New Tides in Shipping
Studying incumbent firms in maritime energy transitions
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Mylimiems Tėveliams Irenai ir Vytautui
Abstract
Shipping is a cornerstone of global transportation responsible for moving large volumes of traded goods. At the same time, negative environmental impacts of shipping operations have attracted growing concerns. Although recognised as the most energy-efficient mode of transportation compared to air and land-based transport, maritime transportation contributes significantly to air-borne emissions, alongside other types of pollutants. Hence, it is apparent that alternatives to highly polluting conventional marine fuels, i.e., crude oil or diesel, have to be found in shipping, just as in other sectors. Responding to calls for a greater attention to actors’ roles in transitions, as well as for broader sectoral coverage of empirical work in the field of sustainability transition studies, this doctoral thesis explores the role of incumbents (established shipping firms) in the early stages of maritime energy transitions.

Focusing on incumbents is a relatively recent, yet rapidly evolving, stream of research in sustainability transitions studies, with increasing evidence showing heterogeneity and strategic variety in incumbent activities in various transition contexts. By drawing on a multi-level perspective from the socio-technical transition literature, the dynamic capabilities approach from the strategic management literature, and structuration theory, this thesis contributes new knowledge on “how” and “why” frontrunner incumbent shipping firms engage with maritime niche technologies and alternative energy solutions as well as what strategies they adopt to overcome increasing environmental sustainability pressures. These are the topics that have so far received scant attention in sustainability transitions studies. The thesis utilises a qualitative case study approach to study the selection of firms from passenger, vehicle carrier and container shipping business segments that are active in environmental work.

The findings of this thesis indicate that the roles of shipping firms in the early stage of maritime energy transitions are diverse and more complex than often accounted for in sustainability transitions literature. It is demonstrated that due to increased regulatory, social and competitive pressures, firms’ activities with regards to engagement in maritime niche technologies and alternative energy have shifted from reactive to a mix of strategies where a portfolio of solutions are pursued at the same time across and within individual firms. While adoption of incremental end-of-pipe technologies reinforces dependence on the fossil fuel energy system, a parallel engagement and experimentation with alternative energy solutions indicates that incumbent firms can also adopt a central role in niche development activities.

Keywords: shipping, incumbent firms, maritime energy transitions, multi-level perspective, dynamic capabilities, regime-niche interactions, decarbonisation, air-borne emissions, sustainability transitions
Sammanfattning
(Summary in Swedish)

Sjöfart utgör en hörnsten i det globala transportsystemet, och svarar för stora volymer av handelsvaror. Samtidigt väcker de miljöproblem sjöfarten ger upphov till oro. Även om marina transporter är mer energieffektiva än luft- och landbaserade transporter, medför sjöfarten betydande utsläpp till luften och andra typer av föroreningar. Precis som i andra sektorer finns det starka skäl att utveckla alternativ till dagens förorenande konventionella marina drivmedel, som exempelvis råolja och diesel. Den här doktorsavhandlingen lägger sitt fokus vid de etablerade rederiernas roll i de tidiga stadierna av energiomställningar inom den marina sektorn. Detta svarar mot ett behov av att rikta större uppmärksamhet mot olika aktörers roller i omställningar, och att bidra med empiriska studier inom sjöfartssektorn som kan underlätta omställning till en mer hållbar utveckling.

Avhandlingens fokus på etablerade rederier utgör en relativt ny, men snabbt växande, forskningsinriktning inom hållbar omställning, där allt mer vikt läggs vid rederiernas breddade verksamhet och strategiska variation. I avhandlingen används ett flernivåperspektiv hämtat från litteraturen om sociotekniska omställningar, teorin om dynamisk kapabilitet från området strategiskt ledarskap samt struktureringsteori. Denna ansats gör det möjligt att bidra med ny kunskap om hur, och varför, framstående rederier engagerar sig i marina nischteknologier och alternativa energilösningar, samt vilka strategier de använder för att hantera det ökande trycket att minska negativa miljöeffekter och blir mer hållbara. Detta område har hittills fått ringa uppmärksamhet i studier inom hållbar omställning. I avhandlingen används en kvalitativ fallstudiemetod, i syfte att studera utvalda företag i affärssegmentet för passagerar-, biltransport- och containerfartyg, som arbetar aktivt med miljöfrågor.

Avhandlingen visar att rederiernas roll i de tidiga stadierna av marin energiomställning är mångfacetterad, och mer komplex än vad som tidigare framgått i litteraturen om hållbar omställning. På grund av det ökande trycket från konkurrenter, lagstiftning och det omgivande samhället har rederiernas engagemang i marina nischteknologier och alternativa energilösningar utvecklats från ett huvudsakligen reaktivt förhållningssätt till en blandning av strategier, där en kombination av lösningar tillämpas såväl inom, som mellan, enskilda företag. Medan en successivt ökande användning av processteknik för avskiljning av föroreningar (så kallad ”end-of-pipe”-teknik) förstärker beroendet av fossila bränslen, visar ett parallellt experimenterande med alternativa energilösningar att även etablerade företag kan spela centrala roller i specifika nischers utveckling.

Nyckelord: sjöfart, rederier, marin energiomställning, regim–nischinteraktioner, flernivåperspektiv, dynamisk kapabilitet, koldioxidminskning, luftburna utsläpp, hållbar omställning
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III. Stalmokaitė, I., Larsson Segerlind, T., & Yliskylä-Peuralahti, J. Revival of wind-powered shipping: comparing the early-stage innovation process between an incumbent and a newcomer firm (under review with a special issue at Business Strategy and the Environment).

IV. Stalmokaitė, I., Rethinking structuration logics in socio-technical transitions theory (manuscript).

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I. Paper I: Idea of the paper and study design, collection of data, data analysis in cooperation with the co-author, conceptualisation, original draft preparation and revisions.

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III. Paper III: Idea of the paper, collection of data and analysis in cooperation with co-authors, conceptualisation together with co-authors, original draft preparation and revisions.

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<thead>
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<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
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<tr>
<td>HELCOM</td>
<td>Helsinki Commission; Baltic Marine Environmental Protection Commission</td>
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<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
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<tr>
<td>MARPOL</td>
<td>International Convention for the Prevention of Pollution from Ships</td>
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<tr>
<td>MEPC</td>
<td>Marine Environmental Protection Committee</td>
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<tr>
<td>MLP</td>
<td>Multi-level perspective</td>
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<tr>
<td>NECA</td>
<td>Nitrogen emission control area</td>
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<td>NO&lt;sub&gt;x&lt;/sub&gt;</td>
<td>Nitrogen oxides</td>
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<tr>
<td>Ro-Ro</td>
<td>Roll-on/roll-off vehicle carrier</td>
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<td>Ro-Pax</td>
<td>Vehicle and passenger carrier</td>
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<td>SECA</td>
<td>Sulphur emission control area</td>
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<td>SO&lt;sub&gt;x&lt;/sub&gt;</td>
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1. Introduction

Most of the things we use and consume in our daily lives be it food, apparel, pharmaceuticals, electronics, furniture, vehicles, building materials, fuel or fertilisers – you name it – do not fall like manna from heaven. More often than not, however, for most of the last decades the question of how these consumer goods reach us and with what environmental impacts was not of highest importance. One of the interviewees of this doctoral thesis once reflected the following: “When you buy a car, do you even think about how was it transported? I did not before I started working here … I have a German car, but it is produced in the U.S., and it was transported here [Sweden] … People started demanding that the production of things should be sustainable, but we also need to think of the transportation chain: how do we get these things to us? And [these types of questions] are growing in society now. People start thinking about that.”

Maritime transport is the dominant sector in global cargo movement responsible for transporting more than 80 percent of the global trade volume (ITF, 2020). Energy and food security around the globe, among other things, rely on international shipping (EEA, 2018). Being the oldest global transport sector, maritime transportation has gone through several major shifts such as a transition from sailing ships to steamships (Geels, 2002; Mendonça, 2013), the introduction of internal combustion engine (Pettit et al., 2018), and containerisation (Poulsen, 2007). Coupled with the growth of the global economy, maritime freight work increased by approximately 250% in the last fifty years, surpassing the growth in energy consumption (170%) and global population (90%) (Eskeland & Lindstad, 2016).

Shipping is often recognised as the most energy-efficient mode of transportation because of scale and relatively low levels of fuel consumption per ton of transported goods (Bouman et al., 2017). For many years, such energy-efficiency arguments undermined shipping firms’ engagement in reducing negative environmental footprints, especially concerning greenhouse gas (GHG) emissions. Regulating the sector, with its high levels of globalisation, has also proved difficult and often lead to weak regulations and increasing regulatory fragmentation in the environmental field (see e.g., Lister et al., 2015). Accordingly, a focus on negative environmental impacts of shipping has come forth relatively late to corporate agendas compared to other sectors (Gilbert et al., 2014). However, there are indications that it is changing now. Environmental sustainability is being referred to as a “burning issue” in the shipping sector and is expected to be a key topic of concern in the years to come (UNCTAD, 2019).

One of the “hot spots” in the current environmental sustainability debate in shipping concerns air-borne emissions. A range of pollutants such as sulphur oxide (SO$_x$), nitrogen oxide (NO$_x$) and carbon dioxide (CO$_2$) contribute to air pollution, acidify-
cation of seas and land, eutrophication and climate change (Corbett & Fischbeck, 1997; Salo et al., 2016). In particular, the levels of SO\textsubscript{x} and NO\textsubscript{x} emissions are much higher in shipping than in other modes of transportation due to the low quality of bunker fuels used in ships (Cullinane, 2014). Meanwhile, the global CO\textsubscript{2} emissions from international shipping are relatively low compared to those of other modes of transport (e.g., approx. 2.89\% of the global anthropogenic CO\textsubscript{2} emissions in 2018) (Faber et al., 2020). Recent assessments indicate, however, that if shipping was a country it would be the sixth largest CO\textsubscript{2} emitter globally (Balcombe et al., 2019).

Based on the International Maritime Organisation’s (IMO) most recent study on GHG, CO\textsubscript{2} emissions from all shipping activities (including international, domestic and fishing vessels) increased by 9.3\% during the period from 2012 to 2018 (Faber et al., 2020). Such an increase is at odds with estimates showing that if shipping is to contribute to keeping global warming below 2°C, it must reduce its carbon impacts by 85–90\% by 2050 compared to 2010 (Anderson & Bows, 2012).

Accordingly, to mitigate climate change impacts, shipping has to explore and reorient towards alternative low-carbon energy solutions (Gilbert et al., 2014; Traut et al., 2018). However, transition to alternative energy solutions in shipping requires overcoming the profound path-dependence that is characteristic to this sector because of large capital costs and the long lifetime of capital assets (vessels) (Pettit et al., 2018) as well as the limited availability of alternative fuels and alternative fuel infrastructure (Traut et al., 2018). In addition, technological considerations alone are not enough because business practices and operational considerations go hand in hand, and thus, as argued by Gilbert et al. (2014), any significant reduction of emissions in maritime transport will require changes across technology, practice and operational domains. Furthermore, a combination of solutions will have to be deployed simultaneously since “no single measure is sufficient by itself to reach considerable sector-wide reductions” (Bouman et al., 2017, p. 418).

While it is increasingly acknowledged that incremental energy efficiency measures will have to be complemented by alternative energy, and some major shipping companies have started experimenting with low or zero-carbon energy solutions (see e.g., IMO, 2021a), a majority of the global fleet, comprised of approximately 52,000 vessels\textsuperscript{1}, are still powered by conventional marine fuels, i.e., crude oil or diesel. Only a small fraction of seagoing vessels in operation (0.3\% of the total global fleet) and the ships on order (6.05\% of the total ship orders in 2018) use alternative energy (DNV-GL, 2019). Considering that the uptake of alternative energy solutions, such as liquefied natural gas (LNG), methanol, battery-electric and wind-based technologies, is in the early stage of adoption and others are under development (see, e.g., DNV, 2021; IWSA, 2021), maritime energy transition in shipping is still in a very early stage. Although decarbonisation in shipping may follow different paths compared to other sectors, the pressure of climate change is the same, and it is apparent that alternatives

\textsuperscript{1} Estimates of larger merchant vessels following 2017 figures (Balcombe et al., 2019). Meanwhile, there were 94,402 commercial seagoing vessels of 100 GT and above based on the early 2019 figures (UNCTAD, 2019).
to carbon fuels must be found in shipping just as in other sectors. Analysing how this early phase of transition unfolds is thus important for understanding challenges and opportunities linked to the emergence and adoption of new maritime niche innovations and alternative fuels (Bach et al., 2020; Rojon & Dieperink, 2014; Sjøtun, 2019) as well as roles that different types of actors such as maritime engineers (Sjøtun, 2020), frontrunner firms (Yliskylä-Peuralahti, 2016) and port actors (Bjerkan et al., 2021) play in this process. This thesis complements this body of work by focusing on the roles of established shipping firms that are more active when it comes to environmental sustainability (frontrunners) compared to other firms – an underexplored topic in the nascent research on maritime energy transitions.

Accordingly, the central focus in this thesis is given to exploring incumbents’ (established shipping firms’) activities oriented towards environmental sustainability in the context of early phases of energy transition in shipping. Focusing on incumbent shipping firms and their engagement with maritime niche technologies and alternative energy is important considering the business characteristics of the sector. Shipping is a highly globalised, competitive and increasingly concentrated sector (Lister, 2015). For instance, the top four container shipping firms (Maersk, MSC, COSCO Group and CMA CGM Group) are responsible for transporting approximately 50% of global container capacity (Alphaliner, 2020). Similarly, the top five vehicle carriers (Wallenius Wilhelmsen, NYK, MOL, ”K” Line and Höegh Autoliners) operate approximately 63% of the global vehicle carrier fleet (MarEx, 2017). Consequently, incumbent firms are well positioned in the markets, and their commitment to particular types of environmental technologies or alternative energy solutions can facilitate the direction of technological change and uptake of environmental innovations, thereby contributing to or hindering sectoral energy transitions in shipping (cf. Geels, 2010; Smith et al., 2010).

1.1. Research puzzle: Why focus on incumbents and shipping?

The urgency to address contemporary environmental challenges such as climate change, resource depletion and biodiversity loss has spurred research on sustainability transitions in the past two decades. Sustainability transitions are defined as “(…) far-reaching changes along different dimensions: technological, material, organizational, institutional, political, economic, and socio-cultural. Transitions involve a broad range of actors and typically unfold over considerable life-spans” (Markard et al., 2012, p. 956). Sustainability transitions research typically adopts a socio-technical system perspective as a special unit of analysis where transitions are understood as shifts from one socio-technical configuration to another (Geels & Schot, 2010). Illustrative examples of such socio-technical shifts are the hygienic transition from cesspools to sewer systems in the Netherlands (Geels, 2006) and transitions from horse-drawn carriages to automobiles (Geels, 2005), to name but
two. Building on historical case studies, the heuristic of the multi-level perspective (MLP) was developed to explain changes in socio-technical systems resulting from interactions between three MLP levels: landscapes (i.e., exogenous pressures and wider societal context), regimes (i.e., dominant practices and a semi-coherent set of rules) and niches (i.e., protected spaces where radical innovations emerge) (Geels, 2002). While the field comprises diverse theoretical approaches (for an overview see Köhler et al., 2019), the MLP framework is the most widely applied approach to studying historical and contemporary transitions (Hansmeier et al., 2021).

