ADAPTATION, GOVERNANCE AND INDUSTRIAL DIVERSIFICATION: NORTH SEA PORTS AND THE GROWTH OF OFFSHORE WIND

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Abstract

This thesis contributes to debates in Evolutionary Economic Geography (EEG) by providing a better understanding of how processes of adaptation and diversification unfold to support new economic growth paths. To date, EEG research has focused upon conventional economic geography research objects and actors, such as firms, industries or networks. Less attention has been focused upon the evolving roles of infrastructural asset bases in supporting and driving new growth paths. In response, this thesis aims to better understand the causal processes through which ports, and their infrastructural assets, have been adapted and diversified to capture growth in the burgeoning offshore wind industry.

The research seeks to complement and extend existing studies of port adaptation and diversification within the transport geography research, by developing a more evolutionary approach, capturing how existing infrastructural assets, the agency of key actors and broader political-economic contexts influence processes of port adaptation and diversification through key episodes of change. At the same time, the thesis responds to calls within EEG for more international comparative analysis by exploring the variations between national institutional environments, infrastructural asset bases, port governance models and the corporate strategies and investment from offshore wind firms.

The research provides a comparative analysis of adaptation and diversification across the cases of the 'Humber Ports' (Port of Hull and Port of Grimsby, UK) and the 'Port of Cuxhaven' (Germany). The thesis reveals the critical role played by national policy contexts in establishing a buoyant offshore wind market environment to stimulate investment from port authorities, sub-national government agencies and offshore wind firms, and so enable the port adaptation process. However, even within these broader enabling environments, important variations exist in the vision and agency of port authorities in developing and delivering strategies for adaptation. Of critical importance, are the ways in which different models of ownership and governance within ports influence and mediate the scale, scope and character of strategic investment opportunities. Lastly, the research also reveals the important variations in the roles and positions of ports within the broader external governance of territorial development. The ability of ports to operate within a broader

coalition of actors supporting adaptation and diversification, strongly influences the opportunities to harness and valorise their infrastructural assets for new paths of growth.

Acknowledgements

This doctoral research project has enabled a transformation of myself as an academic researcher and as a person more directly. My research interests at an undergraduate level were originally driven by family connections to previous industrial activities in the North East of England and growing up in the area. I wanted to improve my understanding of how places change and evolve from the past into the present and create new futures. The Centre for Urban and Regional Development Studies (CURDS) and Geography at Newcastle University gave me the platform and opportunity to actively pursue research around this subject, and work towards obtaining a PhD. I entered the project in September 2016 as a postgraduate student who had completed research on the Port of Tyne and was full of confidence going into this project. However, I did not comprehend at the time the scale, complexity and intensity of work required to complete this research project. I could not have navigated my way through the research project without the support, encouragement and engagement of a great number of people, in the UK, Germany and beyond.

The empirical data could not have been obtained, analysed and synthesised without the participation of interviewees who I greatly respect, appreciate and aim to keep in contact with for dissemination of my research. I still find it very heartening that so many people wanted to provide their honest opinions and contextual information to guide and shape my findings. The names of the interviewees will remain anonymous as per their request, but their insights remain equally as valuable to this research project, and to my personal understanding of ports and the offshore wind industry. I would also like to thank colleagues in the PGR office and a range of academics and researchers at Newcastle University, in the UK, Germany and beyond, who have offered me important guidance and advice for completing the PhD, undertaking teaching and mentoring activities, and supporting other research projects.

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Acronyms

ABP	Associated British Ports
AfW	Agentur für Wirtschaftsförderung Cuxhaven (Economic Development Agency of Cuxhaven)
CfD	Contract for Difference
CPDC	Cuxhaven Port Development Company
EEG	Evolutionary Economic Geography
FIDeR	Final Investment Decision Enabling Round
GFDE	Grimsby Fish Dock Enterprises
HCC	Hull City Council
HRO	Harbour Revision Order
MoU	Memorandum of Understanding
NELC	North East Lincolnshire Council
NPorts	Niedersachsen Ports
O&M	Operations and Maintenance
OBC	Offshore Base Cuxhaven
OMP	Offshore Master Plan
OT1	Offshore Terminal 1
OT2	Offshore Terminal 2
PoC	Port of Cuxhaven
PoG	Port of Grimsby
PoH	Port of Hull
RESA	Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz)
ROC	Renewable Obligation Certificate

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Chapter 1. Introduction

"As by means of water-carriage a more extensive market is opened to every sort of industry than what land-carriage alone afford it, so it is upon the sea-coast, and along the banks of navigable rivers, that industry of every kind naturally begins to subdivide and improve itself…" (Adam Smith, 1776, pp30).

