lemos & Agrawal (2006), Lindberg et al. (2019), Loorbach (2007), Loorbach et al. (2015), Loorbach & Rotmans (2010), Markard & Truffer (2008), Markard et al. (2016), Naber et al. (2017), Partzsch (2017), Raven et al. (2016), Rogge & Reichardt (2016), Schot et al. (2016), Skjølsvold et al. (2018), Smith et al. (2016), Van der Brugge et al. (2005).

In the final phase of transitions, *stabilization*, activities related to niche promotion could be expected to fade as they are no longer necessary (Kivimaa et al. 2019b). However, activities related to the destabilization of incumbent regimes may still be in play.

Another central component in the governance of sustainability transitions is the design and enactment of policy. Many studies have aimed to understand the role of policy in sustainability transitions (see Kern et al. 2019 for useful overview), typically by distinguishing between different types of policies and their effects on transition processes (Kern & Howlett 2009, Kivimaa & Kern 2016, Rogge & Reichardt 2016). However, activities related to the *making* of policy are often addressed by research focused on the role of power and politics in sustainability transitions. Many scholars have aimed to elaborate and incorporate theoretical understandings of power and politics into transition research (Ahlborg 2017, Avelino 2017, Avelino et al. 2016, Avelino & Rotmans 2009, Geels 2014, Grin et al. 2011, Hoffman 2013, Kern & Rogge 2018, Lockwood et al. 2017). Others have provided insights into agencies and activities inherent in power and politics. For example, in studying struggles between political coalitions, Hess (2014) refers to discourses and framing, the design of policy propositions, and funding activities as crucial elements. Furthermore, Raven et al. (2016), in their study of the advocacy of selected technologies, address the role of shielding activities, the articulation of expectations, the securement of resources, and the construction of narratives.

In the preceding subchapters I have demonstrated the prominence and span of agency in studies of sustainability transitions. Collectively, the activities summarized in Table 5 inform about *what actors do* in (different phases of) transitions. As such, they are manifestations of agency, and to the degree to which they are intentionally executed to accelerate transitions, I consider them specific examples and expressions of transition work. In the following subchapter I argue for the need to conceptualize more explicitly such activities as transition work.

3.4 Beyond agency: towards a concept of transition work

At the core of this thesis lies the conceptualization of transition work, which is necessary to understand the content and framing of sustainability efforts in Norwegian ports. In Subchapter 3.3, I have demonstrated that agency is represented by several different, more or less abstract concepts and theoretical constructs, such as system building, technological framing, actants, institutional entrepreneurialism, actor roles and typologies, intermediation, and power. I have also demonstrated how transition processes can be shaped by a range of actor behaviors and activities, such as those related to institutional work (e.g., Fuenfschilling & Truffer 2014), the nurturing and protecting of niches (e.g., Schot & Geels 2008), governance (e.g., Wittmayer & Loorbach 2016), intermediation (e.g., Kivimaa et al. 2019a), policy development (e.g., Kern et al. 2019, Schmidt & Sewerin 2019), and the wielding of power and politics (e.g., Ahlborg 2017, Avelino 2017). Many of these concepts and studies describe active involvement and purposive intervention (e.g., niche or transition management), while others describe abilities or resources that *could* be applied to a specific end (e.g., technological framing, power, policymaking, user practices). Given these different facets of agency, I believe there is a need to distinguish more accurately between agency as a latent potential for action

and agency as dedicated actions aimed at specific objectives. In this subchapter, I account for my understanding and reconceptualization of the latter as *transition work*.

Based on above descriptions of agency I understand transition work as the purposeful execution of activities, explicitly conducted to push for sustainable transformation of socio-technical systems. Just as agency could be understood and expressed by the many different actors described above (Subchapter 3.3.2), transition work could also be executed by the range of actors involved in sustainability transitions, including public and private incumbents, niche innovators, intermediaries, and civil society. More simply, I suggest the following understanding of transition work:

Transition work refers to all forms of deliberate and purposeful activities aiming to progress sustainability transitions.

This conceptualization rests on four arguments. First, such an understanding allows for distinguishing between latent and explicit expressions of agency. I understand transition work as agency applied, which supports a more active narrative around agency in transitions. Despite many discussions and presentations of agency in empirical cases, accounts of agency tend to follow a rather passive narrative style. This implies that agency could be presented as incidents or decisions that simply happen, less than as being promoted, encouraged, or executed. There is a need for reorienting towards more active narration of agency, explicitly engaging with the questions of "who did what, when, and why."

Second, I argue for the need to conceptualize agency that is specifically dedicated to the promotion of transitions, thus reflecting the directionality that distinguishes studies of sustainability transitions from conventional STS. If perceiving agency as latent potential to act, it could be applied to promote transformative change as well as obstruct it, as expressed in perspectives on systemic stability in transition studies and STS. However, taking into account how studies of sustainability transitions hold normative connotations about the need to foster change processes that lead in the direction of sustainability, I believe it is both useful and necessary to extract and identify agency that deliberately seeks to promote transition. This need to pinpoint such a directionality of agency is already discussed by transition scholars. For instance, they have referred to activities as deliberate attempts to impact transition processes. As transformative change agents (Haan & Rotmans 2018), actors engage in "a set of recognizable activities and attitudes used by an actor to address recurring situations" (Wittmayer et al. 2017:49). Similarly, Fischer and Newig (2016:21) understand agency as the behavior of actors in purposive attempts to prevent or generate change, whereas Pesch (2015) refers to the ability of actors to stimulate regimes, practices, and institutions deliberately.

My third argument for conceptualizing transition work is that there is need for a more epistemological understanding of agency in transitions. In subchapter 3.3 I have presented extracts from a substantial body of literature on agency and the roles and functions of actors in transition processes. However, this literature is typically theoretically oriented, tending to conceptualizations and ontological discussions regarding agency, in which empirical cases are often used to exemplify claims. Thus, there is a need for a more grounded approach, not only to understand theoretical concepts of agency, but also to study empirically how agency

materializes in the practical efforts associated with promoting and encouraging sustainability transitions. In fact, despite providing strong ontological discussions, the literature on sustainability transitions engages in few epistemological discussions. This point also relates to criticisms of insufficient methodological focus in transitions studies (Geels 2011, Genus & Coles 2008, Smith et al. 2010). Thus, there is need for epistemological awareness of agency, specifically how we can learn about agency in transitions. This requires applicable and easily operationalizable understandings and concepts that to a greater extent incorporate active understandings of agency.

My fourth and final argument for conceptualizing transition work is that there is need for a more explicit definition of transition work than provided by existing literature. Several scholars have referred to transition work without providing an explicit definition, for instance when describing activities undertaken by consulting engineers (Sørensen et al. 2018), households engaged in vision making, imagination, network building, or domestication (Skjølsvold et al. 2018), or connected to visions (Komatsu Cipriani et al. 2020), experiences and impacts (Poland et al. 2019). The overview of agencies presented earlier in this chapter further suggests that there are tacit or non-expressed perceptions of transition work in the research community specializing in sustainability transitions, which need to be taken out of their black box. In one study on sustainability efforts in Norwegian ports, transition work is considered to have both a processual dimension and an outcome dimension (Bjerkan et al. 2021c). As an outcome, the authors argue that transition work refers to "practical or specific sustainability results" (ibid. p. 298), which corresponds to the orientation of existing research on port sustainability towards technology implementation. In the same article, the processual dimension of transition work is exemplified by reference to processes inherent in, for example, TM and SNM. Similarly, in this thesis, my understanding of transition work takes a processual perspective, but more broadly builds on existing understandings of socio-technical change and agency, and therefore expands to a greater extent on the more simplistic understanding provided earlier by Bjerkan et al. (2021c).

Most recently, Löhr et al. (2022) have proposed a conceptualization of transition work that derives from understandings of institutional work, in which the same processes that comprise institutional work (creating, maintaining, disrupting) are extended to other transition dimensions as well, such as artifacts and technologies, actors and organizations, and policies. Löhr et al. (2022:255) refer to transition work as "activities that determine the shift to more sustainable modes of production and consumption." Like in this thesis, the concept of transition work presented by Löhr et al. thus refers to a multitude of activities that shape transitions. They further emphasize how different activities co-relate and build on each other, which is also discussed in Chapter 6 of this thesis.

However, the understanding of transition work provided by Löhr et al. departs from the conceptualization presented in this thesis on one crucial point. Whereas my conceptualization of transition work stresses how activities should be conducted deliberately and purposefully to progress sustainability transitions, such an emphasis is not put forth by Löhr et al. Although they highlight how some activities are "applied with the intent to advance the transition process", Löhr et al. also contend that other activities "are either usually more hindering in

their effect or they are applied alternatively to (..) hinder transition" (Löhr et al. 2022:262). Their understanding that activities could also be geared to preserve the status quo likely reflects their perception of transition work as a component of the negotiation over shifts that ultimately constitutes transition processes. Although I recognize the confrontational nature of sustainability transitions and the constatations between incumbencies and novelties that they entail, I believe there is need for a conceptualization of transition work that aligns with the directionality and normativity inherent in the research field of sustainability transitions.

Thus, building on the above arguments, Subchapters 3.1–3.3, and the empirical work conducted as part of this thesis, I propose an understanding of transition work that encompasses *applied, directed, and observable agency*, manifest in many different activities it may include. The work conducted in this thesis also shows that activities intended to progress sustainability emerge in response to their surroundings. Grin et al. (2011) have previously described agency as the product of ways in which actors understand and interact with opportunities and constraints in their immediate contexts. This is also likely the case for transition work, and leads to the third research question addressed in this thesis, concerning how particular forms of transition work emerge.

3.5 Shaping transition work through socio-technical configurations

In the preceding subchapters I have shown how transition work could be understood as applied, directed and observable agency, intentionally executed to progress or accelerate sustainability transitions. As agency applied, transition work is also embedded in the duality of structure (Giddens 1984), suggesting that different contexts might produce different types of transition work.

Many perspectives reviewed earlier in this chapter, such as LTS, SCOT, ANT, and different strands of sustainability transitions, orient quite heavily towards actors and agency, and therefore they may inform about the contents of transition work, specifically what kind of activities transition work constitutes. However, they could also provide input on the shaping of transition work. The aforementioned perspectives have been considered core in scholarly discussions on the social shaping of technology (SST), which were particularly prominent in the 1990s. The SST concept covers a collection of perspectives that challenge deterministic ideas that "technological change is beyond social influence" (Russell & Williams 2002:37) and is used to examine "what shapes technology" (Howcroft et al. 2004:330). More specifically, SST focuses on how organizational, political, economic, and cultural factors shape the design and implementation of technologies (Williams & Edge 1996). Hence, following the different facets of the SST concept, technologies and innovations are shaped by their socio-technical contexts, referred to as socio-technical systems, socio-technical constituencies, socio-technical enablers, and actor-networks. In this thesis, a parallel to SST perspectives can be found in my discussions on how *transition work* is shaped by socio-technical contexts. In this thesis, socio-technical contexts are operationalized as socio-technical configurations. In the following paragraphs, I summarize core concepts and understandings that are incorporated in my application of socio-technical configurations throughout the remainder of this thesis.

As an analytical framework, socio-technical configurations build on understandings in the multi-level perspective (MLP) described in Subchapter 3.2.3. As a "global model," the MLP

"takes as its unit of analysis the overall trajectories, paths, phases, or stages in the development of an innovation" (Geels 2020:12). As the MLP has been criticized for insufficiently addressing agency in understandings of socio-technical change, and encouraged to introduce actor-oriented understandings from STS (Genus & Coles 2008), the MLP provides less input to the content of transition work. By contrast, its ideas of socio-technical systems, regimes, landscapes, and niches are useful for understanding the context within which transition work is conducted. Therefore, I refer to socio-technical configurations as the interrelations and interconnections between elements that represent transition dynamics inherent in the MLP, meaning the concepts of landscapes, niche innovations, socio-technical regimes, socio-technical systems, and actors. The many publications on the MLP have shown how these elements contribute to processes of socio-technical change. As elaborated in Subchapter 3.2.3, the MLP assumes that transitions occur when socio-technical regimes are replaced or transformed as the result of pressures from landscape developments and competing niche innovations. In describing the dynamics of socio-technical transitions, Geels (2004) explains how actors contribute to transition processes by carrying and reproducing the rules and institutions that constitute the socio-technical regime, while these rules in turn contribute to guide the perceptions and interactions of actors (Geels 2004). Following the MLP, actor behavior is shaped both by the socio-technical system and by the socio-technical regime, while also contributing to their maintenance and functioning.

A schematic overview of change dynamics as understood by the MLP, conceptualized in this thesis as socio-technical configurations, is given Figure 6. The concept of socio-technical configurations has been applied in earlier studies, with reference to socio-technical regimes (Smith et al. 2010) and socio-technical systems (Geels 2002, Schot & Kanger 2018) alike. Previous uses of the concept have highlighted the multitude of different but interconnected socio-technical elements that, when aligned, contribute to maintain and fulfil societal functions. In a recent study, my colleagues and I leaned on these understandings and a set of dictionary definitions to define socio-technical configurations as "the arrangement of socio-technical elements that condition the maintaining of societal functions" (Bjerkan et al. 2021a:3). However, in the same study, we applied an understanding of socio-technical configurations that mainly encompassed socio-technical elements typically associated with socio-technical systems and socio-technical regimes. In understanding the shaping of transition work, I also include landscapes and available niche innovations to provide a fuller idea of the shaping of transition work. My take on this, as depicted in Figure 6, rests on the assumption that elements of socio-technical configurations interact and that these interactions support the working of societal functions. This implies that interactions between elements could also *change* conditions under which societal functions are upheld, for example in ways that uphold the societal function in a more sustainable manner.

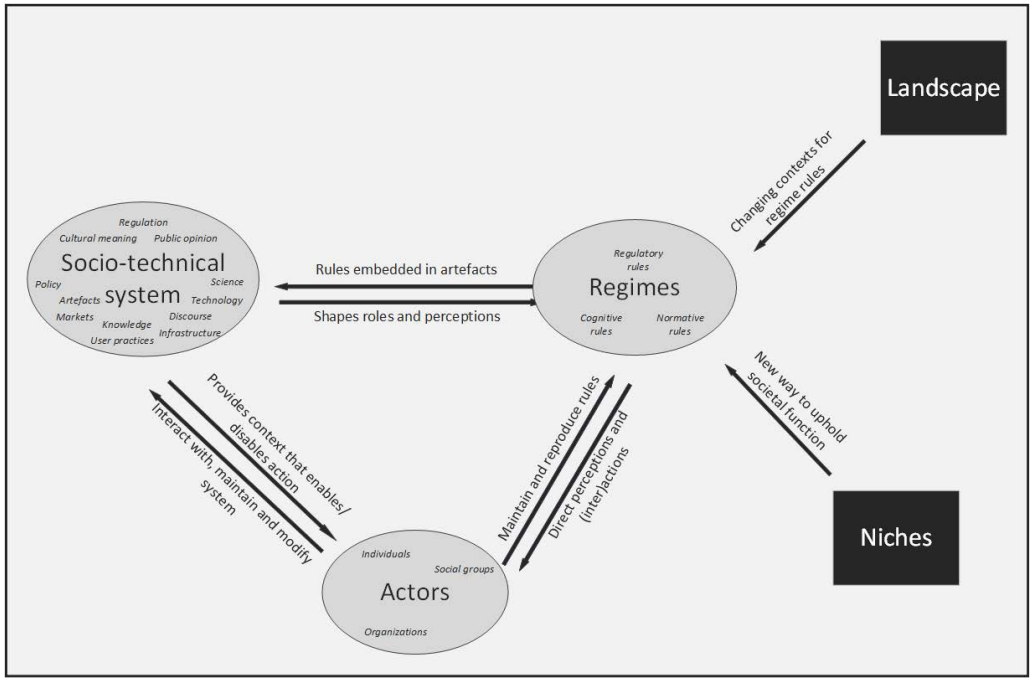

Figure 6. Context for transition work: socio-technical configurations. Adapted from Geels (2004:903, 913)

Thus, in this thesis I use the concept of socio-technical configurations to exemplify and discuss the shaping of transition work. In Chapter 7, I demonstrate how each element of socio-technical configurations could shape how ports do transition work, for example expressed in specificities of socio-technical systems, normative rules around port roles, and landscape pressures. My detailed operationalization and understanding of these concepts are elaborated further in each subchapter of Chapter 7.

3.6 Summarizing transition work

The purpose of this chapter has been to present the theoretical foundations of my understanding of transition work, as well as the theoretical framework that I rely on when discussing the shaping of transition work. As stated in Subchapter 3.4, I understand transition work as any deliberate and purposeful activity that contributes to progress sustainability transitions. I believe such a conceptualization contributes to produce active narratives around applied agency, induces directionality onto agency in studies of sustainability transitions, provides empirically applicable constructs, and leads to more explicit definitions of transition work than found in previous studies.

In this chapter, I have presented the basis for the above-mentioned conceptualization by pointing to transition work as a driver for socio-technical change, referencing understandings of change and stability inherent in studies of sustainability transitions and STS. The theoretical foundation for conceptualizing transition work is summarized in Table 6, which shows that my understanding of transition work resonates with existing notions of change and agency. The primary contribution of the theoretical backdrop is to demonstrate the role of agency in socio-technical change and to provide examples of transition work.

Table 6. Summary of the theoretical foundations for conceptualization of transition work.

Theory	Main idea of socio-technical change	Input to conceptualization	
LTS	Evolution and alignment of LTS components	System building	→
SCOT	Closing controversy Shared perceptions	Problem perceptions Technology perceptions Systems of meaning Framing of technology	→
ANT	Actors/actants pursue stability Relations between actors/actants Translation	Follow the actors Empiricism Network relations	→
Agency	Alteration of discursive fields Institutional changes Embedded agency/duality of structure	Applying bodies of meaning Institutional/entrepreneurial work	→
SNM	Emerging niches can be nurtured and protected	Create visions and expectations Build networks Social learning	→
TM	Transitions can be steered and managed	Experimental governance activities: strategic, tactical, operational, reflexive	→
TIS	Change follows interaction between actors, networks, institutions, and technologies	Establish systems and align system elements with emerging technologies	→
MLP	Change follows niche and landscape pressures on socio-technical regimes	Actors carry and reproduce regime rules Actors maintain/modify socio-technical systems	→
			Transition work: deliberate and purposeful activities that progress sustainability transitions

According to LTS, change requires technical and social issues to be solved, so that system components (e.g., technologies, artifacts, social organization, resources, science, legislation) can be assembled and aligned. Similarly, SCOT suggests that transition work should orient towards *perceived* problems and issues that technologies are expected to solve. Furthermore, perceptions and expectations should be surrounded by systems of meaning that are constructed to frame the fit between problems and technologies in a positive manner.

The framing of problems and technologies resembles the translation activities that are prominent in ANT, and that nurture shared understandings and strengthen relations between actors. According to ANT, researchers should take empirical approaches to observing the actions and relations of actors and understanding how changes have come about. As I show in the subsequent chapters, the actor orientation of ANT is reflected in my approaches to transition work in ports, implying that ANT also provides useful input to the practical operationalization of transition work.

However, as evident from above sub-chapters, my understanding of transition work has left behind the STS emphasis on the material and on non-human actors. Although material aspects of transition work are exemplified in Chapter 6 and Chapter 7, I have mainly studied transition work carried out by human actors. This corresponds with the main focus of existing research on sustainability transitions, which, as shown in Subchapter 3.3, provides numerous examples of agencies and activities executed by different actor groups that could be considered expressions of transition work. These activities comprise social processes that are studied by

scholars of strategic niche management, governance activities that lie at the core of transition management, and the building of innovation systems studied by scholars who focus on technology innovation systems.

Furthermore, Subchapter 3.5 has shown how the transition dynamics presented by the multi-level perspective are useful for understanding how the agencies and activities of actors are embedded in socio-technical configurations, which in addition to actors comprise socio-technical systems, regimes, landscapes, and niches. This shows how this thesis turns away from the flat ontologies of STS, particularly expressed in ANT, and rather discusses transition work as part of the duality of structure.

In sum, this chapter demonstrates that ideas of the content and shaping of transition work are already latent in the theoretical understandings and concepts that characterize sustainability transitions and its STS legacy. As such, conceptualizing transition work could be considered a specification and extraction of notions that already exist. In the next chapter, I account for how I have sought to capture transition work in my studies of sustainability efforts in Norwegian ports.

4 Methods

In the preceding chapter I have summarized the theoretical underpinnings of my new transition work concept. As such, the first research question of this thesis has been addressed with a conceptualization of transition work that allows empirical observations of activities intended to promote and accelerate transitions. Specifically, this conceptualization understands transition work as "all forms of deliberate and purposeful activities aiming to progress sustainability transitions."

In this chapter, I turn to my approach for increasing our understandings of what the purposeful activities involve and how they emerge in the port sector. Thus, this chapter accounts for the methods and data used to address the two empirical research questions of this thesis. In answering RQ2 and RQ3, which concern the contents and shaping of transition work, I rely on qualitative data collections from three Norwegian ports: the Port of Narvik, the Port of Kristiansand, and the Port of Oslo. These ports have all been partners in the research project TRAZEPO[5], in which this thesis is also a deliverable.

This chapter begins with an introduction to the three ports and to the Norwegian port sector. I then elaborate on the qualitative methods I have relied on to address RQ2 and RQ3. The chapter concludes with reflections upon the scope and transferability of the research, as well as the naturalist character of the data collection.

4.1 The empirical domain: the Norwegian port sector

The maritime sector is a prominent feature of Norwegian society, with hundreds of ports and quays along the Norwegian coastline. Today, the main port network includes 32 ports, typically located in cities and large towns. They are governed by local authorities in the form of publicly owned enterprises, sometimes as cooperatives between authorities in neighboring municipalities. Although the Norwegian maritime sector also includes offshore petroleum, aquaculture, and shipping, the fishing industry is particularly prominent, with more than 600 fishing ports regulated by regional authorities. In addition, many private enterprises in the maritime sector and other industries operate their own port and quay facilities to serve their own production and distribution needs. Other ports serve the needs of local communities, leisure activities, and tourism.

In an international context, Norwegian ports are small, both in terms of tonnage throughput and in terms of organizational size. Figure 7 provides an overview of the number of port calls and total tonnage throughput in the period 2010–2020 decade. In 2020, a total of 514 million metric tons passed through the 32 main Norwegian ports. By comparison, the Port of Rotterdam, the largest port in Europe and the 10th largest port globally, reported a throughput of approximately 437 million metric tons in 2020 (Port of Rotterdam 2021).

[5] TRAZEPO home page: https://www.sintef.no/prosjekter/2018/trazepo/

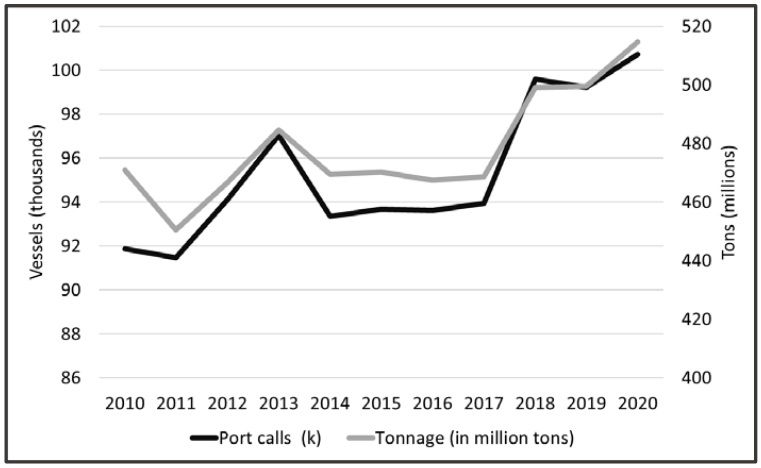

Figure 7. Port calls and throughput in Norwegian ports, 2010–2020.
Source: Statistics Norway (2021a)

The three ports that have been investigated for this thesis share several characteristics. In addition to being owned by local authorities, all three ports have in common that they have outsourced terminal operations and goods handling to private enterprises, such as Greencarrier (Kristiansand) and Yilport (Oslo). All ports are also heavily vested in real estate management and development, which represents an important source of income. Although all three ports are located in urban areas, they are characterized by industrial production in the port area. In common with ports worldwide, the ports are also increasingly required to weigh the value and presence of their many port activities against the needs and desires of their surrounding urban environments. The development of port areas are prominent issues in all three ports, the expansions plans of which have faced opposition from neighboring communities. Therefore, the ports constantly seek (re)development projects to maintain legitimacy and support in their local communities.

However, the three ports differ on several accounts, among other related to traffic characteristics described in Figure 8. During my empirical investigations, the *Port of Narvik* appeared to be in the early phase of pondering transition work. The Port of Narvik is located in Northern Norway and its main activity is the handling of iron ore from mines across the Swedish border. A large mining company owns and operates its own private quay in the port's basin, and the publicly owned Port of Narvik has established a subsidiary company to handle mineral bulk from other iron ore suppliers in the port's own facilities. The extensive mining activities imply that the Port of Narvik has few port calls, but a lot of throughput, especially if the private facility is included. Given that the port is so heavily dominated by dry bulk traffic, and the ships are yet not equipped or suited for the provision of shore power at berth, the Port of Narvik is not among the many Norwegian ports that have installed shore power. However, it is working on providing high voltage shore power for cruise ships, as cruise traffic is increasing and has become a focal area of the port organization.

The port organization in Narvik has 15 employees, who are mainly involved with port operations and maritime affairs. In common with approximately 47% of Norwegian ports

(Bjerkan et al. 2021c), the Port of Narvik does not have port personnel explicitly responsible for issues relating to climate, environment, and emission reduction. It has yet to develop comprehensive plans for climate and environment, and the port organization adheres to the more traditional roles of port authorities related to regulation, port operations, and real estate management. However, they are increasingly orienting towards low-emission technologies such as shore power and work dedicatedly to strengthening the port's connection to global railway lines. The port also represents a good example of laissez-faire ownership strategies that have traditionally characterized the Norwegian public port sector, which leaves the port organization with significant autonomy and independence from political steering.

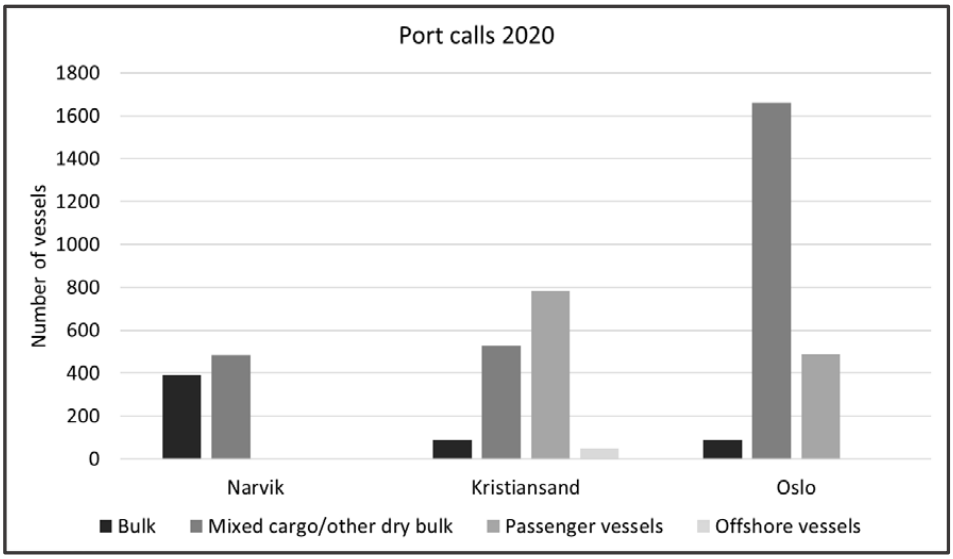

Figure 8. Port calls from main vessel segments in the case ports in 2020.
Source: Statistics Norway (2021b)

The *Port of Kristiansand* is located on the southernmost coast of Norway, and thus closely and strategically placed near mainland Europe, as well as major road networks (E18, E39). The port especially serves the offshore industry and cruise lines, as well as passenger ferries, container ships, and bulk vessels. In contrast to many Norwegian ports, where the traffic mainly consists of imports, the Port of Kristiansand is characterized by a more equal balance between import and export. The port is aiming to increase container transport and activities linked to marine industries such as petroleum, wind power, and seafood.

The Port of Kristiansand has made significant efforts in the electrification of port operations, including extensive deployment of low and high voltage shore power, solar panels, the use of the Environmental Ship Index (ESI)[6] to determine port fees, and reduced in-house energy consumption. Many of the port's efforts have been made in collaboration with research and development activities nationally and in the EU. The terminal operators have started to replace cranes and equipment with electric models. The port has also established an

[6] About ESI, see https://sustainableworldports.org/environmental-ship-index-esi/.

agreement with LNG providers, but LNG facilities are not yet in place due to lack of demand from port users.

The port organization consists of approximately 30 employees, half of which are engaged in operative services. The port has recruited personnel with specific technological skills to remain technologically competent, as they consider that a move towards the port as an energy hub will require specific knowledge beyond maritime competence.

The Port's work with electrification of port activities was done in response to calls from the port owner, the City of Kristiansand, to initiate such efforts. The city has promoted strict international environmental requirements on ports, in anticipation that this will increase the competitiveness of the Port of Kristiansand. Although the port maintains continuous dialogue with its owner (as shown in Paper 2), ownership strategies in Kristiansand also lean towards the traditional laissez-faire approaches that characterize the Norwegian public port sector.

The *Port of Oslo* is located at the heart of the capital region and along main European roads (E6, E18). Most goods that arrive in the port are transported approximately 7 km north to the Alnabru terminal, from which the whole of Norway is served by road and/or rail transport. The Port of Oslo is characterized by mixed activities. International cruise ferries represent a core activity in the port, along with extensive container transport and bulk (petroleum) transport. Also, a substantial amount of production and processing-related activity takes place in the port area (cement, grain, coffee), as well as the reception and storage of goods.

The Port of Oslo is characterized by a proactive approach to sustainability. As in Kristiansand, electrification has been high on agenda in the port organization and among users in the port. This includes efforts to apply shore power, electric cranes and reach stackers, and electric port tractors. The port is also increasingly focusing on circularity and the full energy system of the port, which is represented by a long-term, masterplan approach to port development. In its sustainability efforts, the port has also emphasized the need to signal direction and provide predictability for its users.

In Norwegian terms, the port organization in the Port of Oslo is large, with more than 90 employees, who are divided between administration, traffic, real estate, and the technical department. To even greater extent than in Kristiansand, the port organization employs specialized personnel, including personnel dedicated to issues related to climate, environment, and sustainability. Having been ushered in by their environmental director, the port works dedicatedly to the development of plans and strategies for reducing its emissions. Much of this work includes the port's owner, the City of Oslo. The Port of Oslo is distinguished from most Norwegian public ports by very active ownership on part of the City of Oslo, increasing politicization of port business, and extensive involvement of users and stakeholders in the port area. The port is increasingly integrated into the very ambitious climate strategies for the city as a whole, and it is explicitly placed within the system boundaries of the city.

4.2 Methods and data

To gain a better understanding of the content and shaping of transition work in Norwegian ports, the research for this thesis studied the practices of the three case ports. The data collection is summarized in Table 7. The work commenced with a series of port visits, which

included workshops with port organizations and a selection of prominent port users. During those visits, I was introduced to several port actors who presented their own organizations and the activities they did in the port, including what sustainability issues they encountered and their responses to them. This gave me a idea of how actors in each port operated and the realities by which their transition work would have to navigate. The visits also allowed me to establish informal relations with actors in the ports, which was useful to ensure trust and prepare more structured and purposeful data collection. Throughout the work on this thesis, I also increased my general and basic understanding of the port sector through a series of workshops with partners in the TRAZEPO project and through spontaneous interviews held during conferences on ports and energy, with representatives from Ports of Norway, Port of Drammen, Port of Larvik, Port of Elsinore, and Port of Le Havre. However, the most prominent empirical work for this thesis consisted of extensive document studies and expert interviews related to the ports of Narvik, Kristiansand, and Oslo. Accordingly, in much of this chapter I describe and reflect on how the studies and interviews have aided my study of transition work in Norwegian ports.

Table 7. Overview of the data collection.

	Port visits	Semi-structured interviews	Spontaneous interviews	
Port of Kristiansand	1	13		**14**
Port of Narvik	1	6		**7**
Port of Oslo	1	15		**16**
Other ports			4	**4**
Other stakeholders		5	1	**6**
	3	**39**	**5**	

4.2.1 Document studies

Document analysis is a systematic procedure for reviewing or evaluating documents, and consists of finding, selecting, interpreting, and synthesizing documents (Bowen 2009:27). Despite few scientific discussions on the methodological implications and preconditions of successful document analysis, document analysis has become a popular component of scientific scrutiny. One reason might be that it is an efficient and cost-effective way of collecting data, that the data are stable, and neither affected nor constituted by the research process (Bowen 2009). Document analysis can also be used for data collected from several different events, spanning large timescales, and numerous settings.

Document analysis can serve many functions, including triangulation, contextualization, and developing the researcher's knowledge base and/or research approach (Bowen 2009). In the research for this thesis, document analysis provided preliminary knowledge about the socio-technical contexts of which port actors were a part. It also provided formal official descriptions of transition work, as well as perceived needs and preconditions for transition work. Thus, in addition to allowing for an initial non-systematic mapping of transition work, the document analysis enabled *contextualization.* Contextualization implies providing context for the topic under study (in my case, transition work), as well as background information and insights into the topic's association with other issues (shaping of transition work) (Bowen 2009).

Several types of documents were useful for describing the socio-technical contexts of transition work in ports. Reviews of scientific publications on port sustainability and socio-technical transitions were a source of general knowledge about the port sector and transition work respectively, while statistics and reports by researchers, consultants, public agencies, and ports provided case-specific facts and information. However, the contextualizing document analysis mainly revolved around policies and regulations on local, regional, and international levels (the main documents listed in Table 8). This also included corporate strategies or corporate policies expressed by private actors in and around ports, for instance as found in sustainability reports and policies available from their web pages.

Table 8. Policies and regulations reviewed in the research relating to the thesis.

Local	City of Oslo (2016): Climate and energy strategy for Oslo City of Oslo (2019): Climate strategy for Oslo towards 2030 City of Oslo (2008): The Fjord City Program Port of Kristiansand (2016): Action plan for shore power Port of Oslo (2012): Action plan for shore power Port of Oslo (2015): Blue-green strategy 2013-2023 Port of Oslo (2017): Climate strategy for the port of Oslo Port of Oslo (2018): Zero Emission Action Plan Port of Oslo (2020): Southern port as zero-emission port
National	Enova investment programs (www.enova.no) Ministry of Climate and Environment (1981): Pollution Control Act Ministry of Climate and Environment (2017): Climate Change Act Ministry of Climate and Environment (2020): Climate plan for 2021–2030 Ministry of Fisheries and Coastal Affairs (2013): More goods on sea Ministry of Local Government and Regional Development (2008): Planning and Building Act Ministry of Trade Industry and Fisheries (2007): Ship Safety Act Ministry of Trade Industry and Fisheries (2019): Ports and Waters Act Ministry of Trade Industry and Fisheries (2021): Greener and smarter. Tomorrow's maritime industry Ministry of Transport (2015): National Port Strategy Ministry of Transport (2017): National Transport Plan 2018–2029 Ministry of Transport (2021): National Transport Plan 2022–2033 Norwegian Coastal Administration: Support scheme for cooperation between ports (ended 2021) Norwegian Coastal Administration (2020): Support for investments in efficient and environmentally friendly ports Norwegian Coastal Administration (2021): Support scheme for transferring gods from road to sea Norwegian Government (2019a): Action Plan for Green Shipping Official Norwegian Report (2018): Coastal shipping strategy The NOx Fund (2021): NOx Fund
International	EU (2014): EU Directive (2014/94/EU) on deployment of infrastructure for alternative fuels European Union (2017b): EU regulation 2017/352 on port services and financial transparency European Commission (2016): Maritime Transport Strategy 2009-2018 European Union (2017a): Priorities for maritime transport policy until 2020 European Commission (2019b, 2021): European Green Deal and Fit for 55 European Sea Port Organisation: Environmental reports 2019, 2020, 2021 IMO (2018): IMO Initial strategy for GHG emissions World Ports Climate Action Program (https://sustainableworldports.org/wpcap/)

Contextualizing a topic allows the researcher to discover and describe meaning, patterns, and processes (Altheide et al. 2008). This approach was vital in my document analysis, which was

also used to capture expressed motivations and explicit intents, values, and justifications for whatever transition work in which port actors were or were not engaged. Although document analysis provided useful background for all three cases, it was most prominent in the study reported in Paper 3, in which implementation of shore power in the Port of Oslo represented one example of transition work in that port. In studying the involvement of actors in that specific implementation process, documents were not only supplementary to expert interviews, but also represented a field in which phenomena could be studied. Document analysis allows phenomena that "exist" in documents to be studied "in situ" (Altheide et al. 2008). In studying the introduction of shore power, documents represented "a field of decision-making processes" where I was the spectator scouting for movements that signaled changes in perceptions, intentions, actions, and actor relations that drove or halted transition work.

For Paper 3, document analysis proved particularly useful due to the cover it provided in allowing me to study a range of different events spanning large timescales and numerous settings (Bowen 2009). As such, document analysis was an efficient way to gain a fundamental grasp of the different actors' approaches to shore power implementation. Understanding the implementation process also implied studying events dating back to 2008, which did not involve any of the actors currently engaged with shore power and who might have proved challenging to identify and contact. Furthermore, accounts of events more than one decade ago might have been blurred by the time passed or by reinterpretations by the actors. By contrast, the stability of the documents conveyed stories as told at the time, rather than as they would have been told ten years later.