The “bigger picture” of how socio-technical shifts occur over time has been studied in different empirical contexts and through different lenses. However, some scholars have raised concerns that it may “have come at the expense of a more actor-oriented and agency-sensitive analysis” (Farla et al., 2012, p. 992). In response to these concerns, more nuanced accounts of actors’ roles and their agency in transitions have been elaborated (see, e.g., Avelino & Wittmayer, 2016; Farla et al., 2012; Fischer & Newig, 2016; Geels, 2020; Wittmayer et al., 2017). A recent review has indicated that although analyses of actors’ roles in transitions increased by half in the time period between 2016 and 2019, if compared to transitions literature before 2016, there is a need to deepen knowledge in this area, especially through widening “the sectoral and the spatial coverage of empirical studies” (Hansmeier et al., 2021, p. 173).

A “turn” towards actor-oriented analysis facilitated a more detailed examination of business firms’ roles in transitions – a relatively recent, yet rapidly expanding theme of research in sustainability transitions studies (Köhler et al., 2019). In this corpus of literature, the established business firms – incumbents – receive increasing attention, yet their roles and strategies are often portrayed through dichotomous regime vs. niche categories. For example, informed by a three-layered understanding of transitions, where seeds for change are assumed to emerge in niches, incumbent actors are often portrayed as proponents of status quo and contributors to the stability of a given technological regime (Geels, 2014; Johnstone et al., 2017). Such representation of incumbent firms’ roles in transitions is supported by empirical evidence and literature on path dependency, wherein incumbents are portrayed as inert and locked-in due to knowledge spill-over, complementarities in established business relations, and high switching costs (Henderson & Clark, 1990; Hockerts & Wüstenhagen, 2010; Unruh, 2000).

However, such one-sided views of incumbent firms’ roles in transitions have been argued to underestimate the potential roles of incumbents to support and engage in radical change processes (Bergek et al., 2013; Karltop & Sanden, 2012; Steen & Weaver, 2017). More recent empirical evidence from the automobile, horticulture and heavy vehicle sectors, among others, has demonstrated that incumbents can strategically reorient towards radical niches (Bergek et al., 2013; Berggren et al., 2015; Kishna et al., 2017) and develop new business models supporting radical innovations (Wainstein & Bumpus, 2016). Acknowledging the complex nature of organisational reality, van Mossel et al. (2018, p. 59) suggest “to maintain an open view when study-
1. INTRODUCTION

ing the behaviour of incumbents during a transition” and offer alternative explanatory approaches from the organisational studies, enabling a deeper understanding of incumbent behaviour during transitions and how it changes over time. Four typical roles of incumbent firms in transitions are proposed: incumbent firms first enter niches; incumbents wait until other pioneering actors enter niches first and then enter niches; incumbents do not move into niches and stay inert; incumbents use their authority and resources to delay and prevent the transition (van Mossel et al., 2018). While some approaches drawing on institutional, resource and strategy literature have been used to understand the potential roles of incumbents in transitions (see, e.g., Hansen & Coenen, 2017; Jain, 2020; Karltorp & Sanden, 2012; Mäkitie, 2019; Smink et al., 2015), others, such as the dynamic capabilities approach have received less attention (for few examples see, e.g., Hartman et al., 2017; Lieberherr & Truffer, 2015; Strom-Andersen, 2019). Accordingly, it is recognised that the transition theory could benefit from stronger links with strategic management and dynamic capabilities literature, especially for studying business actors’ roles in transitions (Geels, 2010, 2020).

Against this background and considering the call to deepen the understanding of incumbent behaviour in a variety of transitions contexts empirically (Turnheim & Sovacool, 2020) as well as conceptually (van Mossel et al., 2018), this doctoral thesis provides new insights by focusing on incumbents in the shipping sector – an empirical context that has so far received scant attention in sustainability transitions studies (Bergek et al., 2018; Köhler et al., 2019). Although the interest in the maritime industry in general, and shipping firms in particular, from a sustainability transitions perspective is in the early stages (see, e.g., Bach et al., 2020; Köhler, 2019; Mander, 2017; Sjøtun, 2020; Yliskylä-Peuralahti, 2016), the field of maritime transportation research has a long history and comprises a broad range of topics including, but not limited to, shipping safety, finance, ship performance management, governance and, more recently, innovation as well as environment and climate change (Acciaro & Sys, 2020; Bergsma et al., 2021; Shi & Li, 2017; Talley, 2013). Nevertheless, in the context of maritime research, a recent literature review conducted by Acciaro and Sys (2020) has revealed considerable gaps when it comes to a detailed understanding of strategic processes leading to innovation uptake among shipping firms, especially in the context of mounting environmental pressures to reduce negative environmental impacts, indicating a need for firm-level analyses. This doctoral thesis adds to the literature a new knowledge on “how” and “why” frontrunner incumbent shipping firms engage with environmental innovations, which is important for understanding how a window of opportunity for alternative vessel energy solutions comes about and what is the role of businesses in this process.
1.2. Research questions and structure of the thesis

Considering the aforementioned gaps in maritime research and sustainability transition studies, as well as the topical phenomenon of contemporary decarbonisation challenges faced by the shipping sector, this doctoral thesis aims to provide an empirical and theoretical account of how and why incumbent shipping firms engage in energy transitions as well as processes that provide different incentives and barriers to their agency. To this end, the thesis focuses on frontrunner firms’ decisions to uptake and develop environmental innovations aimed at reducing carbon footprints as well as local atmospheric pollutants such as sulphur and nitrogen emissions. In contrast to other industries and sectors, which are embedded in national contexts, maritime logistic companies – shipowners and shipping companies – operate in what van Leeuwen (2010) defines as a “footloose sector”. This means that shipowners have a high degree of flexibility and can choose to register their vessels in open-registry countries with less regulatory burden. The locational flexibility of shipping operations and the highly competitive business environment make the focus on individual frontrunner shipping firms especially interesting from a sustainability transitions perspective, facilitating analyses of agency dynamics. To provide a more nuanced understanding of incumbent firms’ agency in transitions, the thesis draws upon and integrates theoretical approaches from sustainability transitions and the strategic management literature (Papers I–III) as well as insights from the theory of structuration (Paper IV).

The aim of the thesis is divided thereby into two overarching research questions:

**RQ1:** What is the role(s) of incumbent shipping firms in the context of emergent energy transitions in shipping?

**RQ2:** How can a more nuanced understanding of business firms’ agency in transitions be captured with the support of the dynamic capabilities approach and the theory of structuration?

The first research question explores the role of incumbent shipping firms in relation to adoption of maritime niche technologies and alternative energy solutions in different empirical contexts (Papers I–III) and thus makes it possible to provide an empirical account of how shipping firms engage in the early stage of maritime energy transitions. The second research question sets out to nuance business firms’ agency theoretically by drawing on theories that make it possible to account for both dynamics of change and stability (see section 3) as well as by drawing on empirical insights gathered throughout the conduct of empirical case studies. Through answering the above questions, this thesis contributes to the field of sustainability transitions studies, as well as the maritime literature, by “zooming in” on how incumbent shipping firms perceive and handle increasing environmental sustainability pressures.
and what strategies they adopt to overcome them – a topic that has rarely been studied in detail. The apparent need for research pluralising the discussion on incumbent firms’ roles in transitions has been recently highlighted by Turnheim and Sovacool (2020), and this doctoral thesis responds to this call by providing new empirical insights from the shipping sector. Simultaneously, the thesis provides an alternative approach to analysing “strategic processes leading to innovation uptake in maritime logistics” – a topic that has to date received scant attention in the maritime literature (Acciaro & Sys, 2020, p. 3). Therefore, by merging the dynamic capabilities approach (Teece et al., 1997) with the MLP framework (Geels, 2002), the thesis contributes to a more integrated research agenda for management and transitions studies (see e.g., Markard, 2017; Schaltegger et al., 2020). In doing so, the thesis sheds light on the perceptions and activities of incumbent shipping firms and the processes through which incumbents engage in a variety of environmental innovations.

The thesis consists of the introductory essay and four individual research papers (see Figure 1, p. 30). Papers I–III focus on interrelated cases addressing contemporary environmental challenges in shipping. Altogether, these empirical case studies facilitate analyses of incumbent shipping roles in the early stages of maritime energy transitions from different angles. The vertical and horizontal axes in the Figure 1 position all papers in terms of their empirical and theoretical focus (y-axis) as well as capture to what extent each paper addresses either retrospective or ongoing processes (x-axis). For example, while Paper II zooms primarily into incumbents’ past activities oriented towards decarbonisation, Paper III focuses on the ongoing innovation process. Meanwhile, Paper I addresses both past and ongoing activities oriented towards the adoption of maritime niche technologies and alternative energy. The location of individual research papers along the continuum of the vertical axis indicates that papers differ from one another in terms of their theoretical focus (Paper IV), empirical focus (Paper I) or the combination of both (Papers II–III).
Figure 1: Paper overview

This introductory essay consists of six chapters. In the following Chapter 2, I provide a brief overview of the general characteristics of the shipping sector and discuss the regulatory context. Chapter 3 introduces the theoretical background and key literature that is combined in different ways in individual research papers. Thereafter, in Chapter 4, I discuss the research methodology, starting with the general research approach and research process. Then, I present the research material and analyses. In Chapter 5, I summarise key findings from individual research papers. Finally, in Chapter 6, I discuss key findings in relation to the overarching aim and research questions of this thesis, summarise overall contributions, discuss limitations and provide suggestions for further research.
2. Background: Empirical context

Shipping is often described as “the world’s first truly transnational phenomenon” (Vorbach, 2001, p. 28). A vessel can be owned by a Danish company, registered in Panama and chartered to a Portuguese shipping firm that provides shipping services in the Baltic Sea. Furthermore, considering the characteristics of the maritime value chain, the vessel can be designed by a naval architecture firm located in one country, contracted for building in the shipyard located in another country and have its parts (e.g., mechanical or electronic equipment) manufactured by highly specialised suppliers located yet in another country. Accordingly, shipping is a highly heterogenous sector and is situated in multi-jurisdictional environments, making its environmental impacts transboundary by nature.

Previous research indicates that shipping is a conservative sector where risk-averse attitudes towards new technologies have significant impacts on firms’ willingness to uptake new energy solutions or other types of technologies oriented towards reduction of negative environmental impacts (Gilbert et al., 2014; Rojon & Dieperink, 2014). This is not surprising given that large capital investments are needed for retrofitting existing vessels whose commercial life spans 20–30 years or building new vessels and associated infrastructures (e.g., landside investments in alternative fuel stations). Furthermore, Pettit et al. (2018) observe that socio-technical transition towards sustainability in shipping is complicated because maritime transport is strongly embedded in global production and consumption patterns that have taken decades to form and may take many years to change. In addition to high levels of globalisation, another structural factor influencing possibilities for change in the established business practices is the lagging, uncertain and fragmented regulatory environment (Poulsen et al., 2016). It is suggested, therefore, that environmental engagement is more likely when regulations are clearly defined and have strong enforcement mechanisms as well as when shipping firms’ customers are close to consumer firms with reputational risks (Poulsen et al., 2016). Previous studies also indicate that environmental regulations are often found to be facilitating the adoption of new technologies in shipping (Hermann et al., 2015; Hyvättinen & Hilden, 2004; Lai et al., 2011; Makkonen & Repka, 2016). Therefore, in what follows, I briefly introduce the regulatory environment in shipping.

2.1. Regulatory context: Global dimension

The global nature of shipping means that a large part of shipping operations takes place in international waters, making it “a footloose sector that is difficult to govern for a single state” (van Leeuwen, 2010, p. 54). Accordingly, most of the legislative measures regulating safety and environmental aspects in shipping are formed on the basis of international conventions, which are in turn ratified, enforced and imple-
mented on a national level. International conventions are developed under the umbrella of the IMO – a specialised agency of the United Nations mandated to address questions of safety, security and pollution prevention in international shipping. Given that environmental pollution from shipping activities is transboundary and thus beyond the capability of any single country to address, the IMO is the main international forum where Member States, primarily as flag states\(^2\) and coastal states\(^3\), discuss, negotiate and set international conventions for international shipping.

Although IMO was formally established in 1948, one of the first attempts to regulate intentional pollution from shipping activities at the global level was initiated as early as the 1920s by the United Kingdom and the United States of America, who were encountering oil pollution on their coasts and sought to launch international regulation to address it. However, the lack of engagement from other states resulted in failure to adopt the international agreement. (van Leeuwen, 2010) It was not until the 1950s and the 1970s that the first International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL, 1954) and International Convention for the Prevention of Pollution from Ships (MARPOL, 1973) were adopted as a result of increasing pressures from local environmental groups and growing oil transport traffic at sea (Mitchell, 1994). The major oil spill incidents of the grounding of the tanker Torrey Canyon (1967) near the south-west coast of England and the Exxon Valdez accident in Alaska (1989), to name but two, stimulated greater societal concerns over environmental damage caused by the release of large amounts of crude oil into the marine environment, which often led to the development of stricter environmental regulations in shipping (Knudsen & Hassler, 2011). The latter can be illustrated by the MARPOL 1973 convention, which, in addition to oil pollution, was set to cover other pollutants such as chemicals, sewage and garbage but was not enforced until 1983. According to Linne and Svensson (2016), a number of new pollution incidents at sea had to occur to facilitate the enforcement of what is now referred to as the MARPOL 73/78 convention – the primary international legal framework regulating pollution from shipping due to both operational and accidental discharges (Andersson et al., 2016).

In contrast to more visible pollution from shipping, such as oil spills, other type of pollution, such as air-borne emissions, are typically less visible. In addition, operational pollution is often more complex to address from a regulatory perspective since the amounts of pollutants introduced into the environment “seem harder to grasp and are consequently not as likely to increase the progress of regulation in the same way as visible pollutants released in spectacular accidents” (Linne & Svensson, 2016, p. 81). The slow pace and complexities behind setting emission targets to control air-borne emissions from international shipping at IMO are well docu-

\(^2\) Flag State refers to the country where the vessel is registered. Shipowners have the freedom to decide in which country to register individual vessels, which may be different from the country of residence of the shipowner.

\(^3\) Coastal State refers to any country whose maritime zone is used for maritime transport and which may have special interests in ensuring environmental protection within its maritime zone (Linne & Svensson, 2016).
mented. For example, regulations of air-borne emissions came relatively late compared to other sectors and are addressed in the MARPOL 73/78 Annex VI – Prevention of Air Pollution from Ships – which was adopted in 1997 and entered into force in 2005. In a nutshell, Annex VI covers a range of technical and operational measures oriented towards reduction of sulphur oxides (SO\textsubscript{x}), nitrogen oxides (NO\textsubscript{x}), ozone-depleting substances and volatile organic compounds (IMO, 2021b).