1.1 Port adaptation and diversification

Ports have existed for thousands of years and are important gateways for the movement of goods and people between the marine and land environments, whilst existing as "obvious sites for industry" to embed and support the development of associated localities (Alderton, 2008, pp4; Hall & Jacobs, 2012). Ports have been traditionally viewed by many in industry, government and academia as being critical for industrial expansion and a catalyst for the socio-economic growth of localities directly adjacent and closely connected to them (Alderton, 2008; Bottasso et al, 2014; Hall & Jacobs, 2012).

Ports have the potential to be key assets for driving economic change through adapting and diversifying into new and emerging markets (Maskell & Malmberg, 1999; Notteboom, 2016; Martin, 2010). In the post-war period this has occurred through different rounds of adaptation and diversification, which has enabled ports to capitalise on opportunities in new markets and growth of emerging sectors such as oil and gas, subsea engineering and container handling (Notteboom, 2016; Martin & Sunley, 2006; Pike et al, 2010).

To understand how ports adapt and diversify, existing research in port studies and transport geography provides insights into how national and sub-national policy arrangements and the governance of port authorities influence port adaptation and diversification into new markets (see Notteboom, 2016; Monios & Wilmsmeier, 2016; Brooks & Cullinane, 2007b; Debrie et al, 2013; Verhoeven, 2010). Essentially, this literature illustrates how ports have distinctive ownership contexts, governance models and practices, which vary depending upon the national political economic context they're operating in, with fluctuating levels of government ownership and intervention (Verhoeven, 2010; Suykens & Van de Voorde, 1998;

World Bank, 2016). As such, these variations of national policy arrangements and port governance models, means port authorities and associated sub-national government institutions have differing abilities and capacities to shape port adaptation and diversification (Verhoeven, 2010; Debrie et al, 2013; Notteboom, 2016). Although the research in port studies and transport geography considers port adaptation and diversification by investigating national policy and port governance arrangements (Notteboom, 2016; Monios & Wilmsmeier, 2016; Jacobs & Lagendijk, 2014), it is quite narrow in its qualitative and conceptual understanding of what actually causes port adaptation and diversification to occur and unfold in an evolutionary manner (Martin, 2010; Martin & Sunley, 2006; Pike et al, 2016a).

The first limitation of existing research on port adaptation and diversification is that it is overly focused upon empirically analysing the internal context of port authorities to understand how ports have diversified into markets such as container-handling (Notteboom, 2016; Jacobs & Notteboom, 2011), meaning a more qualitative and deeper conceptual understanding of how external factors, influences and conditions shape port adaptation and diversification is required (Martin, 2010; Martin & Sunley, 2006). Secondly, existing studies need to consider port adaptation and diversification as a more evolutionary process, shaped and driven by key episodes or moments of change (Martin, 2010; MacKinnon et al, 2019; Dawley et al, 2019). Thirdly, there needs to be greater consideration given to how port authorities are situated in particular localities and interact with distinctive sets of regional actors including local government institutions and firms, to enable port adaptation and diversification (Notteboom, 2016; Dawley et al, 2019). Fourthly, the existing literature largely overlooks how ports shape and drive broader regional economic development and industrial growth (Notteboom, 2016, Martin, 2010). As a result of these limitations in the empirical studies and understandings of port adaptation and diversification, the thesis must look beyond the existing set of port literature and explore and utilise concepts in the field of EEG.

1.2 Significance of Evolutionary Economic Geography (EEG) to ports

EEG provides an alternative lens for researching ports and its relations to broader regional economic development, whilst allowing for a more advanced comprehension of adaptation and diversification processes (Martin & Sunley, 2006; Martin, 2010; Notteboom, 2016). Several scholars in EEG perceive evolutionary paths as open systems of change and as a process, forming a continually interactive system of path dependence, path creation and path destruction (Martin & Sunley, 2006; Boschma & Martin, 2007; Martin, 2010). The notion of evolutionary paths changing through different stages as a process is important for considering how the adaptation of ports influences the evolution of broader regional paths (Boschma & Martin, 2007; Martin, 2010; Pike et al, 2010).

Adaptation is a key concept in within EEG to explain regional economic evolution and change. Adaptation is the renewal of a previously dynamic and successful development path (Pike et al, 2010). Moreover, adaptation is the outcome of an episodic process of alteration, allowing regions to respond and manage changes in extra-regional contexts, requiring a reorientation to extra-regional political-economic contexts (Evenhuis, 2016; Martin, 2012). Adaptation is characterised by a process involving interconnected social agents absorbing and responding to exogenous shocks, which shapes a new shift towards a regional evolutionary path (Pike et al, 2010; Evenhuis, 2016). The concept of adaptation as perceived in EEG provides a new way of conceptualising and understanding port adaptation, by considering how port authorities and regional actors respond to challenges and changes in broader political-economic contexts, and subsequently adapt a port's existing path of development (MacKinnon, 2017; Notteboom, 2016). Given their theoretical overlaps, the thesis will utilise and apply adaptation in coordination with the concepts of adaptability and adaptive capacity (Pike et al, 2010; Evenhuis, 2016). Adaptability is underlying ability of socio-economic agents to be adaptive and focuses upon the competence of agents to respond to potentially damaging future events within a region (Pike et al, 2010; Dawley et al, 2010). Adaptive capacity is the ability of economic entities to be adaptable and facilitate economic adaptation (Pike et al, 2010; Dawley et al, 2010; Martin & Sunley, 2015b).