As my document analysis relied on formal official documents, it did not capture informal personal exchanges and/or internal discussions concealed by the apparent consensus presented in such documents. The document analysis gave me a general understanding of the socio-technical contexts of ports and general familiarity with port actors. However, to ensure that my understanding was realistic and applied to the ports under study, I also needed to conduct qualitative interviews with actors in the specific ports. Thus, a further purpose of the document analysis was to supplement and corroborate (or contrast) information gained from qualitative interviews. Document analysis is commonly used as part of the method known as *triangulation*, in order to corroborate, contradict, or contrast findings in other qualitative approaches (Bowen 2009). In the work reported here, document analyses provided foundations for continuing with qualitative interviews, and as such served to establish a knowledge base that allowed for further development of research-related inquiries (ibid.).

4.2.2 Expert interviews

The document analysis described in the preceding subchapter was less geared towards studying informal, non-material aspects of transition work and socio-technical contexts, such as practices, knowledge, and culture. To capture these in a better way, interviews were conducted with representatives of port authorities, local authorities, regional authorities, the National Coast Administration, the Norwegian association for public ports (Ports of Norway), energy companies, transport providers, terminal operators, and a wide range of other port users. The interviews provided first-hand accounts of activities that constituted the transition

work of different actors, and they allowed for fuller descriptions of the socio-technical contexts within which those activities took place.

Given that port actors have particular technical knowledge (e.g., related to technologies, administrative procedures, mandates) and process related knowledge (e.g., related to port operations, concession policies, collaboration) that specifically impact transition work in ports, I considered the interviewed informants to be experts. Table 9 gives an overview of actors that were interviewed. As argued by Pfadenhauer (2009:84), "the expert interview (...) focuses on the exclusive knowledge assets of experts in the context of their (ultimate) responsibility for problem solutions." Definitions of experts and expertise have evolved over time, and Meuser and Nagel (2009) argue that the definition of experts must follow prevailing definitions of expert knowledge. New modes of knowledge production (e.g. Weingart 1997) have provided more comprehensive understandings of what constitutes expertise. Whereas experts were historically certified professionals trained in strong institutions, they have gradually come to encompass also those who acquire knowledge to solve a particular problem, those who acquire special knowledge through the activities they perform (e.g., in NGOs), and those who carry out functions that contribute to solve a problem (although the activities they participate in are not necessarily intended to solve the problem) (Meuser & Nagel 2009). In its widest sense, the concept of experts suggests that everyone is an expert, either in their own field or their own life (Bogner & Menz 2009). As such, expertise could be considered a relative and constructed concept. The constructivist concept of expertise focuses on the making of experts and how the roles of experts are ascribed. Bogner and Menz (2009) argue that experts can be constructed by the researcher who assumes the expert to have knowledge about a topic, regardless of their actual knowledge. Also, an expert could be constructed through societal processes, wherein societal reality deems a person as expert because of training, specialization, or because they belong to a functional elite.

Table 9. Actors included in the data collection

Port authorities	Port of Narvik, Port of Kristiansand, Port of Oslo
Local authorities	City of Narvik, City of Kristiansand, City of Oslo
Regional authorities	Agder County, BaneNor
National authorities	Norwegian Coastal Administration
Terminal operators	Yilport, Greencarrier
Port users	Glencore, LKAB, Heidelberg, Skanska, GC Rieber Salt
Maritime transport providers	Samskip, DB Schenker, Norlines, DFDS, Color Line, Stena Line
Road transport providers	DB Schenker, Norlines, Bring, Agder kollektivtrafikk
Energy providers	Gasnor, Agder Energi, Naturgass Nord, Hafslund
Trade and interest organizations	Ports of Norway, Norwegian coastal shipowners, GCE NODE, Zero

In this thesis, the experts were port actors with expertise in their own realities, and as such they fitted well with the notion of "everyone is an expert." However, their roles as experts were also constructed by me, the researcher, when I sought to access their specific knowledge of port activities and business. Their expert knowledge rested on their functions in the port, such as transporting or shifting goods and passengers, industrial production, or providing storage, towage or piloting services, energy provision and customs. In sum, their fulfilment of their functions gave a comprehensive picture of actors and activities that constitute the

foundation for transitions in ports. The port actors provided me with expert knowledge because they had particular first-hand knowledge about their functions and their interactions. Thus, the participants were experts on port actors and activities by virtue of fulfilling port functions themselves.

Expert interviews place certain requirements on the researcher. Active interviewing presumes that the researcher recognizes the contexts, cultural assumptions, and linguistic practices inherent in the interview (Holstein & Gubrium 1995:3). Therefore, to be an active interviewer, the researcher should gain as much knowledge as possible about the special knowledge that the expert has (i.e., the interviewee's knowledge corpus) (Pfadenhauer 2009:90). Document analysis was one way for me to prepare for this. By improving my understanding of ports' socio-technical contexts, the document analysis was instrumental in developing the interview guide and raised my credibility when recruiting informants and when conducting the interviews. Successful expert interviews derive from a communication situation that feels familiar to the expert (i.e., a quasi-normal conversation) (Hooner 1994, in Pfadenhauer 2009:84). Such conversations should, as far as possible, resemble conversation situations among experts, which requires both parties of the conversation to be experts (ibid. p. 86).

Additionally, background knowledge and shared experience are important for the researcher to assist the participant in reflecting upon and exploring their perception of the issue in question (Holstein & Gubrium 1995:45). Hence, the researcher "must build up a knowledge base of the field that the experts are moving in," because naivety could be perceived as incompetence (Meuser & Nagel 2009:31-32). In that way, document analysis became a tool for me build trust and confidence, and helped me to "activate, stimulate and cultivate the informant's interpretive capabilities" (Holstein & Gubrium 1995:17). This suggests that researchers relying on expert interviews need be particularly wary about ascription. Bogner and Menz (2009:57) assume that "whatever is said in the interview is in essential respects guided by "the informant's perception of the interviewer's competence, professional background, normative orientation and attitudes, and possible influence within the relevant field of investigation." Whether the informant considers the researcher to hold similar expertise as the informant themself, or to hold a different type of expertise, or merely perceives the researcher as a lay person, could influence the attitude, translation efforts, and self-censorship of the informant. Furthermore, the informant's openness could reflect their perception of the researcher as either an authority, an accomplice, or a potential critic (ibid.), which prove a particular challenge for researchers when studying increasingly normative phenomena such as sustainability.

Given the heterogeneity of the interviewed actors, it is likely that I was subject to all of the above-mentioned ascriptions. For instance, the different types of specializations that characterized the port actors suggest that I was probably regarded as a lay person during parts of almost all interviews. Ascriptions could also have changed during the course of an interview. One example is when an ascription changed from co-expert to expert from another knowledge culture, as the informant realized that I did not have the same level of knowledge about the port domain as them. Although understanding the knowledge corpus of informants was vital to attribute credibility to me as a researcher (ref. Pfadenhauer 2009), I also experienced that

my lack of knowledge relating to specificities was an advantage. My lack of familiarity with the informants' realities, coupled with their explicit trust and enthusiasm in the interview setting, led to particularly fruitful and honest reflections on the basics of their operations. This finding corresponds with the assumption made by Bogner and Menz (2009), namely that in a trustful interview situation, naive questions can give productive and interesting answers and encourage the informant to reflect on what they take for granted.

Expert interviews in Paper 1 and Paper 2

The document analysis was essential for developing the interview guide and establishing credibility. Another critical preparation was port visits. The ports visits were the first empirical work in the port domain and allowed for observations of selected port operations. They also enabled me to become familiar with the port organization and meet personally with port actors who the port organization considered prominent in the port's transition work. The interview guide for Paper 1 and Paper 2 was developed to serve the TRAZEPO project as a whole, and therefore it was developed in collaboration with my colleagues. The interview guide allowed for a broad mapping of socio-technical realities of port actors, and their perspectives on emission reduction and transition work in general. The main categories and central issues covered by the guide are listed in Table 10 (see Appendix A for the full interview guide). Thus, the main purpose of the expert interviews upon which Papers 1 and 2 were based was to increase our understanding of (1) the daily operations of actors in and around the port, (2) factors that influenced their operations and business development, and (3) their perceptions of emission reduction and efforts to achieve them. Collectively, findings related to these issues shed light on the contents and shaping of transition work.

Informants were recruited through purposive sampling. In purposive sampling, the researcher relies on their "special knowledge or expertise about some groups to select subjects who represent this population" (Berg 2001:32). In the research for this thesis, the sampling began with port representatives and stakeholders in the TRAZEPO project, who were engaged in the project precisely because they were responsible for activities and strategies for transition work in ports. We relied on the initial interviews with these informants to identify and contact other prominent port actors with explicit responsibility for dealing with sustainability issues in the port. As such, informants that were identified through purposive sampling enabled further snowball sampling: the identification of other relevant informants with relevant attributes based on the information provided by the existing informants (Goodman 1961). One risk with sampling procedures that rely heavily on an initially small group of informants is biased sampling, which for this thesis could imply that the data only covered certain aspects of transition work or transition work that was more progressive. If the purpose of this thesis had been to increase our understanding of non-existent or lagging transition work, such biased sampling would have had obvious bearings on the relevance of the data. However, when the purpose is to describe the content and emergence of transition work, sampling that directs the data collection towards cases that are rich in terms of transition work allows for fuller stories about transition work.

Although the interview guide was structured to aid the researchers in form of cues and probes, the interviews were conducted in a semi-structured manner. Accordingly, the informants were encouraged to narrate freely around questions and to address other issues that they

considered central in the operations and strategies of their organization. Thus, the questions listed in the interview guide were used as reminders by the researchers, which ensured that each interview covered the many different aspects of the informant's socio-technical realities.

Interviews were conducted throughout 2018 and early 2019. All interviews were conducted by telephone and lasted between 30 and 60 minutes. The researchers took notes continuously during the interviews, and notes were collected and collated after each interview. Notes were uploaded using NVivo software for coding and analysis. The data were then subject to two rounds of content analysis. Hsieh and Shannon (2005:1278) define qualitative content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns." We first performed conventional content analysis to obtain an overview of the many issues covered in the interviews. Conventional content analyses aim to "describe a phenomenon […] when existing theory or research literature on a phenomenon is limited" (Hsieh & Shannon 2005:1279). In the research for this thesis, conventional content analysis served to establish a knowledge base on transition work in and around ports, which had previously mainly been described in terms of what technologies and solutions could be applied to improve port sustainability (see Subchapter 2.2). In practice, this involved coding data according to the question categories listed in Table 10.

Table 10. General topics covered in interview guide for collecting data for Paper 1 and Paper 2.

Question categories	Main issues
Actors	Actors in and around the port in position to impact activities in the port
Level, scale	Levels of decision-making that impact the port, administrative levels, decision-making, regulatory levels, market orientations
Networks	Formal and informal networks of which port actors are a part, actors on the different levels described above, financial and non-financial resources in networks
Goals, ambitions, perspectives	Formal and informal objectives and ambitions in organizations, perspectives on surroundings and own business
Responsibilities	Mandate and responsibilities for sustainability in own organization, perceived responsibilities in other organizations, basis of responsibility/non-responsibility
Resources	Material, infrastructural, economic, financial, cultural, social, and technological resources, knowledge, organizational competence
Instruments	Measures, instruments, incentives, and other solutions that aid the organization and others to achieve emission reduction targets
Regulatory rules	Explicit formal rules that guide behavior and interactions
Normative rules	Values, norms, role expectations, duties, rights, and responsibilities
Cognitive rules	Perception of reality, interpretation of reality and symbols, formation of meaning, understandings of concepts
Rewards and sanctions	Factors that structure and regulate social transactions

As an exploratory approach, conventional content analysis builds on open-ended interview questions, followed by defining, revising, and organizing codes. As such, these types of analyses are not considered particularly suited for theoretical development. Although questions and topics were inspired by the existing corpus of theory and research on sustainability transitions, the interview guide was not defined to pursue specific theoretical insights or concepts. Rather, it was designed to maintain relevance for socio-technical studies and to keep a sufficiently open approach to allow for dives into the breadth of issues that it addressed. Table 11 exemplifies analysis of two such dives in Paper 1 and Paper 2.

Table 11. Codes used for analyzing the interview data for Paper 1 and Paper 2

Paper 1		**Paper 2**	
Producer	The informant talks about own or other organization's involvement in designing, modifying, testing innovations.	Networks	The informant talks about formal and informal networks that their organization is (not) part of and dialogue/cooperation they do/do not engage in concerning sustainability issues.
Legitimator	The informant talks normatively about innovations and their support/non-support for particular solutions.		
Intermediary	The informant talks about own or other organization's involvement in establishing structures and system, infrastructure, regulations to support a given innovation. The informant 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.	Expectations	The informant describes their imagined future. The informant talks about their organization's expectations and visions for the future, and how and to what degree they expect having to change. The informant talks about innovations expected to emerge.
Consumer	The informant talks about own or other organization's incorporation of innovations in their daily operations and practices.	Learning	The informant talks about their knowledge of innovations and external aspects that do or do not foster diffusion of innovations (first-order learning). The informant talks further about the assumptions that underlie his/her organization's motivations, priorities, and decision-making (second-order learning). The informant talks about his/her perception of what the port is and should be (second-order learning).
Citizen	The informant talks about own or other organization's involvement in active open promotion of particular innovations.		

When conducting the studies reported in the Paper 1 and Paper 2, the initial content analysis provided an open reading of the full data material, which allowed for identification of traits and tendencies in the data that could be investigated further. The broad data collection and conventional content analyses also allowed in-depth consideration of issues that were not

necessarily on the agenda when designing the interview guide. As such, conventional content analysis inspired direct content analysis, which was geared more to increasing our understanding of theoretical constructs. While the study reported in Paper 1 relied on the role typology suggested by Schot et al. (2016) to investigate what roles port actors took in pursuit of sustainability, Paper 2 discusses ways in which social processes around expectations, network-building and learning constituted transition work. Thus, coding and analysis in the two studies were defined explicitly on the basis of existing theoretical work in the transition literature, primarily that of Schot et al. (2016). Codes were specifically defined to investigate the research objectives of the studies, and are presented in Table 11. In both studies, text data for each interview was thoroughly reviewed and text extracts corresponding to the different codes were extracted and collocated for further review.

Expert interviews in Paper 3

In contrast to the studies reported in Paper 1 and Paper 2, in which scope and objectives evolved from conventional content exploration of rich data on the socio-technical contexts of port actors, the data collection behind Paper 3 explicitly targeted a specific issue: the implementation of shore power in the Port of Oslo. This issue emerged when analyzing the broad interview data described above, and when reviewing scientific studies of technologies that promote sustainability in ports. While previous interview data suggested that the scope and premises for transition work in the Port of Oslo was distinguished from other ports, reviewing state-of-the-art research on sustainability efforts in ports (documented in Bjerkan & Seter 2019) revealed a clear lack of empirical data on implementation processes. Thus, the study reported in Paper 3 aimed to provide empirical data and actual experiences of implementing shore power. To do so, there was a need for targeted data collection and specific data analysis.

As described in Paper 3, the study relied not only on substantial document studies to identify events in the implementation of shore power, but also on interviews with actors in and around the Port of Oslo that could shed light on the implementation process and provide perspectives on shore power as a solution to sustainability challenges. The interviews were organized around preliminary timelines for each actor, which described the actor's involvement with decision-making and implementation of shore power. Preliminary timelines were identified through data collection related to Papers 1 and 2, and document studies, which mainly included policy documents, as well as media coverage and opinion pieces. The timelines served as starting points for each interview, in which the informant was encouraged to narrate freely around the events we had already identified. An important aspect of the interviews was probing the informant for information about additional events or information that could corroborate (or contradict) our interpretations of events as described in the preliminary timelines. Thus, each interview was tailored to capture the involvement and events specifically relevant to the organization or informant in the interview. Accordingly, individual interview guides were developed for each interview, based on the preliminary timelines. A stylistic example of one such interview guide, based on a hypothetical, preliminary timeline, is shown in Figure 9.

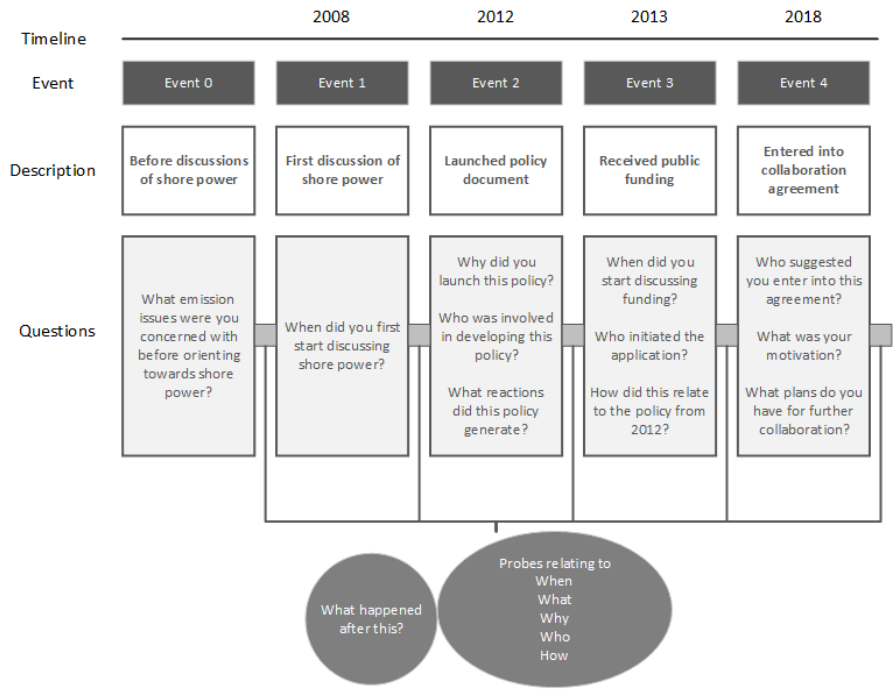

Figure 9. Hypothetical preliminary timeline used to guide interviews.

The study reported in Paper 3 also relied on purposive sampling and snowball sampling. The population of interest was persons directly involved in decision-making around the implementation of shore power for cruise ferries in the Port of Oslo. To a certain degree, these had already been identified through the data collection for studies presented in Paper 1 and Paper 2, but they were also identified by informants when explicitly discussing the shore power case. For Paper 3, it was crucial to identify informants who were personally involved in decision-making prior to the implementation of shore power, and therefore had first-hand experience of the implementation process. Given that shore power was also a prominent feature of the qualitative data underlying Paper 1 and Paper 2, data on shore power from these informants were also used to provide further background and context to the specific implementation process. Although we considered the informants in the final sample to be highly relevant participants in that process, and despite those representatives providing fairly consistent narratives, we cannot rule out the possibility that representatives in the organizations that were not interviewed might have provided other or contradictory stories.

The interviews were held throughout 2019. All interviews were conducted by telephone and lasted approximately one hour. The interviews were conducted by one colleague and me, and were recorded in full. Thereafter, each interview was transcribed, and all texts uploaded using the NVivo software for analysis. Whereas analysis in Paper 1 and Paper 2 followed predefined codes based on theoretical assumptions regarding the research objectives under study, text data in Paper 3 were analyzed along two lines. First, data were organized according to the

information they contained about events leading to the implementation of shore power, simply to obtain an overview of the full implementation process and the steps involved. This provided us with a chronological timeline of the implementation and full descriptions of the events included. Second, data were analyzed with regard to the theoretical underpinnings reported in Paper 3, namely the role of problems, policy, and politics in decision-making processes. The chronological timeline was reviewed to identify events and circumstances related to the problem stream of shore power, the policy stream, and the politics stream (see Table 12). Accordingly, event descriptions were revisited and coded according to Kingdon's understandings of these streams (1984), which represented the theoretical underpinnings of Paper3.

Table 12. Codes used to identify problems, policies, and politics in events

Problem stream	Perceived problems that need to be solved
Policy stream	Solutions available to solve the perceived problem
Politics stream	Political factors that lead policymakers towards particular problems and solutions to them

4.3 Scope and transferability issues

To increase our understanding of the content and shaping of transition work, this thesis draws on data relating to transition work in the ports of Narvik, Kristiansand, and Oslo. Although the TRAZEPO project (of which the research for this thesis is part) also reports on transition work in Norwegian ports more generally (Bjerkan et al. 2021b, Bjerkan et al. 2021c), this thesis does not delve into the greater variation in the transition work if ports. Therefore, sharing stories from representatives of the ports investigated here is not an attempt to make claims about the port sector in general. By contrast, and as highlighted in Chapter 7, the immense heterogeneity of the port sector suggests that transition work is likely to vary substantially from one port to another. Thus, although ports around the globe are facing similar challenges, transition work will not necessarily emerge in the same way in all ports.

As evident from subsequent chapters, this thesis mainly revolves around transition work in and around the Port of Oslo. Consequently, the three ports under study do not receive equal attention in the analysis. This particularly applies to the Port of Narvik, which at the point of data collection had yet to initiate substantial transition work. However, documents and interviews held in and around the Port of Narvik provided a richer context for understanding the premises for transition work in the port sector and provided a useful contrast when analyzing transition work in the other two ports. This also applies to interviews with representatives of the other national and European ports listed in Table 7, which provided me with a deeper and instinctive perception of the public port sector and its many facets.

It is also evident in subsequent chapters that the stories of transition work were mainly oriented around the activities of port organizations. Ports could also be considered as physical areas that comprise different port activities, as nodes in transport and industry networks, or as heterogeneous actor constellations (Damman & Steen 2021). Given that many ports are located close to urban areas, many of them need to incorporate neighboring communities into their system boundaries, suggesting that the transition work of ports could also comprise civil

society. Thus, although discussions on the content and shaping of transition work mainly focus on the transition work of port organizations, they also refer to the involvement of and shaping provided by other actors (e.g., in the role of the public, markets, business strategies, and environmental organizations in shaping transition work). Thus, I recognize transition work as the collective product of sustainability efforts of the many different corporate actors that comprise or engage directly in port areas. I further recognize that future stories of transition work should also contain more explicit reference to agencies of non-human actors, as exemplified by legislation, infrastructures, and artifacts in this thesis.

4.4 Naturalist approach to qualitative data

This thesis is positioned within the scholarly culture around socio-technical sustainability transitions. As seen in its lineage with STS, this culture orients quite prominently towards constitutive processes, ontologically as well as epistemologically. Although this thesis is clearly anchored in the research field of sustainability transitions, the collected data contain more naturalist and less constitutive elements than might be typical of studies associated with STS. For this reason, I share some reflections on the naturalist nature of the methods and data described earlier in this chapter.

Although content analysis can encompass manifest content as well as latent content (Berg 2001), it is often considered to originate in a naturalist paradigm (Hsieh & Shannon 2005), or a naturalist idiom. As thoroughly accounted for by Gubrium and Holstein (1997), qualitative methods can be considered to represent different ways of knowing (i.e., how knowledge is produced). They distinguish between different idioms, specifically different sets of language or methods talk that "shape knowledge of social reality" (Gubrium & Holstein 1997:5) and that relate to the researcher's approach to the phenomenon under study. The *naturalist* idiom describes actors in their natural world and assumes that there is a natural world ready to be discovered and described. Naturalism "seeks rich descriptions of people and interactions as they exist and unfold in their natural habitats" (Gubrium & Holstein 1997:6). Within this idiom, informants are the medium through which the researcher taps into that world and that enable the researcher to capture reality as it "really is." This requires the researcher to be present in that world and take on a *tabula resa*—to meet the world without prejudice and adopt the reality presented by the informant.

Practically every aspect of my document analysis had naturalist connotations. When working with documents to understand the socio-technical systems of ports, I treated the documents quite straightforwardly as mere conveyors of words and images. As such, I bluntly accepted the documents I studied as representations of the natural socio-technical world of ports, and the documents mainly served as sources of information. The approach was opposite to the reflexive turn in document analysis (Altheide et al. 2008), which suggests that documents can also be considered symbolic representations, which require the analyst to be reflexive with regard to sources, meanings, and relationships. In this sense, document analysis includes reflections upon the unspoken contents of documents: what they neglect to address, what their purpose is, and what audiences they target (Bowen 2009). A more naturalist approach to document analysis implies that the researcher ignores the multiple realities that could be inherent in documents, which in turn could lead to bias and misrepresentation.

A potential challenge in my document analysis was *selection bias*. This related to the selection of documents to be included in the document analysis, which could occur through iterative search and selection processes and the criteria applied in them. For this thesis, the selected documents included in analysis were mainly formal official documents. Public documents are often considered to have high credibility (Ryghaug 2002), but one should also remember that they are intended to bear the scrutiny of the public eye. Including informal documents, such as correspondence, internal memos, and meeting minutes, could provide alternative or nuanced realities, hidden by the apparent consensus presented by official document. Although other types of documents may also represent the same voices and perspectives as those represented official documents, chances are that the variety of voices concerned with port issues, or any other issue, would not be represented when only analyzing formal public documents.

Another challenge with formal official documents is not only knowing how they were produced, but also why they communicate what they do. My document analysis did not delve into the construction of reality as presented by the studied documents, that is, whose realities and perceptions they were based on and whose sensemaking lay behind the documents. There is inherent power in choosing whether or not to make documents available, and in choosing what to present and not to present (Altheide et al. 2008). Insecurities, discussions, controversies, and conflicts are all masked by formal documents, which suggests that formal documents typically present the reality the authors want to be real. Therefore, Bowen (2009) argues that reflecting on the balance of documents is essential when the researcher evaluates them. For example, when reviewing the sustainability reports of shipowners, one could expect less successful (or lack of) endeavors to be less prominent or even absent from documents. Furthermore, the absence or sparseness of documents altogether could suggest little attention to an issue (Bowen 2009). Absence of formal documents could also suggest that an actor does not *want* attention to a particular issue. In conclusion, pondering the non-existence of documents or issues could be equally important when analyzing documents as evaluating their contents.

During the research for this thesis, naturalist aspects were also found in the expert interviews. In seeking to explore and map the socio-technical contexts of ports, my interviews relied on treating the informants as vessels of answers (Holstein & Gubrium 1995), since the interviews were mainly fact-finding missions (i.e., what the port actors had done, what they were doing, and what they were planning to do). As such, I did not pay specific attention to how the realities presented to me were constructed. On the contrary, it was important to me to tap into the informant's world as they described and perceived it, and to document their perspective. Hence, understanding the premises for transitioning socio-technical contexts around ports relied on switching between the different worlds that different port actors occupied.

Part B: Papers

5 Papers

The following pages present the papers that are published as part of this thesis. All three papers provide responses to RQ2, about the content of transition work in ports, and to RQ3, about the shaping of transition work. However, considering how transition work is not an explicit focus in all papers, the papers are followed by a summary of ways in which they describe the content and shaping of transition work.

Paper 1: Bjerkan, K. Y., M. Ryghaug & T. M. Skjølsvold (2021): Actors in energy transitions: Transformative potentials at the intersection between Norwegian port and transport systems, *Energy Research & Social Science*, 72, 101868 https://doi.org/10.1016/j.erss.2020.101868

Paper 2: Bjerkan, K. Y. & M. Ryghaug (2021): Diverging pathways to port sustainability: How social processes shape and direct transition work, *Technological Forecasting and Social Change*, 166, 120595 https://doi.org/10.1016/j.techfore.2021.120595

Paper 3: Bjerkan, K. Y. & H. Seter (2021): Policy and politics in energy transitions. A case study on shore power in Oslo, *Energy Policy*, 153, 112259 https://doi.org/10.1016/j.enpol.2021.112259

Paper I

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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, topplers, 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 evolvement 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 Parags 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 lobbyism 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 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.

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 agentsVehicles/train owners Infrastructure owners Fuel providers
Sustainability issues	Emissions from vessel on arrival/departure and at berth (SO_X, NO_X, CO_2, CH_4)	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	Electrification of terminal operations Efficient goods handling Automation Clean industrial production Port management	Efficient loading/unloading Modal shift Technological shift in trucks and drayage
	Alternative fuels (LNG, biofuels, methanol, hydrogen, ammonia, low-sulfur fuel) Alternative power sources (wind, solar, wave, tidal, geothermal)		

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_2 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_2 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 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

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*

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 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.

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.

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*

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

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

	Producer	Legitimator	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 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 faciliatory 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[1] and electrification in general appeared to be a universally accepted approach to promote energy transitions. Port actors 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 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*

[1] Shore power allows vessels to shut down auxiliary engines and rely on electricity from the shoreside at berth.

"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 eco-cultural 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 technologý, they found it safer to remain on the sideline. This was exemplified by one shipowner, who discredited other shipowners who 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

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)	–	–

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 activites 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 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

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	–	–

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, thee 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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Paper II

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Diverging pathways to port sustainability: How social processes shape and direct transition work

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Sustainability transition

ABSTRACT

To counter climate change, societies are under pressure to transform energy and transport sectors. Considering the crucial node position of ports in the intersection between energy and transport systems and their connecting of numerous sectors, markets, and values chains, they have hitherto received surprisingly little attention as potential sites for whole system thinking and deep transition. Their heterogeneity suggests that ports are likely to follow different transition pathways. This study explores two Norwegian frontrunner ports to demonstrate how social processes are part of the fabric that constitutes transition pathways in ports. The transition pathways in the two ports diverge according to how they are shaped by deep learning, resource capacity and the collective action of their wider networks, as well as the specificity of expectations. The study complements existing research on transition pathways by focusing on social processes beyond the niche level and by suggesting inter-process and inter-level dynamics to be decisive for the direction of transition work. Contrary to earlier findings, the paper demonstrates how broad and diversified networks may also represent a challenge to the directionality of transitions work. Ports can, however, promote transition work by aligning expectations to port sustainability with expectations in specific value chains.

1. Introduction

Societies, sectors, and systems are under pressure to reduce climate emissions and build more sustainable communities. A well of research has delved into the premises for making such a transition (see Köhler et al., 2019; Sovacool et al., 2020 for recent overviews), focusing on how sociotechnical systems could be nudged, lured or forced onto more or less disruptive pathways towards sustainability. Research on socio-technical transition pathways has also been sparked by the recognition that transitions are context dependent and unfold differently under highly different circumstances (Lindberg et al., 2019).

This study focuses on a transition site where a variety of contexts and circumstances clearly shape presumably similar transition cases in different directions, namely ports. Ports are important nodes in the intersection between energy and transport systems, ensuring the shifting of goods and passengers between sea and land transport. In connecting a number of sectors, markets and value chains, ports can promote whole system thinking (McMeekin et al., 2019) to ensure deep transitions (Geels et al., 2017). However, the complexity represented by the conglomerates of actors and activities in ports, also suggests that each port represents a unique transition context. Among other, transition potentials in ports depend on geographical contexts, port characteristics and capacity, ownership strategies, local history and culture (Damman & Steen 2021). Previous research has studied the port of Rotterdam, focusing on the symbioses between the port and industrial activities in the region (Baas, 2008); the role of partnerships in moving the urban port towards sustainable co-existence with the city (Frantzeskaki et al., 2014); and how transition management may be employed to destabilize the fossil fuel regime of the port (Bosman et al., 2018).

Overall, however, the scientific literature on sustainability transitions has largely overlooked ports as transition sites and thereby also the multitude of transition pathways that could emerge (and diverge) in ports. This paper will contribute to fill that gap by exploring emerging transition work in two Norwegian ports. These two ports are placed in seemingly similar transition contexts, but are nonetheless on diverging transition pathways. Thus, by studying these two cases we can know more about how pathway creation occurs in this domain. More specifically, we seek to demonstrate how emergent transition pathways in these two ports appear to diverge by studying social transition processes that the port actors engage in. This shows not only how these processes

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enable transition work altogether, but also how port actors operating in these two ports shape the direction of transition work. The purpose of this study is therefore to demonstrate how social processes are part of the fabric that constitutes transition pathways. More specifically, we ask, *how can social transition processes shape transition pathways through enabling and directing transition work?*

Answering this question allows us to understand how social processes build transition work and thereby promote (or impede) transition. By emphasizing processual characteristics, we also go beyond most scholars, who stress technological components of transition pathways. Social processes are considered essential in driving transitions forward (e.g. Schot et al., 2016; Naber et al., 2017; Schot and Geels 2008; Söderholm et al., 2019; Borup et al., 2006), and are in literature on sustainability transitions often thought to revolve around networks, expectations and learning. The production of *expectations* contributes to align perceptions and produce shared realities which build legitimacy and protective spaces for emerging niches. Building *social networks* that support emerging niches and collaborations can destabilize incumbent regimes, especially when networks draw on diverse stakeholders that commit resources. *Learning* has proven important for modification and improvement of niches, as well as modification of assumptions and interpretations upon which the stability of incumbent regimes is built.

By exploring emerging transition work in two ports, this study addresses *uncomplete transitions*. Such an approach is crucial to identify factors that might tilt a potential transition in one direction or the other. Studying emergent transitions calls for targeting cases that are at an early phase of transition, or cases that might eventually evolve into transition. Should research on sustainability transitions be able to contribute to accelerate transitions, understanding failures, struggles and factors that hamper emerging transitions is just as important as studying successful transitions. As such, this study could also increase understandings of acceleration, a phase of transitions which is relatively under-explored (e.g. Valkering et al., 2017), but which depends on the enrolment of new actors like, for instance port actors, into transition processes.

Studies of sustainability transitions need to look beyond niche developments and focus more on institutional and organizational contexts (Truffer et al., 2017). Unlike most studies of social processes within sustainability transitions research that typically relate to a particular niche (e.g. Pedersen and Nygaard, 2018; Falcone and Sica, 2015), this study therefore explores the orientation of port actors within the place specific and spatial contexts they are situated. This is an important endeavor, as understanding how networks, expectations and learning constitute such contexts also shed light on geographies of transition (Hansen and Coenen, 2015; Binz et al., 2020) which overcut regimes that the heterogeneous mass of port actors is part of. This means that our study does not explicitly aim to explore constitutive aspects of social processes, i.e. how these processes are maintained and (re)produced, but rather aims to understand the current *functions* of the social processes in shaping transition work.

The remainder of this article is structured as follows. The next section gives an overview of existing literature on transition pathways and how they could be shaped by networks, expectations, and learning. Section 3 presents methods and data used to understand the role of social transition processes in the two case ports. The next four sections present the case ports, and ways in which their transition pathways are shaped by social transition processes. Finally, Sections 8 and 9 provide discussions and summaries of the study.

2. Theorizing transition pathways and social processes

A central issue in transition studies is the prospects of socio-technical systems and how they over time evolve onto different pathways. Socio-technical transition pathways "(..) are concerned with the multiple and interlocking causal processes involved in transitions" (Rosenbloom, 2017). Part of the transition literature is thus dedicated to understanding how transitions evolve and by what types of processes systemic renewal occurs. In their early work, Geels and Schot (2007) suggested a typology of four transition pathways, based on whether pressure from niche and landscape levels were disruptive or reinforcive, and whether innovations were sufficiently mature. Others have suggested other typologies, emphasizing pressures and resources (Smith et al., 2005), coordination and resources (Berkhout et al., 2004), or degrees of sustainability and disruption (Lindberg et al., 2019).

Geels and Schot's (2007) systemic approach to transition pathways has received criticism for under-acknowledging the role of agency. As a response, nuance was added to their typology (Geels et al., 2016:901), arguing that transitions do not just emerge as a result of struggle and pressure on the regime level, but that transitions can also be non-linear and enacted, stressing that "(…) shifts between transition pathways are influenced by a range of developments: changing composition and strength of actor coalitions; learning processes and on-the-ground experiences (..) [and]; landscape developments (…)". In line with this, sustainability transitions scholars have highlighted the roles of agency and actors in shaping transition pathways, for instance, stressing that system-level change, by definition, is "enacted through the coordination and steering of many actors and resources, whether these are intended or emergent features of transformation processes" (Smith et al., 2005:1492). Others have claimed that understanding transition pathways calls for an analytical approach that goes beyond the regime-niche dichotomy (Berggren et al., 2015). Building on these insights, this study emphasizes the need to understand actors and agency beyond the niche-regime dichotomy should we be able to identify emergent features of transformation processes and pathways.

The discussion above also points to the tendency of transition research to study transitions either from a systemic (regime) perspective (e.g. Köhler et al., 2020) or a niche perspective (e.g. McDowall, 2014; Mirzania et al., 2020). Granted, studies focusing on the niche level have been more attentive to the role of actors and agency. In studying low-carbon electricity in the UK, for instance, Foxon et al. (2010) and Fox (2013) describes different sets of actor logics that can produce different transition outcomes. Yang et al. (2020) describe institutional activities in niche and regime actors to demonstrate divergencies between pathways in solar PV. Many studies also discuss how expectations, networks and learning shape how transitions evolve, for instance, talking about how actors build networks to reinforce their 'logic' (Foxon et al., 2013) and suggesting that visions and expectations hold several functions for shaping transitions, such as mapping possibility spaces and providing narratives for mobilizing resources (Smith et al., 2005). There are also studies of transition pathways targeting social transition processes specifically, presenting the theoretical underpinnings for understanding these processes that remain at the core of this study.