To demonstrate difficulties in regulating global shipping as well as highly complex policy-making processes at the IMO level, Svensson (2011) traces the history of SO\textsubscript{x} emission reduction standard development by studying the IMO documents issued between 1988 and 2008. The study results reveal that the first SO\textsubscript{x} reduction target of 4.5% adopted in 1997 was well above the global average of actual sulphur content in marine fuels (less than 3%) used at the time, indicating the lack of regulatory pressures and the highly politicised nature of the decision-making process at IMO, where industry interests influence regulatory outcomes (Svensson, 2011). As noted by an expert on regulatory affairs from a shipping classification society: “There [at IMO] are a lot of vested interests and people use whatever they can to delay things. When things are more complicated then we need more knowledge. So it is about “eating” an elephant “one bit at a time” (Interview-21). After 1997, SO\textsubscript{x} emission reduction targets were revised several times and led to a differentiated approach to regulating SO\textsubscript{x} emissions (see Figure 2, p. 34): (a) vessels operating in so-called Emission Control Areas (ECA) were set to follow stricter SO\textsubscript{x} reduction requirements, and (b) vessels operating outside ECA areas were set to follow less ambitious SO\textsubscript{x} regulations. Similarly, the efforts to control NO\textsubscript{x} emissions from international shipping were addressed in MARPOL Annex VI and are regulated by three separate emission reduction logics: Tier I, Tier II and Tier III. While Tier I and Tier II regulations are global and stipulate maximum permitted levels of NO\textsubscript{x} emissions on marine diesel engines that are installed on newly built vessels from 2000 and 2011 respectively, Tier III level requirements are applicable only to newly built vessels that operate in existing NO\textsubscript{x} ECAs from 2016 and future NO\textsubscript{x} ECAs when agreed, enabling reduction of NO\textsubscript{x} emissions by 80% compared to the global Tier I emission reduction standard. (Salo et al., 2016)
In contrast to SO\textsubscript{x} and NO\textsubscript{x} emissions, which over the course of time received relatively stronger regulatory measures, the progress of addressing GHG emissions advanced with considerable delays. Although the need to address GHG emissions from international shipping was recognised by the IMO in the 1990s (Salo et al., 2016), it was not until April 2018 that the first IMO strategy on reduction of GHG was agreed. One important reason for the delayed action is that the IMO Member States, including the industry and environmental organisations that have the right to participate in the IMO meetings with observer status, have diverse interests and views on how GHG should be regulated. In addition, developing countries among the Member States argue that developed countries should take a larger responsibility in relation to the United Nations Framework Convention on Climate Change principle of “common but differentiated responsibilities and respective capabilities”. Meanwhile, others refer to the “no more favourable treatment” principle, implying that IMO rules should apply to all vessels regardless of their country of registration (Flag State). Disagreements upon the guiding principles create a negotiation environment that is particularly complex. (Hackmann, 2012)

Nevertheless, in the last two decades several recommendations and incentives aiming to control GHG emissions from international shipping have been agreed upon. In 2003, the IMO tasked the Marine Environmental Protection Committee (MEPC) to find the most suitable mechanism to reduce GHG emissions and acknowledged that some CO\textsubscript{2} reduction measures can exhibit an inverse relationship with efforts to reduce local atmospheric pollutants such as NO\textsubscript{x} emissions (IMO, 2003). In 2011, the IMO introduced the first technical and operational requirements aiming to improve vessels’ energy efficiency – the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP). The EEDI was designed to
incentivise energy efficiency improvements on new vessels (Bows-Larkin et al., 2015). However, it is regarded as a “soft measure” because it is applicable only to newly built vessels and reduces incentives to invest in more radical improvements going beyond energy efficiency (Gilbert & Bows, 2012). The SEEMP is operational and is designed to monitor the energy efficiency of existing vessels without setting concrete CO₂ reduction targets.

Considering that shipping was not included in either of the previous international accords on climate change – neither the Kyoto Protocol (1997) nor the Paris Agreement (2015) – IMO Member States were pressured to adopt an accord of their own. The Initial IMO Strategy on Reduction of GHG from Ships was adopted in April 2018. The strategy set out a list of short-term, mid-term and long-term measures to decarbonise the shipping sector by the end of this century, with the following ambitions: (i) to reduce carbon intensity from international shipping by further strengthening the EEDI requirements; (ii) to reduce CO₂ emissions per transport work across international shipping by 40% by 2030 and 70% by 2050 compared to 2008; and (iii) to reduce the total annual GHG emissions at least 50% by 2050 compared to 2008 (IMO, 2018). Finally, it was agreed that the strategy should be reviewed and updated in 2023.

To summarise, the global regulatory structure makes the control of emissions especially challenging, not least when it comes to monitoring and enforcement of existing regulatory standards. The example of early efforts to address SOₓ emissions in the 1990s indicates that new regulations can sometimes reinforce the status quo and “codify” already-established practices instead of becoming the motors for change. Although contemporary developments indicate that more stringent environmental regulations to control SOₓ and NOₓ emissions have been put in place, global regulations to reduce CO₂ emissions are still in the early stage and leave much room for strategic manoeuvring among shipping firms.

2.2. Regulatory context: Regional dimension

Uniform and international regulations that allegedly ensure a level playing field among shipping firms are generally supported in shipping. Even though the IMO is the main international agency entrusted to regulate pollution from shipping, a number of regional, national, local and private initiatives have emerged over the last decades. In most cases, such initiatives are developed by different actors, such as the European Union (EU), the Helsinki Commission (HELCOM⁴), port authorities and private industry actors, with the goal of strengthening or filling the gaps in international regulatory standards. Furthermore, considering that some of the world’s sea areas are extremely vulnerable to pollution, the global approach has been supplemented by regional regulations (van Leeuwen, 2015). In addition, implementation of

⁴ Contracting Parties of HELCOM are Germany, Denmark, Estonia, European Union, Finland, Lithuania, Latvia, Poland, Russia and Sweden.
global regulations and standards must be enacted on a regional and/or national level, which makes the latter an important source of influence as well (Gilbert et al., 2014). Van Leeuwen (2015) frames this development as “regionalisation of maritime governance” and provides four examples to illustrate it. The Port State Control⁵ and “Special Areas” are two IMO initiatives aiming to enhance the enforcement of already existing regulations as well as making it possible to introduce stricter environmental regulations in particularly sensitive sea areas. Two other examples concern a more active participation of the EU in the development of more stringent environmental and safety standards for shipping as well as the emergence of market-based incentives (van Leeuwen, 2015).

The incentives of the EU and other regional cooperation formats (e.g., HELCOM) have been instrumental in strengthening environmental protection from the pollution of shipping at regional levels (Hassler, 2016; Söderström, 2017; van Leeuwen, 2015). The Baltic Sea area is a prominent example of a regional approach to regulating pollution from shipping where more rigorous environmental regulations, in the form of ECAs to control SOₓ and NOₓ emissions from shipping are applied⁶ (see Figure 3, p. 38). The backbone of regional environmental cooperation is HELCOM – the governing institution of the Helsinki Convention – which is the first regional sea convention of this kind, established to protect the Baltic Sea marine environment in 1974 (see e.g., Söderström et al., 2015). HELCOM played an important role in proposing to grant a special protection status to the Baltic Sea and establish a Sulphur Emission Control Area (SECA) under the MARPOL Annex VI in the early 1990s. When the resistance to introducing global SOₓ regulations at the IMO level in the early 1990s became apparent, leading to a failure to meet the environmental objectives of the Baltic Sea states, HELCOM Member States proposed the introduction of a regional and thus more stringent approach to regulating SOₓ emissions from shipping activities in the Baltic Sea area (Interview-16). Consequently, in 1995, HELCOM Member States submitted a proposal to the IMO underlining the need to designate the Baltic Sea as a SECA, highlighting the environmental vulnerability of the Baltic Sea as well as high levels of SOₓ emissions caused by intense shipping traffic in the area (IMO, 1995). The decision to adopt Baltic Sea as a SECA was made in 1997 and entered into force in 2005, making it the first sea area in the world where a more stringent SOₓ emissions standards for shipping are applied (IMO, 2021c). Since then, SOₓ emission requirements have been tightened several times (see Figure 2, p. 34) and more SECA areas have been introduced globally.

⁵ Port States have a full jurisdiction to inspect ships entering their ports for compliance with international safety and environmental regulations and thereby complement the responsibility of Flag States whose capabilities to ensure compliance have been increasingly questioned by environmentalists and Coastal States (van Leeuwen, 2010).

⁶ Other sea areas that are covered by ECA regulations are the North Sea, the English Channel, the North American coastlines and the United States Caribbean Sea (IMO, 2021c).
HELCOM was also a focal point for discussions regarding the introduction of tighter NO\textsubscript{x} emission limits for shipping activities in the Baltic Sea area. In contrast to the SECA, the introduction of a Nitrogen Emission Control Area (NECA) in the Baltic Sea was accompanied by a heated discussion among HELCOM Member States. Although the first regional agreement to submit a proposal to the IMO for the NECA status was agreed in 2010, the process was postponed in 2013 due to the resistance from the Russian Federation (HELCOM, 2013; Winnes et al., 2016). The delay occurred due to political disagreements on the enforcement date and the availability of technical measures enabling the compliance with the NO\textsubscript{x} Tier III emission standard. Notably, the same NO\textsubscript{x} Tier III emission limits were adopted for shipping in the North American ECA in 2010 and came into effect in 2016. However, in the case of the Baltic Sea NECA, high costs, competitiveness and the availability of alternative energy solutions such as LNG were key arguments that were put against introducing NECA in the Baltic Sea in 2016 (Winnes et al., 2016). An interviewed official from HELCOM noted the following: “…the whole debate was a bit different than with SECA because the focus in NECA has been on new ships. So, I would say it was fundamentally different debate because it is not addressing existing ships. So, it is more what kind of technology is expected to be used when they [shipowners] order new ships” (Interview-16). When disagreements about technical and enforcement matters were resolved as well as when a similar initiative aiming to introduce tighter NO\textsubscript{x} Tier III emission limits in the North Sea came about, HELCOM submitted a proposal to the IMO underlining the need to introduce the Baltic Sea as a NECA area in 2016 (IMO, 2016). During the MEPC meeting, in July 2017, IMO adopted the decision to introduce NECA in both the Baltic Sea and the North Sea with regulatory requirements coming into effect from 1 January 2021 (IMO, 2017).
To summarise, regional initiatives such as the introduction of more stringent environmental requirements in ECAs were instrumental in enhancing the prevention of pollution from shipping activities in some regions. The examples of the Baltic Sea SECA and NECA demonstrate how proactive countries can use established regional cooperation formats to push for stricter regulations. However, they also indicate that countries may be driven by different interests, which can delay the regulatory progress.
The theoretical foundation of this doctoral thesis comprises two bodies of literature: (a) the multi-level perspective (MLP) of socio-technical transitions theory, and (b) the dynamic capabilities approach from the strategic management literature. Both approaches are used independently (Papers I–II) as well as in combination (Paper III) to guide and inform empirical observations and to answer the research questions of individual case studies in this thesis. An overview of both bodies of work is provided in the subsequent sections. First, the central concepts that constitute the theoretical backbone of this thesis and are applied in Papers I–IV, although to different extents, are defined. The primary focus is given to four concepts, namely incumbents, environmental innovations, agency and structuration. The latter two represent the basis for theoretical discussion in Paper IV. Next, general characteristics of the MLP framework are discussed, since this helps to contextualise incumbents’ activities in relation to the broader environment. Thereafter, the dynamic capabilities perspective make in possible to “zoom in” on firm-level processes is introduced.

3.1. Defining key concepts: Incumbents, environmental innovations, agency and structuration

The term *incumbent* can be used to refer to actors in a variety of social domains such as state, civil society, trade unions, non-governmental organisations, knowledge production and markets (Turnheim & Sovacool, 2020). As noted by Apajalahti (2018), the notion is used “to create juxtaposition between the old and the new” and carries specific connotations. In so doing, it ascribes certain characteristics and qualities to actors and their activities. For example, the most common incumbent-like attributes referred to in the literature are authority, concentration of influence, privilege and power. The varying depths and forms of these attributes are argued to “(...) often form a reason why so many grave worldwide problems remain so persistently unresolved” (Stirling, 2019, p. 1). In a nutshell, incumbents are often portrayed as protagonists of the status quo whose practices to a greater or lesser extent contribute to the continuity of established ways of doing.

While the term *incumbent* can refer to actors in a variety of societal realms, it is used in this thesis primarily to define established corporate actors – business firms. I apply the definition introduced in transition studies by Steen and Weaver (2017), who define incumbent firms in the following way:

(...) profit-seeking actors that are ‘established’ and ‘positioned’ in markets. Incumbent firms have vested interests, historically accumulated capabilities, established supply chain linkages and institutionalized ways of operating (Steen & Weaver, 2017, p. 1073).
It is important to point out, however, that while acknowledging the above characteristics of incumbent business firms, I do not adhere to the simplistic incumbent vs. newcomer dichotomy where incumbent firms are often viewed as resisting radical innovations whereas newcomers are portrayed as first movers in the economy – a view that is increasingly challenged in transitions studies by new empirical observations (Bergek et al., 2013; Berggren et al., 2015; Bohnsack et al., 2020; Geels et al., 2016; Strom-Andersen, 2019; Turnheim & Geels, 2019). As demonstrated by Hockerts and Wüstenhagen (2010), “big vs. small” or “incumbent vs. newcomer” distinctions are common in the field of organisational and innovation studies, although the roles of incumbents and newcomers have a long history of being questioned (Aghion et al., 2009; Chandy & Tellis, 2000; Christensen & Bower, 1996; Hill & Rothaermel, 2003; King & Tucci, 2002). Following O’Reilly and Tushman’s (2008) observation that there is ample empirical evidence to support both views, the one contending that established firms are inert and unable to address radical changes and the other asserting that firms can and do adapt in changing environmental circumstances, I maintain an open view, which, according to van Mossel et al. (2018) is a fruitful approach for studying the behaviour of incumbent firms during transitions. The dynamic capabilities approach makes it possible to maintain flexibility and an open view, since it represents “a continuum from low-impact (i.e., no major change on the firm’s operations) to a fundamental impact on how the business is run” (Lieberherr & Truffer, 2015, p. 104).

Another central concept in this thesis is environmental innovation. In contrast to the term innovation, which has a long history and is associated with the pioneering work of Joseph Schumpeter, who brought the concept into economic studies and situated the firm into the centre of the innovation process (Godin, 2017), the term environmental innovation is a recent construct (Kemp, 2010; van den Bergh et al., 2011). As demonstrated by Carrillo-Hermosilla et al. (2010), different definitions can be found in the literature, such as green, eco-, environmental or sustainable innovations. Albeit defined in various ways, the reduction of negative environmental footprints and their resulting impact on society is fundamental to the understanding of these concepts. For example, van den Bergh et al. (2011, p. 5) argue that “the main difference between environmental and ‘regular’ innovations is the combination of an urgent environmental problem that needs a solution but which is associated with external costs that do not enter the private costs of the polluter”. From this perspective, the term “environmental innovation” differs from the concept of innovation,

7 It is important to note that Schumpeter’s work is classified into two periods: (a) the earlier period – Schumpeter Mark I (1912) – where the focus is on the innovative activities of entrepreneurs and new firms, and (b) the later period – Schumpeter Mark II (1942) – where large and established firms are portrayed as key actors behind innovation in the economy (Malerba & Orsenigo, 1996). Although this shift in focus has often been interpreted and described in the literature as, e.g., “a ‘Schumpeter’s dichotomy’ (new entrants do radical innovation and incumbents do incremental innovation)” (see, e.g., Geels, 2019), some scholars observe that such a dichotomy is not apparent in Schumpeter’s work (see, e.g., Apajalahti, 2018, p. 39).
where the primary focus has been on economic value creation. “Environmental innovation” thus refers not only to economic but also to environmental and social value creation. Accordingly, innovation with an environmental sustainability focus is defined and understood in this thesis in the following way:

(...) a production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resource use (including energy use) compared to relevant alternatives (Kemp & Pearson, 2008, p. 7).

Following this definition, and in similarity to Schumpeter, who argued that innovation “need not be spectacular or of historic importance” and that it is important to observe the phenomenon “in the humblest levels of the business world” (Schumpeter, 1947, p. 151), the focus is given to environmental innovations that are new to a specific firm. Another important aspect is the classification of environmental innovations. Throughout this doctoral dissertation, a distinction is made between incremental and radical environmental innovations to highlight different dynamics of change with respect to reducing the dependence on carbon-based energy. Incremental environmental innovations such as end-of-pipe environmental technologies are “(...) gradual and continuous competence-enhancing modifications that preserve existing production systems and sustain the existing networks, creating added value in the existing system in which innovations are rooted” (Carrillo-Hermosilla et al., 2010, p. 1075). In contrast, radical environmental innovations require major changes and reconfiguration of various components (e.g., technology, infrastructure, standards) and may require new value creation. In the context of the MLP framework, radical environmental innovations are assumed to be part of niches, whereas incremental environmental innovations are assumed to reside at the regime level (see section 3.2). However, it is important to point out that any environmental innovation, albeit introduced to address a particular environmental problem, may lead to unintended negative side-impacts.

Finally, considering the aim of this thesis to understand how and why incumbent shipping firms engage in energy transitions, as well as underlying processes that provide different incentives and barriers to their agency, it is important to reflect upon the notion of agency and structuration (further elaborated in Paper IV). Both terms are important for understanding actors – incumbent firms – and processes that make action possible. I lean herein on Giddens’ theory of structuration, which is a common frame of reference among organisation and transition scholars (Albano et al., 2010; Grin et al., 2010). A key characteristic of an actor – individual or organisation (e.g., firms, government, non-governmental organisations) – is a capability to pursue a particular course of action: “(...) to intervene in the world, or to refrain from
such intervention” (Giddens, 1984, p. 14). Following Giddens (1984, p. 181), actors are understood as “the only moving objects in human social relations (...), who employ resources to make things happen, intentionally or otherwise” and, together with structural properties (rules and resources), are central to the understanding of how practices are enacted and reproduced over time (i.e., the process of structuration).

Agency is thus understood in reference to an actor’s capability to act, yet it should not be reduced only to individuals but should also include “collective entities such as trade unions, social movements and corporations” that “can be said to ‘act’ and therefore to exercise creative agency in shaping social life” (Giddens & Sutton, 2017, p. 24). For example, firms can deploy particular strategies and mobilise resources in the pursuit of business goals and by doing so adopt different roles in transitions (Farla et al., 2012). Giddens’ (1979) perspective enables going beyond structure-agency dualism in explaining the role of incumbents in the context of emergent energy transitions in shipping. The duality is embraced with the acknowledgement that both structural (rules and resources) and intrinsic actor attributes (knowledgeability and reflexivity) are of central importance for the understanding of firms’ activities. Importantly, neither structures nor actors’ individual characteristics, such as reflexivity, should be given a primary position in explaining incumbent firms’ activities and how they change over time:

(...) every process of action is a production of something new, a fresh act; but at the same time all action exists in continuity with the past, which supplies the means of its instantiation. Structure thus is not to be conceptualised as a barrier to action, but as essentially involved in its production: even in the most radical processes of social change, which like any others, occur in time (Giddens, 1979, p. 70, emphasis in original).

In a similar vein, Flanagan et al. (2011, p. 706) suggest that “actors are defined by their agency”, which in turn is enabled, shaped and constrained by institutions and the activities of other actors. The authors suggest that instead of seeing actors “as simply fulfilling a specific function in a pseudo-mechanical ‘system’” (ibid, p. 706) it is important to acknowledge that actors are playing roles in various processes, such as, for example, innovation, policy-making or research. In what follows, firms’ roles are defined as “as a set of recognizable activities and attitudes used by an actor [herein a firm] to address recurring situations” (Wittmayer et al., 2017, p. 49). It is important to note that Giddens (1979, p. 118), albeit critiquing the notion of role in social theory, did not reject it altogether and proposed that roles should be studied in relation to “actual practices that are the ‘stuff’ of social life” as well as rules and resources.

To summarise, agency is, in this thesis, defined in reference to firms’ capability to act, while structuration is defined in reference to the mutual dependence between
firms’ activities as well as rules and resources. In what follows, it is accepted that individual firms’ characteristics (e.g., competences, capabilities, reflexivity), as well as structures (e.g., rules and resources) underpin firms’ activities and the roles thereof, which can contribute to both change and stability.

3.2. The multi-level perspective (MLP):
Contextualising incumbent firms

The MLP is one of the most widely used theoretical frameworks in sustainability transitions research (Hansmeier et al., 2021) and was developed by merging insights from different social science theories and sub-disciplines, notably evolutionary economics, science and technology studies (STS), neo-institutional theory, innovation studies, and the theory of structuration (Geels & Schot, 2010). It is defined as a middle-range theory that combines concepts from other social science theories and specifies relationships between them into analytical models to offer explanation about concrete phenomena, for example, the transition from sailing ships to steamships (Geels, 2007, 2011). In so doing, the MLP framework “(…) is geared towards answering particular questions about dynamics of transitions” (Geels & Schot, 2010, p. 19). Transitions, in turn, are defined as “(…) radical transformation[s] towards a sustainable society as a response to a number of persistent problems confronting contemporary modern societies. These persistent problems express themselves into crises, such as food, water, mobility, and health crisis, as well as energy and climate crisis” (Grin et al., 2010, p. 1). Taking persistent societal and environmental problems as the point of departure, MLP scholars analyse how transition dynamics unfold over time. Explanations are built on distinguishing and specifying interactions between three MLP levels: landscapes, regimes and niches. A key premise of the explanatory narrative of how transitions come about is that developments at landscape and niche levels lead to different kinds of pressures; the timing and nature of these pressures, as well as the ways in which regime-level actors enact them, can lead to different change trajectories (Geels & Schot, 2007).

Landscape is understood in reference to (a) slow-changing developments such as demographics, societal concerns and climate change, and (b) external shocks and events such as financial crises, environmental catastrophes, rapid changes in oil prices and wars (Geels, 2019). Landscape-level developments are assumed to operate beyond the direct control of a single actor (e.g., individual firm or government). However, accumulating pressures or unexpected landscape events may influence actors’ activities on regime and niche levels. By drawing on examples from international shipping, Pettit et al. (2018) distinguish several landscape developments and events that can create various pressures on the established shipping regime. For example, structural shifts in trade patterns, climate change, opening or closing of major shipping routes, changes in fuel prices, increasing societal awareness of environmental issues, and major pollution incidents such as the grounding of an oil
tanker – all can create different pressures as well as opportunities for change. Therefore, questions of how landscape developments materialise in regime and niche environments and how they are enacted by regime- and niche-level actors are important for understanding the dynamics of agency.

Regime is another concept in the MLP framework that is central to the understanding of sustainability transitions, especially considering that “(...) transitions are defined as shifts from one regime to another regime” (Geels, 2011, p. 26). Although the notion of regime is argued to be “an interpretive analytical concept” (Geels, 2011, p. 31) and is defined in various ways in sustainability transitions literature (see, e.g., Markard & Truffer, 2008), a central assumption behind the regime concept is that path-dependence leads to institutional, techno-economic and socio-cognitive lock-ins (Geels, 2019; Klitkou et al., 2015). In other words, past investments, established practices and accumulated knowledge are inferred to “blind” regime actors to novel technological possibilities beyond the existing regime (Schot, 1998, p. 190). Although these stabilising mechanisms do no imply an absolute inertia, they allow only for incremental change that is aimed at improving and optimising existing ways of doing (Geels, 2007). Against this background, incumbent firms are often viewed “as the backbone of a regime” (Karltorp & Sanden, 2012, p. 67), who, because of sunk investment costs, complementarities in established business relations and vested interests, aim to maintain the status quo and contribute to the stability of the regime. However, the notion that incumbents are locked into regimes and only engage with incremental innovations is increasingly relaxed in the MLP framework: “(...) incumbent actors may also reorient towards radical niche-innovations (...) they can change strategic direction and reorient themselves as strategy literature has suggested (...)” (Geels et al., 2016, p. 898, emphasis in original).

Niches – the third concept central to the three-layered understanding of sustainability transitions – are the loci of variation, experimentation and radical innovations (Geels, 2002). Building on insights from evolutionary theory of economic change and innovation studies, transition scholars suggest that “radical innovations often emerge outside or on the fringe of existing regimes, where niches act as incubation rooms that protect novelties against mainstream market selection” (Geels & Schot, 2010, p. 22). Such protection is important because niches are largely immature in the initial formation stages from technological, economic and social perspectives, which makes it difficult for them to compete with established regimes (Schot, 1998). Protection can therefore be offered by demonstration and experimentation projects, public subsidies or investments of entrepreneurial actors who believe in the future viability of new technology. Newcomer firms and other actors outside the dominant regime are thus often seen as drivers behind development of radical innovations: “radical innovations are often promoted by actor networks that show little overlap with prevailing actor structures in a sector or technological field” (Markard & Truffer, 2008, p. 610). By utilising examples from the history of technology, Schot (1998) explains how the development of gas lamps in the nineteenth-century England was initiated by the
local network composed of new technology developers and curious investors (English textile barons). The first application of gas light took place in the niche of textile factories and thereafter spread to other public and private domains. The central insight from historical case studies, such as the one mentioned above, is that actors as well as context are important for understanding how the creation of niches takes place as well as how radical niches may contribute to potential regime shifts.

Against this background, the heuristics of the MLP framework are used in this thesis to articulate the research questions and organise empirical observations into narrative explanations by focusing on specific actors – business firms. In particular, the assumptions underpinning regime-level characteristics, often seen through the lens of inertia and path-dependence, are taken as a point of departure for studying incumbent firms’ roles in transitions and for contextualising their activities in relation to the broader environment (i.e., landscape pressures and radical niches).

3.3. Dynamic capabilities perspective

While MLP provides a broad framework for analysing change processes and resulting transition trajectories by focusing on three interdependent levels of explanation (landscapes, regimes, and niches), it has been acknowledged that for a more nuanced understanding of incumbent firm behaviour, and especially firm-level processes, additional theoretical perspectives are needed (Karltorp & Sanden, 2012; van Mossel et al., 2018). As demonstrated above, the analytical scope of MLP reinforces the interpretation that change inevitably comes from below (i.e., niches) (Turnheim & Sovacool, 2020). Consequently, explanation of the possible roles of incumbents (regime-level actors) in respect to niche development activities is limited. In this context, the strategy literature in general, and the dynamic capabilities approach in particular, have been suggested as promising theoretical avenues for capturing business-related mechanisms in the context of niche-regime interactions (Geels, 2010) as well as for extending relatively narrow understanding of firm strategy – beyond “routine-based variation” (Geels, 2020, p. 6).

The primary concern in the field of strategic management is how firms generate and sustain competitive advantage (Ambrosini & Bowman, 2009). The dynamic capabilities perspective, originating from the work of D. J. Teece and colleagues (Teece & Pisano, 1994; Teece et al., 1997), offers a theoretical lens for explaining how firms innovate and change. In so doing, it “occupies a central place in the entrepreneurship and competitive strategies literatures” (Zahra et al., 2006, p. 944). As demonstrated in the literature reviews conducted by Barreto (2010) and Ambrosini and Bowman (2009), the body of work on dynamic capabilities has expanded considerably since the seminal paper of Teece et al. (1997) and thereby proliferated into distinct definitions and understandings. In this thesis, the understanding of dynamic capabilities follows the conceptualisation offered by Teece et al. (1997), which, more recently, was rendered into a capability theory of the firm (Teece, 2019). This specific
approach has been applied to study firms’ management practices oriented towards sustainable innovations in different contexts such as aviation (Mousavi & Bossink, 2017), electricity (Darmani et al., 2017), food (Strom-Andersen, 2019) and water utility sectors (Hartman et al., 2017; Lieberherr & Truffer, 2015) and is therein applied to study incumbent firms’ in the shipping sector.

Departing from the resource-based view (Barney, 1991), evolutionary economics (Nelson & Winter, 1982) and Schumpeterian perspective on innovation (Schumpeter, 1934), among others, the dynamic capabilities perspective was developed to expand the understanding on how firms identify new business opportunities, renew resources and competences via “new combinations”, and develop business models, as well as introduce new services and products into the market with a goal of maintaining competitiveness (Teece, 1998, 2009). Considering the strengths and limitations of the aforementioned theoretical foundations, the dynamic capabilities approach was further elaborated in several important ways. For example, Teece et al. (1997) expanded the resource-based view by suggesting that firms’ competitiveness is subject to firms’ abilities not only to exploit existing resources, but also to renew resources and competences in changing environmental circumstances. Furthermore, acknowledging that the evolutionary theory of economic change was developed to understand “(…) industry behaviour, as contrasted to individual firm behavior” and thereby provided rather simplistic and stylised characterisations of individual firm behaviour (Nelson & Winter, 1982, p. 36), the primary focus in the development of the dynamic capabilities perspective was to enhance understanding of firm-level processes. In addition, it expanded the evolutionary economics’ routine-based explanation of firms’ innovation activities (i.e., variation), which is based on the idea that firms primarily engage in local search activities and radical solutions emerge through accidental discoveries. According to Teece (2012): “Routines identify how projects are run, but not necessarily how projects are identified, prioritized, and selected” (Teece, 2012, p. 1397).

Dynamic capability is defined as “(…) the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” (Teece et al., 1997, p. 516). Firms’ managerial abilities to engage with (1) sensing, (2) seizing, and (3) transforming are key components in the dynamic capabilities approach, which enable firms to both adapt and influence business environments (Teece, 2007, 2019). Sensing includes scanning, learning and interpreting opportunities and threats in the business environment, such as technological possibilities, customer demands, regulations and competitors’ moves. It involves sense-making, generating scenarios, and testing hypotheses against different stakeholders. Seizing means responding to sensed opportunities and threats through the development of new strategies, business models, products or services. Transforming entails realignment of the firm’s resources. The latter is especially important when a firm engages in exploratory activities oriented towards radical innovations. (Teece, 2019)
Against this background, the basic premise of the dynamic capabilities approach is that firms cannot fruitfully be viewed as homogenous black boxes. Firms differ not only with respect to the resources they possess but also regarding their abilities to renew “through learning, entrepreneurship, innovation, and astute decision making” (Teece, 2019, p. 3). Furthermore, dynamic capabilities arise not only from organisational resources and learning but also from organisational history (Teece, 2014). Although the importance of path-dependence and organisational inertia is acknowledged, routines acquired through past experiences are not, according to Teece (2014), “completely wooden” and can be renewed through sensing, seizing and transforming activities. In similarity to the notion of ambidextrous organisation (O’Reilly & Tushman, 2008), dynamic capabilities enable firms to accommodate exploitative and explorative activities (Teece, 2019). In this context, incumbent firms are not viewed as completely inert and unable to engage with radical innovations – a proposition which has been increasingly relaxed since the seminal paper on dynamic capabilities (see, e.g., Teece et al., 1997). Although transforming may be more difficult for some incumbents, it may certainly take place: “Much like the founders of start-up companies, entrepreneurial managers in established firms assemble and deploy resources in pursuit of fresh opportunities” (Teece, 2016, p. 209).
4. Research approach and methodology

In this section, I describe the research approach that guided the overall framing of this thesis including the selection of cases, research material and analysis. In addition, I provide methodological reflections and discuss research limitations.

4.1. Research approach and process

This doctoral thesis was guided by an interest in building a detailed understanding of incumbent firms’ engagement in the early stages of maritime energy transitions. A qualitative case study approach was deemed suitable for exploring how and why a selection of incumbent shipping firms decide to invest in the adoption and development of alternative energy solutions (i.e., environmental innovations). It made it possible to account not only for “a contemporary phenomenon (e.g., a “case”), set within its real-world context” but also for “other complex conditions related to the case(s) being studied” (Yin, 2012, p. 4). The latter are important for understanding how firms’ environment (e.g., regulations, stakeholders) provides incentives and barriers to firms’ agency. Case studies dominate research strategies in the field of sustainability transitions research (Zolfagharian et al., 2019), and in-depth case study designs are argued to be the most appropriate, especially “as new topics and transitions contexts are being explored” (Köhler et al., 2019, p. 20). For example, case studies have been previously used to study historical transitions, taking the system level as the unit of analysis (e.g., Geels, 2002) as well as ongoing transitions, taking the actor level (i.e., a firm) as the unit of analysis (see, e.g., Yliskylä-Peuralahti, 2016).