2.1. Social networks

There is an abundance of research on the role of social networks in sustainability transitions. As we focus on the functions of networks in shaping transition work, we find it useful to draw on the resource based perspective on networks as presented by Musiolik et al. (2012). We consider the functions carried by social networks in shaping transition work to be inherently tied to the capacity of network actors to establish and apply the resources available in these social networks. Musiolik et al. (2012:1033) refer to resources as shaped by the "broader resource space" of networks, arguing that cyclically pooling available resources between networks of actors provides direction and a sense of control. They define resources as "assets which are strategically developed, used and transformed by actors (…)" (Musiolik et al., 2012:1034). Thus, developing transition pathways not only depends on resources such as financial assets and economic or human capital, but also resources embedded in culture, trust, goals, and reputations. Building on this, networks can successfully progress transition if able to draw on the variety of resources available to them.

Transition scholars have suggested several ways for actors to promote transition through building on their resource spaces. For instance, producing and exchanging resources such as knowledge and experience within niches can increase the ability of networks to or modify innovations, demands and preferences (Schot et al., 2016), and thereby impacting the diffusion of innovations. Further, resources are crucial for enabling actors to take *collective action*, that is collectively engaging each other with regard to promoting new technologies and to accelerate their production, use and diffusion (Markard and Truffer, 2008). Collective action is particularly effective when supported by formal networks (Musiolik et al., 2012), in which actors are bound to draw on complementary resources to coordinate strategies and objectives.

Drawing on resources in vast networks may also allow actors to *create protective spaces* for emerging niches (Naber et al., 2017; Smith and Raven, 2012). In particular, wide networks with a wide set of complementary resources (i.e. broad networks) and networks in which actors are committed to pool their resources (i.e. deep networks) are likely to support and promote the successful breakthrough of niche innovations (Schot et al., 2016). Thus, networks that efficiently promote transitions tend to be broad and deep, i.e. include different groups of stakeholders that express multiple perspectives and that mobilize resources and commitment (Schot et al., 2016; Schot and Geels, 2008). This could be translated into network performance (Newell et al., 2017; Provan and Kenis 2007; Klijn, 2005), which in the literature is considered the product of high *actor diversity*, high *level of integration* and high degree of *stability* in the network (Söderholm et al., 2019). In contrast, underperforming networks might impede transitions, particularly by imperiling niche development, and previous research has seen several examples of emerging transitions being obstructed by weak social networks (Giurca and Metz, 2018) or unproductive network composition (Falcone and Sica, 2015; Normann, 2017).

The network compositions in ports are likely to vary from one port to another and to consist of heterogeneous sets of actors, activities, technologies, and institutions. As transition work at ports involves wide networks that cut across sectors and value chains, ports are in position to encourage deep transitions, which requires fundamental shifts in directionality and logic across sectors (Schot and Kanger, 2018). This renders ports interesting sites for studying how differences in network complexity, integration and stability contributes to shaping coherent or diverging transition pathways.

2.2. Expectations

Transitions could also be shaped by expectations, which are real time representations of future situations (Borup et al., 2006; Budde et al., 2012). The evolution and diffusion of innovations rely on widely shared perceptions of future prospects (Schot et al., 2016), particularly in early phases of transitions (Hoogma et al., 2002; Skjølsvold, 2014). Expectations could also provide direct and indirect guidance in innovation searches (Budde et al., 2012; Bakker, 2014) and encourage investments to realize societal and collective goals (Schot and Geels, 2008; Borup et al., 2006).

Several studies discuss the definition and role of expectations in transitions (e.g. Berkhout, 2006; Geels and Smit, 2000; Konrad, 2006; Van der Voorn and Quist, 2018; Hansen and Bjørkhaug, 2017). Summarizing this research, Alkemade and Suurs (2012) provide a useful distinction between four functions of expectations. Firstly, expectations can serve to *coordinate and align* actors and activities, so that expectations shape decision making (Van Lente and Rip, 1998) and cognitive frames (Schot and Geels, 2008). This is particularly salient when expectations are shared by many actors (e.g. Naber et al., 2017). Second, expectations can *build legitimacy* around emerging technologies and create *protective spaces* that allow technologies to mature in peace (Schot et al., 2016). The agency of actors is therefore essential to diffuse visions and innovations (Van der Voorn and Quist, 2018). Third, expectations can motivate actors to *mobilize and dedicate resources* to new technologies (Alkemade and Suurs, 2012) through mutual commitment (Borup et al., 2006), especially when they suggest urgency and imminent change (Schot et al., 2016). The mobilizing effect is particularly fierce when expectations are tested and confirmed by empirical observation (Schot and Geels, 2008; Bakker, 2014). Finally, expectations can contribute to *reduce perceived risks* and uncertainty (Borup et al., 2006; Alkemade and Suurs, 2012), especially in early phases of transition when innovations are immature and uncertainties are high (Budde et al., 2012).

The potential of expectations to shape transition pathways lies particularly in their ability to balance stability and flexibility. Stable perceptions can more easily be placed within larger sociotechnical narratives (Schot et al., 2016) and thereby linked to other expectations (Budde and Konrad, 2019) which may reinforce their legitimacy and validity. A challenge, however, is balancing stability with the need to adjust according to experiences that may dismiss or modify expectations (Schot and Geels, 2008). Expectations are therefore contingent on a temporal dynamic, often characterized by hype-disappointment cycles (e.g. Borup et al., 2006; van Lente et al., 2013; Verbong et al., 2008; Dedehayir and Steinert, 2016). Thus, expectations can also slow transitions down, and lack of shared visions (or directionality) is known to be a potential transformation failure (Weber and Rohracher, 2012). Lack of expectations to an emerging niche could for instance obstruct actors from engaging in that niche (Budde et al., 2012; Budde and Konrad, 2019) or actors might withdraw their support if developments are expected to change (Bakker, 2014). Transitions could also halt if expectations are inconsistent and not shared between actors within a niche (Hansen and Bjørkhaug, 2017; Alkemade and Suurs, 2012) or between different governmental levels (Mutter, 2019; Tidwell et al., 2018).

Given the complexity and context laden nature of ports, it is likely to assume that the multitude of actors and markets interacting in ports are also reflected in a multitude of expectations. This could pose a challenge in uniting actors around common visions, but could also represent an opportunity for enhancing our understanding of how expectations and co-production of visions shape transition pathways.

2.3. Social learning

From the transitions literature on actors, agency and local specificity, we know that social learning is essential to realize sustainable development (Van Poeck et al., 2018). The main function of learning in progressing transition is to allow *modification of innovations, expectations and sociocultural perceptions* (Naber et al., 2017). This includes learning about innovations and their exogenous aspects (Schot et al., 2016), as well as fundamental assumptions that may guide interpretations and behaviors (Argyris, 1976; Argyris and Schon, 1974). It is therefore useful to distinguish between different types of learning in transition work.

Broad learning (first order learning) implies learning about the technology at hand, but also external aspects such as regulations, societal, cultural and environmental impacts, market potential and user preferences (Schot et al., 2016). The diffusion of such knowledge could be instrumental in producing radical transition pathways, as it has been argued that one area of expertise alone does not have sufficient "problem-solving capacity" (Van Poeck et al., 2018). However, broad learning can mostly produce incremental changes (Pahl-Wostl et al., 2013). In contrast, *deep learning*, or second order learning, implies fundamental changes to assumptions that guide interpretations and behaviors. Deep learning therefore often allows for more radical changes (Argyris, 1976; Argyris and Schon, 1974). It may resembles "triple loop learning" (Pahl-Wostl et al., 2013), where revisiting, scrutinizing and potentially altering, underlying values, beliefs and world views are considered necessary for structural transformation. Questioning what is taken for granted and institutionalized (i.e. "unlearning", Baas, 2008) has proven to allow for creatively producing new perspectives, skills and practices (Van Poeck et al., 2018). Furthermore, deep learning can occur both at the individual and group level (Sengers et al., 2019), and can be

Table 1
Summary of functions and reinforcive characteristics of social processes in transitions. Authors' composition.

	Social networks	Expectations	Learning
Dimensions	Create collective action Build protective spaces Diffuse knowledge and technology	Coordinate/align Build legitimacy/ protective space Mobilize resources Reduce risk perception	Modify innovation Modify expectations Modify sociocultural perceptions
Reinforcive characteristics	Diversity Integration Stability	Shared Specific Confirmed	Broad Deep

achieved through actual use of innovations when users reflect around assumptions they take for granted (Schot et al., 2016). Experiments that confirm or contradict expectations are therefore essential in this kind of learning processes (e.g. Brown et al., 2003; Rosenbloom et al., 2018; Berkhout et al., 2010).

Considering the many technologies and innovations that are relevant in transitioning ports towards sustainability (Bjerkan and Seter, 2019), substantial broad learning is likely to be crucial for the ability of port actors to identify and select technological components of their transition work. The strong incumbency of many of these actors could also indicate that deep learning (or even unlearning) could be cardinal for transitions to evolve in ports.

2.4. Summing up dimensions of social processes that shape transition work

Table 1 summarizes dimensions of social processes that can enable and shape transition work, as presented by the literature referenced above. The table distinguishes between i) different dimensions of social processes and ii) characteristics that might provide momentum in the transition work. The latter refers to aspects of social processes that may impact the forcefulness of transitions. For instance, expectations that are shared, specific and confirmed, and heterogeneous, tight networks, are considered to effectively drive transitions forward.

The dimensions and characteristics displayed in the table will be used throughout the following analysis to demonstrate how social processes shape transition pathways in the two ports. However, before demonstrating how social processes can produce diverging transition pathways in ports, we will first elaborate on how data was collected and how the analysis was carried out .

3. Methods

3.1. Data collection and sample

The paper is based on data from interviews with 25 actor representatives in the Norwegian ports of Oslo and Kristiansand between October 2018 and February 2019. The representatives were identified through purposive sampling (Berg, 2001; Tongco, 2007) in collaboration with key port contacts. Actors considered to play active roles in sustainability efforts in and around ports were explicitly targeted. Some informants were also suggested by other informants (i.e. snowballing, Goodman, 1961).

The port literature provides several categorizations of port actors (e.g. Rodrigue et al., 2010; Lam et al., 2013; Hall et al., 2013), which typically encompass actors in the port area (terminal operators, goods owners, warehousing, piloting and towage, waste collection etc.), actors in the transport domain (transport users, providers, agents and operators), and community actors (authorities, NGOs and interest organizations, port authority, residents etc.). This study applied a similarly broad approach, thereby encompassing the variety of actors that might engage in and shape transition work in the two ports.

Table 2
Port and transport roles covered by actors interviewed.

Interviews in Port of Oslo (n=10)	Interviews in Port of Kristiansand (n=10)
Local authority*	Local authority
Port authority	Port authority
Terminal operator	Regional authority
Energy supplier	Terminal operators
Goods owners	Energy suppliers
Vessel/vehicle owners	Goods owners
Transport service providers	Vessel/vehicle owners
Transport buyer	Transport service providers
	Transport buyers
	National Rail Authority, regional division
Interviews related to both ports (n=5)	
Norwegian Coastal Administration	
Norwegian Port Association	
Vessel/vehicle owners	
Transport providers	

*The City of Oslo is both local and regional authority.

Interviews were based on a semi-structured interview guide which allowed the informant to narrate freely around each question and address issues that were not defined in advance. Table 2 gives an overview of interviews with port actors. The sample included representatives from transport companies, forwarding agents, terminal operators, industrial companies, local, regional, and national authorities, port authorities, port association, and energy suppliers. Energy suppliers provided hydropower electricity, LNG, biogas and hydrogen. The sample also included organizations that conducted several types of business and have several roles in the port and the transport system. The same organization may for instance be a transport provider, a forwarding agent, and a terminal operator. All industrial companies in the ports were further goods owners. Thus, the sample comprised non-exclusive categories of informants with several roles in ports and transport systems.

The interviews were conducted on telephone and lasted between 30 and 60 minutes. The researchers took notes continuously throughout the interviews. Upon completion of the data collection, all notes were loaded into text processing software for coding and analysis.

3.2. Data analysis

Data was explored through conventional content analysis (Hsieh and Shannon, 2005) based on codes in Table 3. These were defined with reference to theory and previous research on social processes within the sustainability transitions literature described in Section 2. The data gave an overview of the actors' main network connections and the character of these connections. The accounts of the informants also described relations to actors that were not interviewed in this study (e.g. universities, environmental organizations). Such relations were also included in the analysis. The network relations were further analyzed with regard to actor diversity (i.e. number of different actors and sectors in network) and integration (i.e. degree of formalized relations). The analysis also identified how actors engaged in and/or pursued collective action, how they worked individually or collectively to build protective spaces around niches, and whether specific niches and technologies were adopted by the actors in the network.

The analysis of expectations included mapping the informants' expectations about the future and assessing whether these expectations were shared between port actors, specific and confirmed. This included expectations about the organization itself and its surroundings, possible future market developments, regulation and incentives, innovations, and technologies. The mapping allowed us to assess whether expectations served to coordinate/align actors and activities, build legitimacy and niches, mobilize actors and resources, and reduce risk perceptions.

The analysis of learning processes included identifying the attempts

Table 3
Description of codes applied in data analysis. Authors' definition.

Code	Summarized description
Networks	The informant talks about formal and informal networks their organization is (not) part of and dialogue/cooperation they do/do not engage concerning sustainability issues.
Expectations	The informant describes their imagined future. The informant talks about their organization's expectations and visions for the future, how and to what degree they expect having to change. The informant talks about innovations expected to emerge.
Learning	The informant talks about his/her knowledge about innovations and external aspects which do or do not foster diffusion of innovations (first-order learning). The informant further talks about the assumptions that underlie his/her organization's motivations, priorities and decision-making (second-order learning). The informant talks about his/her perception of what the port is and should be (second-order learning).

of the actors to gain knowledge about innovations and preconditions for use. It also included identifying changing assumptions about innovations, expectations and sociocultural perceptions.

4. Two case ports in emerging transitions

This study addresses social transition processes in two Norwegian frontrunner ports to demonstrate how such processes are part of the fabric that constitutes transition pathways. The Port of Oslo is located in the heart of the Norwegian capital and is a hub in the national transport system. The Port of Kristiansand is located at the southern tip of Norway, closely located to continental Europe. The ports are similar in many respects. Their goods traffic is dominated by container transport, tanker, and bulk transport, although with higher volumes in Oslo than in Kristiansand (Fig. 1). Both ports are served by cruise ships and ferries. During the first nine months of 2019, 1,8 million international (cruise) ferry passengers passed through the Port of Oslo, and 1 million through the Port of Kristiansand (Statistics Norway, 2019a). A lot of the goods transported to the port in Oslo is connected to the industrial activity in the port area, whereas the offshore and supply sector is a prominent port user in Kristiansand.

Despite belonging to a group of progressive Norwegian ports in terms of sustainability and technology implementation, the two ports differ in ways that make them interesting contrasting cases for studying emerging transition pathways. The Port of Oslo is a Norwegian frontrunner port when it comes to sustainability ambitions and endeavors, with explicit and ambitious sustainability goals. The port is owned by the City of Oslo, which aims to reduce the city's greenhouse gas emission by 95% within 2030 (City of Oslo, 2016). This implies substantial reductions in the port area as well. The port is therefore explicitly included in the city's ambitious climate policy, with an ambition to reduce 85% of CO_2 emissions from the port within 2050. The port has also appointed a Director of Environment, and the large port organization (at least in a Norwegian context) has employees with specific competences on technology, business development, policy, and governance. The port provides high voltage shore power to international ferry lines, and its terminal operator is moving towards automation and full electrification. This is in line with the port's zero emission action plan, which also emphasizes charging facilities and biofuel infrastructure for local passenger ferries. The Port of Kristiansand is one of several Norwegian ports who ambitiously implement technologies and innovations to improve own sustainability. It could be considered a frontrunner because of its position as an early mover in implementing high and low voltage shore power and installing solar power on rooftops. It also aims to become an environmentally friendly transport hub in the region. The port organization in Kristiansand is less specialized than the one in Oslo, and the 30 employees form a lean organization that hires needed competence from the outside.

Thus, the two ports share certain similar transition contexts. They belong to the same geopolitical and macroeconomic realities; they are publicly owned and located in the city centers; they have similar traffic; are progressive in making use of new technologies and innovations; and are engaged in research and development to strengthen own sustainability efforts. Exploring these similar cases is useful to identify factors that promote progress in one case or impede it in another. The port organization could for instance draw actively on its social network in one case but not engage in network building in the other, or expectations could be aligned in the latter but divergent in the former. Hence, this study investigates the two cases' emergent transition pathways by exploring how social processes shape their transition work. These explorations are analyzed in the following.

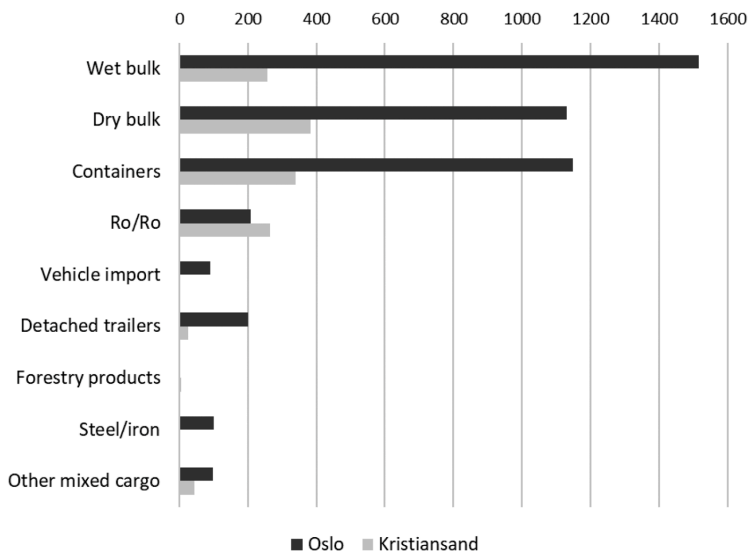

Fig. 1. Goods throughput in the two ports Q1–Q3 2019, in thousand tons. Source: Statistics Norway (2019b).

5. Producing visions and sharing expectations

Expectations and visions can drive transitions along several dimensions. As described more in detail in the theory section, they serve to coordinate and align actors and activities; they can build legitimacy around and protect innovations; they may mobilize and dedicate resources and reduce perceived risks among actors. The following passages demonstrate how expectations enabled and shaped transition work in the ports of Oslo and Kristiansand.

The largest difference between the two ports related to their agency and scope in facilitating visions. Unlike the Port of Kristiansand, the transition work in the Port of Oslo rested on visions that included the width of port activities and actors, as represented by the Port's 17-point zero emission action plan. The Port envisioned a wide approach to transitioning the port, encompassing a multitude of innovations and stakeholders. The Port further sought to *produce* shared imaginaries among its users and other stakeholders. For instance, the port invited the city and a range of its users to develop a concept for the future zero emission port in Oslo. Not only did this serve to co-create long-term visions, but it also expanded their scope in providing visions for a range of technologies, such as energy production and storage, autonomous vessels, biogas and waste heat, hydrogen and alternative fuels.

In contrast, the Port of Kristiansand did not actively seek to (co) produce visions among its users and stakeholders. Rather, the port's transition work mainly centered around stepwise electrification of port activities, and projects and dialogues with individual users. As such, visions in the Port of Kristiansand were less produced and less encompassing both in terms of scope (technologies) and time perspectives.

Nonetheless, expectations in the two ports also aligned in several ways. Transition work in both ports was supported by the actors' expectations that they must prepare for a green future by reducing emissions and improving energy efficiency. Port actors were as such aligned in working towards more sustainable production, operations, and value chains, and their expectations about a green future drove them to explore sustainable solutions. This motivation seemed to be grounded in an almost promotional strategy. The belief that pressures to transform in a more sustainable direction would increase, raised the legitimacy of nearly any technology or innovation that was expected to improve sustainability issues. This pressure, however, was not perceived to be urgent and port actors did not expect to be penalized by their markets if they did not adjust accordingly. As such, non-change was not associated with high risk. The lack of urgency also related to how the port actors perceived the competitiveness within their sectors. There was a general assumption that no one would pursue sustainability if it implied economic loss, but actors disagreed on whether one could expect to profit from becoming greener or not. Port and local authorities considered sustainability transitions at ports as a viable business opportunity that enhanced their competitive edge, and thus expected green ports to win market shares over less green ones. They therefore mobilized for stricter regulation and greener policies to strengthen the positions of their ports. Conversely, actors enmeshed in port operations questioned the value of green profiling compared to time and cost-effective production.

Further, transition work in both ports was strongly tied to expectations regarding electrification. These were largely the result of clear policies and generous public funding schemes which reduced the actors' risk perceptions and enabled mobilization of resources. Although port actors were unsure of the urgency and profitability of sustainability efforts, many port actors invested in electrification technologies, which reflected their high expectations around electrification. Electrification has been prominent in Norwegian energy policies, as also reflected in the policies of the two ports. Action plans and shore power strategies have built legitimacy to and continued protection of electrification as a viable pathway. Expectations and visions regarding operations that could be electrified were therefore strong, stable, and shared, and continuously confirmed by collaboration projects and practical experience.

Nonetheless, we seem to be witnessing two cases of directionality failure in this study. Previous studies point to collective priorities and technology-specific policies (Weber and Rohracher, 2012) and the alignment of regulation and policy with social discourse as means to avoiding such failure (Yap and Truffer, 2019). In the two ports examined here, transition work and pathways not related to electrification were modest and vague. Technology and innovation expectations were highly unspecific, and few expectations served to legitimate specific innovations or fuels. The difficulty in co-producing expectations beyond electrification might relate to the lack of directionality signaled by authorities and that 'the battle of fuels' was still considered undecided. One actor particularly highlighted the previous confusion related to liquified natural gas (LNG): after being perceived as a viable solution in the early 2000s, new knowledge about the climatic footprint of LNG caused great skepticism and uncertainty (e.g. Gilbert and Sovacool, 2017), not unlike typical hype-disappointment cycles (Dedehayir and Steinert, 2016). Given the lack of political direction and interest, shared and specific expectations beyond electrification failed to mobilize actors, as risks felt prominent, leaving the ports to solve their challenges uncoordinatedly and by themselves.

We found that directionality appeared to be strongly connected to sector-specific expectations. Identifying a clear transition pathway for the entire port can be challenging when expectations are not aligned and coordinated across value chains. The analysis, however, revealed, that expectations of various port actors were very closely related to the specific markets or industries they engaged with. Their actions were first and foremost connected to transformations in their own value chains. Among industrial port actors, for instance, environmental upgrading in value chains was closely connected to expectations regarding their future production. An industrial port actor in the mineral market expected little change in future production and therefore saw no need to change own operations, whereas an industrial port actor in the cement market expected increased production due to new methods for obtaining raw materials and therefore prepared to use larger vessels more suited for emerging technologies. Thus, different actors could favor different transition pathways depending on what value chain they were part of. Given the heterogeneity of actors and corresponding value chains in ports, this could produce a variety of imaginaries that are not necessarily mutually supportive. In turn, this leaves transition work a challenging task for ports, which will have to align and navigate the complex and heterogeneous web of value chains that port actors constitute.

6. Mobilizing social networks

Social networks can drive transition along several dimensions. According to the literature, networks can engage actors to collectively act towards a specific end; they can deliberately shield or support innovations; they can contribute to diffuse innovations, knowledge, legitimacy and resources. The following section analyzes and discusses how the mobilization of social networks contributed to initiate transition work in the ports of Oslo and Kristiansand, and how different characteristics of the social networks found in each port contributed to shape the direction of their respective emerging transition pathways.

Actors in both ports were part of extensive, informal networks with relations between public policy (port, local and regional authorities, national transport authorities, national energy transition agency), expertise (consultants, R&D, technology and energy suppliers), interest and support organizations (port associations, environmental and business organizations), and operational port users (goods and vehicle/vessel owners, terminal operators, transport buyers, providers and agents). The two cases differed, however, with regard to i) whether informal networks were converted into formal, collective action, ii) whether they engaged in strategic or ad-hoc use of network relations, and ii) the degree of integration in the port-city relation.

The Port of Oslo demonstrated strategic use of network relations in actively and deliberately drawing on its wide network resources to

define and create support around its own transition work. The Oslo case was therefore characterized by successful collective action between the port and its users, its owner, and environmental organizations. The port engaged all its users in a variety of interactions, spanning from day-to-day discussions to collaboration agreements, and actively facilitated dialogue between port users and the port. The port also strategically involved its network resources to shield and nurture specific technologies, such as shore power, automated solutions, and electric cranes.

For instance, the port authority established a financial support scheme which allowed operational port actors to apply for funds to cover investments in more sustainable solutions. The port also orchestrated its wide range of users (terminal operator, equipment provider, mineral company, import company) and other actors (consultants, energy company, city administration) to develop a joint zero-emission concept for the future port which entailed conceptualizing an innovative energy system for the entire port area. We further saw how the port authority drew on this large and coordinated network when preparing to introduce shore power. In planning the shore power connection for international cruise ferries, the port invited shipowners and a range of technology providers to a dialogue conference to ensure that the shore power solution would be usable and acceptable. The introduction of shore power was further enabled by mobilization across the social network; shipowners modified their vessels, environmental organizations pushed for ambitious policies; the city set ambitious emission targets; the port authority funded and coordinated activities; and the energy supplier and consultants provided technological knowledge.

To increase support and legitimacy around transition work in Oslo, the port and the city further sought collective action and teamed up with environmental organizations, who pushed for stricter regulations and more ambitious environmental policies. Environmental organizations had fiercely promoted sustainability measures in the City of Oslo, and their active lobbying eventually also compelled the port to enter into collaboration agreements to increase mutual understanding and ensure exchange of knowledge and perspectives. In continuing its efforts towards electrification, the Port of Oslo further entered into an intentional agreement with the local energy company to establish a joint enterprise dedicated to construct, operate, and maintain shore power facilities. Thus, we see that specific social networks were formalized, and that collective action was fostered to ensure directionality of the transition pathway in the port.

In contrast to the Oslo case, extensive, informal dialogue in the Port of Kristiansand was to a limited degree converted into collective action. The port authority appeared more focused on providing sustainable services *to* its users (e.g. low voltage power supply) and less focused on developing joint port strategies together *with* its users. Collaboration between actors was often sporadic and project based. One example was the introduction of shore power, where the Port of Kristiansand was among the very early adopters in Norway. Unlike the meticulous process proceeding the shift to shore power in Oslo that involved diverse actors and that had gone on for several years, the introduction of shore power in Kristiansand was a more bilateral response to requests from particular port users and R&D actors. Both passenger ferries and offshore vessels requested it and the port authority was invited into an ongoing research project looking for a port willing to demonstrate their technology. As such, the nurturing of shore power did not result from collective action among actors mobilized in a broad network, but rather resulted from ad-hoc responses to specific requests in the network. Like in Oslo, the strategy was supported by the diffusion of competence and resources in the network, as the port authority relied heavily on competence from research and development, the regional energy company and consultants involved in solving practical challenges.

The two cases also diverged on the level of integration between the ports and their owners: the cities of Oslo and Kristiansand. The direction of the transition work in Oslo was strongly shaped by the close relation between the port and the City of Oslo. The City of Oslo was instrumental in setting ambitious targets for port sustainability (Bjerkan and Seter, 2021) and increasingly wielded its port ownership to steer and accelerate transition work in the port. Hence, the city administration and the port in Oslo kept an extensive, continuous dialogue and collaborated to define shared policies and to jointly implement measures for reducing port emissions.

In Kristiansand there were few examples of deliberate city-port collaboration. Local authorities supported the sustainability efforts of the port, but not very actively. This corresponds with the common approach among Norwegian public port owners (i.e. local authorities), who have tended to take a more laissez-faire approach, not emphasizing their role as port owners and accentuating the port's autonomy as a legal entity (Bjerkan et al., 2021). Thus, in line with most Norwegian ports, the port authorities in Kristiansand, to some extent seemed to neglect opportunities to foster fruitful collective action towards sustainability transitions in the port.

Thus, we clearly see how the transition work in the Port of Oslo was shaped by the mobilization and creation of collective action through building strong and stable networks with interest organizations, experts and port users. Transition work was also shaped by the network building protective spaces around certain technological solutions, such as shore-power, which rested on and contributed to knowledge and resource diffusion within the larger network. Consultants and R&D provided a basis for policy making and enabled public decision makers to understand their surroundings, technologies, and markets. In this way, port authorities gained access to knowledge resources they did not have themselves. This also made it easier for public policy actors such as port authorities to protect and legitimize these technologies. It also helped actors in port operations to select more sustainable technologies (e.g. vehicles or equipment). Thus, we see how the large and diverse social networks that were mobilized in Oslo enabled broad learning among port actors and the way relations in the network also served to diffuse knowledge about each other's operations, perspectives and sustainability efforts, which again made it easier to enter into more formalized and specific collaborations related to sustainability transitions in ports. Already, we therefore see an indication of the important relationship between social networks and social learning, which is further elaborated on in the following section.

7. Social learning

As pointed out in Section 2, social learning can drive transitions through modifying innovations, expectations, and sociocultural perceptions. This section discusses how social learning enabled transition work and shaped emerging transition pathways in the two ports. Common for both ports, was the prominence of broad learning (i.e. learning about technologies and innovations). Increased knowledge of and first-hand experience with technologies and innovations enabled port actors to identify and select measures for improving sustainability in own operations and value chains. Given the low maturity of many technologies, these experiences can contribute to modify innovations, and enable port actors to navigate among a range of emerging (and often competing) niches to make more qualified decisions regarding use and non-use.

In the Port of Kristiansand, the port practiced learning by doing through incremental trial and error with specific technologies. The introduction of shore power, for instance, progressed in close collaboration with the regional energy utility and R&D actors. This strategy allowed the port to steadily increase own technology competence, as well as awareness around lacking or needed competences in the port organization and competences it could seek from others.

In Oslo, broad learning increased the port's ability to identify potential paths forward. Broad learning particularly related to the Green Shipping Program as an arena for learning about technologies and solutions for sustainable maritime transport. The program was administered by a renowned consultant company and built around an evolving set of pilots (e.g. autonomous transport, shift cargo from road to sea, environmental port index, alternative fuels) that joined port authorities,

regional and local authorities, goods owners, ship owners, technology providers, R&D, and port and industry organizations. The port actors described the program as a nexus for dialogue and experimentation which allowed them to realize and learn from solutions for green and efficient shipping. The program could also propel transitions as a network of complementary actors that shared resources, and that developed joint expectations and visions. Port actors therefore relied on knowledge from outside the port (e.g. experts and consultants) in broad learning, but also learned about innovations through dialogue between port actors, practical projects, and strategic planning. The previously mentioned dialogue conference on shore power in 2017 for instance educated the port on technical solutions for shore power.

The transition work in the two ports diverged, however, in how port actors engaged in deep learning. Whereas changing role perceptions and perceptions about power distribution characterized the Oslo case, similar processes seemed absent in the Port of Kristiansand. In Oslo, the port's explicit and ambitious transition work was among other the product of deep learning regarding the roles of port and city authorities. Port actors, the port, and the city all questioned the purely commercial orientation of ports and the laissez-faire ownership of cities. The increasing pressure on the city to act on climate change and local pollution, coupled with a green shift in political leadership, appeared to induce more active port ownership in Oslo. This coincided with overall urbanization of port areas and port regulation which strengthened the owners' hold over public ports.

The Port of Oslo was therefore increasingly considered a problem owner when it came to emissions. The port became embedded in local environmental policy and was expected to follow up on the city's ambitions. As such, the port authority experienced new, emerging expectations to become a more active community manager, i.e. joining actors to facilitate collaboration and improve performance. The actors in Oslo considered the port to be a facilitator and uniformly pointed to the port authority as key in progressing port sustainability. Strengthening the port's role as community manager added to the list of competences the port needed and required it to cooperate with external expertise and consultancy to adequately fulfill its commitments. These commitments derived from the perceptions of a new, green reality for ports, suggesting that they should proactively deal with climate and environment to remain relevant and maintain autonomy.

Further, the wide and coordinated transition work in the Port of Oslo derived from changing perceptions about distribution of power among port actors. On one hand, this related to the port's potential reach into energy and transport systems. Historically, ports have been perceived as maritime, but informants stressed that ports needed to orient equally towards landside activities (i.e. port operations and hinterland transport) should they facilitate sustainability transitions. This implied appreciation of the port as a node in entire transport systems and that the Port of Oslo might influence transitions on the landside more than it currently did.

On the other hand, deep learning seemed to modify perceptions about the distribution of power among operational port actors in Oslo. Transport buyers were considered to have more leverage than what is usually recognized in policy making, and port actors argued that the potential of non-maritime actors to induce transitions was underacknowledged. Transport buyers explicitly reflected around own potential to influence the maritime sector, for instance through transport service procurement, which could pressure ship owners and agents in placing requirements to vehicles, vessels, and fuels.

8. Discussion

The purpose of this study has been to demonstrate how social processes are part of the fabric that constitutes transition pathways (see Table 4 for an overview). As such, we look beyond technological components of transition pathways, and rather emphasize their social characteristics. The social processes that characterized the Port of Oslo suggested that the port is moving towards a whole-system transition, where port actors transform their understandings of own roles, which might lead to more radical innovations and system wide acceleration. The current social processes in the Port of Oslo suggested that its emerging transition pathway could be labeled *strategic, coordinated and scalable*. It was strategic and coordinated because the Port of Oslo worked strategically with a long-term perspective on sustainable transitions. This reflects one main difference between the two ports' emerging pathways; namely the ways in which they included network resources to progress and define the scope for transition work. The Port of Oslo united its wide network in close and formal collaboration, which allowed co-production of strategies and visions and enabled the port to coordinate joint projects with the city, environmental organizations, the local energy company and a range of its users. The transition pathway can also be considered scalable, because the Port of Oslo took a wide approach in its sustainability endeavors, encompassing a multitude of innovations and stakeholders. This was particularly represented by the Port's active involvement of the city and port users in developing the future zero emission port, which included reconceptualizing the entire energy system of the port area.

Table 4
Summary of social processes reflected in the two ports' diverging transition pathways.

	Port of Oslo Strategic, scalable, and coordinated transition pathway	**Port of Kristiansand**Incremental and niche-oriented transition pathway
Expectations	Co-production of visions Prepare for green future Electrification pathway Lack of expectations beyond electrification Sector-specific expectations	Prepare for green future Electrification pathway Lack of expectations beyond electrification Sector-specific expectations
Networks	Collective action with users, owner and environmental organizations Shield/nurture innovations through strategic involvement of network Knowledge and resource diffusion in wide network Collective action in value chains	Informal, bilateral collaboration Less collective action with owner Knowledge diffusion from R&D and energy sector
Learning	First order leaning in extensive network Second order leaning: role perceptions Second order learning: perceptions of influence	First order learning by doing Second order learning not prominent

Conversely, the emerging transition pathway in the Port of Kristiansand could be characterized as *incremental and niche-oriented*. Here, the lack of formalized relations and a less integrated network implied that the port remained more loosely connected to other actors and mostly engaged in bilateral, ad-hoc projects with its users. Followingly, the port did not deliberately draw on resources available in its network to the same degree as in Oslo. Further, port development did not rest, as in the Oslo case, on visions co-produced between the variety of port users. In Kristiansand, the lack of committing collaboration corresponded with lack of joint vision-making which in turn discouraged coordinated, scalable sustainability endeavors. As in Oslo, the City of Kristiansand focused on emission reduction but did not engage in a similarly strategic collaboration with the port and did not challenge the port's role perceptions. Further, the port's transition work mainly centered around stepwise electrification of port activities.

The above demonstrates the importance of moving beyond studying pathways for specific niches or innovations. In this article we have

studied emerging transition pathways of a whole domain, namely *ports*, which comprise many potential niches and innovations which themselves could be tied to specific pathways. The study – and the Oslo case in particular – reflects how transition pathways can transcend the regime-niche dichotomy (Berggren et al., 2015). In the Oslo case there were no obvious niche actors and transition work was mainly conducted by incumbent actors. There were also examples suggesting that transition work was not exclusively found at the niche level: networks that mobilized efforts and resources were closely tied to the regime level; and expectations that shaped transition work were located on the landscape level (e.g. urban restructuring), on the regime level (e.g. developments in value chains) and at the niche level (e.g. the battle of fuels). Further, deep learning among some actors (e.g. port authority, local authority) seemed futile if not followed up by or aligned with similar developments in other actors (e.g. national policymakers).

This study also provides examples suggesting that transition pathways can be shaped by interaction between different social processes. Networks were for instance crucial for broad learning, which was enabled by the mobilization of competence and knowledge of actors in diverse networks and facilitated by the experiments these set up (e.g. though the Green Shipping Program). Networks were further instrumental in co-producing visions and shared imaginaries, like when the Port of Oslo entered into formal collaboration precisely to encourage shared realities and expectations. This study also showed how expectations were shaped by the networks port actors belonged to, particularly those represented by value chains. Sustainability initiatives were often closely related to the value chains port actors were part of, and different expectations existing in different value chains could discourage actors from aligning their endeavors and engaging in collective action. This brings nuance to current research on the role of networks in sustainability transitions, which would assume the diverse and integrated network of the Port of Oslo to represent an advantage in progressing transition work. Based on the above, however, this study suggested that network (e.g. value chain) diversity could also represent a challenge in aligning the direction of the different actors' transition work, and thereby also in aligning transition pathways.

Although this challenges the ability of the port to align transition work across the myriad of value chains in the port, it also indicates that ports could be successful in facilitating and shaping transition pathways *within* value chains. The permeability of value chains suggests that they are suited for scaling up or accelerating transition efforts. Targeting transitions in entire value chains could therefore enable systemic approaches to coordinate actors and activities. Similarly, van Welie et al. (2019) have in a recent study argued that studying value chains is useful to understand systemic preconditions for transition work. However, the fluidity of value chains challenges transition work as each value chain consists of heterogeneous actors situated in own contexts, which are part of potentially distinct regimes and located at different places. This has also been pointed out by others; transition processes in value chains are distributed across different spaces (Hansen and Coenen, 2015). Thus, the place-specificity of ports could thus challenge ports' ability to induce transitions in value chains. Hence, ports can primarily be expected to shape transition work in value chains by facilitating co-production of general expectations to port sustainability, which port actors in turn can translate and integrate with (more or less) aligning expectations in own value chains.