It is important to note, however, that “case study” is not a self-explanatory term and can refer to different things to different people (Schwandt & Gates, 2018). In this thesis, a case study is defined as “a research strategy that examines, through the use of a variety of data sources, a phenomenon in its naturalistic context, with the purpose of “confronting” theory with the empirical world” (Piekkari et al., 2009, p. 569). Therefore, a relatively broad understanding of a case study research is adopted, which could be best described as an overarching research approach to data collection, analysis and reporting rather than a mere description of what is studied (i.e., incumbent firms). Furthermore, case-derived narrative explanations are at the centre of the research approach adopted in this thesis. Narrative explanations combine description and interpretation: “Narratives are always about something or someone, who has certain aims, undertakes action, learns and adjusts” and thereby are suitable for capturing “complex interactions between agency and changing contexts” (Geels & Schot, 2010, p. 97).

The thesis consists of one theoretical (Paper IV) and three thematically interlinked case studies (Papers I–III) (see Table 1, p. 50). The selection of cases was guided by the overarching research interest to obtain a detailed understanding of an
interesting empirical phenomenon, namely the emergent experimentation with alternative energy solutions among shipping firms, indicating an early stage of sustainability transitions in shipping. It is important to note, however, that cases were not determined in advance but emerged during the research process (more detailed reflection provided in section 4.2). In other words, the first case study informed the development of the subsequent case, and so on. For example, the findings of the first exploratory case study (Paper I) did not contribute to theory development as such yet yielded an interesting conceptual and empirical puzzle that I chose to address further in Papers II-III. Insights gathered throughout the conduct of three individual cases altogether led to Paper IV, where a focus is given to an in-depth analysis of structuration logics in the MLP framework.

Table 1: Summary of case studies

<table>
<thead>
<tr>
<th>List of Papers</th>
<th>Type</th>
<th>Focus</th>
<th>Level(s) of analysis</th>
<th>Empirical material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper I (case study 1)</td>
<td>Exploratory multiple-case study</td>
<td>The case of incumbent firms’ engagement with maritime niche technologies and alternative energy</td>
<td>Organisational level: 5 firms and environment (changes in regulations)</td>
<td>Semi-structured interviews, company reports, informal communication, policy documents</td>
</tr>
<tr>
<td>Paper II (case study 2)</td>
<td>Explanatory multiple-case study</td>
<td>The case of incumbent firms’ reorientation towards decarbonisation</td>
<td>Organisational level: 5 firms</td>
<td>Semi-structured interviews, company reports, observations</td>
</tr>
<tr>
<td>Paper III (case study 3)</td>
<td>Comparative case study / extreme case</td>
<td>The case of an early-stage innovation process in the context of decarbonisation</td>
<td>Organisational level: 2 firms and environment (stakeholders)</td>
<td>Semi-structured interviews, company reports, observations, email correspondence, informal communication, press releases, news articles</td>
</tr>
<tr>
<td>Paper IV</td>
<td>Conceptual paper</td>
<td>Structuration logics in the MLP framework</td>
<td>Theoretical</td>
<td>Academic literature and empirical examples from Papers I-III</td>
</tr>
</tbody>
</table>

The socio-technical system is the common unit of analysis distinguishing the field of sustainability transitions studies from other research fields. At the same time, it is acknowledged that dynamics of change and stability of socio-technical systems can be studied “through different lenses and at different levels” (Geels, 2018, p. 230). In this thesis, the organisational level constitutes the main level of analysis in all case studies. A combination of theoretical lenses and empirical material is used to acquire a detailed understanding of “micro ideas, decisions, actions, or events of particular development episodes” (Poole & Van de Ven, 2000, p. 643). Accordingly, environmental innovations at the firm level constitute a central unit of analysis. Although such “zoom-in” strategies have been argued to be important, it has been highlighted that they run the risk of undermining the importance of other characteristics such as the multi-dimensionality of socio-technical systems, co-evolution and multi-actor
4. RESEARCH APPROACH AND METHODOLOGY

processes (Köhler et al., 2019). However, a focus on firm-level processes does not undermine the importance of a broader context in which firms are embedded, especially considering that firms’ engagement with radical environmental innovations requires simultaneous engagement with various elements of socio-technical systems (e.g., infrastructure, standardisation, stakeholders).

4.2. Selection of cases

When selecting cases to be studied, I considered the general characteristics of the shipping sector. A first important observation was that the extent of engagement in deploying environmental technologies and experimentation with alternative energy solutions varies between shipping firms and different shipping business segments. Therefore, it was important to select information-rich cases: “(…) those from which one can learn a great deal about issues of central importance to the purpose of the inquiry” (Patton, 2002, p. 273). For this reason, a decision was taken to focus on those incumbent firms that are more active when it comes environmental sustainability. Second, considering the fragmented regulatory environment in shipping, it was expected that the engagement in environmental innovations would be more pronounced in those regions where firms were experiencing stronger sustainability pressures (i.e., stricter environmental regulations). Therefore, the focus was placed on firms that operate in the Baltic Sea area with stricter environmental regulations (see section 2.2). Accordingly, the shipping segment and environmental performance were important selection criteria that were identified through desk research and participation in industry seminars.

The selection of the first case study (Paper I) was triggered by the interest in exploring to what extent stringent environmental regulations guided shipping firms’ decisions to invest in environmental innovations to reduce dependence on fossil fuels. Due to changes in environmental regulations that substantially reduced the permitted sulphur and nitrogen emission levels from shipping activities in the Baltic Sea area, the choice was made to focus on shipping companies trading in the Baltic Sea area on a permanent basis. In addition, the decision was made to focus on five established and information-rich frontrunner shipping companies specialising in particular shipping segments: passenger (Ro-Pax), vehicle carrier (Ro-Ro) and container transport. The choice of the first case study was motivated by the context conditions (institutional environment) as well as company characteristics (front-runners, established firms, shipping segments). The same set of companies were studied in the second case study (Paper II). In contrast to the first case study, where the focus was on local air-borne emissions and shipping firms’ practices oriented towards reducing them, in the second case, the attention was given to another environmental issue – carbon emissions. The findings of the first paper were puzzling: although it indicated that regulations were important, it explained little with regards to the variety of innovation practices that were adopted and opened new
perspectives to further assess the role of established firms in maritime energy transitions. Therefore, a focus on decarbonisation strategies in the context of thin governance framework (i.e., uncertain institutional environment when it comes to reduction of GHG emissions) made it possible to analyse agency dynamics more thoroughly in the second case study. Finally, the selection of the third case study (Paper III) was prompted by a puzzling empirical phenomenon. Two different types of firms operating in the Ro-Ro business segment – an incumbent and a newcomer – were discovered to be engaged in the development of alternative wind-based energy solutions for deep-sea shipping. Therefore, in contrast to Paper II, where focus was on the retrospective process of decarbonisation, in Paper III a focus was placed on the ongoing early-stage innovation process. The comparative case study thus made it possible to “confront” the incumbent vs. newcomer dichotomy and prevalent assumptions of business firms’ behaviour in transitions.

Finally, although the selection and design of all case studies was primarily driven by interesting empirical phenomena, reflection needs to be given to the role of theory and how it informed the selection and analysis of cases. The MLP heuristics and three interdependent conceptual levels (landscapes, regime and niches) prompted me to question whether changes in environmental regulation in shipping can provide stimulus for an endogenous regime change and to what extent it may provide a window of opportunity for regime actors – shipping firms – to invest in environmental technologies and alternative energy solutions. Although the MLP framework proved useful in guiding and organising my empirical observations linked to firms’ responses, especially taking into consideration broader processes, it turned out to be rather limited with regards to studying agency dynamics more thoroughly. The MLP framework was therefore kept in the “background” with regards to problematising the behaviour of incumbents during transitions in the second case study. The dynamic capabilities perspective was found to be a useful theoretical lens for explaining firm-level reorientation and change in strategies over time. Moreover, theoretical preconceptions linked to novelty emergence in socio-technical systems, as well as assumptions with regards to the role of niche- and regime-level actors in transitions, stimulated my thinking and prompted me to explore these questions in more detail in the third case study. Finally, I found it to be important to reflect upon the idea of structuration in MLP, to which I briefly refer in the first case study (without a more substantial engagement). Although I adopted the idea of structuration, as suggested in MLP, in the beginning of my research, over the course of time, I kept thinking of the limitations of structuration as conceived in MLP. In particular, I considered the lack of micro-foundations of agency in MLP and kept asking myself to what extent structuration logics, as conceived in MLP, provide equal opportunities to account for structural and agency components. My engagement with the last paper was motivated and inspired by these theoretical considerations.
4.3. Research material and analysis

Different types of primary and secondary material were utilised in this thesis to answer the research questions in the individual papers, including transcripts from semi-structured interviews, notes from seminar and workshop observations, company reports and press releases, policy documents and reports, email correspondence and peer-reviewed literature (see Appendix A). In what follows, I provide an overview and explanation of how this material were used and analysed in the thesis.

Semi-structured interviews were used to learn about shipping firms’ past decisions to engage with environmental innovations, ongoing innovation processes and how shipping firms rationalise their activities, paths for the future and changes in the business environment. To gain a broader understanding of shipping firms’ business environments additional interviews were conducted with four shipowner associations representing shipping firms’ interests on national and international levels, national authorities, a ship classification society and a regional authority responsible for environmental protection. Interviews with representatives from a broader shipping environment made it possible to get clarifications on specific topics linked to individual case studies, such as the policy context of sulphur and nitrogen emission regulations and standard setting procedures linked to alternative energy technologies.

The collection of semi-structured interviews was undertaken in two phases. The first round of interviews (N=16) was collected during the period of 2017–2018, while the second round of interviews (N=6) was conducted in 2020. The material acquired during the first phase is used in Papers I–III. In addition to open-source interviews (N=3), the interview material acquired during the second phase is used in Paper III.

Interviewees were selected directly based on the area of expertise as well as through “snowball” sampling (i.e., following recommendations received from previous interviewees or other experts met at the seminars). Representatives from all studied firms were from different levels of organisation: managing directors, senior managers working with environment, sustainability as well as research and development projects. In all firms but two, more than one representative from a single company was interviewed to ensure as high a saturation in responses as possible (Rubin & Rubin, 2012). In the case of two shipping firms, the opportunity to talk to more than one representative was limited, and this aspect was considered during the interpretation of research material. This limitation was addressed by complementary open-source material (e.g., a firm’s reports and presentations).

In addition to interviews, participation in maritime seminars and workshop events facilitated entry into the empirical field and provided opportunities to learn about various themes that are topical in the maritime sector, such as best practice examples from shipping firms’ engagement with environmental issues and sustainability, environmental technologies and alternative fuels. I “entered” workshops and seminars with an open question (e.g., what is going on in shipping in terms of sustainability and reduction of negative environmental impacts?). I took notes during
presentations and engaged in conversations with participants from industry and other researchers undertaking research in the maritime field. It is important to note that these spontaneous meetings facilitated access to the shipping firms. A chance to meet senior managers proved very useful for conducting interviews and getting to know “whom to talk to” at the later stage. Finally, documentary material acquired from open sources such as firms’ annual and sustainability reports, press releases, firm websites, and news articles as well as internal firm documents (e.g., environmental programs) were used in different ways in individual papers. For example, in Paper I annual and sustainability reports were used to obtain background information on firms’ environmental work, prepare for the interviews and complement interview material in the analysis. In addition, an extensive number of annual and sustainability reports (dated 2007–2018, N=52) were used in Paper II to get information on firms’ commitments to address climate change and identify carbon reduction measures that firms adopted during the studied period. In Paper III, a mix of sources of evidence, such as interviews, firms’ press releases, annual reports, presentations, email correspondence, news articles and seminar observations, were important for tracing and identifying key events that lead to the initial phase of the innovation process.

The collection and analysis of empirical material unfolded in parallel. In other words, there has not been a clear distinction between data collection and data analysis. For example, the first interview was transcribed verbatim and analysed when the collection of additional interviews was still in progress (Kuckartz, 2014). Moreover, the interpretation of interview material included primary and secondary interpretations (Alvesson & Sköldberg, 2009). The first stage included making decisions about who should be interviewed, what questions were relevant for the purpose of the study, and what questions should be included in the interview guide as well as what follow-up questions should be asked during and after the interview. Meanwhile, secondary interpretations started after all interview material was transcribed verbatim. This stage included interpreting interview material and placing it into thematic categories and sub-categories. The qualitative content analysis research method (Kuckartz, 2014) was employed to analyse collected material (with the support of data analysis software NVivo in Papers II–IV). The analysis proceeded through the establishment of key categories (based on the research questions of the respective case studies and theoretical concepts) and sub-categories (based on empirical material). Thereafter, patterns and crossovers between categories and subcategories were analysed considering the analytical framework of the respective case study. Detailed overviews on operationalisation of key concepts, including examples from empirical material, are provided in the individual papers (e.g., see annexes of Papers I–II and method section in Paper III).
4. Research Approach and Methodology

4.4. Limitations of the methodology

The first concern linked to the case study design is the generalisability of findings. In this doctoral thesis, I have chosen to study a selection of shipping firms from the Ro-Ro, Ro-Pax and container business segments that are frontrunners in the field of the environment in order to gain a detailed understanding of what makes firms innovate for the environment, how they do it and for what purposes. Therefore, the findings of this thesis are context-dependent and can only be analytically generalised (Yin, 2012). Comparing the findings of this study with other case studies on shipping firms’ activities oriented towards adoption and development of alternative energy solutions is thus necessary. The second concern linked to the case study design utilising interview material is the question of accuracy and reliability. The degree of accuracy was ensured by audio-recording all interview occasions, followed by word-by-word transcription and by asking interviewees to review the interview transcript to make sure I was able to capture not only what interviewees said but what they meant (Rubin & Rubin, 2012). Additionally, on some occasions, follow-up questions were sent to interviewees asking them to clarify and elaborate particular aspects important for the case study report. To further enhance the construct validity of the study (Yin, 1994), I asked interviewees to review parts of the case study draft of Paper I and a full case study report of Paper III. The received feedback concurred with interpretations. Finally, the question of reliability is important. It concerns not only the process of data collection (e.g., finding interviewees who are knowledgeable about the research topic) but also the process of data analysis and reporting. Concerning the former, shipping firms’ sustainability reports may entail reporting bias, while interviewees may be inclined “to put the best face possible on their organisation” (Rubin & Rubin, 2012, p. 65). I have tried to mitigate this limitation to some extent by using complementary data sources, by ensuring confidentiality to all interviewees and by asking interviewees the same question in different ways (cf. Rubin & Rubin, 2012). Furthermore, considering that it may be challenging to know if the interviewee is speaking from first-hand experience or providing the firm’s official position, it was important to design interview guides to allow this distinction at least to some extent. For example, I have formulated questions by asking an interviewee to reflect upon a firm’s position and then asked the interviewee to share personal views. Finally, ensuring confidentiality to all studied firms in Papers I–II was another way to allow interviewees to openly reflect upon regulation and innovations – topics that may be considered sensitive for business firms. It is important to note, however, that only one of the studied firms objected that their company name would be used in the case study report. Ensuring confidentiality to firms studied in Paper III was not possible given that the studied innovation projects are very well known to the industry and it would have been difficult to secure the confidentiality.
5. Summary of papers

This thesis consists of four individual papers, which all contribute to increased knowledge on the role of incumbent firms in the context of emergent energy transitions in shipping empirically and theoretically as well as discuss actors’ agency in transitions more generally. While the entry points in Papers I–III are specific phenomena linked to contemporary environmental challenges in shipping, Paper IV deviates, yet is largely inspired by empirical observations derived from empirical case studies on incumbents in transitions. Paper IV is a theoretical paper attempting to map the progression of my thinking on actors’ agency in transitions more generally by drawing on the work of Anthony Giddens – the sociologist whose theorising on social change constitutes one of the “building blocks” of the MLP framework that I draw upon in Papers I and III. In this chapter, I outline the focus and main results of each individual paper, which I then discuss against the overarching thesis questions in Chapter 6.