This study also hinted at a hierarchy among social transition processes. It has demonstrated that deep learning (e.g. role perceptions) in the Port of Oslo produced new expectations about what the port should and could do (for the city), and what responsibilities the port should take. This created new knowledge needs in the port, which in turn led it to make active use of the resources and knowledge available in its network. As deep learning produced new expectations which further required more formal and dedicated network relations, one could argue that the divergent transition pathways in the two ports above all derived from deep learning (which characterized the Oslo case but not the Kristiansand case). It could therefore be useful to construct a hierarchy of social processes. In the Oslo case, deep learning appeared to precede modification of expectations and spur collective action. Defining the Port of Oslo as a problem owner and emphasizing the port authority's faciliatory role produced expectations to the port authority which compelled it to engage more actively and formally with its existing network and to draw on the network's competence to (re)develop ambitions and strategies for port sustainability. These strategies in turn provided directionality through specific expectations, thereby reducing perceived risk among port actors. As new perceptions were also tied to greener and more active port ownership on the side of the city, they further disallowed the port authority from opting out of the faciliatory role and continuing their focus on commercial operations.

In contrast, the Port of Kristiansand did not experience similar deep learning because of the laissez-faire approach of the port owner, which in turn placed fewer expectations on the port's role. Hence, the incremental, ad-hoc transition work continued because there was neither internal motivation nor external pressure on the port to engage in formal, more binding collaborations. This kept the port from absorbing resources and knowledge available in its network to develop long-term, strategic and encompassing plans for their transition work.

9. Conclusion

This study has set out to demonstrate how social processes are part of the fabric that constitutes transition pathways. To do so, we studied how such processes in different ways shaped transition work in two Norwegian ports. The Port of Oslo is becoming a frontrunner on an international scale. It shares certain characteristics with other international frontrunners (e.g. in Los Angeles/San Pedro, Vancouver, Rotterdam, Hamburg) in being publicly owned and located close to urban citizens, however smaller in terms of transport volumes. Future research should therefore explore if social processes facilitate sustainability transitions in other frontrunner ports in a similar manner. However, as a temperature check on transition work in general, investigating social processes could prove valuable to specify transition strategies also beyond frontrunner ports.

When investigating social transition processes in the Port of Oslo and the Port of Kristiansand, we found that these processes were reflected in their transition pathways. We found that actors in both ports had clear and stable expectations associated with electrification and a green future. Still, the actors struggled with specifying what the green future would look like, which lead them to orient by expectations they had for the markets and value chains they were part of. The two ports diverged, however, in their approach to involving wide networks, and in the degree of deep learning, particularly related to role perceptions.

This study has stressed that the interplay and hierarchy of social processes provide important understandings of how transition pathways could be developed. Future research should seek to elaborate further how such process dynamics might influence transition pathways in other contexts. Given the complexity of ports, as they comprise a number of regimes (port, maritime transport, land transport) and a number of potentially emerging niches (see f.ex. Bjerkan and Seter, 2019), identifying or anticipating one single transition pathway is very unlikely. However, this complexity of ports (including the heterogeneity of port actors) also represents a tremendous potential for aligning compatible sets of transition pathways that could lead to deep and sector-wide transitions. Thus, better understanding how social processes and the dynamics between them induce and hamper transition work and transition pathways is important. Piggybacking on the multifaceted and sustainable future of ports can therefore enhance our understanding of and the drivers for transition efforts in other domains.

CRediT authorship contribution statement

Kristin Ystmark Bjerkan: Conceptualization, Methodology,

Investigation, Formal analysis, Writing - original draft, Writing - review & editing. **Marianne Ryghaug:** Conceptualization, Writing - review & editing, Supervision.

Declaration of Competing Interest

None.

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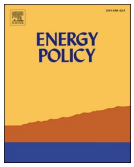

Policy and politics in energy transitions. A case study on shore power in Oslo.

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ABSTRACT

Their position in transport systems allows ports to play a fundamental role in energy transitions. In increasingly ambitious quests to promote sustainability, ports often look to shore power to reduce emissions. To fill knowledge gaps regarding empirical experiences with shore power, this study turns to the transition to shore power in Oslo, Norway. In doing so, it demonstrates the instrumental role policy and politics can play in transitions. To explore this particular transition, we rely on document analysis and interviews with actors around the Port of Oslo and discuss their involvement with reference to the Multiple-Streams Approach. We argue that the main reason for successful implementation in this case was the *environmental thrust and the lack of controversy*. The transition was supported by shore power's ability to address different problems experienced by different actors, by the lack of competition from other policies and by a range of political influences which gave momentum to and aligned policy domains. Specifically, we find that the political stream was less prominent in selecting a policy, but more prominent in realizing it. Although the experiences from this particular transition are not necessarily transferrable beyond this case, our study demonstrates the importance of policy alignment, and argues that holistic policy making could be crucial to ensure deep transitions – in which ports can be expected to be prominent.

1. Introduction

As links in transport networks, ports play a crucial role in both land-based and sea-based transport. Since many actors and stakeholders interact in the port area, ports could also function as energy hubs in the transport system. This implies that ports could play a critical role in energy transitions (Damman and Steen 2021). This paper dives into one such transition process and investigates the role of policy and politics in the transition to shore power in the Port of Oslo, Norway. The Port of Oslo aims to remove 85% of its CO_2 emissions within 2030 (Port of Oslo 2018), and shore power is a focal point in its pursuit to become a zero-emission port. Shore power allows vessels at berth to shut down their fossil auxiliary engines and instead rely on shoreside electricity to power their operations. Shore power and has become the most prominent approach to improve the environmental footprint of ports (Bjerkan and Seter 2019). Above all, it reduces visible, local emissions in the port area, but is in most cases also expected to reduce global emissions (Hall 2010). However, current research provides few empirical accounts of experiences with use and implementation of shore power. This study therefore provides a much-needed empirical account of the transition to shore power in the Port of Oslo.

The main objective of this study is to *demonstrate the role of policy and politics in the transition to shore power in the Port of Oslo*. Although we recognize that a range of other factors also impact transition processes, we wish to emphasize these because transition studies have been criticized for under-acknowledging aspects of power, policy and politics in transitions (Meadowcroft 2009; Shove and Walker 2007). We therefore conduct an in-dept analysis of the processes proceeding implementation of shore power in Oslo. Through document analysis and interviews with involved actors, we develop a timeline that structures and demonstrates the transition to shore power. This is analyzed and discussed with reference to the Multiple Streams Approach (MSA) (Kingdon (1984), which has been successfully applied to understand policy and politics in transitions in other domains (Normann 2015). By taking this approach, we address a research gap put forth by Svensson and Nikoleris (2018), elaborated in the latest agenda for sustainability transition research (Köhler et al., 2019): "Transitions (should) provide more systematic process explanations (…) with tighter links between events and

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identification of critical conditions that link events". This paper responds to this call by identifying empirical steps (events) in the transition to shore power in Oslo and by defining timelines which inform about the prevalence of policy and politics throughout the transition process. We find that the problems, policy and politics emphasized by MAS are interdependent in their support of shore power. Our findings further stress the importance of policy alignment and holistic policy making, and that political work is essential to ensure policy realization as well as policy selection.

The transition literature contains interesting discussions on what constitutes a transition in terms of incrementality and timescales, and different types of transitions (pathways) that can be identified (e.g. Berkhout et al., 2004; Elzen and Wieczorek 2005; Geels and Schot 2007; Roggema et al., 2012). Within the scope of this paper, we choose to put a pin in those discussions. As such, we do not seek to problematize by what standards what we have observed is a transition and whether/how our observations are compatible to a particular theorized pathway. Rather, we observe that a new technology, with social and cultural bindings, has been implemented with the intent to impact energy practices. We consider this a change that per se is worthy of scientific scrutiny.

The article is structured as follows. In the next section, we will account for the theoretical underpinnings of this study, focusing especially on the Multiple Streams Approach. Section 3 presents methods and data, hereunder the actors who were most prominent in the transition to shore power. Section 4 presents and analyzes problems, policies and politics associated with the transition, before section 5 discusses how these contributed to reduce controversy and push for policy realization. Section 5 also discusses how the relations and interconnectedness between these streams supported this particular transition. Section 6 concludes and discusses implications for policy and research.

2. Multiple streams in the politics of energy transitions

This section describes the prevalence of policy and politics in transition studies, and elaborates on the Multiple Streams Approach, which we apply to structure and demonstrate the role of policy and politics in our case study on shore power.

2.1. Policy and politics in sustainability transitions

Although criticized for overlooking such aspects of transition, transition studies increasingly orient towards the roles of policy and politics. Several studies address how policy mixes can promote (or impede) transition (Kivimaa and Kern 2016; Kivimaa and Virkamäki 2014; Lindberg et al., 2019; Reichardt et al., 2015; Schmidt and Sewerin 2019; Uyarra et al., 2016) and existing studies provide different approaches for categorizing the content and functions of policy instruments (Kern and Howlett 2009; Kern et al., 2019; Rogge and Reichardt 2016). Further, scholars increasingly focus on how policy is produced, drawing on established theories of political science to highlight the roles policy and politics play in shaping transition pathways and outcomes (Köhler et al., 2019:22). These are inherently tied to the bargaining of political processes, and thereby expressions of different types of power being exercised (Ahlborg 2017; Avelino 2017; Avelino and Rotmans 2009; Grin 2010; Hoffman 2013; Pel 2016).

Politics are at play at niche, regime and landscape levels (Meadowcroft 2011), which has ushered a growing body of literature on politics in transitions (see Avelino et al., 2016 for a useful overview). Hess (2014) studied struggles between opposing political coalitions, and Raven et al. (2016) investigated the role of technology advocates in promoting sustainable technologies. Normann (2015, 2017) found that the breakthrough of emerging niches was influenced by specific political positions and political bargaining, as well as access to policymaking processes. Some studies have incorporated politics to refine existing theoretical understandings of transitions (e.g. Lockwood et al. (2017); Geels (2014)), while others attend to politics inherent in transition management (e.g. Shove and Walker 2007; Smith and Stirling 2010).

Kern and Rogge (2018) argue that the full width of policy theories might be useful to analyze transition processes, depending on the focal point of the specific study. The focal point of this study is the transition to shore power in Oslo, and the strong prominence of policy and politics in this narrative makes the Multiple Streams Approach (MSA) useful to demonstrate the of roles policy and politics in transition.

2.2. The Multiple-Streams Approach

The Multiple-Streams Approach (MSA), originally presented by John W. Kingdon (1984), derives from political science theory, using a systemic approach to understand policy outcomes. It was developed to understand agenda-setting in policy processes, but is also useful to understand dynamics in the full policy process. The MSA originally evolved from the Garbage Can model of organizational choice, which considers policy outcomes to occur through coincidental interaction between opportunities, problems, solutions and participants (Olsen 1972). The MSA assumes that policy outputs are produced through interaction between three streams: problem, policy and politics. Policies change when policy entrepreneurs recognize and seize opportunity to exploit so-called "policy windows" (Sabatier 2007). We claim that such interactions were vital in the transition to shore power in Oslo.

2.2.1. The problem stream

The problem stream consists of problems looking for solutions (Winkel and Leipold 2016). Problems are unwanted situations that someone believe they can correct (Kingdon 1984). Even more important are *perceptions* of problems (Béland and Howlett 2016), as policies occur when "political entities want solutions to issues they perceive as problematic" (Jones et al., 2016:15). This implies that understandings of situations are more important that their actual state. In Norway, for instance, increasing attention to the cruise industry has spurred problem perceptions concerning local emissions from ships.

Problem perceptions typically arise from sudden events and shocks that jolt policy makers, or from permanent monitoring and feedback procedures (Béland and Howlett 2016; Jones et al., 2016). In this study for instance, we will see how monitoring GHG emissions singled out cruiseferries as particularly problematic. However, limited processing capacity implies that only a few problems receive political attention (Zahariadis 2007), and problems continuously compete with other problems over the short life-span of this attention (Cairney and Jones 2016). Problems could also lose attention because policymakers are content with what they have already achieved (or tried to achieve) or because vested actors fail to remain persistent (Normann 2015).

2.2.2. The policy stream

Kingdon (1984) considered policies to be a "primeval soup" in which ideas of how to solve problems floated around, waiting for someone to adopt them. As such, policies represented iteratively evolving strategies (Cairney and Jones 2016) that could be mobilized to solve particular problems (Winkel and Leipold 2016). In the policy stream, different solutions to the problem are identified and evaluated before one is selected (Béland and Howlett 2016). MSA assumes that certain policy characteristics make them more likely to be selected (Kingdon 1984), especially if they are technologically feasible (Jones et al., 2016), comply with the value-system of the community and supported by policy entrepreneurs (Jones et al., 2016; Normann 2015), are competitive in terms of costs, and have public and administrative acceptance (Liu et al., 2010; Normann 2015). The policies of MSA typically find their counterparts in the niches described by transition studies (Normann 2015).

In this study, shore power circulated the policy stream and was picked up as a solution to solve several problems to the City, the Port and to Shipowners. We will describe expectations associated with shore

power and its correspondence with technological feasibility, value acceptability and competitiveness.

2.2.3. The political stream

The political stream contains any political element that might impact policymakers' orientation towards a problem and potential solutions to the problem. In this stream, policymakers that are motivated and have the opportunity to do so, can choose to turn a solution into a policy (Cairney and Jones 2016:40), and developments in the stream occur through bargaining between different positions (Normann 2015).

The political stream is comprised of several potential influences, including the national mood, elections, replacement of executive or legislative officials, issue jurisdiction, stress and crisis, pressures from interest groups, party ideology, consensus and coalitions building (Béland and Howlett 2016; Jones et al., 2016; Kingdon 1984, 1995). In this study for instance, we will see how the constellation of political parties influenced the implementation of shore power in Oslo.

2.2.4. Stream interaction

Originally, Kingdon described the three streams as independent. He contended that transformative change occurs when the streams intersect, through so-called windows of opportunity (see Fig. 1), i.e. "opportunities for advocates of proposals to push their (..) solutions or push attention to their (…) problems " (Kingdon 1995:165). Windows of opportunity appear when streams change to the extent that they align (Normann 2015).

In the earliest application of MSA, this alignment implied a great deal of coincidental timing. It was therefore criticized for underacknowledging agency and deliberate attempts to connect the streams (Bendor et al., 2001; Mucciaroni 1992). Critics claimed that streams were *inter*dependent rather than independent, implying that change in one stream triggers change in another. Zahariadis (2007) argues, however, that whether streams are independent or interdependent is an empirical issue, especially because the rationales in the policy process can shift.

The MSA tries to mend the agency deficit through introducing policy *entrepreneurs* into the mix of streams, who represent an interesting parallel to niche actors in transition studies. Policy entrepreneurs "skillfully engage in coupling [streams] to launch their "pet" proposals onto the policy agenda" (Winkel and Leipold 2016). They are not only advocates of specific solutions, but also power brokers and manipulators who initiate actions when windows of opportunity emerge (Zahariadis 2007).

3. Methods

In demonstrating the role of policy and politics in the transition to shore power in Oslo, we have studied a *contemporary* transition. Given the lack of research on contemporary transitions there is need for exploratory work, for which case studies are particularly suited (e.g. Berg 2001; Bidart et al., 2012; Rowley 2002). Case studies are analyses of subjects (e.g. transition to shore power) within an analytical frame (e.g. MSA) that provide meaning and allow interpretation (Thomas 2011).

Our study primarily focuses on the four actors who were most prominent in this transition. Since the early 2000s the **City of Oslo** has struggled to tackle poor air quality (NPRA 2010). Environmental and climate issues are high on the City's agenda and it has introduced a range of environmental policy measures, including infrastructure for cycling and public transport, car free zones, incentives for use of electric vehicles, and biofuels. Since 2016, the City has aimed for a 95% reduction of GHG emissions by 2030 (City of Oslo 2016), necessitating emission reductions also in the port area.

The **Port of Oslo** is a public enterprise owned by the City of Oslo, located in the city center of Oslo. It is the busiest port in Norway, and expects a 50% volume increase by 2030 (Port of Oslo 2018). The Port is managed by a politically appointed board and the Port Director, who oversees the doings of the (by Norwegian standards) large and specialized port organization. The Port is expected to take a leading role in reducing emissions. Accordingly, it plans to become a zero-emission port, and has launched an action plan which highlights 17 actions estimated to reduce CO_2 emissions with 85 per cent (Port of Oslo 2018).

The **local energy company**, Hafslund, is owned by the City of Oslo. It has 80 powerplants with 100% renewable power from hydropower (Hafslundeco.no, 2020), and its activities are continuously diversifying and strengthening its position in electrification and energy systems. The company is preparing to actively facilitate and shape energy transitions, through for instance establishing subsidiary companies particularly dedicated to innovation and business development in electrification.

Three Scandinavian **cruiseferry**[1] lines operate between Oslo and cities in Denmark and Germany, carrying more than 2 million passengers a year (Port of Oslo 2020). Cruiseferries are the largest source of CO_2 emissions in the Port of Oslo, and half of these are emitted at berth. The ferries are located at two different quays. Shore power was established at the first quay in 2011, and at the second quay in 2019.

3.1. Sequential timed events plotting

Inspired by process theory (e.g. Bidart et al., 2012), transitions could be understood as "temporal sequences of events, timing and conjunctures of event-chains", where processes are "sequences of events (..) enacted by (…) actors" (Geels and Schot 2007). This study does not provide a full-blown processual analysis of the transition to shore power in Oslo, but borrows from process theory to structure the actors' narratives about policy and politics.

To capture these narratives, we used sequential timed events plotting (STEP), which was originally designed to identify events and errors leading to accidents (Hendrick and Benner 1987). The main goal of STEP analysis is to understand how different actors perceive and influence processes (Stanton et al., 2019). In practical terms, STEP involves developing time lines for all actors involved in a particular process (e.g. transition), focusing on the actions and interactions within and between actors (Rausand and Utne 2009). This provides a multi-linear description of the process (Sklet 2004). Fig. 2 presents our timeline for actors involved in the transition to shore power in Oslo.

3.2. Document analysis

Document analysis has been central in identifying the steps (events) in the transition process. We reviewed planning and policy documents related to policies and objectives in the Port of Oslo and the City of Oslo. Particularly prominent were the Port Climate Strategy (2017) and Zero Emission Action Plan (2018), and the City Climate Strategies (2016, 2019) and Plan for emission free Oslo Fjord. We also relied on media coverage and opinion pieces in local and national media (Aftenposten 2017; Aftenposten 2018a; Aftenposten 2018b; Elgvin 2017; NRK 2018; Vårt Oslo 2017). Documents were mainly accessed through web searches, and some were suggested by interviewees. The document analysis provided important background information for the interviews and helped to identify preliminary events and timelines for each actor.

3.3. Qualitative interviews

Based on the document analysis, preliminary timelines were developed for each actor. Interviews were conducted to test, remove, or modify preliminary events, and to identify additional events. The interviews provided the actors' subjective perceptions of transition events. Considering the lack of pre-existing knowledge on transitions in ports and empirical experiences with shore power (Bjerkan and Seter, 2019)

[1] Cruiseferries combine features of a cruise ship with a passenger and car ferry, which is common in the seas of Northern Europe.

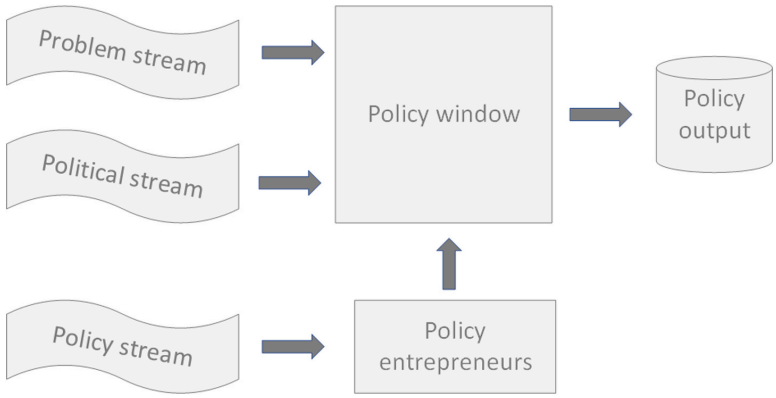

Fig. 1. Multiple-Streams approach. Sources: Jones et al., (2016), Zahariadis (2007).

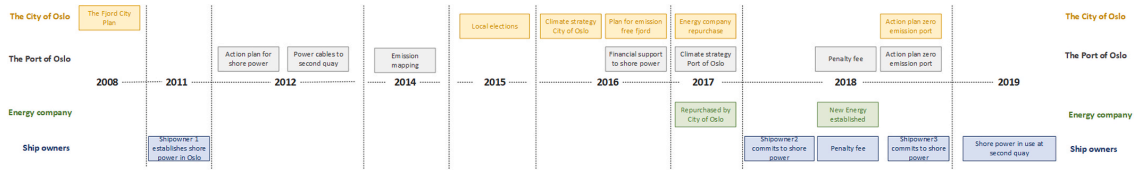

Fig. 2. Timed events in the story of shore power in Oslo.

semi-structured interviews were considered appropriate.

For each actor we defined an interview guide based on the actor's preliminary timeline, with questions related to each event (i.e. what was the motivation behind … ? When did you first start to discuss …. ?). The interviews provided detailed, chronological accounts of events in the preliminary timeline. When one event was thoroughly accounted for, the interviewers asked the interviewee to describe what happened next. In some cases, the interviewee did not have knowledge about all events, which made it necessary to interview several representatives of the same actor.

Given the comprehensiveness and uniqueness of the interviews, all questions and topics from the interview guide cannot be displayed here. However, Table 1 gives a stylistic image of an interview guide based on a hypothetical, preliminary timeline.

In total, we conducted 12 interviews about shore power in the Port of Oslo. Seven of these were conducted with actors involved in implementing shore power for the cruiseferries; the Port of Oslo (n = 3), the City of Oslo (n = 1), shipowners (n = 3) and the local energy company (n = 2). Four interviews were conducted with users in the port who considered or had actually implemented shore power for the own operations. These interviews mainly served to shed light on the problem stream and the policy stream, and were not directly relevant to the transition process itself. Finally, we conducted an interview with the politically independent environmental organization Zero, which mainly served to inform about the political stream. Interviewees were identified through the researchers' network or suggested by other interviewees (i.e. snowballing, Goodman 1961). The interviewees were all closely involved in the process of implementing shore power in Oslo, and all provided in-depth information on what perspectives were guiding their decisions. The interviews were conducted on telephone and lasted approximately 1 h.

Interviews were transcribed, and coded and analyzed using the NVivo software. Preliminary events were used as codes, and iteratively modified and added/removed as interviews shed light on new and existing events. As such, the final set of codes corresponded to the set of events described in the next section.

3.4. Selection of case and events

The Port of Oslo is an interesting case for understanding energy transitions in ports. For one, it is a frontrunner port in applying dedicated and ambitious strategies for energy transition. Second, it is distinguished from international frontrunner ports because of its smaller size and its geopolitical location. Thirdly, the use of shore power in Oslo has generated substantial discussion, media coverage and interest. The transition process was therefore well documented. Finally, given that the last shore power connection was opened 2019, the interviewees had events fresh in their memory and provided first-hand accounts of the process.

To tell the story of policy and politics in the transition to shore power in Oslo we selected events that *expressed or influenced the actors' motivations and decision-making*. Selected events are listed in Table 2. Events that have impacted technical specifications and the practical realization of shore power (e.g. dialogue conference with suppliers, technology providers and other stakeholders) were generally not included. Such events were only included if they directly impacted transition progress, such as laying power cables to the second quay (Event 4).

4. The problems, policies, and politics of shore power in Oslo

This section accounts for the transition to shore power in Oslo. First, we present problems that made shore power a relevant solution. Then we describe how shore power evolved as a policy and how it allowed actors to solve their problems. Finally, we introduce political influences that we consider instrumental in the transition to shore power.

4.1. The problem stream: multiple problems for multiple actors

In Oslo, arguments for shore power related to both local environmental issues and global climate issues, and these discussions started

Table 1
Stylistic example interview guide based on hypothetical, preliminary timeline.

Timeline			2008		2012		2018	
Event no.	Event 0		Event 1		Event 2		Event 4	
Event description	*First discussion of shore power*	What happened after?	*Launched policy document*	What happened after?	*Received public funding*	What happened after?	*Entered into collaboration agreement*	What happened after?
Questions	When did you first start to discuss shore power in your organization?		Why did you launch?		When did you start to discuss applying for funding?		Who suggested you enter into formal collaboration?	
			Who was involved in developing this policy?		Who initiated the application?		What was your motivation?	
			What reaction did you receive?		How did this relate to the policy document?		What plans do you have for this collaboration?	

Table 2
Short description of events in the transition to shore power in Oslo.

Event	Description	Year
#1	**The Fjord City program**. Introduced shore power as principle in sustainable transport	2008
#2	**First shore power installation**. Initiated by Shipowner1. Shipowner1 funded 70% of all costs. The rest was funded by the Port of Oslo (approx. 8%) and public agencies (approx. 22%).	2011
#3	**Action plan for shore power in the Port of Oslo**. Introduced the port's goal that "all passenger ships with regular calls shall have the opportunity to use onshore power".	2012
#4	**Power cables to second quay**. The Port of Oslo places power cables to quays used by Shipowners 2 and 3.	2012
#5	**Mapping of emissions in the port.** Highlighted the need for cutting emissions from the cruise ferries	2014
#6	**Local election**. A new green-left city council replaced eighteen years of conservative city government.	2015
#7	**Climate Strategy for City of Oslo**. Aimed for shore power and other measures to reduce port emissions with at least 50% within 2030	2016
#8	**Plan for Emission Free Fjord**. Called for the City Council to initiate use of shore power for cruiseferries from 2020 at the latest.	2016
#9	**Financial support from Enova**. Grants covered 75% of costs with establishing shore power at the second quay.	2016
#10	**The Port of Oslo's Climate Strategy**. Identified shore power as solution to reduce port objective in the City's Climate Strategy of 2016.	2017
#11	**The City of Oslo repurchases energy company**. The City of Oslo regained over 90% ownership and removed the company from the stock market	2017
#12	**Shipowner2 committed to use shore power.**	2018
#13	**Penalty fee for cruiseferries without shore power**. Introduced by the Port Board.	2018
#14	**Shipowner3 committed to use shore power.**	2018
#15	**Subsidiary to energy company established**. Dedicated to innovation and business development of future solutions for electrification.	2018
#16	**Action plan for zero emission port**. Included shore power as one of seventeen measures to reduce CO2 emission in the port by 85%	2018
#17	**Shore power for international cruiseferries is launched.**	2019

about ten years before shore power for cruiseferries was implemented. Locally, there was a desire to "improve the city" (City of Oslo 2008; City of Oslo 2016), by addressing the **disconnect between the urban population and the seaside**. In promoting the motto "The Blue and the Green, the City in between" (City of Oslo 2008), the Fjord City Program aimed to redevelop the urban shore side to connect urban life with the fjord. This mirrors worldwide trends, where cities redevelop port areas to accommodate growing city populations (e.g. Jauhiainen 1995; Oakley 2005; Wang 2014). Shore power was suggested together with other so-called "principles" for promoting a sustainable city by the fjord in 2008, but these principles were less specific, such as increasing accessibility to the fjord or better utilization of the area. To connect the city and the seaside, redeveloping port areas was important to reduce **local emissions and noise**, which also threatened the port's position and legitimacy in the urban environment (Port of Oslo 2012), and jeopardized the desire to improve the city. This also corresponded with the problem agendas of port users, whose economy and reputation relied on solving noise issues.

> "The most important thing we can do, economically, is to operate 24/t, and then we need to be as noise free as possible (…) this is why we choose shore power (..) because neighbors call to complain".
>
> Port User A

Although the Port also addressed local emissions (e.g. nitrogen, sulfur), the "**climate problem**" (Port of Oslo 2017) and CO_2 emissions were increasingly emphasized. As discussed below, the 2015 elections raised global emissions on the agenda and produced the City's ambitious CO_2 objectives. The City's 2016 ten-point plan for an emission free fjord (Event 8) further pinpointed passenger vessels, particularly emissions

from vessels at berth, and as such pointed at the port as problem owner when it came to vessel emissions.

> "It is important that the ports have electricity and shore power to ships when they are at port".
>
> Port User B

In 2014 the Port did a mapping of emissions sources that lay the foundation for their actions. This allowed the port to identify its primary emission problem and became a decisive event for the port's priorities with respect to climate and environmental actions:

> "We became very interested in fact-based actions"
>
> The Port of Oslo

After monitoring and documenting its emission sources, the Port found cruiseferries to represent 38% of CO_2 emitted from vessel operations in the port (Port of Oslo 2018).

> "First, the hotels in these ferries are energy intensive, and second, the ferries come and go every day"
>
> Port of Oslo

This made cruiseferries the first priority for reducing emissions in the port. To shipowners, this represented potential image problems. Shipowner1 therefore collaborated with an environmental organization to explore how to improve their sustainability profile. As a big actor, they felt expected to take social responsibility.

> "[We] are expected to take social responsibility and follow developments (..) Travelling with us should not compromise the customer's personal perceptions. [Still] we expect to get economic return and recognition"
>
> Shipowner1

These motivations were also tied to commercial assessments that suggested a proactive, green reorientation was necessary to maintain (or improve) own market position and to prepare for the green future; Shipowner1 launched its sustainability initiatives expecting to be rewarded and recognized as an early mover.

Hence, shore power responded to problems associated with global emissions, as well as local emissions which reduced urban life quality, and the public's access to the shoreside. Local port emissions were further considered a threat to the legitimacy of port activities in urban areas, which are common problems in port cities (Fusco Girard 2013). According to MSA, however, policies become successful not only because they respond to problems, but also because these problems are raised on the political agenda. In the case of Oslo, these problems represented an opportunity to raise political flags. As elaborated below, the increased thrust of environmental policy produced more attention to emission problems and sustainable urbanism, encouraging local politics to capitalize on green sentiments by expressing drive and deliverability.

4.2. The policy stream: shore power for port and city sustainability

Local port emissions represented a challenge in connecting the city with the seaside. Historically, port areas have not been attractive housing or recreational areas because of noise and pollution. With the introduction of shore power local air pollution and noise would be significantly reduced (Poulsen et al., 2018; Vaishnav et al., 2016), and it may therefore be an efficient tool to improve the relationship between ports and their neighboring communities.

The City also considered shore power a response to reducing global emissions. The 2016 Climate Strategy (City of Oslo 2016) aimed to reduce the City's CO_2 emissions with 95% by 2030,[2] and shore power was introduced as one of 16 priority areas. However, it did not suggest detailed approaches for how to promote shore power. Rather, specific actions to initiate shore power rested on a ten-point plan for reducing emissions in the Oslo Fjord approved by the City Council in September 2016. The plan originated from a private proposal by representatives of the conservative opposition and was unanimously approved. The plan therefore represented cross-partisan consensus regarding emission reduction. Among other, the plan stated that the city council should initiate shore power for cruiseferries from 2020 and promote national regulation which allowed ports to require calling vessels to use shore power.

> "The work in 2016 pointed out a clear direction and ambitions for the Port of Oslo"
>
> City of Oslo

As port owner, the City's increasingly explicit port policies also compelled the Port to raise its own ambition in terms of emission reduction. As stated by the Port's 2012 *Action plan for shore power* the Port aimed for "all passenger ships with regular calls [to] have the opportunity to use shore power" (Port of Oslo 2012). In the wake of Shipowner1's shore power installation (2011), the Port prepared for a second shore power connection. The port applied for public funding to establish shore power for Shipowner2 and Shipowner3 in 2016, although neither were at this time planning to use shore power. The funding covered 75% of the costs and was decisive for the Port's decision to establish shore power at the second quay. The ambitious national policy for electrification of transport, expressed through this funding scheme, thus directly enabled similar policies at the local level. Following policy developments in the City, the Port launched their own climate strategy aiming to reduce climate emissions with 50% by 2030, in which shore power was essential to succeed.

> "After the climate strategy of the City of Oslo was launched, we decided at the Port of Oslo, that we needed our own climate strategy."
>
> The Port of Oslo

In 2018, the Port launched its Action Plan for Zero Emission Port, aiming to reduce CO_2 emissions in the port by 85% within 2030. The Port's action plan represented efforts to merge port and city policies on energy and sustainability. The interviews suggested that the work with the Action Plan for Zero Emission Port (2018) marked the beginning of a closer policy collaboration between the Port and the City. Previously, these two had not cooperated to a large extent on joint policies.

> "[We worked] shoulder by shoulder with the bureaucrats, who have lifted issues to a political level (..) Everyone who has been involved have learned more about the port than they had anticipated, which is a benefit in itself".
>
> Port of Oslo

This collaboration revolved around defining an appropriate policy mix, which allowed the City to reach its ambitious emission reduction goals while avoiding disrupting the Port's operations and customer relations. It was important to the City that the action plan resonated in the Port and that the Port assessed the realism in proposed policy mixes. This collaboration further allowed knowledge transfer from the Port to the City, and the Port stressed a sufficient understanding of port and maritime business in the City.

To shipowners, shore power represented a solution to maintain

[2] Using 1990 as year of reference.

reputation in times when sustainability in general and vessel emissions in particular were prominent in public debate. One shipowner highlighted shore power as a solution to problems associated with their environmental profile:

> "We did something that people can see and understand, because we are so visible and close to the city"
>
> Shipowner1)

To Shipowner 1, initiating and financing shore power in 2011 (Event 2) addressed problems related to green profiling. These problems were particularly pressing because the shipowner's port operations were close to the urban environment and therefore visible to the population. As such, shore power was a way of ensuring co-existence with the urban population also among shipowners.

As such, in reducing local and global emissions and thereby facilitating co-existence between the port and the urban population, shore power responded to the problems facing the City, the Port and the Shipowners alike. The MSA further stresses that successful policies hold comparative advantage over other potential solutions. One could also imagine other policies to solve these problems, such as reducing traffic to the port, refusing particularly polluting vessels, moving or modifying port operations, or requiring vessels to operate on non-polluting fuels. However, there did not seem to be any explicit discussion around these alternatives after the mapping of the emissions was launched in 2014, and shore power appeared in policy documents as early as 2008. As such, it seems that shore power was established as the chosen solution quite early, and that there was **no real competitor** to shore power in tackling these challenges.

Shore power corresponds well with the advantageous policy characteristics emphasized by Kingdon (1984); technological feasibility, value compliance, and competitiveness. For one, shore power was **technologically feasible** and power supply in the region was abundant. Following the entrepreneurial work of Shipowner1, an industrial standard for shore power connections was launched, suggesting that the port's work to establish shore power at the second quay faced few technological challenges. The Port also sought to enhance technological feasibility through inviting technology suppliers and users (i.e. shipowners) to a dialogue conference on shore power in which participants provided input to design an optimal solution. Further, shore power complied with the green **political climate** characterizing the city, but also reflected national calls for protecting Norwegian fjords from ship emissions. In contrast to other potential policies, shore power was also pushed forward by **policy entrepreneurs**. Shipowner1 relied on own initiative and funding to establish shore power in several Norwegian ports, and through dialogue and collaboration it raised ports' awareness and knowledge about shore power. Shipowner1 even claimed their solutions to have inspired the industrial shore power standard, suggesting that their entrepreneurialism reached beyond Norwegian shores. As elaborated below, Zero further appeared to play an instrumental role in setting shore power on the political agenda and actively worked to produce cross-partisan consensus around the proposal that eventually produced a political resolution for the introduction of shore power to cruiseferries.

Finally, shore power was a superior policy because costs were low and acceptance high. The generous public support **scheme** for electrification of transport has enabled approximately 90 Norwegian ports to install shore power. In Oslo, this support scheme covered 22% of Shipowner1's costs with establishing the first facility, and 75% of the Port's costs with establishing the second facility. Further, there is large **political consensus** and **public acceptance** concerning shore power, which has continued the long line of strong incentives for electrification of transport. Public acceptance could also be particularly high because shore power impacts the population directly; in reducing visible air pollution it improved public health and public access to the shore.

4.3. The political stream: green-left push in public policy

Several political influences can be identified in the transition to shore power in Oslo, and in the following we highlight political influences that we consider to have been crucial for its success.

4.3.1. Political and administrative restructuring

The 2015 **local elections** accelerated attention to port sustainability. These elections changed the political landscape in Oslo, as the landslide of the Green Party allowed a green-left city council to replace eighteen years of conservative city government. This spurred substantial emphasis on climate and environmental policy, and subsequent political influences which collectively supported the transition to shore power. For one, the change in government implied new political priorities, new agenda setting and new values underpinning policies and instruments. In July 2017, the **Climate Agency** was established as a permanent agency to oversee the implementation of the City's climate strategies (City of Oslo 2016; City of Oslo 2019). This reflected the new city government's emphasis on climate and environment, and their effort to realize ambitious policy. The Agency was for instance heavily involved in developing the City's Climate Strategy and the Port's Zero Emission Action Plan, and became instrumental in aligning the policy perspectives of the Port and the City.

4.3.2. Political steering

Another political influence following the local election was more active **port ownership**. Before the 2015 elections, local politics were largely unconcerned with port activities. Norwegian ports have historically enjoyed great autonomy from public owners, which in Oslo has been reflected in the lack of coordination between the Port and the City in matters of port sustainability. However, the years following the local elections saw an increasing politization of port issues, which evolved through direct collaboration between the Port and the City, and through more political engagement by the port board.

The City's 2016 Climate Strategy represented an opportunity for the new rule to demonstrate this political shift. It allowed the new local government to make their mark on the political landscape and to point out direction and ambition for the city's emission reductions. Active ownership from the City, with more explicit port policy, thus became apparent.

> *"[The City's 2016 Climate Strategy was] first and foremost a political document, which pointed out a clear direction and the level of ambition for the Port of Oslo*"
>
> City of Oslo

Following the City's ambitious emission reduction goals, the Port decided to define specific reduction measures as well. The Port considered it vital to adjust to the political goals of their owner, and in raising their own reduction targets they hoped to avoid a politically controlled process. Hence, the Port's efforts were motivated by their concern that the City might interfere with port business and that the Green-Left City government would exercise its formal power over port activities and strategies, which resides in the City's ownership of the port and the politically appointed Port Board. The discussions with the bureaucrats in the Climate Agency were not without controversies, but the collaboration gave a mutual understanding of what level the goals of the Port of Oslo needed to be to be politically accepted.

> "Initially, we believed [the objectives] were too ambitious, but it was clear that it would not be politically acceptable [to reduce ambitions], [and then] they [would] begin with nonsensical measures. So, we need to be ambitious and go the extra mile and define demanding measures"
>
> Port of Oslo

Although the election represented a political shift, it did not introduce a large number of opposing ideas between the City government and the Port. The Port of Oslo seems to have decided on going into dialogue with the Climate Agency and then adjust their own policies in line with the expectations raised by the City government.

> "It is more interesting to collaborate, getting the different stakeholders to meet, and solve problems together"
>
> The Port of Oslo

Controversy around shore power was more prominent in the reactions of the shipowners. The shipowners found expectations of using shore power challenging since it implied long-term, expensive investments. Given the age of cruiseferries calling on the Port of Oslo, the shipowners would have to retrofit "old" vessels. One shipowner had already installed catalysts which reduced local emissions, and sunk costs were therefore substantial. Thus, they expected costs with retrofitting vessels to outweigh potential gain. Nonetheless, all shipowners eventually started to use shore power, but displayed different, political rationales for doing so. As seen above, Shipowner1 took a proactive stance towards green consumerism and became an early mover to remain on the good side of their market. Although initially hesitant, Shipowner2 redecided because their company owner shared the sustainability ambitions of the Port and the City, and resolutely decided that the company itself would bear the costs of retrofitting. The company had used shore power since the early nineties and was continuously working to accelerate shore power use and implement additional measures from its sustainability strategy.

> "In the end the [company] owner decided that we should take the money from our own pockets to get [shore power] done (..) The motivation was simply that we wanted to go for sustainability (..) [In other ports] we are the ones investing and pushing for shore power (..) Shore power is one of the pillars [of the company]"
>
> Shipowner2

Finally, Shipowner3 only agreed to use shore power because of **political pressure**. A penalty fee for cruiseferries without shore power was introduced by the Port Board in 2018. The Port Board argued that the cruiseferries had been given enough time to adjust, and the penalty fee was introduced. In addition, a discussion piece was published in a national newspaper where a Port Board member representing the Green Party referred to the lacking shore power connection for all cruiseferries as "demoralizing" for the green shift in Oslo.[3] With the political engagement of the Port Bord, it became difficult for Shipowner3 to withstand the pressure.

> "We were given an ultimatum, as we see it (..) I won't say we had a business case that showed us it was sensible (..) There was political pressure to do it [use shore power]".
>
> Shipowner3

4.3.3. Public energy ownership

The transition to shore power was also supported by renewed local **energy politics**. In the 1990s, the conservative city council privatized the City's energy company. In 2017, however, the City of Oslo repurchased stocks, regained over 90% ownership and removed the company from the stock market. This was part of a strategy to strengthen public ownership of power and electricity in the city (Aftenposten, 2017). A year after the repurchase, the local energy company, now owned by the City, established a subsidiary company dedicated to innovation and business development related to future solutions for electrification.

> "It is amazing [when] [the local energy company] wishes to contribute to Oslo becoming the Climate City that is politically envisioned (..) [As owners we] do not want to dictate how to run the company, but [the City] wishes to show direction and main trajectories for the company, without distorting commercial aspects"
>
> City of Oslo

The repurchase and restructuring of the local energy company were ideologically based decisions to proactively induce energy transitions in which public ownership was an objective per se. These actions were intended to substantiate electrification policies, which in turn supported environmental policies. The energy company could as such be considered a tool for the City to accelerate electrification.

> "We have a good dialogue with [the energy company] about electrification in Oslo (..) [also] to ensure that capacity, infrastructure and other issues are aligned to provide a satisfactory transition pace"
>
> City of Oslo

However, although the energy company can be seen as an important tool to accelerate electrification, transitioning towards zero emission takes time, and a holistic approach is needed.

> "We need a holistic approach, where the number of shore power systems are seen in relation to for instance solar panels, the use of hydrogen, and the need for batteries for peak-shaving"
>
> Energy Company

Public ownership as a tool for promoting electrification thereby allowed the energy company to engage in new business areas and promote the electrification of transport and port activities, thereby supporting the ambitious objectives of the City. A continuous dialogue between the City and the energy company has been vital for the City of Oslo.

4.3.4. Environmental thrust

A final and very prominent political influence in the transition to shore power was the instrumental role of environmental organizations (Bellona and Zero), who promoted ambitious port policies and shore power. Bellona had a long-time collaboration with Shipowner1 and argued strongly for the shipowner to install shore power in 2011. Zero engaged to accelerate discussions around shore power.

> "It was hard, slow, and [there was] little interest [in shore power] the among ports and users (..) So to make it happen we needed political resolutions".
>
> Zero.

Bellona and Zero therefore exerted substantial influence over the Action Plan for Zero Emission Port. They actively pushed the City for stricter emission objectives, requested an action plan for the port and exercised pressure to realize it.

> "There is no doubt that Zero was a driving force that influenced politically to have [the action plan] realized. They exercised significant pressure on all politicians in the city council"
>
> Port of Oslo

Zero also engaged directly with shipowners and the port to "push shore power" and to facilitate its actual implementation.

> "We had a close collaboration with shipowner 2 to push them in the direction of implementing shore power."
>
> Zero

[3] See https://www.aftenposten.no/meninger/debatt/i/xqV9j/fossile-dans kebaater-geir-rognlien-elgvin only available in Norwegian.

Following the political opposition's proposal to introduce shore power in April 2016, the initial response from the new government was to wait with installing shore power until shipowners were ready to introduce new cruiseferries in 2020–2021. They argued that installing shore power to be used by old cruiseferries was not economically viable. However, in September 2016, the ten-point plan for an emission free fjord, initially suggested by representatives of the opposition, was unanimously adopted by the city council. During the course of these five months, Zero had actively engaged with both the green-left rule and the conservative opposition to ensure cross-partisan consensus and to more explicitly include the port in the ambitious environmental policy of the new city government.

> "We had a dialogue with the opposition about how to improve port policy and helped them devise a proposal that they submitted. Although the green-left wanted to present the "best" environmental policies themselves, after some push from us, they realized that this [proposal] was an improvement of policies that they actually agreed on. So they could not vote it down, as it improved policy"
>
> Zero

Hence, Zero worked with the green-left city government to demonstrate how the proposal from the opposition represented a way of improving environmental policies, leading to the spectrum of political parties standing by the goal of strengthening the environmental profile of the port. Zero therefore seems to have played a decisive role in *accelerating* the introduction of shore power. Although no political wing opposed shore power per se, they clearly disagreed on under what circumstances it should be implemented. Hence, the political discussion did not center on what policy to adopt, but when to implement it. This suggests that shore power was not really politically controversial.

> "[We] did not experience that [controversy in discussions on shore power]. The controverse was more how detailed the resolutions politicians make should be, how much micro-management"
>
> Zero

The involvement and successful entrepreneurialism of Zero demonstrates the position of the environmental organizations, compelling both the City and the Port to take their requests into consideration. The Port therefore initiated dialogue with Zero so that Zero could learn more about the realities that the port and its users were operating under.

> "We invited to dialogue so that they can participate, discuss, meet our customers (..) to avoid suggestions that are not knowledge-based. (..) We have entered into a collaboration agreement with [the environmental organizations] (..) to have good, competent discussions with them and their networks"
>
> Port of Oslo

As such, it was important for the Port to install realism in the issues being lobbied by environmental organizations. The Port realized that these had valuable competence and networks, and recognized the need to develop a common understanding of realistic opportunities. Therefore, the Port entered into collaboration agreements with both Bellona and Zero in 2019 to ensure that the political pressure exercized by these organizations aligned with the leeway and ambitions of the port.

This study therefore hints at politicization of shore power. There had been a long-standing political wish to implement shore power dating back to at least 2008, which was explicitly incorporated into plans and policy documents for nearly a decade before it was eventually implemented with a broad cross-partisan consensus. As such, politics have been less instrumental in deciding *if* to realize shore power, but rather influenced the pace of transition. This pace could have been rushed by the local and national moods' increasing awareness and problem perceptions associated with local emissions from ships. Further, the new city government demonstrated push in climate and environmental policies: by involving progressive environmental organizations, establishing the Climate Agency, actively using their port ownership and repurchasing the local energy company. As such, the political influences considered crucial by MSA, including national mood, elections, administrative appointments, and interest groups, were all instrumental in pacing up the transition to shore power in Oslo. These all represent important support structures for the legitimacy and implementation of policy. However, what appears most decisive political influence is this case, was the work to establish cross-partisan consensus in 2016, which not only accelerated shore power, but also raised the port on the political sustainability agenda and triggered other sustainability efforts in the port.

5. Discussion

The previous chapter has told the story of how shore power for cruiseferries was implemented in the Port of Oslo. We consider the success factor of this story to be its environmental thrust and lack of controversy. More precisely, we would like to argue that this study demonstrated how *lack of controversy is necessary but not sufficient for a policy to be implemented*. The lack of controversy rested on all three streams presented in the MSA. For one, the lack of controversy resulted from the ability of shore power to address the problem agendas of numerous actors: it allowed the City to redevelop urban areas; it allowed the Port and the City to set ambitious emission reduction targets; it allowed port users to operate longer and avoid negative publicity; and it allowed shipowners to demonstrate social responsibility.

Second, the lack of controversy rested heavily on the policy characteristics of shore power: it was technologically feasible, ushered by policy entrepreneurs in Shipowner1 and Zero, and a green national mood, heavily supported by public funds and public acceptance. Furthermore, shore power was alone able to address the largest emission source identified in the emission mapping conducted by the port, which made it a clear first choice for the transition work in the port.

Third, shore power had been a long time coming through broad cross-partisan consensus; emerging as a proposal from the conservative right but implemented by the environmentalist left. As such, politics were not evident in this case through the formation of alliances, the mobilization of arguments or clashes of interest. Rather, politics became evident in the *implementation* of shore power, reflecting how policies might also hold political purposes (May and Jochim, 2013). A particular example of this is the role of Zero. Zero clearly acted as a policy entrepreneur in applying their vast shore power knowledge to place shore power more forcefully on the political agenda. More prominently, the work of Zero in brokering between political wings did not really concern what policy to choose – because nobody bluntly opposed shore power - but rather getting a political resolution that pushed its implementation. Although the timeline of shore power shows it had been brewing for quite some time, it appeared to be at a halt until hit by the environmental thrust, as particularly represented by Zero working with both political wings to achieve a political, binding resolution that ensured and accelerated implementation. This resolution was in turn sustained by a number of political support structures following the 2015 elections, such as the Climate Agency and active ownership strategies.

We therefore suggest that the role of politics does not end with the selection of a policy, but that it extends also into the implementation of policy. As such, we like to stress how politics can "affect the extent to which [policy is] broadly and faithfully implemented, or, routinely and strategically ignored, deflected, altered or overturned" (Malen 2006:83). Especially in the case of environmental and climate policy, where the stakes are high and a variety of opposing stakeholders and interests are involved, the policy implementation might require even more political work than policy adoption. In this study, the prominence of politics in implementation contributes to show how the lack of political controversy around the solution (i.e. shore power) in policy

adoption itself was not sufficient. Rather, a series of political decisions proceeded its successful implementation. Although the political work to ensure consensus around the 2016 resolution was perhaps the most decisive political influence, implementation also followed influences that expressed the wish of the new political rule to plot a new course for the city, like establishing a climate agency, wielding more active port and energy ownership, and formally collaborating with environmental organizations. These influences could also represent an increasing politization of energy issues and port business, as these topics became an opportunity for the new city rule to raise their political flags and place a green-left mark on something that originated in the opposition and was unanimously adopted.

5.1. Stream interdependence

This empirical case provides ammunition to the early critics of MSA, because the transition to shore power in Oslo *did* involve significant interdependence and interaction between streams, and suggested that the streams evolved in symbiosis rather than coincidentally intersecting at a given point. This interdependence could have consolidated the importance of policy and politics in this transition, as the streams aligned, supported, and strengthened each other. Fig. 3 displays an attempt to illustrate how this works in this case.

This study demonstrates that problem perceptions could be modified both by the policy stream and the political stream, for instance by placing new problems on the agenda, increasing attention to existing ones or suggesting how acute problems are. In the case studied here, we could for instance see how politics shaped the problem stream when a political member in the new port board following the 2015 elections publicly criticized shipowners for not using shore power. Although shore power policies at that point in time were well established on the political agenda and among policy makers, this criticism gained substantial media coverage and thereby raised the issue in public opinion. As this corresponded with greater media attention to vessel emissions in Norwegian fjords, the publicity following a symbolic, political statement about shore power in Oslo might have strengthened the problem perception of the public, thereby increasing the reputational risks of shipowners reluctant to use shore power.

Problem perceptions could also result from the perceived prominence and forcefulness of policy. Whereas strong and prominent policies could signal that the problems they target are serious and acute, weaker policies that receive little attention could communicate that the problems they address are less pressing. One example of the former in our study was the generous support scheme for shore power, which is one of many components in the strong Norwegian policy portfolio for electrification of transport. The millions distributed to establish shore power connections communicate that at-berth vessel emissions are a problem worth addressing, and could particularly increase the problem perceptions and urgency of ports yet to establish shore power, as they observe one port after the other making these investments.

The strength of policy could also indicate how seriously a problem should be dealt with; the generous support scheme for shore power could for instance incline ports and cities to monitor emissions (problems), or policies aiming to connect the fjord and the city could produce more awareness and problematization around their disconnect.

Conversely, this study also illustrates how problem perceptions can impact both policy and politics. For one, problem perceptions can inform about what solutions are needed. In our study, this could for instance be reflected in complaints about port noise and emissions from neighboring communities, which in many Norwegian ports have been central in developing port areas and activities. As such, problem perceptions of port neighbors provide direct support to shore power as a policy for allowing the co-existence of the port and the city's population.

Second, problem perceptions can impact the politics stream, for instance by assessing whether existing political constellations are equipped to deal with these problems. In our study, this was best exemplified by the green landslide in the 2015 election. The new green-left city council following the elections could be an expression of public perceptions of climate change being so severe that the public saw the need for political change in order to more effectively address them.

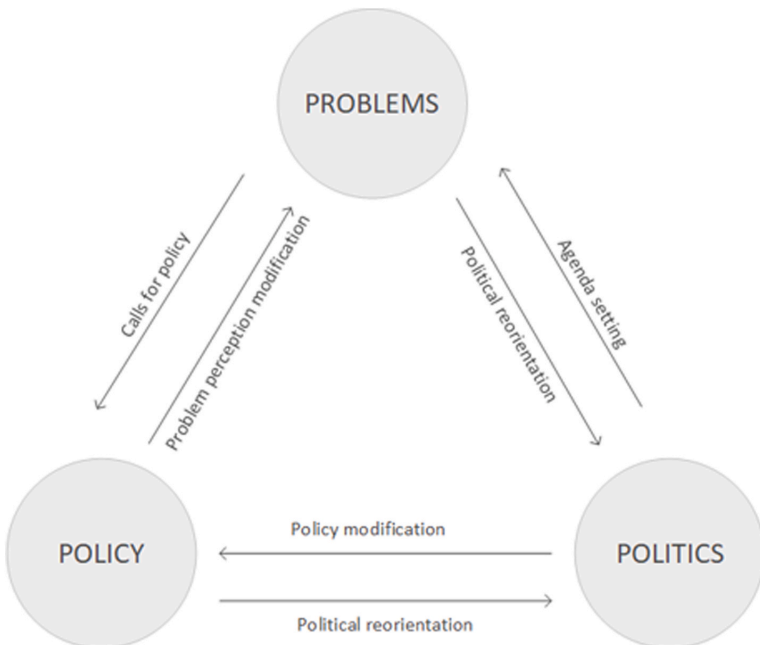

Fig. 3. Symbiosis between streams.

Finally, this study also demonstrates the perhaps obvious interdependence between policy and politics. Policy is shaped by politics, which can place more thrust behind policy, alter existing policies or shut them down entirely. In our study, this is well demonstrated by the range of political influences following the 2015 elections that installed revived pace and vigor in policies for port sustainability and shore power. Policy can therefore be a way to demonstrate political drive or to strengthen political image, for instance through the Port Board's penalty fee, which was not really expected to impact the problem (i.e. cruiseferry emissions) but rather gave a symbolic political statement.

Conversely, more or less successful policies can impact politics in producing calls for political change. If policies do not reflect the national mood or societal values, or if they are considered insufficient to counter problems, they could influence the political stream. In our study, we could argue that the inability of existing policy to sufficiently address climate and environmental problems led to a shift in political leadership (i.e. local election outcome), which in turn spurred the establishment of administrative units and positions (e.g. Climate agency, political port board) and produced more or less political steering (i.e. of energy resources and port business). As such, politics could be considered responses to developments in the policy stream, and vice versa.

6. Conclusion and policy implications

In this study we have applied the Multiple Streams Approach to demonstrate the role of policy and politics in the transition to shore power in Oslo. As seen above, the alignment of and mutual support between streams could explain why this transition was successful. For one, shore power addressed problems experienced by a number of actors, who thus benefitted from its implementation. Second, there was little competition from other policies that could abate the same problems, and shore power was pushed forward by increasingly ambitious and aligned policies related to electrification of transport, urban development, environment and climate, port policy and energy policy. Third, political shifts established support structures equipped to sustain and implement a politically uncontroversial policy. Table 3 displays a brief overview of the main keywords for each of the streams.

Hence, the most important policy implication of this study relates to policy alignment. The interwovenness of actors and policies in this transition, demonstrates the usefullness of holistic policy making in progressing transition. Shore power was supported by urban policies to connect the city and the fjord, by energy policies to ensure electrification, by climate policies that encompassed the port, and by ownership policies that ushered sustainable port policy. The policies grew increasingly detailed and ambitious over time, and an explicit representation of such policy convergences is the intentional agreement between the port and the energy company to establish a joint venture for installing, operating and maintaining shore power facilities. Realizing policy alignment is a demanding task in the complex political system that parties and other stakeholders operate within. However, when the problem at hand generates broad political agreement, and several policy entrepreneurs recognize and seize opportunity, policy windows open.

Table 3
Overview of problems, policies and politics in the transition to shore power in Oslo.

Problems	Policy	Politics
Disconnect seaside/urban population	No obvious competitor	Political consensus Environmental thrust
Global GHG emissions	Strong policy entrepreneur	Political support structure
Local emissions	Mature technology	Political support structure
Image problems for shipowners	Sufficient power supply National funding Public acceptance	Environmental thrust Local elections Climate Agency Active port ownership Political steering Energy politics

Although other policies, targeting other problems and being supported by other political influences, might be more relevant to other ports and cities, aligning these to provide mutual support is equally important. Both politically and administratively, the City of Oslo played a critical role in developing holistic policy which supported the transition to shore power. Similar approaches to holistic policy making could promote transitions in other cities. Not the least, this is vital to ensure deep transition, in which ports could be prominent because of their position between intersecting sociotechnical systems (Bjerkan et al., 2020). Deep transitions could be considered "a process by which some rules emerge, come to be aligned to each other and diffuse to various systems" (Schot and Kanger 2018). Policy is one expression of rule sets (on the metalevel or nor) at the core of deep transitions, and holistic policy could for instance promote deep transition through allowing the rise of different surges (i.e. support one without disabling others), reducing competition between niches or levels, and facilitating coupling between sectors and policies. Cross-sectoral approaches target the nexus between multiple sectors of policy making (Boas et al., 2016) and could enable holistic transition work. Cross-sectoral coupling is particularly potent in transitions involving the port sector, which joins countless domains and sectors whose transition work might follow non-compatible pathways.

The scientific literature on energy issues in ports tends to focus on large frontrunner ports (Bjerkan and Seter 2019), and considering that most ports worldwide are in the small-medium range, studies targeting these ports complement state-of-the-art. However, the observations made in this study are unlikely to represent any (attempted) transition to shore power. For one, each port is characterized by distinct features (e.g. difference sizes, actors, activities, geopolitical prerequisites) that impact what sustainability efforts are made and how they are carried out (Damman et al., 2019). Second, Norwegian ports in general are in a unique position, due to strong national incentives for electrification of transport (including shore power), large supply of hydropower, and because 90% of the electricity production capacity is owned by public authorities (Energifakta 2019). Third, the Port of Oslo is not representative of Norwegian ports; it has a larger, specialized organization, personnel dedicated to environment and sustainability, and a more progressive, active owner than most ports.

This study offers two contributions to transition research. For one, it adds to the transition field by systematically exploring the role of policy and politics, and as is one of relatively few studies exclusively dedicated these aspects of transition processes. Second, this study responds to a call for bringing process explanations into transition studies, by drawing on STEP analysis to review a specific transition process. We find this a useful approach to discern factors that enable or disable transition. Although our study has focused on the prominence of policy and politics, similar approaches could be applied to explore other aspects of transition, such as agency, the role of incumbents or social movements, niche developments etc. Although a daunting task – and far beyond the scope of this study – conducting an all-encompassing process review of a specific transition, covering (and perhaps comparing?) the width of explanations that research offers in understanding transitions, could be a next step in consolidating process approaches in transition studies.

CRediT authorship contribution statement

Kristin Ystmark Bjerkan: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition, Project administration. **Hanne Seter:** Conceptualization, Methodology, Investigation, Formal analysis, Writing – review & editing, Project administration.

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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5.1 Paper summaries on transition work

In the following I describe ways in which the content and shaping of transition work is covered by papers published as part of this thesis, as all three papers to not explicitly refer to the concept of transition work. The empirical foundations of the three papers, as well as empirical foundations of discussions in Chapters 6 and 7, are summarized in Table 13.

Table 13. Content and shaping of transition work.

	Content of transition work	**Shaping of transition work**
Paper 1	Coordinate port and city policy and strategies Enable port users through funding schemes Structure initiatives among port users Develop shared visions Develop projects across port actors Implement technologies (electrification) Test new technologies Adapt practices to new technologies Incorporate technology/emission demands in contracts	Socio-technical system elements: Regulation and policy Artifacts and technologies Infrastructure Public opinion Normative rules (port role) Local and international landscape pressures
Paper 2	Co-create visions Build shared imaginaries and worldviews Understand value chain developments Mobilize for regulation Formalize networks Establish subsidiary company Exchange knowledge and viewpoints Learn about technologies and innovations Experiment Map competence needs Build or acquire competence Define issue jurisdiction	Socio-technical system elements: Regulation and policy Artifacts and technologies Markets Normative and cognitive rules Port roles Landscape pressures Expectations for the future Directionality Actors and niches Network building Technology implementation Broad learning
Paper 3	Adopt policy Aling policies/strategies/perspectives Apply for funding Build consensus Build network Claim jurisdiction Co-create solutions Collaborate Design technology Develop policy strategies Exercise pressure Implement technology Legitimize technology Lobby Map problems Provide funding Raise awareness Restructure organization Set policy objectives	Socio-technical system elements: Infrastructure: cables in place Public opinion: perception of port, port-population relationship Local government structure Normative and regulative rules Penalty fee Issue jurisdiction Politicization Local and international pressures Emissions and noise Urbanization Political consensus Technologies and actors Technological maturity Company profiling Economic strength Organizational (re)structuring

Paper 1: Actor roles in the Port of Oslo

Paper 1 focuses on the port actors' roles and how those roles might constitute transition work. Although it does not refer explicitly to transition work, but rather to the potential of actor roles and constellations to shape energy transitions, the paper accounts for actions and activities that fall under the different roles that actors might take. It discusses actor roles with reference to the role typology developed by Schot, Kanger and Verbong (2016), who distinguished between different types of users: user-producers, user-legitimators, user-intermediaries, user-consumers, and user-citizens.

User-producers contribute to transitions through designing, modifying, and testing niche innovations, while user-legitimators provide support to innovations by attaching values and symbolic meaning that spark interest and increase diffusion. Schot et al. (2016) describe user-intermediaries as establishing support structures that enable other actors to participate in transformation processes, whereas user-consumers are end-users of emergent niche innovations that incorporate these into daily practices. Lastly, user-citizens engage to progress niche innovations at the expense of incumbent technologies or competing niches, such as through lobbyism, grassroots opposition, or social movements.

Paper 1 investigates the prevalence of the above-described five roles in the Port of Oslo. The investigation is based on 20 semi-structured interviews with actors in the port and with actors whose daily operations relied on port services. Drawing on these interviews, the paper discusses the prominence of roles and their implications for transitions in sea transport, hinterland transport, and port operations. It concludes that all roles were prevalent in port operations, but not in the other two domains. Thus, the paper argues that, collectively, port actors were in better position to shape energy transitions in ports than in connected transport systems.

By examining the roles in the port, Paper 1 also allows for a description of the transition work done by the different actors in the different domains. Albeit not explicitly referred to as such, codes used to identify actor roles in the interview data revealed what types of transition work activities that characterized the roles described by Schot et al. (2016). This includes transition work in the form of designing, modifying, or testing innovations (producer role), promoting and creating positive narratives (legitimator role), establishing support structures and systems, infrastructure, and regulation (intermediary role), and incorporating innovations in daily operations and practices (consumer role). Thus, the analysis of the prevalence of actor roles revealed that the transition work of port actors mainly related to port operations.

Paper 1 provides several examples of the shaping of transition work. For example, it points to the role of policy in providing directionality for actors, and regulatory changes that increased public port owners' incentives to engage in port matters. Furthermore, ambitious policy could be considered the result of landscape pressures related to climate change and local pollution, which directly initiated many efforts to reduce emissions. Also, regime rules could be considered to have shaped transition work in the Port of Oslo. For instance, cognitive rules that identify ports as maritime could keep ports from doing transition work in the hinterland domain.

Paper 1 also shows that transition work revolved around electrification, and that the maturity of niche innovations (e.g., shore power) or lack thereof (e.g., fuels and energy carriers in maritime transport) informed the transition activities of actors in and around the port. Actors' efforts to promote transition might also have been shaped by their own strategies to maintain or strengthen market position and/or survive as incumbents of the existing regime.

Paper 2: Transition pathways in the ports of Oslo and Kristiansand

Paper 2 deals more directly with transition work than Paper 1 and makes explicit reference to the concept. More specifically, Paper 2 investigates the social processes that the Port of Oslo and the Port of Kristiansand are engaged in and discusses how they might constitute different pathways towards transition in the two ports. The paper claims to understand how "social processes build transition work." However, following the conceptualization of transition work in this thesis, I would argue that the social processes also constitute examples of transition work themselves.

The social processes investigated in Paper 2 refer to activities that are typically associated with the building and strengthening of niches. One of these processes concerns the use and building of social networks. Social networks are important to transition work because they can offer different types of resources (e.g., financial, human, culture, reputation) that could be produced and exchanged within networks. In turn, this might allow actors collectively to promote low-emission technologies or to create protective spaces around emerging innovations, especially when actors draw on a diverse pool of resource and are integrated into stable network relations. A second social process investigated in Paper 2 is the creation of expectations. Efforts to co-create, diffuse, or translate expectations and visions could lay the foundation for further transition work because they coordinate and align actors, build legitimacy and protection around niches, mobilize resource, and reduce risk perceptions. Finally, Paper 2 investigates processes of social learning, in which actors gain knowledge about, for example, technology, regulation, impacts, markets and users, or they reorient assumptions that guide their interpretations and actions. Such learning processes could contribute to transition work by modifying innovations, expectations, or perceptions in ways that make them drive transitions more effectively.

To explore the above-mentioned social processes in the ports of Oslo and Kristiansand, 25 interviews with ports and port stakeholders were analyzed. The ports are considered to share similar transition contexts in that they belong to the same geopolitical and macro-economic realities, are public owned, are located in urban areas, have similar traffic, and are making similar efforts in terms of progressive sustainability. However, Paper 2 finds that transition work differs between the two ports, which are considered to follow distinct transition pathways. While transition work in the Port of Oslo is described as strategic, coordinated, and scalable, transition work in the Port of Kristiansand is considered incremental and niche-oriented.

The characteristics described above are based on differences in social processes (expectations and vision-making, network building, and social learning), and Paper 2 supports its claims by exemplifying how the two ports relied on and engaged in these processes as part of their

transition work. For example, Paper 2 shows that transition work in the Port of Oslo was characterized by explicit attempts to facilitate visions (e.g., their zero-emission action plan) and produce shared imaginaries (e.g., the concept of the future port with zero emissions). The transition work in the port was also characterized by the formalization of extensive networks and the establishment of strategic alliances to align ambition and perceptions, and to prepare for the implementation of niche innovations (e.g., shore power).

Both the Port of Oslo and the Port of Kristiansand relied on their networks and experimentation to learn about technologies and innovations that could reduce emissions in their port area. However, the ports diverged with regard to reorientations around port roles and mandates. This was not a prominent feature in the Port of Kristiansand. Furthermore, transition work in the Port of Kristiansand was less characterized by vision-making and dedicated network building than in the Port of Oslo.

Paper 2 also shows that the studied social processes can contribute to shape further transition work. First, expectations about the future, which in Paper 2 were seen to provide directionality and guide actor orientations towards specific niches, could be considered expressions of perceived landscape pressures. As such, expectations could be understood as the actors' specific interpretations of how the landscape level would develop. Second, by bringing together actors with different backgrounds, network building could provide resource and competence that would allow decision-making, and aligning strategies and objectives could induce more efficient technology implementation. Third, and finally, learning processes in the two ports laid an obvious foundation for further transition work: broad learning allowed actors to orient more competently and effectively among the many niche innovations that were relevant to port sustainability, while deep learning could have redefined cognitive and normative rulesets that enhanced the ports' capacity and motivation for progressing transition.

Paper 3: The implementation of shore power in the Port of Oslo

Whereas Papers 1 and 2 take a broad perspective on transition work, Paper 3 studies one specific example of transition work in the Port of Oslo, namely the implementation of shore power. Shore power allows vessels visiting the port to shut down their (fossil) auxiliary engines, and instead rely on electricity from the shoreside to power the vessel while at berth. In the Port of Oslo, two different shore power facilities have been established, and Paper 3 describes and analyzes implementation processes in order to demonstrate the role of policy and politics in energy transitions. To do so, the paper relies on the multiple streams approach to identify and analyze how problems, policymaking, and politics produce windows of opportunity that facilitate implementation of shore power. The streams are investigated with reference to interviews held with 12 persons who had either been directly involved in the implementation process or had used or planned to use shore power in the port.

Paper 3 finds that the successful implementation of shore power in the Port of Oslo rested on the ability of the specific niche innovation to solve different problems for different actors, such as the disconnect between the fjord and the urban population, noise, and local and global air emissions. A further finding is that shore power was technologically feasible and faced little competition from other innovations. The paper also finds that implementation followed a green-left political push in policymaking, in which public ownership of the port and the energy system, as well as increased political thrust from environmental organizations, were instrumental in ensuring the realization of consensus-based policy adoption.

As Paper 1, the objective of Paper 3 is not explicitly to describe transition work. However, by investigating the introduction of shore power, it captures transition work among the many stakeholders involved. Paper 3 mainly describes extensive transition work associated with developing and adopting policy, and with developing strategies for realizing policy objectives. In this regard, the paper provides evidence of significant collaboration and dialogue around the alignment of policies, perspectives, and strategies between different actors. Paper 3 also provides examples of activities related to designing, developing, and funding emerging technologies. Finally, the paper particularly demonstrates political transition work, such as expressed in lobbyism, consensus-building, and the exercise of political power.

Additionally, Paper 3 provides insights into the shaping of transition work. For example, discussions on the interactions between problems, policy, and politics shed light on how one such stream might shape the development of another stream. A prominent development identified in the implementation of shore power was the increasing politicization of port business. This might have resulted from increasing landscape pressures associated with climate change and urbanization, but it might also have been an expression of increasingly normative discussions of ports. In addition to the obvious contribution of technological maturity, the transition work presented in Paper 3 is also clearly linked to the strategic, financial, and promotional assessments of corporations. Thus, Paper 3 complements Paper 1 and Paper 2 in terms of its coverage of socio-technical elements that might shape transition work.

Part C: Cross-cutting analysis

6 The contents of transition work in Norwegian ports

As I have shown in the preceding chapter, the research reported in this thesis contains many stories of the transition work being done in ports. This chapter draws on the research documented in Papers 1–3 to address the second research question of this thesis, namely the content of transition work. Accordingly, I present the transition work done in the three case ports and relate it to the theoretical concepts and understandings that are used to conceptualize transition work in Chapter 3. As I have shown in Chapter 3, these concepts and understandings provide many perspectives on how sustainability transitions progress. Thus, they are laden with (mainly unexpressed) notions of what could or should be done to ensure such progress, but the ways in which these could impact transition processes have yet to be understood as particular types of "work."

In the following subchapters I demonstrate how the important contributions of, for example, technological experimentation, vision-making, governance, and politics, manifest in transition work. Following my understanding of transition work as agency applied for a specific purpose, namely the acceleration of sustainability transitions, in this chapter I show how established ideas of the dynamics and processes of sustainability transitions could also be interpreted as different expressions of transition work, as summarized in by Table 13. By reinterpreting this multitude of approaches to understanding transitions as narratives of *who does what*, I aim to encourage more active narratives around the progress of transitions.

Above all, this chapter tends to *what* is being done to progress sustainability transitions. However, it is important to make a note on *whose* transition work is described as well. As mentioned in Chapter 3, my application of transition work has mainly captured the agency of human actors, although recognizing that the agency of non-human actants (e.g., vessels, infrastructure) could also be vital to transition work in ports. As also described in Chapter 3, scholars of sustainability transitions have studied how many different actor groups might shape transition processes, including governments and policymakers, incumbent firms and industries, niche actors, NGOs, consumers, and social movements. All these groups have potential for doing transition work, and this range of transition agents is also relevant to the transitioning of ports. Nonetheless, this thesis primarily describes transition work conducted by actors closely located to the transition site, such as public authorities and incumbents in the port, logistics, and transport sectors, as well as incumbents of different industrial sectors. Although other actors, such as niche actors (e.g., energy providers) and civil society (e.g., NGOs, media, neighboring communities) have played a part in the transition work described in this thesis, future research could more elaborately explore transition work expressed in actors, values, and discourses originating outside the port. Therefore, it is important to emphasize that transition work can be executed by any actor, independent of their physical location vis-à-vis the transition site or their relation to existing regimes. Executives of transition work have in common that they deliberately and purposively seek to progress sustainability transitions.

Table 14. Examples of transition work discussed in the thesis.

Technological work	**Visionary work**
Entrepreneurial work	Develop shared visions
Designing/co-create technological solution	Facilitating vision-making
Test new technologies	Produce shared imaginaries
Implement technologies	Exchange knowledge and worldviews
Adapt practices to new technologies	Align policies, visions, and strategies
Governance and policy work	**Political work**
Define policy	Mobilize for regulation
Set objectives	Adopt policy
Coordinate policy domains	Raise awareness and knowledge
Intermediate	Legitimize technology
Establish/provide funding (schemes)	Influence political agenda
Structure initiatives	Consensus-building
Incorporate heterogeneous expectations	Lobbyism
Corporate/organizational (re)structuring	
Reflexive work	**Relational work**
Learn about technologies and innovations	Build and formalize networks
Experimentation, trial and error	Engage informal networks
Identify competence/knowledge needs	Broker
Purchase competence	Coordinate
Renew or claim problem/issue jurisdiction	Unite actors in specific projects
Learn from others	Align policies, visions, and strategies
Learn about each other	Identify shared needs and opportunities
Align perspectives and worldviews	

Thus, the typology of transition work presented in Table 14 is not innately distinct from prevailing understandings of transition dynamics, but rather builds on these to demonstrate ways in which they might be observed in explicit expressions of transition work. Although there are probably many ways to group or structure the different activities that could comprise transition work, the reflections presented in the following subchapters (6.1–6.6) are a first contribution to the development of a conceptual framework for describing transition work. I discuss transition work with reference to six different subgroups, which may interconnect and build on each other. Above all, relational work seems to span all types of transition work and, as such, appears be a foundational component of efforts to progress transition.

The above-described typology of transition work is based on activities that are prominent in the empirical material of this thesis, and future studies of transition work in other contexts and domains would be useful to complement or modify the categories of transition work discussed here. The grouping described in the following subchapters is further colored by the empirical focus on this dissertation on *public* port organizations, which implies that activities associated with, for example, creating markets, identifying demands, and other commercially oriented rationales behind transition work, are less prominent in the framework.