5.1. Paper I: Incumbents, regulatory changes and environmental innovations

*Sustainability Transitions in Baltic Sea Shipping: Exploring the Responses of Firms to Regulatory Changes*

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Paper I is an exploratory case study aiming to understand how incumbent shipping firms address increasing regulatory pressures and what implications their choices may have for a reduced dependence on fossil fuels in maritime transport. To this end, the paper focuses on the adoption of environmental innovations amongst five incumbent shipping firms in the Ro-Pax, Ro-Ro and container shipping business segments by exploring their perspectives and responses to pressures caused by sulphur and nitrogen emission regulations (i.e., specific case) in the Baltic Sea emission control area (i.e., specific region). Using primarily interview data and the MLP framework from sustainability transitions studies, this paper provides empirical evidence for how an altered environmental regulatory regime prompted divergent incumbents’ responses and opened up a window of opportunity for the adoption of both incremental environmental innovations such as exhaust gas cleaning and selective catalyst reduction technologies, a switch to low-sulphur marine gas oil and more “transitional” fuel options (e.g., LNG and methanol).

Paper I contributes to the discussion on regime fragmentation and heterogeneity in sustainability transitions, by demonstrating that a single regulatory instrument can lead to considerably different response strategies amongst incumbent firms but also
to the adoption of different environmental innovations within a single firm. Previous research defined *regime fragmentation* as the emergent divergence in firms’ technology strategies (Karltorp & Sanden, 2012). **Paper I** demonstrates the role of incumbents in relation to the changing regulatory environment in this process and thereby addresses **RQ1** of this thesis. The comparison of incumbents’ perspectives and responses to SECA regulation on the one hand and NECA regulation on the other hand demonstrated considerable variation in relation to exhibited resistance and support towards environmental regulations. All studied incumbents, except for one, were highly critical and resisted a regional approach to regulating sulphur emissions in the Baltic Sea area, arguing for the importance of maintaining a level playing field. However, despite the resistance, three out of five studied incumbents (including the firm that demonstrated initial support for SECA regulations) chose to invest in equipping some of their vessels with alternative energy options. Meanwhile, the decision to introduce more stringent nitrogen emission level requirements in the Baltic Sea area did not trigger the same level of resistance among the studied firms. The fact that nitrogen emission regulations were designed to be operationalised mostly on newly built vessels constructed during or after 2021 that operate in the Baltic Sea area was found to be important for relatively positive responses. However, in contrast to SECA, none of the studied incumbents were found to be planning for the adoption of environmental innovations going beyond NECA requirements.

Although the level of regulatory stringency provided some explanation regarding incumbent firms’ engagement in experimentation and realisation of alternative energy solutions (e.g., LNG and methanol-fuelled vessels), it was not the only factor contributing to the uptake of environmental innovations going beyond regulatory requirements. In addition to the timing of other pressures (e.g., fluctuations in fuel prices, customers’ demands, increasing societal awareness of climate change, and the moves of competitors), firm-level strategic commitments were found to be important for launching LNG- and methanol-powered vessels into the market. Three studied incumbents were among the first ones to introduce alternative energy solutions in the short-sea-shipping vehicle carrier and passenger shipping segments. The use of LNG and methanol fuels required overcoming technological, infrastructural, regulatory and cognitive barriers since there was no previous experience with their use in shipping. Therefore, incumbents’ agency was found to be critical for managing technical and commercial barriers (e.g., lack of rules for ships using alternative fuels, fuel availability and infrastructure).

The findings of **Paper I** point to the need for a closer analysis of incumbents’ agency in a mature and global shipping sector characterised by a complex regulatory environment. It also demonstrates that although existing frameworks such as the MLP can help to explain some processes oriented towards radical system change, they lack the analytical sensitivity required to capture underlying firm-level processes and contribute to a more nuanced understanding of incumbents’ agency in transitions. Although different types of landscape and regime pressures (e.g., changes in regul-
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tions and fuel prices), as exemplified in Paper I, can provide relevant insights for understanding firms’ decisions to adopt environmental innovations, individual firm-level characteristics should not be overlooked. The latter is corroborated by the empirical findings in Papers II and III.

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5.2. Paper II: Incumbent firms’ reorientation towards decarbonisation

Dynamic capabilities and strategic reorientation towards decarbonisation in Baltic Sea shipping

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In contrast to Paper I where incumbents’ perspectives and innovation activities are explored against the backdrop of stringent local air-borne emission regulations, the focus in Paper II is given to the analysis of Baltic Sea shipping incumbents’ decarbonisation strategies in a relatively thin GHG regulatory context facilitating the analysis of firms’ agency. By drawing on multiple sources of evidence such as companies’ reports, observations and semi-structured interviews Paper II investigates incumbents’ reorientation towards low-carbon sustainability during the period of 2007–2018. The findings of this study question common views of established firms as agents resisting change and contribute to the discussion on the role of incumbents and strategic reorientation in the field of sustainability transitions studies empirically and theoretically. The paper addresses RQ1 and RQ2 of this thesis.

Theoretically, Paper II provides new insights on how the concept of dynamic capabilities and its underlying elements of sensing, seizing and transforming from the strategic management literature can be adapted to improve understanding of incumbents’ reorientation in sustainability transitions. Incumbents’ reorientation is argued to be characterised by: (1) directionality (focus on climate change), (2) innovations (mechanism enabling the reduction of carbon footprint), and (3) change in strategy and timing. Paper II demonstrates how focusing on underlying firms’ sensing, seizing and transforming activities enables capturing the dynamics of reorientation over time.

The results of Paper II demonstrate overarching commonalities in the patterns of innovation strategies oriented towards reduction of carbon emissions and how they change over time as well as differences within the portfolios of innovation strategies among firms. The analysis of incumbents’ sensing activities made it possible to capture a gradual shift with regards to how firms perceive opportunities and threats in their business environment and how they associate these observations with climate
change. We found indications of emergent reorientation in the form of changes in firms’ sensing activities in the later years of the studied period, when incumbents began acknowledging the importance of moving beyond energy efficiency measures due to increasing socio-political pressures, customer demands and competitiveness concerns. In relation to seizing and transforming, incumbents’ activities oriented towards the reduction of carbon emissions were found to be characterised by a gradual shift from reactive innovation strategies to a mixed portfolio of integrated active and proactive innovation strategies. During the early years of the studied period, all incumbents’ decarbonisation strategies were found to be centred solely around energy efficiency measures while during the later years of the studied period incumbents were found to increase variation in their seizing activities. In addition to considerable emphasis given to energy efficiency measures incumbents were found to engage in explorative activities such as experimentation with alternative energy solutions (e.g., hybrid-battery, biofuel and wind-based propulsion technologies).

Despite apparent commonalities in overarching patterns of reorientation (i.e., a shift from reactive to a mixed portfolio of active and proactive innovation strategies), the results of Paper II also point to considerable variations in the contents of active and proactive innovation strategies across firms but also within firms. The latter demonstrate that distinctive firms’ dynamic capabilities to build upon existing and develop new resource combinations are essential for engagement in entrepreneurial activities. In-house competences in ship design and vessel conversion as well as past experiences from operations in other maritime value chain segments (e.g., ship-building) strengthens incumbents’ capabilities to experiment with alternative energy solutions. Furthermore, one of five studied incumbents were found to simultaneously combine proactive and active innovation strategies whereby experimentation with hybrid-battery electric solutions onboard the older vessel is combined with conventional energy solutions for newbuilt vessels which are in advance prepared for potential fuel switches in the future. The latter example illustrates that incumbent shipping firms do not simply go from one type of seizing to another but strategically combine solutions enabling to reduce regulatory, market and technological uncertainties.

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5.3. Paper III: Early-stage innovation processes of wind-powered shipping

Revival of wind-powered shipping: Comparing the early-stage innovation process between an incumbent and a newcomer firm
Paper III offers an analysis of the early-stage innovation process of wind-powered shipping between an incumbent and a newcomer firm in the Ro-Ro shipping business segment. This study challenges common assumptions that incumbents are more resistant in relation to radical innovations and that smaller niche actors are the primary change agents in the economic systems. Although the literature increasingly acknowledges that this is not always the case, the focus on underlying firm-level processes that lead to engagement in sustainability-oriented innovations has so far gained only scant attention, especially in the context of maritime transportation. Paper III responds to this gap through a comparative analysis of ongoing innovation processes in two firms – one established and one newcomer – that have decided to bring wind-powered vessel design solutions to deep-sea transportation.

Paper III contributes to the knowledge on business firms’ roles in the emergent energy transitions in shipping. Firstly, by drawing on multiple sources of evidence such as semi-structured interviews, observations, companies’ reports, presentations and press releases, news articles and governmental reports, the study demonstrates how studied firms proactively engage in the development of renewable energy solutions and underlying processes, enabling firms to turn their strategic commitments into a concrete action. Secondly, by merging the dynamic capabilities perspective (sensing, seizing and transforming) and the MLP perspective, Paper III subscribes to a more integrated research agenda for strategic management and transition studies. In so doing, it develops a novel theoretical approach enabling it to capture business firms’ agency in the context of regime-niche interactions (RQ2). In particular, it demonstrates that the MLP framework affords the broader stakeholder perspective, which enables it to integrate MLP with the dynamic capabilities perspective and allows for novel insights into business agency in transitions.

The findings of this paper contribute to answering RQ1 of this thesis by demonstrating that business firms’ roles in transitions (newcomer/niche vs. incumbent/ regime) are not clear cut: incumbents can act as niche actors and newcomers can have tight connections with the established regime. The comparative analysis of the ongoing innovation process in both firms revealed that sustainability-oriented innovations – relevant from a wider sustainability transitions perspective – can be initiated by both incumbents and newcomers. Firms’ capabilities to sense, seize and transform across niche and regime boundaries were found to share overarching similarities and differences. While the analyses of both firms’ sensing revealed commonalities with regards to how both firms perceived the feasibility of wind-powered vessels for commercial shipping, their sensing activities were underpinned by different types of learning: “learning-by-doing” in the case of the newcomer Neoline and “learning-before-doing” in the case of the incumbent firm Wallenius. Past experiences from an earlier start-up firm were of key importance for the newcomer’s sensing, while systematic assessments, trend analyses and scenario develop-
ment were found to be essential for the incumbent’s sensing. These findings indicate that an incumbent’s position, resources and accumulated competences indeed allowed for a comprehensive market screening and exploration of alternative solutions which fed into seizing and transforming activities – something that newcomer firms may not always have access to. However, the findings also indicate that a newcomer’s prior experiences, albeit in different ways from an incumbent’s, can prove critical with respect to cumulative learning in the innovation process, facilitating the new value co-creation process that challenges the established ways of doing and thereby should not be underestimated. Another finding of Paper III revealing the complexity behind business firms’ roles in transitions derives from the analysis of both firms’ seizing and transforming activities. Both firms’ seizing and transforming activities were found to be interwoven with what is often assumed in the literature to belong either to niche or regime levels of structuration. In other words, despite differences in firms’ positions (newcomer vs. incumbent), simultaneous engagement across niche and regime boundaries (in the form of R&D projects, connections with established regime actors, etc.) were found to be critical in the early-stage innovation processes of both studied firms.

Status of the paper: Under review at Business Strategy and the Environment

5.4. Paper IV: Sustainability transitions, agency and structuration logics

Rethinking structuration logics in socio-technical transitions theory

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This paper revisits the multi-level perspective (MLP) of socio-technical transition theory from the point of view of one of its early foundations, Giddens’ theory of structuration. It introduces the concept of structuration logics to point out diverging interpretations of structuration in transition studies as well as in adjacent fields of research that transition scholars draw inspiration from. This paper provides an alternative view on how structuration logics can be interpreted – a view that is sensitive to the agency dimension but at the same time allows equal treatment of structural elements. In so doing, it contributes to answering RQ2 of this thesis. The argument is made that transitions theory may benefit from a broader understanding of structuration, where in addition to rules, the element of resources is equally accounted for. Bringing back the resource pillar to the prevalent “structurationist” explanations of the increasing levels of structuration in MLP is important for a more balanced account of agency dynamics. It makes it possible to demonstrate that a strong structuration on a regime level does not always lead to a stronger constraining influence on actors’ activities. Stronger structuration can also stimulate entrepreneurial agency
among regime-level actors if they possess enough transformative capacity to mobilise resources.

Accordingly, opening the black box of resources from a sociological point of view enables a more symmetrical and differentiated view on conceptualising structuration dynamics in MLP and provides a conceptual foundation for emerging empirical insights demonstrating that rules and resources manifest in agency in various ways, going beyond niche- and regime-level boundaries. Therefore, in addition to rules, dynamic resources are an important component that simultaneously enables and constrains actors’ use of niche- and regime-level environments.

Status of the paper: Manuscript
NEW TIDES IN SHIPPING
6. Discussion

In this chapter I discuss the findings of each individual paper in relation the overarching thesis research questions, main contributions and limitations, and outline potential avenues for future research.

6.1. The dual roles and different faces of incumbent shipping firms

The first research question of this thesis explores the role of incumbent shipping firms in the context of emergent energy transitions in shipping. Which strategies to reduce carbon footprint do the studied firms adopt and how do these strategies change over time? What are the underlying firm-level strategic processes leading shipping incumbents to engage in niche development activities? How and to what extent does the changing regulatory environment guide the shipping firms’ technology and alternative fuel choices and in what directions? These sub-questions guided the development of three case studies (Papers I-III) and thereby provided insights on how and to what extent incumbent shipping firms address contemporary energy challenges with respect to taking part in niche activities.

Shifting roles of incumbents: from reactive to mixed strategies

The overall findings of this thesis confirm results of earlier research from energy and automobile sectors suggesting that incumbent firms are not monolithic actors, implying that their roles and strategies change over time (Penna & Geels, 2015; Smink et al., 2015; Wesseling et al., 2015). The analysis of carefully selected frontrunner shipping firms providing transportation services in container, Ro-Ro and Ro-Pax shipping business segments indicates that shipping firms’ roles with respect to engagement in niche activities shifted from reactive to a mix of strategies, where a portfolio of solutions are pursued at the same time across and within individual firms. Based on the findings of Papers I–II, several contrasting roles can be distinguished that blur the ideal-type of incumbent roles in transitions reviewed by van Mossel et al. (2018): first to enter niches; follow into niches; remain inert or delay the transitions.

The opposition to stricter SO$_x$ regulations in the Baltic Sea area displayed by all but one of the studied incumbent shipping firms can be compared to the “delay the transition” mode of behaviour, resembling a reactive or what van Leeuwen and van Koppen (2016) describe as a “crisis-oriented environmental strategy”, that is dominant in maritime transport (cf. Penna & Geels, 2012). Perspectives towards stricter NO$_x$ regulations were found to resemble the “remain inert” mode of behaviour and were found to be influenced by the design features of the regulatory standard (e.g., applicable to new vessels constructed during or after 2021 that operate in the Baltic
Sea) and the fact that off-the-shelf solutions enabling compliance with the regulation were fully available and already tested by some of the incumbents (Paper I). The position of one incumbent, who supported stringent SO\textsubscript{x} emission regulation and was found to adopt the “first to enter niches” role, was found to be strongly linked with the company’s environmental vision, objectives and capabilities. Furthermore, it can be compared to the results of Mickwitz et al.’s (2008) study suggesting that those firms that already possess know-how and experience with respect to a particular environmental technology can benefit from stricter regulations and thus are likely to support tighter emission standards in the pursuit of competitiveness.