6.1 Technological work

I understand *technological transition work to encompass any activity related to the development, implementation, and application of emerging niche innovations*. As demonstrated in Papers 1–3, port actors engaged in many phases of niche development. For instance, port actors have designed solutions to accommodate needs not met by the market, as exemplified by how Shipowner 1 engaged in entrepreneurial work to develop the first shore power facility in Port of Oslo. Furthermore, three case ports provided sites for piloting technology that R&D was seeking to validate (e.g., shore power in the Port of Kristiansand) and they entered into co-creational processes to ensure successful design and implementation processes (e.g., dialogue meeting on shore power in the Port of Oslo).

My understanding of technological transition work echoes many existing notions in STS and studies of sustainability transitions alike. For example, co-creational processes represented by the dialogue meeting on shore power could reflect the importance of user perceptions, as emphasized by SCOT theory (Pinch & Bijker 1984). Orchestrated by the Port of Oslo (Paper 1), the conference could be an expression of the port's attempt to identify relevant social groups (power suppliers, technology providers, end-users) and their perceptions of problems and potentials inherent in the proposed shore power solution. Furthermore, technological transition work has an obvious connection to strategic niche management, as expressed in, for example, how ports and port actors nurture specific niches by setting aside funding for their own and others' investments in emerging technologies (shore power, electrification) or by seeking funding to invest in specific technologies. As such, technological transition work also encompasses different port actors' implementation of niche innovations and their efforts to adapt practices to new technologies. Many of these adaptations follow early involvement in testing and pilot studies (e.g., DNV's Green Shipping Programme), which are considered vital to progress transition, by transition management in particular (Loorbach 2007) and by transition scholars in general (Ryghaug & Skjølsvold 2021). Such experimental activities have allowed for substantial learning, which is discussed as an expression of reflexive transition work in Subchapter 6.5.

6.2 Visionary work

I understand *visionary transition work to emphasize attempts to produce shared, collective perceptions and understandings of what the future could and should look like*. Visionary transition work could have an incremental character (e.g., focusing on specific technological innovations or practical planning), as well as a more transformative character (i.e., reorientation of fundamental ideas and mandates). Papers 1–3 provide many examples of the former kind of visionary transition work, such as how vision-making centered on specific low-emission solutions. For instance, in the Port of Kristiansand the visions that guided sustainability efforts mainly centered on electrification activities. In the Port of Oslo, the co-creation of a concept for the future zero-emission port was oriented heavily towards specific technological solutions. The coherence of the future port concept was strongly tied to technological specificities, such as the production, storage, and distribution of energy carriers, automated vessels, carbon capture and storage, alternative fuels for heavy duty vehicles (HDVs), and smart energy management.

Existing understandings in STS and studies of sustainability transitions are also concerned with visionary work. For example, in SCOT (Pinch & Bijker 1984), the success of technological artifacts is considered to be the product of relevant social groups' ability to build shared perceptions and systems of meaning around those artifacts. This success could be considered one parallel to visionary work. Similarly, strategic niche management (SNM) (e.g. Schot & Geels 2008) explicitly refers to the creation of visions and expectations as fundamental to the nurturing of emerging niches. Thus, both SCOT and SNM include examples of visionary transition work, but both relate the work to a specific technological artifact or to a specific niche. As such, these perspectives display a similarly incremental character as much of the visionary transition work discussed in this thesis, which Papers 1–3 all show strongly revolves around electrification. However, in contrast to SCOT and SNM, some of the visionary transition work identified in this thesis was also directed at *collections* of technologies (e.g., the future port concept in Oslo). The visionary work of ports cannot be limited to specific technical systems, technological artifacts, niches, or innovation systems. The port sector serves to demonstrate the need for transition scholars to move away from technology-centered or innovation-centric approaches, and towards studying how transitions unfold through interactions between multiple technologies and the systems surrounding them. Thus, those favoring the emerging notions of whole-system transformations and deep transitions (e.g. Kanger & Schot 2019, McMeekin et al. 2019, Schot & Kanger 2018) are well advised to learn from ports as potential transition sites. I elaborate further on this point in Chapter 8.

In addition to visionary work encompassing multiple technological innovations, visionary transition work in the research for this thesis revolved less around visions that were not technology-specific, but rather revolved more around ideas and perceptions of what ports should be. Visionary work in the ports of Oslo and Kristiansand, both publicly owned and located in urban areas, needed to incorporate visions for the ports' neighboring communities and/or the city as a whole. Particularly in the Port of Oslo, visionary work related to developing shared understandings and perceptions of reality. There, developing bodies or systems of meaning, perceptions, and framing (Pesch 2015, Pinch & Bijker 1984) related to what problems the port and its users should address, what possibilities they could envision for solving those problems, and how to engage in those specific problems or capitalize on the envisioned possibilities. For example, as shown in Paper 3, the Port of Oslo wanted to work closely with both the City of Oslo and influential environmental organizations to exchange viewpoints and worldviews and to exchange knowledge about the practical and operational functioning of the port. The port hoped that would contribute to align perceptions of what were realistic transition pathways and goals, and thereby maintain the port's autonomy and legitimacy as a transition agent. This kind of visionary transition work resembles ideas of translation, as the Port of Oslo clearly sought to harmonize the perceptions of others with their own. For instance, harmonization and alignment was considered crucial to set shared objectives and develop specific strategies to fulfil them. This finding clearly points to a link between visionary work and policymaking.

6.3 Governance and policy work

I understand *governance and policy work to cover activities that provide direction for transition work and/or enable others to act in line within that direction*. Defining policy mixes

is vital for accelerating transition processes, and previous studies of sustainability transitions have focused on the characteristics of policies that address sustainability issues, such as their design, consistency, and credibility (e.g. Kern & Howlett 2009, Rogge & Reichardt 2016). Although policies could be considered to abate directionality failures, coordinating different policies is in itself crucial to avoid transformational failure altogether (Weber & Rohracher 2012). For this thesis, policy work also revolved around providing directionality. Papers 1–3 all refer to how strong, predictable policies have led to the establishment of electrification at the core of transition pathways in energy and transport sectors. Similarly, all three papers show how the Port of Oslo worked with its users, the city, and environmental organizations to develop policy that directed the sustainable development of the entire port area. In addition, policy work was characterized by policy coordination. In the case of the Port of Oslo, collaboration between the port and the city produced emission reduction objectives and policies for the Port that conformed with objectives and strategies for the city as a whole, as expressed in the city's climate strategy (City of Oslo 2016, City of Oslo 2019) and Fjord City Program (City of Oslo 2008), and the zero-emission action plan for the Port (Port of Oslo 2018).

Strong and clear objectives and integrated policy could be a precondition for effective governance (Nilsson & Nykvist 2016). As shown in Subchapter 3.3, governance entails interactions dedicated to solving societal problems and/or creating societal opportunities (Kooiman 2003). In general, scholars have increasingly oriented their attention towards governance as a way to implement solutions (Mayntz 2003), and in studies of sustainability transitions, governance is particularly studied by scholars of transition management. The studies reported in Papers 1–3 provided several examples of governance in the transition work of ports, and such work was particularly prominent in the Port of Oslo. First, in subchapters 6.2 and 6.3, I have already shown how the port engaged in what transition management considers strategic activities, which include developing visions and setting goals and associated strategies for reaching them (Loorbach 2010). Second, the Port of Oslo initiated several tactical activities (ibid.), which provided structures and contexts (e.g., rules, regulation, organizations, institutions, networks) that enabled transition work. For instance, the port established a support scheme under which port users could apply for funds to invest in low- or zero-emission technologies. The Port also assisted port users in applying for funds from public support programs. Another interesting tactical aspect of the transition work of the port and the city alike was organizational restructuring. Following the 2015 local elections, the new political rule of the City of Oslo sought to leave a green mark by increasing the visibility and effectiveness of environmental policy, as described in Paper 3. To do so, it reorganized the administrative structure of the city administration to establish the Agency for Climate, which was given explicit responsibility to realize climate policy.

Governance aspects of transition work also appeared in the organizational restructuring of the local energy company. Considering how electrifications is at the core of strategies for reducing climate emissions, and considering how energy is a crucial issue in sustainable transformations of entire societies, the City engaged to reestablish public ownership of the local energy company. As seen in Paper 3, the City not only repurchased the company and removed it from the stock market, but also established a subsidiary company intended to develop innovations and business areas that could further electrification. Similarly, the Port of Oslo—in common

with several other Norwegian ports—prepared to set up a joint venture dedicated to establishing, operating, and maintaining facilities to provide shore power to vessels in the port. The administrative restructuring undertaken by the City and the Port could be considered expressions of governance work aiming to facilitate and accelerate transition.

A third example of governance work in the Port of Oslo related to its intermediary work. While certain aspects of intermediation can contain elements of political work (e.g., brokering) or relational work (e.g., matchmaking, coordination, configuring), the facilitatory work of intermediaries can be considered expressions of governance. As discussed at length in Subchapter 7.4, intermediation was a prominent feature of transition work in the Port of Oslo, and as shown in Paper 1 it could be considered an enabler of other types of transition work. The port contributed to facilitate transition by setting demanding emission reduction targets, calculating port fees according to the emission levels of vessels, and by establishing the support scheme mentioned above. However, to succeed with the implementation of those policies, the port relied also on political efforts. Considering how the adoption and execution of policy often following political debate and voting, both governance and policy work are closely tied to political transition work.

6.4 Political work

Politics is a multifaceted construct that could be ascribed many different definitions and emphases. For example, politics can be considered equivalent to conflict, state business, governance, and resolution practices. I consider *political transition work to span activities that more and less explicitly draw on power resources in the pursuit of particular values and priorities (e.g., sustainability) or particular distributions of gains and losses*. As such, I emphasize politics as an exercise of power and a means for resolving differences.

Politics has gained an increasingly prominent position in studies of sustainability transitions, as "any attempt to steer societies towards sustainability will involve and affect politics" (Hendriks & Grin 2007:346). Politics can also play a crucial role in destabilizing unsustainable regimes and systems (Oers et al. 2021). Given its interconnectedness with governance and policy, studies of sustainability transitions are increasingly drawing on policy theory to understand the role of politics in transition processes (see Avelino et al. 2016 for a useful overview), such as by studying opposing political coalitions (Hess 2014) or technology advocates (Raven et al. 2016), or by discussing theoretical and ontological understandings of transition politics (Geels 2014, Lockwood et al. 2017, Shove & Walker 2007, Smith & Stirling 2010). Thus, political debate and political processes of decision-making are considered obvious contributors to transitions. However, the ways in which the processes constitute transition work (e.g., in the form of specific activities intended to progress transitions) has yet to be discussed by transition scholars. This thesis contributes to fill this gap by pointing to ways in which actors in and around the Port of Oslo worked to gain political support for their initiatives.

Overall, political work is not very prominent in the sustainability efforts of ports. One probable reason for this is the general lack of political interest in the port sector and the prominence of operational and commercial perspectives in port mandates. As ports have enjoyed significant autonomy from public owners, administratively and politically, there has been little need in

the past for ports to engage politically. However, in this thesis I provide examples of an increasing politization of (public) ports, following the needs of cities to reduce emissions and demonstrate vigor in the face of climate change. Climate change has spurred greater interest among public port owners, which have increasingly taken jurisdiction over port issues, which in turn requires ports to relate more actively to the political sentiments of their owners. Thus, political aspects of transition work could be expected to become more prominent in the years to come. However, currently, political transition work primarily seems to be a feature of larger ports, typically those located in larger cities with larger emission problems and more imminent land use conflicts. This point is also reflected in this thesis.

In this thesis, political transition work is most prominently captured in Paper 3. The paper shows that there was a lack of controversy around the technology under debate (i.e., shore power), which implies that institutional work, framing, and interpretive flexibility were not prominent aspects of political transition work. Rather, political transition work revolved around deflating practical and symbolic disagreements between opposing coalitions to accelerate implementation. Thus, consensus-building was at the forefront of political transition work. In doing that work, environmental organizations relied heavily on established networks and power relations, in which they functioned as translators between political wings. This finding could point to ways in which political work might appear in the form of intermediation activities, such as brokering.

Another example of brokering is the Port of Oslo's extensive translation efforts in dialogue and collaboration with the City and with environmental organizations. The efforts had an obvious political nature, as they sought to harmonize understandings of what ports (can) do to accelerate transition, which contributes to align political pressures for accelerated transition with the reality assessments of the Port. To the Port, such alignment was essential to foster political decisions that did not disturb its operations and its relations with its customers. One such clash between political ambition and operational pragmatism occurred during the introduction of the second shore power facility. As shown in Paper 3, the political side of the port board publicly criticized shipowners for not converting to shore power and threatened to sanction their non-use with penalty fees. On the one hand, the incident represented political work on the side of the board member, who succeeded in exerting significant pressure on Shipowner 3 in particular. On the other hand, it demonstrated to the Port that it needed to engage more in political circles and with political circles in order to harmonize political ambition with its own operational reality.

Paper 3 also describes political transition work that did not relate specifically to the introduction of shore power, but rather sought to the strengthen the City's overall grasp of energy and sustainability transitions. Decisions to restructure the city administration and repurchase the local energy company, which held significant political symbolism, were aimed at increasing the efficiency of climate policy in general and to demonstrate determination on the side of the new political rule in particular. This finding also points to interconnections between political transition work and governance, as political work was done explicitly to enhance governance and policy implementation.

6.5 Reflexive work

I understand *reflexive transition work as activities that enable the progress of transitions through enhancing knowledge, increasing awareness, or reorienting perceptions.* In studies of sustainability transitions, reflexive activities are a central component of transition management, as they provide knowledge and learning that is needed to develop new ways to structure, frame, and manage societal functions (Loorbach & Rotmans 2010). Reflexive transition work also resembles ideas of learning that are inherent in strategic niche management (Schot et al. 2016), which distinguishes between (1) learning processes that increase knowledge about technologies, associated markets, and user preferences (i.e., broad learning), and (2) learning processes that enable reorientation of fundamental assumptions that guide interpretations and behaviors (i.e., deep learning). Although existing studies of sustainability transitions have not described them as such, learning processes could be induced or activated to progress transitions, and as such provide examples of transition work.

In this thesis, I consider reflexive transition work to include knowledge about technologies and actors, as well as reorientation of role perceptions. Paper 2 demonstrates how the Port of Oslo and the Port of Kristiansand learned about technologies and innovations by engaging their networks. In Kristiansand especially, experimentation through R&D projects proved useful by demonstrating to the port what kind of knowledge and competence it needed to execute transition work effectively. Consequently, the Port expanded its organization with staff whose expertise matched the competence it needed. Similar reflections characterized the transition work in the Port of Oslo, which also formed strategic alliances with consultants and sectors that were coupled with the port (e.g., the energy sector, maritime transport) in order to establish a knowledge-based foundation for its transition work. One example of such work was the mapping of emission sources in the port area, as described in Paper 3, which allowed the Port to orient its transition work towards port operations that could provide the most cost-efficient emission reductions.

A second expression of reflexive transition work in this thesis concerns ports' efforts to learn about other actors and sectors that they connect with on a daily basis. This related primarily to the visionary work described in Subchapter 6.2, whereby the Port of Oslo in particular sought to learn about the perspectives of its owner and its users in order to harmonize reality perceptions and ideas for the future. Although increasing the familiarity between organizations was necessary in purely practical terms (e.g., to produce shared policies and objectives), it also allowed for adjusting the Port's own expectations of the transition work of others and demonstrated what were others' expectations of the Port. This in turn enabled the Port to incorporate the transition work of the port actors into its own transition work.

A third expression of reflexive transition work in this thesis is the reorientation of normative expectations of the Port of Oslo itself. In Chapter 2 I have shown how port authority functions increasingly include community management, and Papers 1–3 all demonstrate how the Port has moved beyond traditional port roles. The Port claimed jurisdiction over sustainability issues and incorporated sustainability into short-term and long-term strategies to preserve its legitimacy in the city government and in the population. This clearly indicates the port's explicit purpose of doing transition work, and in this regard probably contrasts the majority of

Norwegian ports, where commercial business operations still dominate port strategies. The reason why this kind of transition work has become a particular feature of the Port of Oslo is discussed further in Subchapter 7.4.

6.6 Relational work

Relational work permeates most transition efforts discussed this thesis. I understand *relational transition work to encompass any activity aimed to progress transition in which an actor engages or interacts with another actor*. All the above-presented examples of transition work (i.e., in subchapters 6.1 to 6.5) to some degree relied on relational work. For instance, in technological transition work, technology implementation required collaboration between technology providers, facility owner, and end-users. In visionary transition work, relational work was an inherent aspect of developing shared visions and aligned policy. In governance, relational work was necessary to orchestrate the sustainability efforts of many port users. Thus, relational work could be an inherent aspect of the orchestrating capacity of ports, which refers to their ability to "coordinate multi-actor processes, foster synergies, and minimize trade-offs and conflicts across scales, sectors and time" (Hölscher et al. 2019:796).

Relational work was also essential when lobbying for accelerated policy adoption (political transition work) and in maintaining dialogues that fostered learning and reflection (reflexive transition work). Thus, this subcategory of transition work clearly demonstrates the relevance of actor-network theory (e.g. Callon 1986, Latour 1996) in understandings of transition work, as the transition work described in this thesis emerged through reciprocal relationships between the heterogeneous myriad of port actors and users. Relational work may also appear in the form of configuring activities that aim at aligning technologies, users, and infrastructure, which implies that relational work could be considered an expression of both intermediation (e.g. Stewart & Hyysalo 2008) and the system-building emphasized in understandings of large technical systems (e.g. Hughes 1987) and technological innovation systems (e.g. Bergek et al. 2008).

Thus, based on the research done for this thesis, I argue that the relational work done by ports is fundamental to any other type of transition work. Perhaps the most prominent feature of relational transition work is the building and maintenance of networks, as practically all transition work necessitates well-functioning relations with others. Paper 2 in particular demonstrates the role of diverse networks in providing support for transition work, nurturing and developing technological solutions, establishing knowledge and competence, and strengthening legitimacy. Paper 2 also demonstrates the importance of relational work by pointing to how the different network relations in the Port of Oslo and Port of Kristiansand contributed to produce dissimilar transition pathways. For instance, the progressive transition work in the Port of Oslo was characterized by extensive dialogue with users and stakeholders, inclusive port planning processes, and formalized relations in joint ventures and collaboration agreements. Hence, the idea or ability to capitalize on network relations appear crucial for both the speed and direction of transition work.

6.7 Summary of transition work in ports

In this chapter I have presented the building blocks of transition work in the three case ports studied in this thesis, thus addressing the second research question: *How are actors in the*

port sector working to promote and accelerate transition in and around ports? With reference to the empirical work done as part of this thesis, this chapter has proposed a conceptual framework for transition work that distinguishes between six types of such work. These subgroups of transition work are in no way mutually exclusive and do not provide a complete categorization of transition work. Rather, the groups serve to simplify the many facets of transition work and provide one way of collecting and gathering different activities that are dedicated to progress transition. As a framework for transition work, the subgroups also demonstrate that existing understandings of the dynamics and processes that constitute transitions are abundant with transition work. However, in order to gain better understanding of transitions in the making and to learn for future transition activities, the stories need to be reframed into active narratives of who does what.

Furthermore, the discussions in this chapter show that distinguishing one type of transition work from another is difficult. For example, visionary work is inherent in efforts to define policy objectives, which are also the results of political work, such as in the form of elections and public debate. Moreover, governance activities, such as establishing funding programs and innovation support, directly relate to technological work. Additionally, reflexive and relational work could be considered inherent aspects of any kind of transition work. These examples also demonstrate that one kind of transition work can contribute to shape other facets of transition work. As such, they also points to the third research question of this thesis, which asks about *how particular forms of transition work emerge*.

7 The shaping of transition work in Norwegian ports

In the preceding chapter I have presented and discussed the types of transition work that was conducted in the three case ports, thereby providing answers to RQ2 about how actors in the port sector are working to promote and accelerate transitions. In this chapter I move on to discuss *the shaping of transition work*, corresponding to RQ3 about how particular forms of transition work emerge. In addressing this question, I discuss and exemplify throughout this chapter how transition work might emerge in response to developments in socio-technical configurations. As described in Subchapter 3.5, I understand socio-technical configurations to be interactions and interrelations between elements that lie at the core of transition dynamics as understood by the multi-level perspective (MLP) (e.g. Geels 2004), thus comprising landscapes, niche innovations, socio-technical regimes, socio-technical systems, and actors. Accordingly, throughout the following subchapters I make a series of claims regarding the shaping of transition work, as listed in Table 15.

Table 15. Examples of the shaping of transition work discussed in the thesis.

Element of socio-technical configuration	Transition work is shaped by ...	Subchapter
Socio-technical system	the unique specificities of socio-technical systems	7.1
Niches Actors	the perceptions of risk associated with specific technologies the need to manage actor complexity the internal transition work of businesses and corporations	7.2
Landscape	pressures that demonstrate the need for transition work pressures that set the scope for transition work pressures that contest existing rationalities	7.3
Regime	normative rules that produce intermediation	7.4

Collectively, the claims provide insights into dynamics that generate and shape transition work. Furthermore, they demonstrate how transition work is shaped by the uniqueness of transition sites, such as expressed by the characteristics of socio-technical systems, the specific actors present, and the innovations relevant to them, as well as the pressures, norms, and perceptions specific to each transition case. Although the uniqueness of ports also comprises place and geographic contexts (Damman & Steen 2021), I do not pay specific attention to the geography of sustainability transitions when discussing the shaping of transition work. Rather, I relate the shaping of transition work to elements of socio-technical configurations. In discussing socio-technical configurations, Geels (2002) particularly emphasizes socio-technical elements that are typically associated with socio-technical systems. Therefore, I first provide examples that show how system elements represent unique socio-technical contexts for transition work in ports. I then move to exemplify and discuss how transition work might follow unique actor constellations, perceptions of different niche innovations, and different types and degrees of landscape pressure. Finally, I discuss and exemplify how changing normative rules associated with the role of port organizations shape transition work through ushering in intermediation.

7.1 Shaping by socio-technical systems

This thesis shows how transition work emerges within the socio-technical contexts of ports. A frequent saying in the Norwegian port domain is that "when you have seen a port, you have seen one port." This implies that knowing and understanding the workings of an individual port provides little knowledge about any other port, highlighting the uniqueness of every port, also in terms of potentials and barriers in its sustainability endeavors. For example, this could be expressed in the specific characteristics of the socio-technical systems of which ports are part. Therefore, in this subchapter I exemplify and discuss how transition work is shaped by

i) the unique specificities of socio-technical systems

As shown in Chapter 3, literature on sustainability transitions describes a range of factors that comprise socio-technical systems, including regulation and policies, artifacts, infrastructure, public opinion, and markets. First, the transition work described in this thesis tended to follow lines of *regulations and policies*. As discussed in Chapter 6, the making of and lobbying for policies and regulation can be essential aspects of transition work. However, regulations and policies also constitute important contexts for transition work. As elaborated in Subchapter 7.3, regulation and policies could be considered expressions of intentional pressures that demonstrate the need for transition work and set the scope of such work. Thus, this thesis shows how *regulation and policy shape transition work by directing the efforts of ports*. Norwegian ports actively relate to several national regulations (e.g., on pollution, noise, emissions, safety) and policies (e.g., goods transfer from road to sea) in their daily operations, which underlines how the boundaries of port systems are hard to define. However, this thesis shows that the transition work of ports is primarily directed by regulations and policies on the local level. In Kristiansand, local policy directed the Port to substantiate already emerging electrification efforts, for instance by requesting the Port to document its work and strategies. In Oslo, local policy pushed for holistic approaches to transition work. The City of Oslo's very ambitious goals to reduce greenhouse gas emissions by 95% before 2030 compelled the Port to set strong targets and to incorporate its many users into a series of different sustainability initiatives. By contrast, in the Port of Narvik, the lack of local policy might have been one reason for the lack of transition work. There, local policy and regulations informed only to a limited extent about desired ambitions and directions for sustainability efforts in the Port. Thus, different local policy and regulation in the three cases encouraged different levels and directions of transition work. Although transition perspectives from the field of geography are not a prominent feature of discussions in this thesis, the above discussion in this subchapter (7.1) clearly points to how place-specific contexts could inform the transition work of ports (i.e., by local agenda setting).

Second, transition work was shaped by the opportunities and lock-ins represented by *artifacts and technologies* in the studied ports. Technological lock-ins are a key challenge in decarbonization (e.g. Foxon 2007, Unruh 2000), and in this thesis I provide at least two examples of lock-ins, in which sunk costs contribute to reduce incentives to invest in alternative technologies (Klitkou et al. 2015). The substantial sunk costs and life spans of artifacts in ports and in maritime transport domains are examples of lock-ins that might shape transition work. This was the case then the Port of Oslo worked to establish a second shore

power facility and faced heavy opposition from shipowners due to the age of their vessels. Lock-ins to particular vessels also slowed transition work I Narvik. Since vessels calling on the Port of Narvik were not equipped to use shore power, the port held back on implementation until growing volumes of other types of vessels encouraged it to work on installing high-voltage shore power. In the Port of Kristiansand, there were examples of how artifacts might represent opportunities for transition work. For instance, the installation of solar panels on roofs tops might have been enabled by particular building designs, while the port's early implementation of low voltage shore power was ushered in by the prominence of vessels and rigs that remained in the port for weeks at a time and only needed power for hotel operations. These examples all suggest that the non-human actors emphasized in ANT (e.g., Callon 1984) might also be part of transition work.

Lock-ins are also apparent in how transition work is shaped by existing *infrastructure*, which has even longer historical trajectories than the lock-ins represented by artifacts. Given the longevity of infrastructure, it provides very concrete examples of path dependencies that could facilitate only incremental changes, and speaks to how transition work is done also within socio-material systems (Birch 2017). The role of infrastructure is discussed by several transition scholars (Broto et al. 2014, Frantzeskaki et al. 2016, Gillessen et al. 2019) and is an obvious element in the transition work of ports, which themselves are important infrastructural nodes and examples of infrasystem actors (Frantzeskaki & Loorbach 2010). In this thesis, the shaping role of infrastructure is evident in how *ports located between different types of infrastructure have different opportunities for initiating and driving change*, and I provide two examples of this.

The first example relates to transport infrastructure. The transition work of the Port of Narvik was aimed equally towards the rail domain and the maritime domain, and it aimed to ensure regional and global supply and logistics chains that moved transport from road to rail and sea. The efforts were mainly enabled by the Port of Narvik's position as an intermodal junction for sea and rail transport, which allowed it to pursue connected transport corridors from China and Russia to North America. The second example of how infrastructure might produce specific transition work relates to energy infrastructure. The ability to direct transition work towards particular types of energy is strongly affected by the availability of energy. In the Port of Kristiansand and Port of Oslo, existing energy infrastructure represented opportunities and challenges in transition work aimed at electrification. Ambitions and priorities in such transition work depend on sufficient power capacity and power effects being available at the right locations, which has been a challenge in the electrification of maritime transport in Norway (Bjerkan et al. 2019). In the ports in Kristiansand and Oslo this produced different types of transition work. Paper 2 shows how available power effects in urban areas were crucial aspects of the Port of Kristiansand's work with high voltage shore power. The Port to maintained dialogue and negotiations with the local energy company (i.e., relational transition work) on how to ensure sufficient power effects for cruise vessels without jeopardizing the energy security of the city, which resulted in the energy company offering disconnected

tariffs[7]. In Oslo, the availability of energy infrastructure also produced specific transition work. However, in contrast to the Kristiansand case, lack of grid capacity and effects were not a challenge in Oslo. Rather, the Port's transition work was shaped by *opportunities* relating to energy infrastructure. As shown in Paper 3, the successful implementation of shore power in 2019 followed infrastructure measures taken by the port seven years earlier, when, as part of other development activities, new power cables extended the local electricity grid to specific quays. These cables could in themselves be considered as an element of the Port's long-term visionary transition work (e.g., envisioning full electrification of port activities), but also demonstrate how transition work might include activities that in fact modify existing socio-technical system elements (e.g., infrastructures) in ways that enable further or future transition work. This also points to the duality of structure and the potential mutual influence between transition work (i.e., agency) and socio-technical systems (i.e., structure).

The above discussion shows how the transition work of ports was guided by opportunities (e.g., rail infrastructure in Narvik, grid extension in Oslo) and lock-ins (e.g., grid capacity in Kristiansand) associated with the infrastructures surrounding the ports. Transition work was also shaped was by the *markets* and economies that surround them. Although many ports represent linkages in global supply chains and allow the connecting of global markets (Becker et al. 2013), they also represent local and regional industrial centers that provide jobs and steady revenue streams (Bailey & Solomon 2004), and that support regional trade and growth (Cheon 2017). As such, ports are located at the intersection between the different value chains that regional sectors and economies are bound to, and, as motors in regional development, transition work of ports needs to accommodate also regional markets. In particular, this thesis shows that *ports are compelled to incorporate into their transition work the markets and value chains of which port users are part*. Considering the quasi-commercial profile of public ports (i.e. as public entities with corporate characteristics), ports are strongly motivated to maintain good relations with their customers. Thus, port organizations need to balance delicately more or less ambitious transition strategies against the business orientations and market development by which the multitude of port users navigate.

Paper 3 provides one example of how transition work is connected to opportunities that ports users see in their markets. In Oslo, a port user expected to make changes in its own supply and production lines that would allow it to make use of vessels more suited for low-emission technologies and shore power. In turn, this enabled the port to expand its transition work for full electrification of port operations. Another example illustrates how transition work could be limited by the markets that port users associate with, in this case the Port of Narvik's users in the mining industry. With the regional growth of this industry, and its effort to expand market shares, it has become an even more prominent user of port services in Narvik. The maritime transport of iron ore, characterized by infrequent and/or irregular port calls, provided little opportunity for implementing shore power. As such, the relatively lagging

[7] Disconnected tarrifs, or flexible tariffs, implied that the energy company's customer (i.e., the ports' shore power facilities) could be immediately disconnected from power supply when power needed to be directed elsewhere (e.g., to the city). The customer was compensated with lower energy tariffs.

transition work of the Port of Narvik with regard to electrification could be considered a consequence of the port's close connection to the market developments of specific users.

The above-mentioned examples illustrate potential clashes between the ambitions of port organizations and port users, as the often-incremental transition work displayed by commercially oriented port users might contribute to discourage or slow down more transformative or disruptive transition work in port organizations. The relationship between the transition work of the port organization and the transition work of port users is discussed further in Subchapter 7.2.

A final element of socio-technical systems that seemed to shape transition work in the investigated ports is *cultural discourse* and public opinion around ports. Overall, this thesis shows that *public discourse shapes transition work by pointing to perceived problems with ports and by calling ports to demonstrate that they are working to solve those problems*. Such discourse seemed to shape transition work in all three ports and is probably relevant to ports as transition sites in general. The public appears to hold rather negative perceptions of ports. Ports are rarely welcomed by their neighboring communities, as they are considered unaesthetic and associated with noise, disturbance, and high traffic volumes. Moreover, in recent years, public debate has addressed emissions from cruise ships in Norwegian fjords. Although this debate has led to a series emissions reduction measures (Norwegian Maritime Authority 2017), it has also cemented a negative narrative around maritime transport.

Such a critical discourse also shapes transition work in ports. All three case ports continuously assessed and accounted for community responses when planning and undertaking their activities. Worldwide, ports in urban areas are under pressure to concede land, and the redeveloping of port areas is a main element in many plans for city development (Jauhiainen 1995, Oakley 2005, Wang 2014). Paper 3 shows that in the Port of Oslo such redevelopment was considered essential to remedy the disconnect between the urban population and the coast. Further, all three ports were developing plans to relocate port activities farther away from cities, but nonetheless faced complaints, aversion, and resistance from neighboring residential areas also in their prospective locations. Similar resistance to port development projects has been found in other Norwegian ports, where local media coverage has voiced opposition based on insufficient investigations before approving plans, infringement on recreational areas, and reduced access to the coast and the commons (e.g. Fanaposten 2013, Fædrelandsvennen 2017, Nordlys 2012, Telemarksavisa 2009). The negative discourse around ports has pushed ports to focus on communicating their roles as a community leaders and engines in the regional economy. For instance, the Port of Oslo has worked actively to demonstrate its low contribution (4%) to the city's CO_2 emissions (Port of Oslo 2018) and the port has gone to lengths to redevelop port areas in ways that give the urban population access to the port and a sense of ownership of it. Thus, transition work could be considered a strategy for maintaining (or raising) the legitimacy and acceptance of urban ports. This signals that the rationale behind transition work does not necessarily derive from innate desires to realize environmental sustainability; it could also stem from needs to ensure the continued relevance and legitimacy of incumbents (e.g., port organizations), resembling transformation pathways that evolve around the reorientation of incumbent actors (Geels et al. 2016).

In this subchapter I have provided an overview of how socio-technical systems could shape transition work. I have given examples of how socio-technical system elements are often unique to each transition site (i.e., each port), but I have also provided more general lessons about the shaping of transition work, as summarized in Table 16. Additionally, I have hinted at issues that are central in discussions on how transition work is shaped by actors, niches, regimes, and landscape pressures. In the discussion above I have demonstrated how the actions taken by port organizations could be considered responses to sustainability efforts made by the public. The media attention paid to polluting ships and the calls of neighboring communities for clean and silent shoreside spaces represent obvious pressures and might themselves be considered expressions of transition work. This underscores how crucial the transition work of other actors is for the transition work of port organizations. This point is elaborated in the next subchapter.

Table 16. Summary of the ways in which socio-technical systems may shape transition work.

Regulations and policies shape transition work by directing efforts.
Artifacts and technologies shape transition work by representing sunk costs and technological lock-ins.
Infrastructure shapes transition work by providing different opportunities for transition work.
Markets shape transition work by compelling the incorporation of market developments into transition work.
Cultural discourse shapes transition work by pointing to perceived problems and the need for specific actors to solve them

7.2 Shaping by actors and technologies

Considering how the implementation of technologies relates directly to actors that are operating in ports, the ways in which technologies shape transition work are equally related to ways in which port actors could shape transition work. Thus, in this subchapter I will first exemplify and discuss how transition work is shaped by technologies, before turning to how transition work is shaped by actor complexity and the sustainability efforts of corporate actors. This subchapter elaborates on ports as potential transition sites, comprised of heterogeneous actor-networks connected to a series of sectors and industries. As the diversification of industries and actors around ports increases (ESPO 2020c), understanding how transition work emerges between port organizations and port actors is increasingly important. Therefore, in the following, I exemplify and discuss how transition work is shaped by

ii) technology perceptions
iii) needs to manage actor complexity
iv) internal transition work of business and corporations.

Thus, while much of this thesis discusses the transition work of port organizations themselves, this subchapter addresses more explicitly the role of corporations, business, and industry in ports, and the ways in which these can singlehandedly or through interaction with the port

organization shape transition work in the port area. As such, this chapter leans on Damman and Steen's (2021) understanding of ports as not only port organizations, but also as networks of port actors.

7.2.1 Technology perceptions

In Subchapter 7.1 I have hinted at how technology and artifacts could shape transition work in ports. In line with the STS perspectives presented in Chapter 3, technologies gain ground to the extent that they align with non-technical system elements, are perceived to solve problems better than other technologies, or are incorporated into stable networks of human and non-human actors. Transition scholars refer to several processes that shield and progress niches and innovations, for example expressed in strategic niche management and technological innovation systems. Thus, transition scholars and STS alike have considered technologies as integrated with social system elements (e.g., organizations, legislation, users, worldviews) or social processes (e.g., vision-making, network building, market creation). This implies that technologies are not only shaped by transition work, but also that technologies could shape transition work themselves.

Literature on port sustainability lists many different fuels and energy sources that could power port operations, vessels, and vehicles, including wind and solar energy, LNG, biofuels, hydrogen, and batteries (Bjerkan & Seter 2019, Lim et al. 2019). However, the transition work of ports to date seems to have focused on only a few of these. This thesis shows that transition work is shaped by technology perceptions that guide transition work towards particular niche innovations. More specifically, technology perceptions in the case ports *directed transition work by pointing it towards relevant and legitimate niche innovations with immediate users*, which underscores the incremental character of much transition work to date. Transition work oriented towards technologies perceived as relevant to the actors and operations specific to each of the three ports. For instance, the Port of Kristiansand's orientation towards low voltage shore power was enabled by its services to the offshore industry, while electrification of port operations in the Port of Oslo was possible because electric models of machinery and equipment for terminal operations were already available in the market. By contrast, similar wide-scale electrification efforts in the Port of Narvik were absent because no electric machinery was equipped to perform necessary operations in their terminal. Thus, the existence of relevant technologies in the market is essential for transition work.

This thesis also shows transition work to orient towards technologies that are perceived as legitimate. Paper 1 shows that transition work oriented towards electrification, not only because technologies were already available in the market (e.g., shore power, electric cranes, and machinery), but also because of the directionality provided by policy and the availability of vast hydropower resources that enabled decarbonization. The paper argues that electrification enjoyed great legitimacy and was universally perceived as a viable approach to foster transitions. Similarly, Paper 3 points to the common technology perceptions of shore power among political wings as one reason for the successful implementation of shore power in the Port of Oslo. By contrast, transition work seemed more reluctant when it came to niche-innovations associated with greater controversy. Such controversy related to insecure market and provision developments, and it was particularly exemplified by discussions about

alternative fuels and new energy carriers in transport, including hydrogen, biofuel, biogas, LNG, ammonia, and methanol. As argued in Paper 1, transition work in transport domains lagged behind the port domain due to insecurities about what technology (i.e., fuel, energy carrier) would become dominant and the fear of investing in the "wrong" technology. Thus, transition work stalled because actors in the transport domain were still debating what technology to invest in, and, awaiting directions from policymakers, they were continuously seeking more knowledge about the implications of making a selection.