Despite considerable opposition to stricter SO\textsubscript{x} regional regulation, some of the studied incumbents chose radical environmental innovations going beyond SECA requirements (cf. Penna & Geels, 2015; Smink et al., 2015). Although the most common strategies of compliance comprised adoption of incremental environmental innovations (end-of-pipe technologies and switching to low-sulphur fuel), indicating the “remain inert” mode of behaviour, few incumbents simultaneously pursued “first to enter niches” and “follow into niches” roles by choosing to experiment with alternative energy solutions that were new to the established shipping regime (e.g., LNG and methanol).

In similarity to findings in other areas, such as the development of maritime water ballast treatment systems (Hermann et al., 2015), stringent environmental regulation, as demonstrated in Paper I, provided important impetus for exploring alternative fuel niches. However, firm-level resources, competences, and normative and cognitive commitments (e.g., expectations and possibility to differentiate from competitors), as well as broader trends such as changes in fuel prices, directed the extent and types of alternative fuels that were selected. The choices of the studied incumbents to build new vessels powered by alternative energy solutions (LNG) as well as to convert one vessel for methanol operation can be interpreted as initial signs of “regime fragmentation” – a concept coined by Karltorp and Sanden (2012) and further elaborated by Steen and Weaver (2017) to demonstrate the emergent incumbent divergence from established technology paths. From the perspective of the studied incumbents, both fuels represented radical solutions that challenged the established shipping regime. In contrast to off-the-shelf solutions such as scrubber technology, the choice of alternative fuels required overcoming technological, infrastructure, regulatory, normative and cognitive barriers. These findings indicate that in this particular context, a stringent maritime environmental regulation provided an important incentive for action among incumbent shipping firms, yet it did not per se direct the types of strategies that incumbent firms chose to adopt. The latter, as demonstrated in Papers II–III, were found to be dependent on how company-specific goals, resources and dynamic capabilities to sense new opportunities for a strategic advantage, and to seize them, interacted with socio-political pressures and customer demands.
It is important to point out, however, that LNG and methanol (unless methanol is produced from renewable sources) do not provide radical alternatives to the dominant fossil-fuel-based energy system in maritime transport since both types of fuels are produced from natural gas. Consequently, a switch to LNG or end-of-pipe technologies (e.g., scrubbers) increases infrastructure and fossil-fuel lock-ins and reduces the scope for decarbonisation options in maritime transport (Gilbert, 2014). This apt observation draws attention to the importance of “issue linkage” (Penna & Geels, 2015), implying that the coupling between environmental problems such as sulphur and carbon emissions as well as other external pressures such as economic crisis, can provide different “room for manoeuvre” for companies. Indeed, as demonstrated in Papers I–II, some of the studied incumbents’ decisions to invest in LNG and methanol were motivated by perceived opportunities to address future NOx regulation and reduce CO2 emissions to some extent, while others maintained that LNG was only an interim solution due to relatively limited possibilities to address carbon emissions.

The observation above leads to the final insight concerning the roles of incumbents in the case of addressing carbon emissions (Papers II–III). On a more general level, as demonstrated in Paper II, incumbents’ engagement in decarbonisation during the period of 2007–2018 has been found to be represented by a gradual reorientation trajectory. While during the early years of the studied period incumbent firms were mainly found to adopt reactive innovation strategies in a form of incremental energy efficiency measures – the “remain inert” type of behaviour, during the later years of the studied period, incumbents started experimenting with alternative energy solutions, adopting “follow into niches” and “first to enter niches” types of behaviour, in parallel with energy efficiency measures. Increasing socio-political pressures (e.g., anticipation of stricter GHG regulations) and customer demands, as well as changed perceptions towards competitive advantage opportunities (e.g., increased coupling between competitiveness and alternative fuels), were found to be important for gradual reorientation towards low- and zero-carbon niches. However, it should be highlighted that the observed changes were not found to be substantive in the sense that the studied incumbents did not yet fully commit to alternative energy solutions. Instead, the focus on increased energy efficiency is increasingly complemented with a gradual exploration of alternative energy solutions that are adapted to characteristics of a particular shipping segment and vessel types (e.g., Paper III). Furthermore, adaptive flexibility in terms of opportunities to use different fuel types is enhanced when ordering new built vessels (Paper II). How and to what extent these initial signs of reorientation at a firm level may contribute to a broader energy transition in maritime transport is a question for future research to explore in more detail. Nevertheless, the observed gradual reorientation towards alternative energy solutions among the studied incumbents can be compared to results from a recent study exploring the motives of incumbent firms in the automobile industry to invest in the development of electric vehicles. As demonstrated by Bohnsack et al. (2020, p.
738), the decisions of first-moving incumbent firms to invest and experiment with electrical vehicles in automotive industry, which Christensen (1997) identifies as an instance of disruptive technology, generated mimetic pressures and encouraged other firms who feared to lose their competitive advantage by “missing the boat” to follow suit. At this point, it can only be speculated whether a similar type of dynamics will unfold in the shipping sector. However, acknowledging the highly competitive nature of shipping and the fact that vessels that are built today will have to be “market proof” for decades to come, it is likely that efforts to explore alternative energy solutions will intensify in the years to come.

Enabling role of incumbents: Creators of radical niches

The observations above indicate that the studied incumbent shipping firms have been found to increasingly adopt a mix of contrasting roles: (a) “reproducers of the status quo” via continuous dependence on fossil-fuel energy system, and (b) gradual reorientation to alternative fuels and thus the creation of an enabling environment for radical niches. Both positions indicate that incumbent shipping firms can simultaneously adopt dual roles, which in the business and organisation studies literature is referred to as “ambidextrous organization” (O’Reilly & Tushman, 2008). This implies that firms are assumed to be capable of engaging in exploitative (refining existing ways of doing) and explorative (searching for new possibilities) activities at the same time. Although the proactive role of incumbents with regards to engaging in niche activities is captured with the “first to enter niches” mode of behaviour, the findings of Paper III indicate that shipping firms may adopt more proactive roles than being “among the first to exploit opportunities of a niche after it emerges” (van Mossel et al., 2018, p. 57, emphasis added). While the latter perspective acknowledges the enabling role of incumbents with regards to niche diffusion, it underestimates the possibility for incumbents to initiate niche development in the first place. As demonstrated by the case study of the ongoing innovation process of ocean-going wind-powered vessel development projects (Paper III), an incumbent can mobilise resources and established stakeholder relations with the support of its dynamic capabilities to initiate niche development. This finding confirms earlier case study observations from heavy hybrid-electric powertrain development by two Swedish incumbent firms (Berggren et al., 2015), the modern tramway niche development in France (Turnheim & Geels, 2019), and wastewater treatment niche development in the city of Ghent (Ampe et al., 2021), where established incumbent firms were found to adopt a central role in niche development activities from the start in cooperation with other incumbent actors (public authorities, suppliers etc.) in the pursuit of new business opportunities and in response to increasing public concerns. How and to what extent the dynamic capabilities can be deemed suitable for studying the business firms’ agency in transitions is discussed in the subsequent section 6.2.
6.2. Incumbents’ agency in transitions: Dynamic capabilities and structuration

The second research question of this doctoral thesis explores how the business firms’ agency in transitions research can be nuanced theoretically with the support of the dynamic capabilities perspective and the theory of structuration. The dynamic capabilities perspective has been applied in this thesis to describe and explain strategic changes in incumbent firms’ environmental innovation activities over time (Paper II) as well as to elucidate configurations of the ongoing innovation process between an incumbent and a newcomer firm by combining it with the MLP framework (Paper III). Considering that the theory of structuration is one of the early foundations of the MLP framework, which has been used to describe three central MLP concepts namely landscapes, regimes and niches in reference to “different degrees of structuration” or “different degrees of stability” (Geels, 2011, p. 37), Paper IV explored the scope of agency that structuration logics, as conceptualised in MLP, afford for actors who are often in quite a narrow sense portrayed as belonging to niche or regime levels. This bears important implications for studying the role of incumbents in transitions, who are increasingly found to be able to simultaneously be part of regime and niche levels (see, e.g., Bakker, 2014; Berggren et al., 2015).

First, as demonstrated in Paper II, the dynamic capabilities perspective can provide differentiated insights for studying how incumbent firms strategically reorient their innovation activities in response to increasing sustainability pressures to decarbonise. In contrast to earlier studies, where incumbents’ reorientation is studied at the industry level and is argued to unfold through successive phases (from the phase of resistance to the phase of full reorientation) (cf. Penna & Geels, 2012), the dynamic capabilities perspective reveals that strategic changes in business firms’ innovation activities – represented by a firm’s agentic dimension: capacity of act – are more nuanced than that and therefore must be explained at the firm level. For instance, as argued in Paper II, the three elements of the dynamic capabilities perspective introduced by Teece (2007) – sensing, seizing and transforming – can offer a conceptualisation of firm-level reorientation which is proposed to be characterised by: (a) directionality, (b) innovation, and (c) change in strategy and timing. As illustrated by the empirical examples of incumbent shipping firms’ engagement in decarbonisation (Papers II–III), the element of sensing indicates if and at what point of time a particular type of pressure (e.g., climate change, regulatory change) is perceived as either a threat and/or a business opportunity, which in turn provides direction for a firm’s strategic activities. The elements of seizing and transforming capture the timing and types of innovation strategies that are adopted, including mobilisation and relocation of resources that is needed to pursue a particular course of action (e.g., develop niches, first move into niches, follow into niches, remain inert). Altogether, the dynamic capabilities perspective and its underlying elements of sensing, seizing and transforming enable a more dynamic positioning of business
firms in transitions, where at any point in time a business firm’s agency can be conditioned by varying types and degrees of external pressures as well as the firm’s varying ability “to integrate, build, and reconfigure internal and external competences” (Teece et al., 1997, p. 516) to address changing environmental circumstances.

The dynamic capabilities perspective has proven useful with regards to nuancing how a business firm’s agency is enacted in the early-stage sustainability-oriented innovation process and enabled problematising the assumptions of the roles of incumbents and newcomers in transitions (Paper III). Here it is demonstrated that firm-level capabilities, underpinned by earlier experiences, different types of learning and contextual factors on landscape and regime levels are important components of firms’ agency enabling the engagement in niche development activities regardless of firm type or position (incumbent vs. newcomer). For instance, zooming into firms’ sensing, seizing and transforming enabled capturing how previous experiences and competences (cf. King & Tucci, 2002), in combination with different types of learning, shaped both of the studied firms’ abilities to act in relation to different stakeholders and initiate new sustainability-oriented business activities (e.g., development of wind-powered vessels). Zahra et al. (2006) suggest that there are key differences between the dynamic capabilities possessed by incumbent and newcomer firms, which indicates, albeit implicitly, that different types of firms may have different possibilities to exercise agency. The findings of Paper III substantiate the observation that an incumbent firm, because of its established resource position, may have better opportunities to engage in explorative search activities, which are often based on careful planning and learning from experience, while newcomers may implement a focused strategy from the beginning where learning is based on learning-by-doing and trial-and-error (see, e.g., Zahra et al., 2006). However, a detailed examination of sensing, seizing and transforming elements between an incumbent and a newcomer firm in the ongoing wind-powered innovation process demonstrates that some forms of learning (e.g., learning from experience and learning-by-doing) are not exceptional qualities featuring either an incumbent’s or a newcomer’s abilities to engage in niche development. Rather, as demonstrated in Paper III, incumbent and newcomer agentic capacity to engage in radical niches were shaped by different forms of learning that required developing intense connections with stakeholders across niche-regime-level boundaries; sensing, seizing and transforming elements enabled capturing these interconnections and provided a differentiated “(…) approach that transcends the niche-regime dichotomy (…)” from the perspective of business firms in transitions (Berggren et al., 2015, p. 1027).

Finally, the considerations above lead to the conclusion that incumbent firms’ agency is dynamic, and strategic management theories such as the dynamic capabilities perspective can be useful for conceptualising how agency is enacted in the context of changing environmental circumstances (Paper II), but also how agentic components (such as a capability to learn and mobilise resources in relation to
different stakeholders) unfold in a concrete sustainability-oriented innovation process (Paper III). However, how can a more dynamic view of incumbent firms’ agency in transitions be accommodated in system frameworks such as the MLP given that landscapes, regimes and niches are assumed to provide different degrees for manoeuvre or “different degrees of structuration” whereby incumbents are often portrayed as backbones of regimes? Considering that the three MLP levels “represent a continuum of structuration, coordination, stability and size” (Fuenfschilling, 2014, p. 32), entrepreneurial agency is commonly associated with niches: “(…) as the rules are less clear, there is less structuration of activities. There is more space to go in different directions and try out variety” (Geels, 2004, p. 913). On the other hand, in regimes, “(…) structures are more developed and provide strong structuration, making it difficult to deviate from mainstream practice” (Geels & Schot, 2007, p. 403).

As demonstrated in Paper IV, structuration logics, as presently conceived in the MLP framework, provide a somewhat one-sided view for conceptualising actors’ agency, since it is primarily linked to rules that enable and constrain actors (see also Sorrell, 2018). For example, it is commonly inferred that rules are more stable in regimes than in niches and therefore regime actors are more constrained than niche actors. The notion of resources, albeit fundamental to the understanding of strategic variation in actors’ activities and thus their capabilities to adopt different innovations (see, e.g., Geels, 2018; Smith et al., 2005), is undervalued in the current version of structuration logics in the MLP framework (Paper IV). Acknowledging that structuration theory has been criticised for giving insufficient attention to materiality (Sorrell, 2018; Svensson & Nikoleris, 2018), Paper IV demonstrates that the resource pillar is just as central as the rule pillar for understanding how agency is enacted through the process of structuration. For Giddens (1984, p. 25, emphasis added), the structuration is directly linked to “(…) activities of situated actors who draw upon rules and resources in the diversity of action contexts (…)”. By suggesting that an overly simplistic treatment of structuration logics, and thereby agency dynamics, in the MLP framework could potentially be overcome by nuancing the resource pillar in relation to structuration, Paper IV opens new questions for a continuously evolving sustainability transitions research agenda. What implications does a more detailed conceptualisation of resources in relation to three MLP levels provide for a well-established foundation of “a continuum of structuration” in the MLP framework? To what extent can “a continuum of structuration”, where rules and resources as well as dynamic capabilities of actors (i.e., different abilities of actors to mobilise and renew resources) are equally accounted for, provide explanation for observed variation of incumbents’ behaviour?

Importantly, it is not suggested that the theory of structuration – as one of the conceptual foundations of the MLP framework – can provide practical answers to the above questions. Indeed, as noted by Giddens (1984, p. 327), “The concepts of structuration theory, as with any competing theoretical perspective, should for many research purposes be regarded as sensitizing devices, nothing more. That is to say,
they may be useful for thinking about research problems and the interpretation of research results”.

6.3. Main contributions

This doctoral thesis has been guided by an interest in developing a better understanding of the role of established shipping firms in the early phases of contemporary maritime energy transitions. To this end, the thesis builds on and contributes to the existing body of knowledge in the field of sustainability transitions, strategic management and maritime studies. In what follows, I present the main contributions of this thesis.

New empirical insights on incumbents from the shipping sector

First, by analysing how and why incumbent shipping firms engage in various environmental innovations that may (not) support the creation of an enabling environment for sustainable energy transitions in the maritime sector, this thesis contributes to widening the sectoral coverage in sustainability transition studies. Arguably, the shipping sector in general, and incumbent shipping firms in particular, are to a large extent “the elephant in the living room” in the field of sustainability transitions research and only recently started catching attention among transition scholars. The scant attention given to the maritime sector in sustainability transitions scholarship is unfortunate given the mounting sustainability pressures faced by the shipping sector, where the importance and urgency of reducing negative environmental footprints on the one hand and the essential role of shipping for global economy on the other are underlined.

The contributions of three empirical case studies (Papers I–III) are therefore positioned in the context of an emergent body of work on maritime energy transitions. A focus on specific actors – incumbent shipping firms – and their roles in transitions provides a concrete angle for analysing early stages of energy transitions in shipping and therefore should not be interpreted as an attempt to provide an exhaustive picture covering “the whole elephant” of maritime energy transitions, a question for future research (see section 6.4). The cases provide new empirical insights with regards to what roles incumbent shipping firms adopt in relation to alternative maritime energy niches and how these roles change over time due to changes in contextual factors at different levels (Papers I–II). In addition to sustainability transitions studies, the empirical cases also contribute to the maritime literature by providing an in-depth insights on strategic processes leading to the uptake of environmental innovations among shipping firms (cf. Acciaro & Sys, 2020).
Furthering the understanding of incumbents with the dynamic capabilities perspective

Second, this doctoral thesis makes several conceptual contributions to the fields of sustainability transition studies and strategic management. By elaborating the relevance of the dynamic capabilities perspective for a detailed conceptualisation of incumbent firms’ agency in transitions (Papers II–III), this thesis contributes to a more integrated research agenda for management and transition studies (cf. Markard, 2017; Schaltegger et al., 2020). It is important to note, however, that in response to concerns over lack of attention to the role of firms and organisations in transition studies as well as lack of conceptual details for micro-foundations of actor-level processes in transitions (cf. Geels, 2020), previous studies made important contributions by importing concepts from organisational studies “(…) which have enriched MLP in many ways” (Geels, 2018, p. 227). However, there is still a relatively small number of studies using the dynamic capabilities perspective for empirical analysis in sustainability transitions studies. A few exceptions are the study by van Welie et al. (2019) who combine the capabilities perspective with the MLP’s regime concept to explain intra-regime dynamics and innovation challenges faced by the public utilities expanding to informal settlements in the Global South. A qualitative in-depth case study of an incumbent from the Norwegian meat-processing industry combines Teece’s (2007) view on dynamic capabilities with the MLP framework to demonstrate how an incumbent firm reorganised its capabilities in the pursuit of a new business strategy due to external pressures (Strøm-Andersen, 2019). In contrast, Darmani et al. (2017) employ descriptive statistics and the dynamic capabilities perspective to analyse firms’ investment decisions in renewable offshore wind power in Sweden. This doctoral thesis complements this emergent body of work by demonstrating how the dynamic capabilities perspective can be used to explain incumbents’ strategic reorientation towards decarbonisation in the traditional and highly globalised maritime sector (Paper II). Although the dynamic capabilities perspective is highlighted as a prominent perspective for studying shipping firms’ innovation activities and competitiveness (Jenssen, 2003), to the best of my knowledge, none of the previous research employs this perspective to account for shipping firms activities in the context of environmental sustainability and energy transitions.

Bridging the dynamic capabilities perspective with the MLP framework

Third, by combining the dynamic capabilities perspective with the MLP framework, Paper III demonstrates that operationalisation of the dynamic capabilities perspective in the context of MLP can help to better account for a broader firm’s environment, which “(…) cannot be defined in terms of markets alone” (Teece et al., 1997, p. 522) as well as to enable a more nuanced perspective on strategic variation in
business firms’ activities which is lacking in the MLP framework (Geels, 2020). Furthermore, focusing on how firms engage with environmental innovations complements the rather narrow perspective on “enterprise-level value creation” (Teece, 2014, p. 348) with a broader perspective on value co-creation in relation to different stakeholders (society, institutions, customers, research, etc.). Considering the latter, Paper III provides an important contribution by demonstrating how an incumbent’s and a newcomer’s dynamic capabilities to sense, seize and transform are interconnected with contextual factors and stakeholders at different levels (landscapes, regimes and niches). This is important given that the development of environmentally-oriented products and services requires broader stakeholder engagement (societal pressures, customers’ willingness to pay, regulatory change etc.). Accordingly, a more nuanced conceptualisation of business firms’ agency makes it possible to go beyond niche- or regime-level boundaries with respect to positioning business firms’ roles in transitions (an incumbent vs. a newcomer dichotomy) and contributes to a more symmetrical understanding of regime-niche interactions in transitions.

New avenues for enhancing the resource pillar of “structuration logics” in transitions theory

Finally, the assessment of the theory of structuration in the MLP framework (Paper IV) made it possible to demonstrate that the two elements of structuration – rules and resources – that are important for understanding actors’ activities have so far received imbalanced treatment with regards to defining the continuum of structuration in MLP. Paper IV demonstrates that in contrast to institutional or rule pillar of structuration, the resource pillar remains under conceptualised in relation to the continuum of structuration. Although the role of economic structures and markets – well established in regimes and lacking in niches – is acknowledged (cf. Geels & Schot, 2007), nuanced views on how resources come into a broader picture of structuration (that is in relation to actors’ activities) are lacking. This insight is especially important for analysing the roles of actors in transitions and in particular for “pluralising incumbencies in sustainability transitions” (Turnheim & Sovacool, 2020, p. 180). Arguably, the present conceptualisation of institutional plurality as a source of endogenous regime change (Fuenfschilling, 2014) provides but one way to explain possibilities for change in transitions. Another element is resources: “Incumbent actors can resist, delay or derail low-carbon transitions, but they can also accelerate them if they reorient their strategies and resources towards niche-innovations” (Geels, 2018, p. 230, emphasis added). The role of resources is increasingly found to be an important explanatory factor in why incumbents in the established industries reorient towards new technology paths (see, e.g., Borghei, 2018; Mäkitie, 2019) and therefore should be given more emphasis in the context of the continuum of structuration.
6.4. Limitations and avenues for future research

In this section, I turn to the limitations of this doctoral thesis and discuss potential avenues for future research.

First, focusing on a particular group of actors, that is, incumbent firms and their roles in transitions, is linked to a more general methodological dilemma in the field of sustainability transitions wherein a balance between “zoom-in” and “zoom-out” strategies involving different units and levels of analysis is discussed (Köhler et al., 2019). By choosing to study emergent energy transitions in shipping from the perspective of a selection of incumbent shipping firms, I followed a “zoom-in” strategy which made it possible to capture nuances of firm-level processes and firms’ roles in transitions, yet the findings of this thesis remained limited in terms of generalisability and could not account for a broader transition dynamics on a sector or system level. These observations thus make it possible to specify two potential avenues for future research. On the one hand, considering the nascent focus on shipping in sustainability transitions, more in-depth case studies are needed for building new insights on this topic. On the other hand, future studies should seek to make use of “zoom-out” research strategies, which remain a challenge when studying contemporary sustainability transitions in the international shipping sector because of high levels of globalisation and the complexity of value chains where shipping comprises only one link in this chain. While focusing on domestic or coastal shipping activities, as illustrated by more recent studies, enables the adoption of “zoom-out” strategies (e.g., Bach et al., 2020; Bach et al., 2021), future studies could further investigate methodological pathways for adopting “zoom-out” strategies for studying the challenges and opportunities of energy transitions in international shipping.

Second, the maritime value chain is comprised of a broad range of actors situated in different parts of the value chain, such as vessel design, shipbuilding, mechanical and electronic equipment manufacturing, shipping and shipping support (e.g., standardisation, regulation, finance, insurance, ports and fuel supply). While in this doctoral thesis the primary focus is given to shipping firms, there is a need to better understand the complexity and potential roles of incumbent and newcomer actors situated in different parts of the maritime value chain system in the emergent energy transitions. The findings of wind-powered vessel innovation processes demonstrate that firms can possess competences from more than one maritime value chain segment (e.g., vessel design and ship management), which can enhance their capabilities to engage in development of alternative energy solutions. Furthermore, the call for “recognising a multiplicity of incumbent actor types” (Turnheim & Sovacool, 2020, p. 182) is especially relevant in the context of shipping, where in addition to actors from the maritime value chain, the roles of policy-makers, non-governmental actors, trade unions and shippers warrant further research from sustainability transitions perspective.
Third, the selection of firms that are generally more active in environmental work, if compared to other shipping firms, made it possible to capture proactive perspectives. Even though a great variation in firms’ roles was observed, future studies could explore the role of firms that are less active in environmental work since they may demonstrate more resistance towards alternative energy solutions in the early phases. In case of the latter, the application of the dynamic capabilities perspective may unravel different dynamics where sensing, seizing and transforming could potentially be oriented towards strategies of imitation (cf. Bohnsack et al., 2020).

From a broader perspective, while in this thesis the focus was on exploring how incumbent shipping firms address a particular type of environmental problem, it is important to note that the question of energy is only one piece in a broader puzzle of serious environmental problems and thus considerations of what sustainability transitions in shipping may imply. Other environmental problems, such as noise pollution, ship strikes, and invasive species, to name but a few, bring forward a number of implications for the marine environment and its conservation potentials and in turn for the well-being of society in general. Furthermore, other mounting pressures such as digitalisation and automation, as well as a debate over degrowth and deep adaptation to climate change, which, as noted by Monios and Wilmsmeier (2020, p. 867), may “require radical changes in supply chains and a reduction in shipping capacity as a result of smaller vessels, shorter distances and contracted supply chains”, cannot be ignored. Although decarbonisation is one of the most pressing challenges confronting society today, it is not the only one. Accordingly, acknowledging this diversity and interdependency can provide alternative ways of thinking and different entry points to analyse the dynamics of sustainability transitions in shipping – enabling a search for synergies and dichotomies between multiple pressures on the one hand and avoiding potential lock-ins into one single issue on the other hand.

6.5. Concluding reflections

This doctoral thesis set out to provide an empirical and theoretical account of incumbent shipping firms’ roles in the early stages of maritime energy transitions. To this end, it explored how shipping firms address changes in the broader business environment as well as what types of environmental innovations they turn to in order to reduce negative environmental footprints. Understanding incumbent shipping firms’ activities and how incumbents rationalise their actions with respect to engaging in niche technologies can contribute to a better understanding of processes that hinder or support energy transitions in shipping. In what follows, I provide final reflections linked to the empirical and theoretical journey that this thesis embarked upon.

The thesis demonstrates that incumbent shipping firms are not a homogenous group of actors. Firms adopt a multiplicity of roles with respect to adoption and development of alternative energy solutions in shipping, which relates to more recent
observation by Turnheim and Sovacool (2020, p. 182) who note that “(…) the behaviours and strategies of incumbents are likely to change over time as part of internal dynamics (e.g., organisational learning) as well as significant changes in transitions contexts (e.g., accelerated dynamics or altered opportunity structures)”. In a similar vein, organisation scholars observe: “(…) incumbents in carbon-intensive industries have attempted to adapt to the heightened environmental pressure to reduce carbon emissions in more diverse ways than has been empirically studied, and theoretically assumed, in the related literature” (Sump & Yi, 2020, p. 3, emphasis in original).

These findings and observations can be taken as a point of departure for a more open reflection about possible roles of incumbent firms as well as other actors in transitions. Binary thinking, albeit tempting, may not be the most fruitful way forward. As the results of this doctoral thesis indicate, incumbent firms may have characteristics of what are often perceived to be qualities of newcomer firms: agility and entrepreneurship. At the same time, a newcomer firm, as demonstrated by the case study of the ongoing wind-powered vessel innovation process, may have incumbent-like characteristics. Furthermore, as demonstrated by earlier studies and empirical cases in this thesis, incumbent firms can simultaneously contribute to the maintenance of the status quo and engage in more radical forms of action. Following Pettigrew’s (1987, p. 658) line of thought that: “Explanations of change have to be able to deal with continuity and change, actions and structures, endogenous and exogenous factors, as well as the role of chance and surprise”, the explanation of incumbent behaviour in transitions in this thesis was offered by building on the MLP framework as well as the dynamic capabilities approach, since both of them make it possible, albeit to different extents, to account for stability and change as well as endogenous and exogenous factors, and when combined together can help to nuance actor roles in transitions. While it is not the first attempt to combine both theoretical perspectives, the integration of both approaches for explaining regime-niche interactions and business firms’ roles in the early stage of sustainability-oriented innovation process is a conceptual novelty.
7. References


NEW TIDES IN SHIPPING


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### Appendix A: List of seminars and interviews

<table>
<thead>
<tr>
<th>Code</th>
<th>Observations</th>
<th>Date</th>
<th>Place</th>
<th>Notes</th>
<th>Informal conversations</th>
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<tbody>
<tr>
<td>1</td>
<td>Lighthouse workshop “Towards a competitive, sustainable and safe maritime sector”</td>
<td>2016–12–15</td>
<td>Gothenburg</td>
<td>Yes</td>
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<tr>
<td>2</td>
<td>Congress Baltic Sea Future “Innovation, vision and leadership for a sustainable Baltic Sea region”, panel “How does the shipping industry contribute to a sustainable Baltic Sea region?”</td>
<td>2017–03–07</td>
<td>Stockholm</td>
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<td>No</td>
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<tr>
<td>3</td>
<td>NOR-shipping 2017 seminar “Sweden – Frontrunners in Sustainability, Efficiency and Innovation”</td>
<td>2017–05–30</td>
<td>Online</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>4</td>
<td>Donsö shipping meet &amp; HELCOM meeting of Sub-group on Green Technology and Alternative Fuels in Shipping</td>
<td>2017–09–05</td>
<td>Donsö</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>FORES lunch seminar “Launch of the report: the role of shipping in climate change”</td>
<td>2018–03–09</td>
<td>Stockholm</td>
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<td>No</td>
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<tr>
<td>6</td>
<td>Lighthouse seminar “Sustainable shipping through improved energy efficiency: why and how”</td>
<td>2018–06–13</td>
<td>Gothenburg</td>
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<td>Yes</td>
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<tr>
<td>7</td>
<td>WMU Global Ocean Conference. Ocean Industry Panel “Integrated Regulatory, Governance, Policy and Science Opportunities for Transformative Partnerships”</td>
<td>2018–05–09</td>
<td>Malmö</td>
<td>Yes</td>
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<td>8</td>
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<td>2019–09–25</td>
<td>Online</td>
<td>Yes</td>
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<td>9</td>
<td>Swedish Shipowners’ Association Seminar “Climate smart shipping: is climate compensation a piece of a puzzle?”</td>
<td>2019–10–29</td>
<td>Stockholm</td>
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<tr>
<td>10</td>
<td>DNV-GL Webinar “Navigating environmental regulations in 2020 – what next?”</td>
<td>2020–04–22</td>
<td>Online</td>
<td>Yes</td>
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<td>11</td>
<td>Sweship Annual Meeting “Hur skapar vi rätt förutsättningar för ökad konkurrenskraft och framtidens teknik?”</td>
<td>2020–04–23</td>
<td>Online</td>
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<td>Swedish Shipowners’ Association Webinar “Fairway Forward webinar best practice and think tank for green, smart and safe shipping”</td>
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<td>13</td>
<td>Webinar “Wind Assisted Propulsion Challenges and Perspectives” organised by Wind Assisted Ship Propulsion (WASP)</td>
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<td>Online</td>
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<td>Swedish Shipowners’ Association Training Week, Day 4 “Examples of how Swedish shipowners work with research and innovation”</td>
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<td>Snowball</td>
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<td>Snowball</td>
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<td>2017-10-23</td>
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<td>2017-10-31</td>
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<td>Position</td>
<td>Method</td>
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<td>n/a</td>
<td>Open-source interview</td>
<td>2020-10-01</td>
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Interview total: 25 (1463 minutes)
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Shipping is a cornerstone of global transportation, yet its negative environmental impacts have attracted growing concerns, especially with respect to air pollution and climate change challenges. This thesis explores how established shipping firms address increasing environmental sustainability pressures and what roles they adopt in the early stages of maritime energy transitions.

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