Finally, this thesis shows that technology perceptions point transition work towards niche innovations with immediate use. Although there are examples of ports implementing technological solutions not directly connected to any of their users (e.g., solar panels in Port of Kristiansand, electric vehicles in Port of Oslo), it seems that transition work is mainly focused on technologies that the ports expect to be taken into immediate use. For instance, the efforts of the Port of Oslo to introduce a second shore power facility (Paper 3) were heavily centered on dialogues with shipowners to ensure that the investments would not remain unused. Although the port itself framed its efforts as a desire to create demand and to "kill the chicken" (referring to the chicken-and-egg problem), they could also be considered efforts to ensure that demand was in place before the facility was operational. Conversely, ports were less eager to implement technologies or provide fuels that were not in demand. For instance, there were efforts to establish LNG in the Port of Kristiansand, where industrial clusters and regular port users were encouraged to consider LNG. However, as LNG facilities require stable outtake and use, the plans fell through, because the port and the LNG provider were unable to recruit committed LNG users. Instead, the port oriented its transition work towards technologies with confirmed, expected use. This speaks to challenges with moving transition work in more transformative directions, which is discussed further in Chapter 8.

7.2.2 Actors

The empirical data underlying this thesis mainly relate to the transition work of port organizations. However, the transition work of port organizations is intertwined with the practices, demands, opportunities, and perceptions of port users and the communities of which ports are a part. Although it was not a prominent feature of the analyses reported in Papers 1–3, the findings hint at corporations and businesses in ports being inherent aspects of transition work, as well as their potential to shape the pace and direction of transition work.

Business and industry actors can engage in most transition processes and thereby influence transitions in many ways. Based on the empirical work done for this thesis, I suggest that corporate port actors contribute to shape transition work in ports in mainly two ways: *by mere existence, and as purposeful transition agents*. By merely existing and operating in the port area, port actors display the complexity that port organizations need to manage in their transition work. Port actors could be considered components of large technical systems, actor-networks or socio-technical systems that port organizations need to integrate into their system building or transition work. Actors represent different perspectives, opportunities, and challenges, which are strongly connected to the sectors and industries of which actors are a part. For example, Paper 2 shows how expectations about the future and the need to transition was tightly connected to the value chains of which actors were a part. It follows that

transition work in port organizations needs to incorporate and align the complexity represented by the heterogenous mass of port actors.

Thus, actors shape transition work by placing sector and industry-specific restraints on transition work. In Chapter 6 I have demonstrated how port organizations take actor complexity into account in visionary work, and in building and learning from networks. Here, I further argue that the degree and prevalence of actor complexity have bearings on how port organizations manage and develop their transition work. For example, the different functions of port actors imply that they orient towards different technological innovations. Hence, to incorporate different industries into the same transformation processes, port organizations need to take holistic approaches to transition work that span multiple niche innovations. The work with the concept for the future zero-emission port in Oslo is one example. Incorporating the complex mass of port actors into transition work also demonstrates the need for intermediation, which could be provided by researchers or other external facilitatory resources, or by the port organization itself (as elaborated in Subchapter 7.4). Taking on intermediation could be challenging for many ports. In fact, it seems that the first sustainability efforts of port organizations typically engaged single port users that were the most willing and progressive businesses in the port. By contrast, more systemic and encompassing approaches to transition work, which include the full width of more and less reluctant industries in the port (and the technologies relevant to them), could become more relevant as the port organization grows into and develops its role as an intermediary. Thus, progressive industries with their own explicit transition work represent an important component in the initiation of transition work.

The above discussion points to the second way that I consider actors to shape transition work, namely as autonomous agents conducting transition work of their own. This implies that many port actors are willing to promote and facilitate transition processes themselves, and to apply their own agency to do transition work that might and might not interfere with the transition work of port organizations. This suggests that the business-internal processes of corporate port actors—related to, for example, their transformational potential (Loorbach & Wijsman 2013) or business model innovation (Wainstein & Bumpus 2016)—are also relevant to the transition work of port organizations. This thesis shows that the transition work of the Port of Oslo related to the needs of port actors to demonstrate their transition work to their markets and the public. Hence, transition work was shaped by the branding of corporations, whose attempts to develop green corporate profiles were prominent features of their transition work. For instance, Shipowner1 worked to establish shore power because its operations and activities were located close to the city center, thereby making its contribution to port emissions physically visible to the public. Previous research has also pointed to how ports tend to prioritize environmental measures that abate problems with high visibility (Poulsen et al. 2018). Considering how Shipowner1 considered the public to represent potential customers, tackling visible emission problems allowed the shipowner to provide those customers with a "greener product." The prominence of green profiling in the transition work of corporations is evident in Paper 3, which shows that Shipowner2 agreed to retrofit its own vessels to comply with an already established corporate image as a frontrunner in sustainability. In the same paper, the decision of Shipowner3 to retrofit for shore power could be interpreted as efforts

to maintain its own reputation, as it followed political scapegoating in local media. Hence, internal decision-making processes and rationales of all three shipowners contributed to the transition work of the port organization.

Although it is difficult to make such assumptions based on the empirical data of this thesis, the prominence of profiling perspectives among corporate port users could suggest that transition work might become an example of greenwashing, or transition washing, in which transformative change is not the endgame. In line with this, and interesting to note, the transition work of businesses and corporations did not merely follow value-laden reflections, which contrasts with understandings of transformative change agents as value-driven and dedicated to change systems in line with their own values (Haan & Rotmans 2018). Rather, economic interest also drove the transition work of businesses. Progressive port actors were typically large, profiled corporations with deep pockets, and expected long-term economic returns from investing in low-emission technologies. For instance, Shipowner 1 provided 70% of the funds for establishing the first shore power facility in the Port of Oslo. Conversely, port actors that could not demonstrate a business case struggled to initiate transition work on their own. One example was freight forwarders in Kristiansand, who were unable to shift transport to low-emission transport modes because their customers were unwilling to prioritize emission reduction over delivery times.

Collectively, the above-mentioned examples demonstrate the role of businesses and corporations in shaping transition work. They shaped transition work by merely existing as complex, heterogeneous actor-networks that port organizations needed to account for in their transition work. Business and corporations also shaped transition work by bringing own, internal transition work (or lack thereof) into the transition work of port organizations. However, the port organizations' need to include port actors in their transition work, and the perceived need of port actors to conduct transition work themselves, were not necessarily expressions of their innate desires and free spirits. Rather, they had grown from substantial pressure for transformative change, primarily following awareness of increasingly acute climate change. In the next subchapter, I pay specific attention to how pressures for change contributed to shape transition work in ports.

7.3 Shaping by landscape pressures

In the preceding subchapter I have provided examples of how niche and actor elements of socio-technical configurations contribute to shape transition work. More specifically, I have shown how transition work emerges in relation to perceptions of technologies, and through needs to manage actor complexity and respond to the internal transition work of businesses and corporations. However, the port organizations' active management and involvement of port actors also follow intentional change pressures on the landscape level.

As shown in Chapter 3, the landscape refers to the external structure and the exogeneous environment that encompass the socio-technical regime and includes both material and non-material structures (Geels 2002, Geels 2004, Rip & Kemp 1998). Landscape pressures can be long-term as well as acute (Köhler et al. 2018), and they can serve to structure the activities of incumbents while being beyond the incumbents' reach (Geels 2004). Thus, incumbents such as port organizations have typically been assumed unable to alter landscape factors

deliberately but are instead pressured by changes on the landscape level that create windows of opportunity for niche innovations. In the sustainable reorientation of transport systems, landscape pressures are typically related to increased transport demand, climate change, local pollution, energy security, and the digitization of society (Geels 2012, Nykvist & Whitmarsh 2008). Similarly, for ports, landscape pressures typically include the material and spatial contexts of the port, infrastructure, artifacts, fuel and energy prices, broad political sentiments, values, symbols, cultural beliefs, and consumption patterns. Furthermore, Damman and Steen (2021) point to increasing exogenous pressures on ports resulting from global warming, and subsequent international policy for emission reduction in ports and the maritime sector.

I relate my discussion on how landscape pressures might shape transition work to understandings of landscape pressures as intentional and unintentional pressures. Morone et al. (2016:64) consider the socio-technical landscape as a "multi-layered institution that is constantly changing and responding to both global and local activities." To increase their understanding of how the landscape level exerts pressure on the socio-technical regime, they attempted to open "the black box of landscapes" and distinguish between intentional and unintentional landscape pressures. Morone et al. consider unintentional landscape pressures to result from exogenous shocks (e.g., natural disasters, war) and/or other unpredictable activities that are not deliberately undertaken to place pressure on the regime level. This understanding mainly resembles most understandings of landscapes in sustainability transitions. However, Morone et al. depart from many scholars by drawing attention to *intentional landscape pressures*, which they consider to be deliberately exerted by local or global landscape actors (e.g., government and public agencies, NGOs, the public) to misalign the landscape and the regime. Thus, actors are crucial to Morone et al.'s operationalization of intentional pressure: they discuss intentional pressures that are exerted by governments on European, national, and regional levels, in addition to committing to agreements, environmental associations, certification bodies, and industry associations. Although the authors contend that intentional pressures themselves could be induced by unintentional shocks, such pressures are distinguished as deliberate attempts to induce regime shifts. This is a critical distinction, as it allows for viewing transitions and regime alterations as something that could be influenced. For example, Sovacool (2016:212) argues that the pace of transition depends on whether transition is "managed or incentivized" or whether it occurs "more naturally as a function of changes in technology, price or consumer demand." Following Morone et al. (2016), intentional pressures could be enacted through incentives and constraints (i.e., economic channels) and through advocacy and direct influence (i.e., political channels). As such, their understanding of intentional pressures strongly emphasizes how power, politics, and policy could contribute to steer transition processes.

The understanding of intentional landscape pressures presented by Morone et al. (2016) is quite broad and could encompass any policy that targets sustainability, for instance in response to exogenous climate change related pressures. Accordingly, some of the following subchapters can also be read as discussions on how transition work is shaped by policy, which is already hinted at in Subchapter 7.1. The ways in which policy might facilitate transitions have already been thoroughly addressed by transition scholars who have studied, for instance,

policy mixes (e.g. Kern et al. 2019), how policy might protect and nurture emerging niches (e.g. Smith & Raven 2012), how policy could foster technological innovation (e.g. Bergek et al. 2008), and how policy reforms could be designed with reference to transition management (e.g. Voß et al. 2009). By lending ear to Morone et al., the following discussions on the shaping of transition work depart from much of existing research on transition policy because they present policy as expressions of intentional landscape pressures. More specifically, I exemplify and discuss how transition work could be shaped by:

i) unintentional pressures that contest existing rationalities
ii) intentional pressures that demonstrate the need for transition work
iii) intentional pressures that set the scope for transition work.

In common with Morone et al.'s study (2016), my discussions on how intentional pressure shape transition work center on pressures expressed by lactors in the form of governments and environmental organizations.

7.3.1 Contesting rationalities

In the research for this thesis, unintentional landscape pressures were primarily represented by intensified pressures associated with climate change, and the shaping of transition work by such pressures was found particularly evident in the Port of Oslo. Specifically, climate change pressures shaped transition work by strengthening the constitutive power of green sentiments, which in turn contested the rationalities under which the Port operated. As shown in Paper 3, the years around 2015 experienced a substantial surge in green sentiments, cumulating in the election win of green-left parties in the local election in Oslo. The rise of green sentiments also strengthened the constitutive power of those sentiments. Constitutive power originates in discourse, institutions, and practices "that cannot be traced to an actor or specific action" (Ahlborg 2017:127), and it implies that power resources are established, instituted, or enacted through, for example, social rules and norms (Avelino & Rotmans 2009:552). With a surge of green political moods on the landscape level, the Port of Oslo was increasingly compelled by orient to green norms and discourses, which contested the existing norms and rationalities the Port adhered to in its daily operations. Therefore the Port was compelled to reorient its rationality.

The rise of green constitutive power manifested in the Port's relations with the Agency for Climate, the Port's Board of Directors, and environmental organizations. As shown in Paper 3, the new city government from 2015 established the Agency for Climate to demonstrate its environmentalist profile, which reflects the increasing weight of green ideology. With the City's increasing jurisdiction over port issues, the port was now compelled to work closely with the Agency to plan and strategize the Port's transition work, which resulted in contestations between the green ideologies of the City and the business-oriented pragmatism that historically has characterized port management. The Port was particularly worried that symbolic policies would unsettle its relations with established clients and port users. Therefore, the transition work of the port needed to accommodate progressive environmental ideologies while still ensuring realism and operational feasibility in policy deliverables.

Similar considerations appeared in the Port's relation with its politically appointed Port's Board of Directors, which called for the introduction of penalty fees for cruise ferries that did not use shore power at berth. The Port was reluctant to introduce such fees because it feared they would disrupt established customer relations. Again, the Port was forced to weigh what it considered symbolic and politically motivated pressures against maintaining its professional relationship with shipowners, which was based on the Port's understanding of the economic and operational realities of shipowners. This example shows how intensified landscape pressures interfered with the business-oriented rationale that guided the Port, and how these pressures reflected in the increasing constitutive power of green rationalities.

The constitutive power of green rationalities was also exemplified in the Port's engagement with environmental organizations. Transition scholars have argued that NGOs, such as environmental organizations, play an important role in framing sustainability issues (Allan & Hadden 2017), and they could be considered representations of pressures on regimes and incumbents (Westley et al. 2011). Environmental organizations could further be considered the embodiment of green norms and ideologies. As such, increasingly green landscape pressures could enhance the constitutive power manifest in environmental organizations. One example of how transition work in the Port of Oslo responded to such power relates to the establishment of the second shore power facility, as described in Paper 3. Paper 3 shows the prominent position of the environmental organization Zero, which brokered an agreement between political wings to produce cross-partisan policy adoption. This policy directly intervened in the transition work of the Port by instructing the continued implementation of shore power for cruise ferries. Another example of the strengthened constitutive power represented by environmental organizations appeared in the Port's increasing collaboration efforts with both Zero and Bellona. As elaborated in Paper 2, the Port entered into collaboration agreements to ensure that the ambitious environmental policies that had been fiercely lobbied for by environmental organizations did not compromise the operational and commercial realities of the Port. The Port's rationale for formally connecting with environmental organizations could reflect perceptions in the Port about the constitutive power of environmental organizations in political circles. Therefore, to the Port, it was important to develop shared understandings of how the Port could and should proceed with its transition work. It expected shared understandings to ensure that the power manifest in environmental organizations would legitimatize the transition work of the port and align political expectations with the ambitions and directions of transition work in the port.

7.3.2 Demonstrating the need for transition work

In the following subchapters I demonstrate how intentional landscape pressure might shape the content and direction of transition work. As mentioned in the introduction to Subchapter 7.3, these discussions depart from the understandings of landscape pressures that many transition scholars apply, which consider landscape pressures to be exogenous macrodevelopments beyond the direct influence of actors—what Morone et al. (2016) label unintentional landscape pressures. By contrast, Morone et al. consider intentional landscape pressure to be deliberately exerted and enacted through, for instance, incentives and advocacy.

In this thesis, I argue that intentional landscape pressures primarily shape transition work by demonstrating the need for transition work. For ports, this need is expressed in the many emission objectives provided by European, national and local government actors. For example, the European Union highlights ports in its "Green Deal," which aims for zero net emissions of greenhouse gases by 2050 (European Commission 2019a), and its "Fit for 55," which aims to reduce climate emissions by 55% before 2030. The Norwegian Government suggests that all ports should be emission-free by 2030, "where conditions are favorable"[8] (Norwegian Government 2019a). Furthermore, to fulfil its ambitious emission reduction objectives, the City of Oslo expects the Port to reduce 85% of its climate emissions by 2030. These policies are all concrete expressions of the efforts of governmental actors to address climate change challenges, which represent a prominent exogenous landscape pressure on ports. As such, they also exemplify the connection between intentional and unintentional landscape pressures.

The need to conduct transition work not only derived from the awareness of climate policies and the acute needs demonstrated by ambitious emission objectives. The need to do transition work also derived from the way intentional pressures allocated accountability and responsibility for tackling climate challenges. This was obvious in the ways intentional pressures led to new or renewed issue jurisdiction in ports and cities. Although jurisdiction typically refers to the formal legal right of an actor to define policy concerning a certain issue, I would argue that an actor's awareness of its potential influence and mandate for action is equally important. During my research I found that transition work was shaped by the jurisdiction of ports over sustainability issues, and by the jurisdiction of cities over port issues. The responsibility of ports to engage with sustainability issues is demonstrated by intentional pressures both nationally and internationally. The European Union points to the role of ports in reducing climate emissions (e.g. EU 2014, European Commission 2019b), while a handful Norwegian regulations and policies demonstrate ports' environmental responsibilities. For example, the Norwegian Pollution Control Act of 1981 specifically addresses "facility owners" such as ports in matters of local pollution, stating their responsibility for the sum of emissions from areas and facilities they own. This lawfully commits public and private ports to ensure that activities in the port area do not exceed local air quality limits. Although the Norwegian Climate Change Act of 2017 does not refer to ports or other domains specifically, it commits all sectors to contribute towards national emission reduction targets. Furthermore, revised regulation on ports and waters displays a renewed focus on the role of ports in environmental issues, including reduction of climate gas emissions, sustainable port operations, and local air quality (Ministry of Trade Industry and Fisheries 2019, Ministry of Transport 2020) Thus, national and European landscape pressures collectively point to the responsibility of ports to deal with sustainability issues.

However, national and European pressures do not automatically translate into transition work. For instance, the extent and content of transition work has been found to vary greatly between ports (Bjerkan et al. 2021c). I suggest that one reason for this could be that the

[8] Translated from the Norwegian source: "*Regjeringen vil i samarbeid med kommuner og havnemyndigheter ha som mål å ha utslippsfrie havner* der det ligger til rette for det *innen 2030*" (p. 7).

degrees of issue jurisdiction, such as over port issues, vary between different cities. This implies that intentional pressures on higher levels need to be substantiated, interpreted, and enacted on local levels. Paper 3 provides two examples of how modified jurisdiction shaped transition work. First, the paper shows how the Port of Oslo was gradually granted jurisdiction over sustainability issues, as expressed in the many policy documents addressing the divide between the population and the shoreside. This corresponds to the Norwegian port sector's increasing orientation towards zero emissions, and it signals a looming shift from the commercially oriented logistics hubs that ports have historically constituted. Second, Paper 3 shows how the City of Oslo was gradually granted jurisdiction over port issues, which signals a shift from the historically prominent laissez-faire approaches cities have taken to port business. Both changes in issue jurisdiction could have contributed to shape transition work because they encouraged the setting of specific policy objectives, as well as the development of specific measures. Ambitious emission reduction targets for the city as a whole compelled the City to incorporate the Port into its policy development and the port to more explicitly and ambitiously include sustainability concerns into their operations. As active governance and steering by owners appear to be important drivers in the sustainability efforts of ports (Bjerkan et al. 2021b), the city's jurisdiction over port issues is vital in setting the frames for transition work.

The prominence of city jurisdiction over port issues calls for the need to note potential differences between the public and the private port sector and the role of public port ownership. Public port owners have historically practiced non-invasive port ownership, in which ports are primarily considered regional economic engines and facilitators of transport and logistics. With increasing jurisdiction over port issues as well as sustainability issues, public port owners might become strongly inclined to engage more actively with the transition work of their ports. However, private port owners have obvious jurisdiction over port issues, but not necessarily over sustainability issues. In the private port sector, transition work could be an option when it is affordable and leads to profit, while public ports could be expected to experience pressure from owners to do transition work, despite the costs associated with it (Bjerkan et al. 2021c). Thus, while intentional pressures that shape transition work in public ports are closely related to public policy and pressures exerted through political channels, transition work in private ports could be expected to rely even more on intentional pressures exerted through what Morone et al. (2016) label economic channels (e.g., tax deductions, subsidies) or pressures from powerful collaborators or customers.

7.3.3 Setting the scope of transition work

Intentional landscape pressures contribute to set the scope for transition work. This relates to the inclusion (or exclusion) of sectors from the transition work of ports, as well as to core priorities identified by landscape actors. As explicitly discussed in Paper 1, the transition work of ports could orient towards the port domain as well as maritime and (hinter)land transport sectors. Government actors on several levels have emphasized the inclusion of the maritime sector in the transition work of ports. For instance, in its initial greenhouse gas strategy, the International Maritime Organization (IMO 2018) encouraged ports to support emission reductions in shipping in order to reduce and phase out fossil fuels. The IMO has further called for voluntary cooperation between the port and shipping sectors to reduce GHG emissions

from ships (IMO 2019), and the IMO project "Green Voyage 2050" has entered into a strategic partnership with the International Association of Ports and Harbors (IAPH) to substantiate the role of ports in transforming the shipping sector. The role of ports in transitioning the maritime sector is also evident in the European Union, as expressed in calls to grant ports the opportunity to regulate access for severely polluting vessels (European Commission 2019b:11). Similar attempts to shape transition work have been expressed by Norwegian government actors, who in new regulations stipulate that ports can vary port fees according to the emission levels of vessels (Ministry of Transport 2021), and that ports can reject and temporarily limit time in port for vessels that pose environmental threats. Thus, national landscape actors have targeted the port sector's function as nodes in maritime transport, emphasizing their importance for greening maritime transport and industries (Ministry of Trade Industry and Fisheries 2021, Norwegian Government 2019a). They also consider ports to be essential for ensuring the efficiency of multimodal transport chains, which is cardinal to increase the attractiveness of maritime transport and shift goods transport from road to sea (Ministry of Fisheries and Coastal Affairs 2013, Ministry of Transport 2015).

This maritime orientation on national and international levels is reflected in the maritime orientations of port organizations. By contrast, port organizations rarely orient towards land transport. Despite pollution legislation that targets pollution in entire port areas (Ministry of Climate and Environment 1981), and despite new port regulation that takes into consideration the environmental consequences of port activities that "materialize onshore" (Ministry of Trade Industry and Fisheries 2019), port organizations are under little pressure to orient their transition work towards land transport. This is particularly evident in Paper 1, which shows that the Port of Oslo mainly oriented towards the maritime domain. The maritime profile of intentional pressures on ports also leads to underacknowledgement of the potential of ports to transition the many other sectors they engage with, including road and rail transport, as well as industrial production activities. This implies that European and Norwegian policymakers alike should pay more attention to the potential of ports to drive transformations in the many sectors connected to them. In line with this, the European Sea Ports Organisation (ESPO) has called for a more "holistic vision on how to strengthen the role of ports as engines of growth and recovery" (ESPO 2020b).

Thus far in this subchapter I have described how intentional pressures on transition work set the scope for transition work by identifying sectors to include in those efforts. Intentional pressures could also set the scope for transition work by defining the core priorities of transition work. The maritime orientation of intentional pressures might be one reason why landscape actors nationally, regionally, and globally have all requested the same technological priorities in the transition work of ports, namely shore power and alternative fuels. To facilitate the decarbonization of shipping, the IMO has specified that ports should provide shore power and alternative fuels, for example through collaboration with alternative fuels supply chains (IMO 2019). The EU has made similar efforts to ensure that member states make LNG and shore power available in all TEN-T core network ports[9] (EU 2014, European

[9] "The Trans-European Transport Network (TEN-T) policy addresses the implementation and development of a Europe-wide network of railway lines, roads, inland waterways, maritime shipping routes, ports, airports and railroad terminals (…) The Core Network includes the most important connections, linking the most important

Commission 2021). In Norway, port regulations (Ministry of Transport 2020) accentuate the Ministry of Transport's right to place requirements on how ports deal with the environment, such as by implementing shore power, shoreside charging, or infrastructure for alternative fuels. Thus, national landscape actors consider ports crucial as investors, owners, and operators of shore power facilities (Norwegian Government 2019a), and as potential providers of alternative fuels to vessels, and electricity for charging and shore power (Norwegian Government 2019b). In sum, landscape actors contribute to the shaping of transition work by pushing particular technologies to the foreground, thereby forcing (some) ports to initiate technologically oriented transition work.

7.4 Shaping by normative rule developments

In the preceding subchapter I have discussed how landscape pressures contribute to shape transition work, for example by contesting rationalities or displaying the need and scope for transition work. These discussions demonstrate the potential of green norms and values to shape transition work, which is also associated with the role of regime rules in transition dynamics (see Chapter 3). Therefore, in this chapter I pay attention to how the socio-technical regime might contribute shape transition work. More specifically, I exemplify and discuss how transition work could be shaped

iv) by normative rules that produce intermediation

In this thesis I regard normative rules to derive from expectations about the increasing orientation of ports towards community management, which adds to the more conventional and business-oriented roles of port organizations. As shown in Chapter 2, taking on a community-oriented role reorients the focus of port organizations and the ways in which they deal with sustainability. During my research, the changing normative expectations of ports above all seemed to produce intermediation. In the following subchapters, I first account for emergent normative perceptions of port roles, before discussing how these shape transition work by enabling or strengthening intermediation.

7.4.1 New norms for port organizations

Although ports have multiple objectives, such as facilitating trade and business, stimulating regional social and economic growth, and developing maritime and hinterland connectivity (DNV GL 2020), Chapter 2 shows that port organizations are increasingly orienting towards their community role and objectives associated with ensuring sustainable port activities. As such, they are seeking to service a wider set of "interests, a much larger port community and a much wider range of stakeholders" (ESPO 2020c). Norwegian port organizations are also becoming aware of the need and opportunity for reorienting towards the social and environmental dimensions of ports. In total, 82% of Norwegian ports have implemented innovations and technologies intended to improve port sustainability (Bjerkan et al. 2021b), and ports that take on community management are generally more progressive in their transition work (Bjerkan et al. 2021c). This corresponds to the qualitative findings discussed

nodes, and is to be completed by 2030" (European Commission 2022). Both the Port of Narvik and the Port of Oslo are part of the network of European core ports.

in this thesis, in which the Port of Oslo in particular is characterized by renewed normative perceptions and social learning concerning its role and function.

Normative rules associated with port roles are changing for several reasons. One reason is that ports are located close to urban populations and spaces, which increasingly compels ports to orient by the needs and desires of their neighboring communities. As mentioned in Subchapter 7.1, public perceptions of ports located in urban areas are becoming increasingly important to the legitimacy of port operations, as urbanization continues and urban populations are seeking access to fjords and waterfronts. Whereas the legitimacy of ports was previously tied to their visible contribution to work and prosperity, their legitimacy is currently more closely tied to their visible contribution to air emissions, water quality, and noise. As argued by Poulsen et al. (2018), the more visible a problem appears to neighboring communities, the greater the need of ports to remedy the problem. Consequently, ports are compelled to reorient their activities and communication to preserve their support and legitimacy in the public. This implies a need for ports to change their own narratives, a sort of translation of the port role as a key component of local communities, detached from the loud and dirty business with which ports are historically associated. For example, the latest press releases from the Port of Oslo (NTB 2021) mainly revolve around design and architecture, zero-emission efforts, redevelopment of port premises, bicycle infrastructure, parks and recreation, collaboration with environmental organization, and services and events for the neighboring community. This displays how the Port is actively seeking to promote itself as a community manager that not only tends to the needs of its users and stakeholders, but also seeks to ensure amiable co-existence between the Port and the urban population. This is also evident in Paper 3, which describes how initiatives to reduce emissions from the Oslo fjord were motivated by wishes to connect the city with the fjord.

Thus, normative expectations of ports have evolved as responses to increasingly close co-existence between ports and urban populations, and are a result of ports being increasingly recognized as problem owners and decisive elements in climate and environmental policy. Papers 1–3 all shed light on changing role perceptions in the Port of Oslo. Paper 2 demonstrates how the social processes in which the Port engaged as part of its transition work were intertwined with changing perceptions of mandates and expectations experienced by the port. The paper finds that the Port of Oslo was distinguished by deep learning around role perceptions, leading the Port to take ownership of emission problems in the port area and to become a more active community manager, with an explicit aim of aligning port actors in pursuit of sustainability. Thus, the issue jurisdiction described in Subchapter 7.3 is one expression of new norms associated with the port role.

Paper 3 further shows how role perceptions evolved in symbiosis with agenda setting and policymaking. This paper demonstrated how the disconnect between the city and the fjord induced problem ownership at the Port of Oslo, which related not only to emissions in the port area but also to more existential issues related to the co-development of the Port and the City. Responding to these challenges required the Port to look beyond the port area and expand the Port's system boundaries, which also encouraged a series of policy documents and

the involvement of many stakeholders to develop solutions with high technological feasibility and public acceptance.

Based on above-mentioned accounts, as well as accounts of community management presented in Subchapter 2.2, the predominant aspects of emergent normative rules that are associated with the port role are presented in Figure 10. As evident from the figure, normative expectations of ports bear strong resemblance to many of the activities that comprise transition work, as listed in Table 5. These normative expectations could also express what types of transition work port organizations should strive to do, such as intermediation. The overview presented by Figure 10 could also inspire ports and researchers alike to define a template for practicing or measuring transition work, such as by identifying where transition efforts should be directed to allow holistic and transformative change processes.

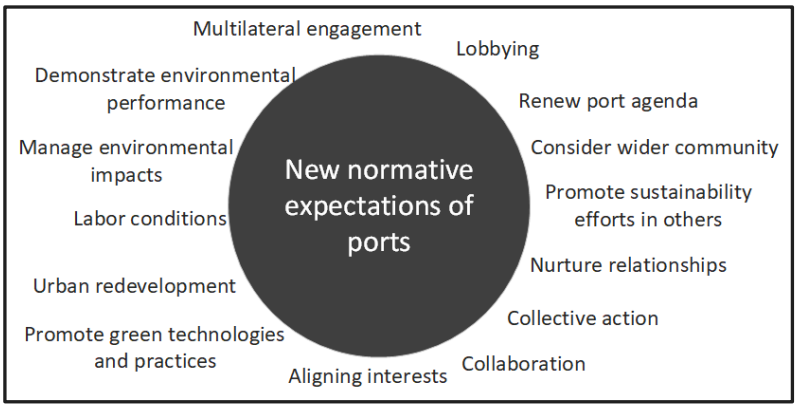

Figure 10. Summarized normative expectations of ports.

7.4.2 Intermediation as response to new norms

Collectively, Papers 1–3 suggest that the Port of Oslo's increasing orientation towards new normative expectations required it to do more pronounced intermediary work. The community manager role, which captures many aspects of new port roles, finds its counterpart in the intermediary role,[10] which has been extensively discussed by transition scholars (e.g. Kivimaa et al. 2019b, Mignon & Kanda 2018, Stewart & Hyysalo 2008). Intermediaries are considered to "perform relational work between multiple actors and technologies" (Barnes 2019:773), suggesting that intermediaries are positioned in-between different networks, actors, and institutions (Kanda et al. 2020). In an elaborate discussion of intermediaries that engage to progress transition, Kivimaa et al. (2019a:1072) refer to intermediaries as follows:

> *actors and platforms that positively influence sustainability transition processes by linking actors and activities, and their related skills and resources, or by connecting transition visions and demands of networks of actors with existing regimes in order to create momentum for socio-technical system change, to create new*

[10] Bjerkan et al. (2021c:299) explicitly juxtapose dimensions of intermediaries and dimensions of community managers.

collaborations within and across niche technologies, ideas and markets, and to disrupt dominant unsustainable socio-technical configurations.

Kivimaa et al. (2019a:1063) further suggest that current literature on intermediation "presents a wide range of interpretations of intermediaries, with varying levels of capacity to influence change, i.e. change agency (..), intent to drive sustainability transitions (..), and normativity ranging from neutral to strongly advocating a certain position (..)". Research on intermediation is therefore far from uniform. For example, intermediation can include many of the transition work activities listed in Table 5, such as the alignment of interests and visions across actors, the creation of narratives and the framing of issues, as well as lobbying, problem structuring and translation. Nevertheless, from the vast literature on transition intermediaries, it is clear that intermediation is a vital aspect of transition work. This thesis also demonstrates the prominence of intermediation in transition work and shows how intermediation might emerge in response to the new norms around the roles summarized in Figure 10. Given the multitude of potential intermediation activities, I focus my reflections on how normative expectations of the Port of Oslo led to intermediation on three bundles of activity typically considered key in studies of intermediation: configuring, facilitating, and brokering.

The Port of Oslo mainly engaged in configuring to accommodate normative expectations of the Port as a promoter of green technologies. The *configuring* of intermediaries refers to networking activities that position elements of socio-technical systems in such a way that they promote or foster systemic transformation. A comprehensive understanding of configuration focuses on how intermediaries engage in "configuring technical and social elements" (Kivimaa et al. 2019a:1071) to "align (...) multiple system elements into configurations that work" (Barnes 2019:769). Most prominent in this regard was the Port's engagement in technological configuring, which enabled the Port to implement green technologies. One example related to the introduction of shore power. As shown in Paper 3, the implementation process rested on a dialogue meeting with technology providers and users to identify feasibility challenges and preconditions for use. This meeting represented configuring between technologies and users, which is considered important to ensure that technologies cater to user needs (Bergek 2020, Sovacool et al. 2020b). Another example of configuring that promoted green technologies related to the development of the zero-emission port concept, which included the implementation of several different technologies and energy sources to improve port sustainability. This could be regarded an example of configuring that aimed at aligning a set of technologies or innovations, but also at aligning the use of those technologies (Stewart & Hyysalo 2008).

More prominently, this thesis shows that new normative expectations lead to facilitation, because facilitating is necessary for transition work to unites and enhance efforts across many actors. Stewart and Hyysalo (2008:306) describe the facilitating function of intermediaries as "providing opportunities to others by educating, gathering and distributing resources, influencing regulations and setting local rules." As *facilitators*, intermediaries can shape and encourage interactions and cooperation, vision creation, the adaption and use of technological solutions, niche development, and project realization (Kivimaa et al. 2019a). To

facilitate diffusion, intermediaries further create spaces in which innovations can grow and settle, be they physical, sociocultural, economic, or regulatory (Stewart & Hyysalo 2008). As part of the new normative expectations of ports, which to greater extent held port organizations accountable for sustainability issues and transition work in entire port areas, ports were expected to include the multitude of port actors in strategies for emission reduction and port (re)development. Thus, facilitating was necessary to unite and enhance sustainability efforts among port actors.

Several examples of facilitatory work in the Port of Oslo enabled the port to demonstrate its sense of responsibility for the constellation of transition work in the port. First, the Port set emission targets for the port area that required port users to raise their own ambitions, which, given the ambitious policies of its owner, could have been an expression of the Port's efforts to interpret and translate policy into practice (Fischer & Guy 2009:2591). Second, the Port deliberately sought to provide opportunities and resources to others, for instance by establishing a financial support scheme and aiding port users in applying for funds to invest in low-emission technologies. Third, the Port demonstrated its responsibility for transition work in the entire port area by setting rules that guided the actions and behaviors of other port actors. One example of this was the introduction of the Environmental Port Index (EPI), which allowed the port to calculate port fees on the basis of vessels' emission levels at berth, thereby economically rewarding vessels with low emissions. Fourth, and finally, the Port facilitated holistic approaches to transition work by providing direction and highlighting probable transition pathways. As shown in both Papers 2 and 3, the Port of Oslo contributed to reduce insecurity and risk perception among port users by extensive actor involvement when monitoring emissions and developing solutions for emission reduction, and by providing step-by-step strategies to fulfil reduction objectives. For that purpose, it practiced intermediation to facilitate transition through the articulation of expectations and visions (Kivimaa 2014), through reducing uncertainty, and by guiding activities (Stewart & Hyysalo 2008).

Normative rules increasingly associated with ports further point ports towards transition work that resembles brokering, which is another feature of intermediation. *Brokering* refers to activities that raise support from different actors, which intermediaries obtain by negotiating and leading dialogues to enhance understandings about technologies, their prerequisites, and impacts. These activities are also closely related to the building and mobilization of networks, for example to establish protective spaces or articulate expectations (Kivimaa et al. 2019b). Spiro et al. (2013) refer to brokering as the filling of "structural holes," as brokers fill the gap between actors who lack a direct connection to each other. Paper 2 particularly shows that networking activities were a prominent feature of the transition work in the Port of Oslo, and effective in accommodating normative expectations about, for instance, aligning interests and lobbying.

Above all, brokering activities in the Port of Oslo served to accommodate new normative expectations of collaboration and collective action. One aspect of brokering is coordination, which refers to intermediaries as go-betweens and links between actors that do not have a direct relationship (Aspeteg & Bergek 2020), which could allow intermediaries to negotiate and communicate needs and requirements between different actors (Stewart & Hyysalo

2008). As collective action and collaboration are themselves expressions of renewed norms for port roles, coordination activities obviously contributed to accommodate normative expectations. The coordinating role of the Port of Oslo is evident in all Papers 1–3. The Port of Oslo was considered an epicenter for dialogue, which encouraged interaction between port actors. As a node in actor-networks, the Port had extensive relations that provided a comprehensive overview that allowed for the development of a holistic approach to transition work. Several examples of existing transition work in the Port could be considered as having coordinative functions: the monitoring of emissions in the port area, the dialogue meeting on shore power, and the development of the zero-emission port concept. Thus, to accommodate expectations of the Port as a driver of collaboration and collective actions across the entire port area, the Port needed to know and navigate the different interests, opportunities, and obstacles related to each port actor.

In sum, Subchapter 7.4 demonstrates how expectations of ports encourage ports to incorporate intermediation in their transition work. this not only adds to the functions and competencies port organizations need to carry, but also accentuates the potential of ports to drive transitions across actors, sectors and systems.

8 Conclusions

The purpose of this thesis is to conceptualize transition work within the frames of research on sustainability transitions, and to increase understandings of the content and shaping of transition work. To do so, I have relied on understandings of agency in sustainability transitions and STS, which collectively point to the role of actors in processes of stability and change. Perspectives from sustainability transitions and STS both emphasize the roles of human and non-human actors alike, and, in this thesis, material agency is among other inherent in how transition work relates to technologies and artifacts, infrastructure, and legislation. Nonetheless, this thesis has mainly described transition work being conducted by human actors.

To increase the understanding of transition work, I have turned to a hitherto underexplored transition site, namely ports. In Chapter 2 I accounted for existing research on how ports are currently approaching sustainability issues and how the focus of ports has shifted towards community management. Previous research on port sustainability has to a large degree lacked empirical accounts of the actual experiences of ports and qualitative understandings of ways in which ports engage with sustainability. Currently, scholars typically understand sustainability efforts in ports as the implementation of specific technologies, solutions, and practices, or exnovation of unsustainable technologies or practices. To better capture the processes that precede such implementation and integrate them into understandings of wider societal change, I have drawn on perspectives that see transitions as socio-technical changes. This has enabled me to develop the concept of transition work.

8.1 The conceptualization, contents, and shaping of transition work

In this concluding subchapter, I revisit the first research question of this thesis: *How could agency be operationalized to capture more fully the active dimensions that promote sustainability transitions?* Although the term transition work has been mentioned by several scholars (e.g. Löhr et al. 2022, Poland et al. 2019, Skjølsvold et al. 2018, Sørensen et al. 2018), it has yet to be fully conceptualized as activities explicitly intended to drive transitions. In this thesis, I therefore understand transition work as *all deliberate and purposeful activities aimed at progressing sustainability transitions.* This understanding sees transition work as an element of socio-technical change processes, which are at the core of studies of sustainability transitions. Different perspectives within the field of sustainability transitions emphasize different aspects of change processes, such as experimental governance, the positioning of niche innovations, or the building of innovation systems. In discussing transition work, I have particularly drawn on the multi-level perspective (MLP), which considers change to follow interaction dynamics between socio-technical regimes, landscapes, and niches (e.g., Geels 2004). Collectively, the well of publications on sustainability transitions provides countless examples of activities that constitute transition work (see Table 5), albeit without them being conceptualized as such. The notion of transition work that I put forward in this thesis further conveys the important role of actors and agency in socio-technical change processes, as highlighted by both transition scholars and STS.

To increase attention paid to transition practices, I seek to conceptualize transition work as agency applied and directed at a particular end (i.e., sustainability transitions), and as

something that could be empirically observed. This leads to the empirical observations discussed in this thesis, and is related to the second research question of this thesis: *How are actors in the port sector working to promote and accelerate transitions in and around ports?* This thesis describes an array of transition work, which I have grouped into six categories: technological, visionary, policy, governance, reflexive, and relational. *Technological work* includes activities aimed at developing, testing, encouraging, or implementing technologies or niche innovations, whereas *visionary work* is dedicated to producing or aligning visions, worldviews, and strategies. This obviously relates to *policy work*, in which visions are expressed in specific and explicit plans and objectives. The execution of such plans and objectives is typically at the core of *governance* work, which includes elements of transition management, as well as strategic niche management and intermediation. Political transition work, such as translation of perceptions and visions, setting problem agendas and mandates, was not a prominent feature in the case ports, but is likely to increase with increasing politicization of port issues. The last two types of transition work discussed in this thesis, *reflexive work and relational work*, could both be considered inherent elements of any other kind of transition work. Whereas reflective transition work encompasses activities that increase knowledge and awareness or reorient perceptions, relational transition work points to engagements and interactions with other actors that enable transition work. This thesis also demonstrates how different types of transition work are intertwined, and how one type of transition work could produce other types of transition work. This leads to the last research question of this thesis, which addresses the shaping of transition work.

The third and final research question addressed in this thesis asks; *how do particular forms of transition work emerge?* In discussing the shaping of transition work, I have referred to how transition work emerges within the context of socio-technical configurations. I consider these to be interrelations and interconnections between elements that represent the transition dynamics described in the multi-level perspective (Geels 2004), which comprise actors, landscapes, niche innovations, socio-technical regimes, and socio-technical systems. Considering how my use of socio-technical configurations draws on understandings inherent in the MLP, my application of socio-technical configurations is also nested within the challenges that many transition scholars have identified in the MLP. For instance, the MLP has been criticized mainly for unclear distinctions between socio-technical systems and socio-technical regimes (Smith et al. 2010, Sorrell 2018), which Geels (2011) concurs is particularly a challenge in empirical applications of the MLP. Furthermore, the regime concept could refer to the rules and institutions that guide actor behavior, while also being perceived as a broader analytical approach to describe the status quo (Smith et al. 2010). Such lack of clarity, and other criticisms levelled towards the MLP as mentioned in Subchapter 3.2.3, have often been addressed through theoretical add-ons and borrowing from established theories in different disciplines and research fields (Geels 2010, Geels 2020), such as institutional theory (Fuenfschilling & Truffer 2014, Fuenfschilling & Truffer 2016), power relations (Avelino & Wittmayer 2016), agency (Hassink et al. 2018), and actor-network theory (Prayag et al. 2020). Thus, the full set of MLP publications to date have evolved into an intricate theoretical complex that is challenging to apply empirically, especially when transitions accelerate and spread across sectors and technologies. Thus, by relying on MLP understandings to define

socio-technical configurations, both empirical and ontological challenges with delineating elements from each other (e.g., system versus regime) and operationalizing abstract constructs (e.g., landscapes) remain. However, it has not been my overall intention to engage with these perceived shortcomings of MLP. Rather, I choose to rely on the dynamics that the MLP describes as influences on transition processes, as well as influences emphasized by other strands of research on sustainability transitions, to frame discussions on how transition work emerges within socio-technical configurations.

Throughout Chapter 7, I have discussed and exemplified how socio-technical elements shaped transition work in the ports studied, and I have posed a series of claims about how transition work in ports has emerged. Discussions around these claims are summarized in Table 17. The first claim is that transition work is shaped by the *unique specificities of socio-technical systems*. The specific transition work of the ports investigated here relates to lock-ins and opportunities provided by artifacts and infrastructure, as well as opportunities provided by markets, and cultural and public discourses on ports. Discussions about unique transition contexts have also pointed towards ways in which transition work is shaped by actors and technologies, landscape pressures and normative rules.

Table 17. Summary of the claims about the shaping of transition work.

Socio-technical systems
• Regulations and policies shape transition work by directing efforts.
• Artifacts and technologies shape transition work by representing sunk costs and technological lock-ins.
• Infrastructure shapes transition work by providing different opportunities for transition work.
• Markets shape transition work by compelling ports to incorporating the market developments of their users into transition work.
• Cultural discourse shapes transition work by pointing to perceived problems and the need for specific actors to solve them.
Actors and technologies
• Direct transition work towards relevant and uncontroversial niche innovations with immediate users
• Need to manage actor complexity, and to place sector- and industry-specific restraints on transition work
• Internal processes of business and corporations produce transition work of their own.
Landscape pressures
• Contest rationalities by increasing the constitutive power of green norms and discourses
• Demonstrate the need for transition work by defining objectives and allocating responsibilities
• Set the scope for transition work by defining what sectors to involve and what priorities to emphasize
Normative rules
• Lead to configuring by requesting green technologies
• Lead to facilitating by encouraging transition work to unite and enhance efforts across actors
• Lead to coordination by necessitating collective action and collaboration

I have made three claims relating to *the role of actors and technologies in shaping transition work*. First, I have shown that transition work orients towards technologies that are perceived as relevant and uncontroversial (i.e., technologies that face little competition) and technologies that are expected to be taken into immediate use. Second, I have shown that port organizations needed to incorporate the myriad of different port actors into their transition work and that high degrees of actor complexity might encourage holistic

approaches to transition work. The transition work of port organizations could also be shaped by the internal transition work of other port actors.

One of the most prominent findings in this thesis relates to how transition work emerges in response to landscape pressures. In Chapter 7 I have shown how transition work responded to intensified pressures associated with climate change, as expressed in the increased constitutive power of green sentiments and ideology. This was manifest in the Agency for Climate and environmental organizations, whose thrust compelled the Port to to reorient its rationalities from pragmatic business operations towards progressive sustainability efforts. I further claim that transition work is shaped by what Morone et al. (2016) label *intentional* landscape pressures, in the form of policy objectives and strategies, demonstrate pressures that are deliberately exerted to progress sustainability transitions. However, such pressures presuppose the existence of systems for politics and governance that are not only able to operationalize global and regional pressure (e.g., in the forms of international treaties and regulations), but also, independently of them, are able to define and execute progressive pressures (e.g., policy objectives) of their own. This thesis shows that the need for transition work is particularly substantiated when landscape actors define or shift issue jurisdictions, here exemplified by ports' new responsibility for sustainability issues and cities' renewed responsibility for port issues. Intentional landscape pressures also shape transition work by setting the scope for transition work. More specifically, intentional landscape pressures point to what sectors ports should engage with (or not) in their transition work, and what niche innovations should be core priorities in transition work.

The final claim of this thesis is that transition work could be shaped by normative rules that produce intermediation. Such rules emerge in the form of new expectations directed at ports, mainly related to involving their wider surroundings in such efforts. To comply with norms that include multilateral engagement, nurturing relationships, collective action, and promotion of green technologies, it is fruitful to concentrate transition work on intermediation activities. In the Port of Oslo, configuring activities around technologies and policies allowed for collaboration and renewed problem agendas, while facilitating activities allowed for promoting green technologies and practices. Finally, brokering activities–i.e., connecting and negotiating between actors –allowed for building and strengthening network relations, and fostered exchanges of knowledge and resources.

In addressing the three overall research questions of this thesis, I have explored what transition work is, what it might contain, and how it might be shaped. However, discussions in preceding chapters have said little about the potential of ports to facilitate whole-system transformations. Based on the findings of my analysis, in the following I will share some reflections on how transition work, as described in the preceding chapters, could impact the transitioning of port sectors. In doing so, I draw on the empirical work of this thesis to argue that transition work could be one way to facilitate whole-system transformations.

8.2 Transition work and transition potentials

Transition scholars have established a number of transition typologies, suggesting that transitions could occur and progress in different ways. However, the role of actors and deliberate actions is more or less absent from current discussions on transition pathways.

Rather, the discussions tend to emphasize either interactions between the different levels of the MLP (Geels & Schot 2007) or interactions between regimes (Raven & Verbong 2007). Admittedly, Smith et al. (2005) present a model of transformation in which they highlight the ability of actors to coordinate and manage responses to change pressures. Also, Geels and Schot (2007) refer to activities that are central under different transition pathways, such as voicing criticism, adjusting regime rules, and developing and adopting novelties and innovations. As such, the existing literature hints at the role of agency applied in producing specific transition pathways. As discussed in Subchapter 7.1 and explicitly addressed in Paper 2, different transition pathways might comprise different types of transition work. Paper 2 shows how the transition work in the Port of Kristiansand and Port of Oslo rested on different approaches to social transition processes, for instance expressed in the degree of incrementalism/transformation and the involvement of port actors. This shows that transition work could be understood as an active narrative on the creation of transition pathways. Further, considering the heterogeneity of ports and the socio-technical systems that surround them, this thesis shows that ports are likely to have different scopes, ambitions, and directions in their transition work and thus follow different transition pathways (Bjerkan et al. 2021b, Bjerkan et al. 2021c).

However, ports could also be considered a particularly potent site for aligning transition pathways across sectors and domains. In the following, I discuss how transition work could be one way to connect the different socio-technical configurations that ports comprise, and thereby facilitate deep transition or whole-system transformation. Considering the many different sectors, markets, and value chains that intersect in ports, the port sector represents a useful site for understanding deep transitions. Scholars who study sustainability transitions are increasingly recognizing the need to consider interconnections and interactions between socio-technical systems, and there is a need for "more sustained interest in the dynamics occurring across rather than within systems" (Rosenbloom 2020:336). Perhaps most prominent are reflections on *deep transitions*, originally formulated through the works of Kanger and Schot (Kanger & Schot 2019, Schot & Kanger 2018), who define deep transitions as "a series of connected and sustained fundamental transformations of a wide range of socio-technical systems in a similar direction" (Schot & Kanger 2018:1045). By using the term deep transitions, they emphasize the very long timelines and path dependencies that alter socio-technical systems (Kanger & Schot 2019, Schot & Kanger 2018). Other transition scholars refer to *whole-system transformations* when discussing large-scale transition processes. For example, Geels (2018b:230) recognizes that the MLP should be extended to conceptualize reconfigurations of whole systems, in which scholars "broaden [their] analytical attention from singular niche innovations to whole system change." Similarly, McMeekin et al. (2019) argue that whole system approaches are useful because system interactions reconfigure the overall system architecture. Other scholars have discussed interactions between multiple niches or multiple regimes (Konrad et al. 2008, Raven & Verbong 2007, Skjølsvold & Ryghaug 2020), sectors (Bauknecht et al. 2020, Konrad et al. 2008), or systems (Papachristos et al. 2013, Rosenbloom 2020). However, many of these scholars are "focused at interactions between regimes of the same or similar sociotechnical or societal systems" (Papachristos et al. 2013:54), suggesting that transformations spanning different sectors have received little

attention. This implies that there is a need to turn to transition sites such as those in ports, as they comprise and span a range of different sectors.

Different sectors in ports all attend to their own societal functions, such as the provision of sea transport services, waste management or terminal operations. These functions are connected to the sectors' own specific landscape pressures, regime rules, niche innovations, actors, and systems. This implies that port areas consist of several socio-technical configurations (for examples, see Figure 11), which contribute to uphold the many different societal functions in ports. Consequently, increasing our understanding of how transition work could induce transformations that span across sectors calls for attention to the full set of socio-technical configurations involved.

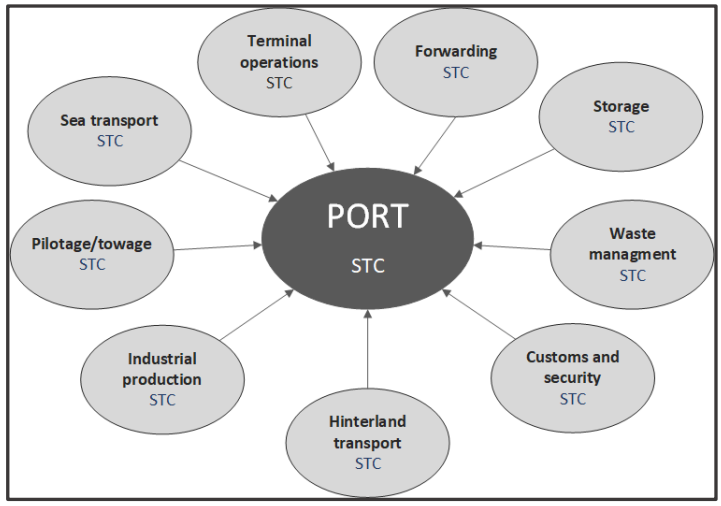

Figure 11. Example of socio-technical configurations in ports.

One reason for tending to socio-technical configurations in ports, is the emphasis of transition scholars on how whole-system transformations are enabled by connections between systems, or, as I argue, *between socio-technical configurations*. The analysis of this thesis suggests that many of the socio-technical configurations in Figure 11 interact and relate to each other, making the port sector a good example of what Rosenbloom (2020) labels "sites of interaction." As seen in Figure 12, interactions between socio-technical configurations in ports could emerge in several ways. For example, different configurations could be connected through similar socio-technical systems. Port facilities such as quays, gates, and the port area itself, are shared by several configurations that depend on them to carry out their societal functions. Socio-technical configurations can further be linked through their reliance on similar technologies and artifacts, such as cranes, port trucks and tractors, arrival/departure systems, logistics systems, goods, and containers. However, I also consider it possible for socio-technical configurations to be connected through common mindsets and through cognitive and normative orientations. As we have seen in this thesis, and particular Paper 2, port actors share many of the same problem agendas related to efficiency and economic margins, environmental reputations, unfavorable discourses around ports and transport, and an under-recognition of their attention to societal functions. Some configurations are also characterized

by certain behavioral norms, such as the lengths actors go to solve problems, and their creative ad-hoc approaches to ensuring that jobs get done.

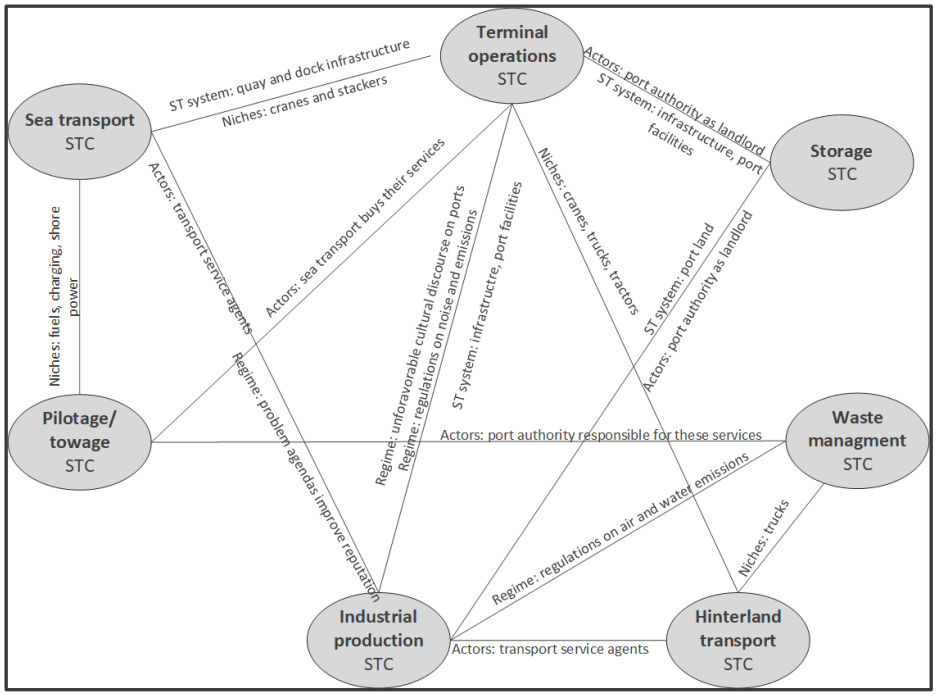

Figure 12. Examples of connections between socio-technical configurations in ports

Thus, societal functions in ports, and the socio-technical configurations that support them, are connected in several ways, making ports an interesting case for increasing our understanding of whole-system transformations. Because such transformations depend on connections between subsystems that allow transformations to move between socio-technical configurations, transition scholars have paid attention to how systems or sectors could be delineated. They argue that different systems, regimes, configurations or sectors could be linked through metarules (Kanger & Schot 2019), complementarities (Markard & Hoffmann 2016), structural and functional couplings between elements in socio-technical configurations (Konrad et al. 2008, Rosenbloom 2020), and fulfilment of and impact on societal functions (Papachristos et al. 2013). Based on the analysis in this thesis, I suggest that following transition work could also be a useful approach to identify couplings between systems, regimes, or sectors, because the transition work that actors engage in often involves more than one socio-technical configuration. This is also reflected in the prominence of relational work pointed out in this thesis. In the following, I give three examples of how transition work could form and produce linkages between socio-technical configurations in ports and thereby promote whole-system transformation.

First, my analysis in this thesis shows that visionary transition work might connect different socio-technical configurations, as particularly demonstrated by the Oslo case. There, visionary

transition work was seen in the whole-system approach to conceptualizing the future zero-emission energy system of the port, in which the City, the Port, and its users co-developed a holistic concept that considered the port area to be a single, shared eco-system of sustainable energy sources. The concept pointed to local production of electricity and hydrogen, extensive shore power installation, the use of batteries for peak shaving, and provision of alternative fuels for trucks and long-haul, as well as smart management of all energy solutions combined (Port of Oslo 2020). Establishing and using these solutions implied the involvement of several socio-technical configurations in the port, such as those surrounding road transport service provision, shipping service provision, provision of terminal operations, and of course the provision of different kinds of energy sources. In addition to specifying solutions that might be included in the port's future energy system, the work with this concept made explicit reference to the City's ambitions of 95% reduction in greenhouse gas emissions by 2030, which presupposes significant emission reductions in the port area as well. This committed actors in different socio-technical configurations to not only pursue specific niche innovations, but also to identify and develop transition approaches that would support and align with the City's ambitions.

Second, in this thesis I have shown that reflexive transition work might connect socio-technical configurations through learning, for example associated with DNV's Green Shipping Programme and the monitoring of port emissions. The Green Shipping Programme has provided its many members with knowledge and experience regarding niche innovations that reduce emissions from the maritime transport sector. Paper 2 discusses the role of this program as a network node joining different sectors to learn from solutions and "propel transitions", as it shared resources and developed joint expectations and visions. These examples of transition work involved actors from several socio-technical configurations (e.g. Figure 11), such as regional and local authorities, goods owners, shipowners, technology providers, and port and industry organizations. Paper 3 shows how monitoring emissions in the entire port area allowed for the identification of primary emission problems and subsequent prioritizing between transition efforts, exemplified by extending shore power to international cruiseferries. These instances of learning involved representatives of several socio-technical configurations in the port area, such as industrial companies and goods owners that relied on maritime transport services, and shipowners that provided transport services themselves.

Learning processes could have contributed to align transition work between the socio-technical configurations in several ways. Broad learning, specifically learning about technologies, regulations, social, cultural and environmental impacts, market potential, and user preferences (Schot et al. 2016), was evident both in the Green Shipping Programme and in the emissions monitoring done by the Port of Oslo. Both aforementioned efforts could be considered to provide knowledge about technologies, as well as about the other actors involved and the realities in which they operate. In turn, this could strengthen the ability of port organizations to build and mobilize a heterogeneous set of actors and networks, as they had shared perceptions of niche innovations and shared perceptions of reality, including what are the (documented) challenges and needs when it comes to transition work. Collaborative aspects of transition work rely heavily on the ability of actors to communicate precisely and

effectively, which not only requires actors to have competence in the issues they are discussing, but also knowledge of the actors with which they are discussing. Thus, the learning process could also enable or shape the mobilization of networks towards common ends. Hence, when actors in different socio-technical configurations perceive the same challenges and needs, there is reason to believe that the scopes and ambitions for transition work in those configurations would also align.

My third and final example of how transition work might connect socio-technical configurations relates to brokering, which is a prominent aspect of both relational and political transition work. Paper 1 discusses the potential influence of goods owners in negotiations on procurement of services from transport and shipping companies. The paper references discussions between procurers belonging to different socio-technical configurations (e.g., industrial production, waste management, forwarding) about placing joint requirements when buying transport services, such as those related to energy efficiency, fuels, or emissions. Although these intentions had not yet been put into practice, they suggested that port users themselves identified ways in which coordination between the sets of socio-technical configurations of which goods owners were part might collectively impact the sustainability activities in socio-technical configurations surrounding maritime transport providers.

The three examples of transition work, which spanned socio-technical configurations in the Port of Oslo, all demonstrate that the complexity of ports might allow the port sector to pursue whole-system approaches (e.g., McMeekin et al. 2019) to transition work.

8.3 Critical reflections on the nature of transition work

Throughout this thesis, I have provided many examples and discussions around the content and emergence of transition work. I will in the following supplement these with a few critical reflections around the basis for and assumptions underlying my understanding and application of transition work as a concept.

8.3.1 Incremental or transformative transition work

This thesis shows that there are many factors that might keep ports on incremental development paths, such as lock-ins to artifacts and infrastructures, intra-sectoral competition, historical emphasis on the operational functions of ports, the position of ports between different sectors and levels of governance, the autonomy of ports' business, and the lack of political interest in port issues. Consequently, most initiatives that ports have taken to improve sustainability, as described in this thesis and elsewhere, could be considered incremental technology switches. The many electrification activities in ports, such as shore power, electric cranes, tractors, and excavators, are all examples of such incremental technology shifts. These incremental steps have been strongly connected to generous public support schemes, vast power resources, and the availability of market ready technologies, implying little risk associated with their introduction. They are further enabled by visions relating to short-term policy strategies (e.g., shore power to maritime transport) that encourage sectors to harvest immediate effects. Thus, in sum, this thesis has mainly described incremental transition work done by incumbent actors, based on short-term visions that could be realized without greater alteration of existing socio-

technical systems. However, there are also examples of transition work with a more transformative character. The concept of the future zero-emission port that is under development in the Port of Oslo (Port of Oslo 2020), has involved a multitude of stakeholders from different sectors in the establishment of long-term visions and agendas that go beyond simple technology shifts (e.g., business model innovation, alternative fuel production, smart port operations, waste heat recovery).

These contrasts bring out some ontological unclarities around the concept of transition work and how transformative activities need to be in order to be classified as transition work. In this regard, it is possible to see a parallel between the transformative nature of transition work and discussions on different transition pathways, indicating how transitions might evolve through different dynamics, involving different degrees of incumbency and disruption (e.g. Geels et al. 2016). When it comes to the disruptiveness of transition work, I will make two claims. First, I argue that transition work could be placed on a continuum with incremental transition work at one end and transformative transition work at the other end of the spectrum. This argument is inspired by established ideas of what distinguishes transitions from transformations (e.g.Hölscher et al. 2018), suggesting that incremental transition work mainly orients towards technical transitions allowed within existing socio-technical contexts, whereas transformative transition work orients towards large-scale socio-technical changes across domains and societies. Following such an interpretation implies that much transition work currently being done in ports is of an incremental nature, although it is difficult to ascertain if activities that appear incremental at one point in time might hold transformative effect in the longer run (Skjølsvold et al. 2022). As such, one should take care in prematurely concluding on the transformative potential of different expressions of transition work.

My second claim is that transition work can contain both incremental and transformative elements. This is obvious from the transition work done by the Port of Oslo, where the initial transition work revolved around short-term visions for specific technological transitions within the socio-technical system into which the Port was already locked. However, that transition work has since evolved into holistic, long-term visions for the transformation of the entire port area. Hence, the port organization has arrived at a point where it works for large-scale change, while stepwise and incrementally working on modifying the socio-technical systems into which it is currently locked. This suggests that incremental transition work might be an important opening act that enables long-term visions for transformative, disruptive transition work. However, such an understanding of transition work might pose a challenge in terms of communicating the dire need for disruptive change.

8.3.2 Motives and rationales behind transition work

In Chapter 3 I have accounted for the theoretical lineage behind my conceptualization of transition work, wherein I have shown how studies of sustainability transitions depart from other approaches to socio-technical change by specifically addressing how socio-technical change dynamics could produce more sustainable societies. This directionality of sustainability transitions also implies a normative stance, which is echoed in the conceptualization of transition work suggested in this thesis: sustainability transitions *ought* to be progressed. The definition of transition work provided here stresses that activities are done "deliberately and purposively to progress sustainability transitions," and thereby fall in line with the normative

directionality of sustainability transitions research. However, this does not mean that actors themselves need to recognize or label their own activities as transition work, or that they should engage in transition work because of concerns for the climate and environment. In fact, this thesis suggests that many actors might engage in transition work—seeking to protect climate and environment—because they feel obliged or compelled to, either by landscape pressures or by market forces. Therefore, I consider it possible to seek deliberately to progress transitions also out of concern for the perseverance of own organization or corporation, as exemplified by the many corporate actors who expect they will either transition or perish. Thus, my concept of transition work emphasizes how actors deliberately and purposefully engage, but it does not require actors to display particular rationales (e.g., concern for climate) in order for their activities to qualify as transition work. This will be important to keep in mind as the quest to speed up transition grows ever more imperative.

Another challenge with the rationales that underly the transition work of actors relates to individual or collective perceptions of what sustainability transitions entail. Although I do not consider it necessary for actors to identify their own activities as transition work in order for their work to be classified as such, the empirical work in this thesis shows that many actors themselves refer to the concept of sustainability transitions. However, how they understand this term has not been explored in depth. Although the transition work of ports is explicitly tied to emission reductions and decarbonization, ports do not necessarily express explicit desires for large-scale transformative change. Thus, a broad understanding of transition work, as suggested above, might run the risk of deflating the need for disruptive change and legitimizing incremental changes that prolong the status quo. The empirical data drawn upon in this thesis points to a tendency of actors (public or private, incumbent or not) to equate and identify *transition* with precisely the shift towards low- or zero-emission technologies. Such understandings, especially with the increasing mainstreaming of the transition concept, run the risk of downplaying the dramatic need for behavioral and structural shifts among other expressed in ideas of deep transition (Schot & Kanger 2018). As argued in Chapter 2, similar tendencies have been observed in research on port sustainability, in which technological transitions are in the forefront. Therefore, continued research on transition work—also in the port sector—should more critically engage with how actors perceive sustainability, what sustainability transitions entail, and how actors should engage to achieving such transition. There is also reason to ask if there is need for policy that to a greater extent stipulates transformative directions for ports and other sectors. My operationalization shows that transition work also revolves around processes that are not explicitly tied to innovation, such as vision-making, political and relational work, and suggests technological innovation is by far sufficient for transformations to occur. As such, there is need for transformative policy (e.g., Kivimaa et al. 2017, Rogge et al. 2020) that recognizes the necessity of initiating transition processes with greater disruptive potential.

8.4 The future of research and ports as transformative sectors

By delving into the transition work of ports I have sought to show how actors deliberately engage to promote or accelerate transition processes. Accordingly, this thesis points to implicit and established notions and understandings of how sustainability transitions proceed. This particularly includes the different types of transition work exemplified in Chapter 6, which

refers to specific domains in studies of sustainability transitions, dedicated to what role, for example, politics, power, governance, and innovation play in transition processes. However, despite leaning on understandings of agency from STS, discussions of transition work could more elaborate draw on the many different STS perspectives that engage with socio-technical change and agency. Considering how this thesis has paid little attention to actants and material agency, I encourage future research to add nuance to concepts of transition work by emphasize more strongly non-human agencies.

Chapter 6 also hints at interconnections and dynamics between different types of transition work, such as how relational work is probably an aspect of any other transition work, whereas visionary work could be instrumental in succeeding with, for example, political work. However, in order to substantiate and better understand such dynamics, further research on transition work should more thoroughly unravel how different types of transition work are intertwined, and whether there are hierarchical relations that make certain types of transition work particularly effective in producing or accelerating transition work altogether.

A hierarchy in relations is hinted at in understandings of transition management (e.g., Loorbach & Rotmans 2010), which distinguish between difference phases of transition governance in which different activities (strategic, tactic, operational, reflexive) are conducted in a particular order. This could suggest that the order of transition work is an important aspect to consider when planning or deliberately executing transition work. Thus, looking further into the order of different transition activities, for example by explicit reference to understandings inherent in transition management, could be a useful avenue for further research. Future research could also more explicitly connect transition work to the production of specific transition pathways. The current transition work in ports is evolving along lines of transformation pathways, in which incumbent actors make adjustments—incremental or radical—to reorient the regimes of which they themselves are a part. In other domains and sectors, where locks-in in infrastructure and artifacts might be weaker, transition work might induce more disruptive change dynamics.

In discussing the shaping of transition work, this thesis draws on existing ideas of socio-technical change processes. For example, my discussions on the shaping of transition work navigate by understandings of socio-technical configurations, which draw heavily on the multi-level perspective (MLP). However, I consider my use of socio-technical configuration to be *one* way of structuring the shaping of transition work, which to me represents more of an analytical choice than an ontological stance. That means that there may be other ways to analyze or structure the shaping of transition work. For example, it would be interesting to explore the shaping of transition work within the frames of STS perspectives, whose flat ontologies contrast the layered structuring provided by the MLP and thus the socio-technical configurations of this thesis. Furthermore, the shaping of transition work could be studied with reference to transition politics. In this thesis, shaping by politics is most evident in discussions on how intentional pressures could alter issue jurisdiction, define target objectives, or increase the pace of transition work. Politics could also relate closely to innovation processes that foster technological maturation, and function as an amplifier of role

expectations that encourage intermediation (Aspeteg & Mignon 2019). Although in this thesis I have emphasized the transition work of a particular actor group (i.e., port organizations), it is clear that transition work in complex transition sites such as ports is undertaken by different actors, whose transition work might vary in itself and also respond to different political contexts and pressures.

Another potential analytical framework for expanding the study of transition work could be the geography of sustainability transitions (GOST). Damman and Steen (2021) have already pointed out the uniqueness of ports with reference to place and geographical contexts, suggesting that the scope for ports to enable transitions results partly from the interaction between local social factors (e.g., networks, capabilities, institutions), and site- and location-specific factors (e.g., energy, industry, infrastructure, traffic). Thus, drawing more on insights from research on geography in sustainability transitions would be useful to enrich empirical explorations of the shaping of transition work and how it is shaped by local and regional settings. For example, place-specific institutions, norms, and values (Hansen & Coenen 2015, Raven et al. 2012) could produce divergent expectations of port roles and transition work in ports. Furthermore, industrial specialization at specific sites (Hansen & Coenen 2015) could determine the relevance and usability of technologies and innovation for specific ports. Others have emphasized the influence of "distanciated" policy interventions (Binz et al. 2020:2), which in Norwegian ports could materialize through EU policies for the provision of alternative fuels (EU 2014).

Hence, the shaping of transition work could probably be studied and understood from many different perspectives, and potentially from as many perspectives as there are perspectives on the nature of transitions, be they actor-oriented or process-oriented. Therefore, I would welcome attempts that add, deepen and explore further the conceptual developments of transition work done here. What is sure, is by investigating transition work as it occurs in the port sector, this thesis draws attention to a very interesting and under-researched transition site. Ports represent a potential locus for deep transition work, that, to date, have been largely overlooked by policymakers. Currently, national and European policy continues to portray a rather narrow framing of the agency of ports, exemplified by their roles as implementers, providers, or facilitators of low-emission technologies and energies. For ports to capitalize on their position as nodes in transport systems, and on their potential locus in large-scale transition processes, policy needs to move away from seeing ports as owners of incremental implementations and towards seeing ports as drivers of transformation.

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Appendixes

Appendix A. Interview guide Paper 1 and Paper 2

A	**Surroundings**
A1	Could you tell us about [your organization] and its work with climate and environment?
A2	What surroundings are more important to [your organization] when it comes to energy and climate? Mandate/allocations Budgets Political guidance/orders Decision/planning processes Collaboration partners (formal, informal) Other public actors/levels Private industries/corporations Interest organizations
A3	What relations does [the organization] have with the port in Oslo/Narvik/Kristiansand?
A4	Is [your organization] required to abide by particular public rules, regulations, laws, guidelines, etc., when it comes to [the organization's] relation with the port? Could you elaborate on these? What about (adjusted to each informant): • Technical standards, product specifications • Subsidies, other allocations and support • Object clauses • Mandates/allocations • Procedure requirements (e.g., with regard to decision-making, fund allocation, measure implementation)
A5	How would you describe the port's functions today? Goods handling Transport Industry and production Workplace Premise provider Access to energy sources
A6	What functions do you think the port/ports should have in the future?
B	**The organization and zero-emission ports**
B1	How would you describe the goals and visions for emission reductions and energy in [your organization]? Why do you have these goals?
B2	How do you consider the role of [your organization] in reducing emissions in and outside the port?
B3	How do you experience the ability of [your organization] to work for reduced emissions in and outside the port? What do you (not) have? Knowledge and competence about technology Best available technology Ability to influence other actors Make use of relations with other actors Capital to invest Economic predictability/solidity Infrastructure/material Access to energy sources Personal contacts/networks Localities/geography Competition/markets
B4	What does [your organization] consider to be the most important challenges and issues when it comes to reducing emissions in and around the port? Regulation Economy Responsibilities Political priorities Collaboration
B5	Do you have any thoughts on how to deal with these?
B6	Does [your organization] work with specific measures or solutions to reduce emissions in and outside the port? Ongoing

	Planned
B7	How does [your organization] experience pressure to work for emission reductions? How Why
B8	What expectations does [your organization] have of other actors when it comes to reducing emissions from activities related to the port/ports? Who is responsible?
B9	How important do you consider it that the port and port actors move in the direction of zero emissions? Why How
C	**Rewards and sanctions**
C1	What consequences will it have for [your organization] to work for emission reductions? Short and long term Mandate/resource allocation/economy Reputation and relation with collaboration partners Public reputation …
C2	What consequences will it have for [your organization] *if it does not* work for emission reductions? Short and long term Mandate/resource allocation/economy Reputation and relation with collaboration partners Public reputation …

Appendix B. Overview of actors interviewed and the use of interview data.

		Paper1	Paper2	Paper3	Background
Port authorities	Port of Narvik				x
	Port of Kristiansand		X		
	Port of Oslo	X	X	X	
Local authorities	City of Narvik				X
	City of Kristiansand		X		
	City of Oslo	X	X	X	
Regional authorities	Agder County		X		
	BaneNOR		X		
National authorities	Norwegian Coastal Administration				X
Terminal operators	Yilport	X	x		
	Green Carrier		X		
Port users	Glencore		X		
	LKAB				X
	Heidelberg	X	X	X	
	Skanska	X	X	X	
	GC Rieber Salt	X	X	X	
Maritime Transport Providers	Samskip	X			
	DB Schenker	X			
	Norlines		X		
	DFDS			X	
	ColorLine	X	X	X	
	Stena Line			X	
Road transport providers	Bring		X		
	Agder Kollektivtrafikk				X
	DB Schenker	X			
	Norlines		X		
Energy providers	Gasnor		X		
	Agder Energi		X		
	Naturgass Nord				X
	Hafslund	X	X	X	
Trade and-interest organizations	Norwegian Ports				X
	Norwegian Coastal Shipowners				X
	GCE NODE		X		
	Zero			X	

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