Diversification is another key concept in EEG used to better understand how firms increase a greater variety of industries within a regional economy, enabling regions to adapt and change over time (Martin & Sunley, 2006; Boschma & Frenken, 2006; Boschma & Martin, 2007). Diversification considers the harnessing and valorising of endogenous territorial assets (infrastructural, material, natural, industrial and human) from existing industries, as key in catalysing new regional paths (Martin & Sunley, 2006; Maskell & Malmberg, 1999). By more closely considering the infrastructural and material assets of ports, diversification can provide a deeper insight into how ports actually diversify their infrastructural assets to capture new markets (Martin, 2010; Martin & Sunley, 2006). The conceptual relationship between diversification and adaptation is critical to highlight given its importance to the research and comparative analysis. The thesis recognises that diversification is one of the processes of long-term adaptation (see Martin & Sunley, 2006; Martin, 2010; Pike et al, 2010). The thesis sees port adaptation as an overarching process of long—term change and sits at a higher level of abstraction than port diversification throughout the thesis (Evenhuis, 2016; MacKinnon). Port adaptation is based upon the harnessing and valorising of existing assets and influenced by key actors, agency and changing institutional environments (Evenhuis, 2016; MacKinnon, 2017; Maskell & Malmberg, 1999; Martin, 2010). The research perceives port diversification as one process of port adaptation and sits at a lower level of abstraction than port adaptation in the thesis, which involves the port moving beyond existing market activities and capturing new opportunities in a new port market (see Martin & Sunley, 2006; Notteboom, 2016).

This thesis will provide a new angle on the processes of port adaptation and diversification by making the argument that path creation has the potential to emerge as an outcome of port adaptation and diversification (Notteboom, 2016; Hassink et al, 2019; Trippl, 2019; MacKinnon et al, 2018; Martin, 2010). In doing the thesis hopes to contribute to work on path creation in EEG which refers to the emergence of industries, technologies and economic activities which create new regional economic paths (Martin & Sunley, 2006; Martin, 2010; Isaksen, 2015).

Whilst the concepts of adaptation, diversification and path creation in EEG provide a new opportunity to explore how ports adapt and diversify in a more comprehensive and advanced way, the study of ports can also provide new empirical and analytical perspective into how processes of adaptation, diversification and path creation are operationalised (MacKinnon et al, 2019; Martin, 2010; Pike et al, 2010; Martin & Sunley, 2006). Firstly, ports are important and strategic asset bases which have previously been overlooked in driving regional economic transformation and in processes of path creation (Notteboom, 2016; Martin, 2010; Maskell & Malmberg, 1999). Secondly, ports provide a new and dynamic vehicle for applying, extending and deepening concepts in EEG, which have been primarily utilised as important lenses for analysing firms and technologies in the context of particular industries, sectors and clusters (Pike et al, 2016a; MacKinnon et al, 2009).

1.3 Ports and Offshore Wind

Port adaptation and diversification occur through different rounds of activity, including oil and gas, subsea engineering and container handling (Notteboom, 2016). Offshore wind provides the most recent and critical case of port adaptation and diversification into an emerging market. Offshore wind has been explored in EEG as an empirical case and its role in shaping regional path creation and development (Dawley, 2014; MacKinnon et al, 2018; Dawley et al, 2019; Fornahl et al, 2012). However, existing studies in EEG which investigate the case of offshore wind have tended to overlook the ways in which port assets can be harnessed and diversified to capture opportunities in this emerging sector (Notteboom, 2017; Dawley, 2014). "The offshore wind industry, in particular, is inextricably linked to ports, as the construction, installation and maintenance of offshore wind farms requires dedicated portside infrastructure and expertise" (IPPR North 2016, pp22).

Informed by concepts of adaptation, diversification and path creation in EEG, offshore wind has emerged as a new and dynamic case for exploring port adaptation and diversification in a new context (Martin, 2010; Dawley et al, 2019; Notteboom, 2016). Ports serve as an important infrastructural base for operationalising the offshore wind industry and are valuable economic entities in stimulating new regional economic development through supporting the offshore wind industry, which is emerging as an dynamic industry by continually fostering new employment, supply chain and inward investment opportunities (IPPR North, 2016; Renewable UK, 2017a; Wind Europe. 2017a; Dawley, 2014). Therefore, ports are being increasingly perceived by national and sub-national government actors as being vital economic entities to be considered with greater importance in regard to being harnessed and revalorised to support offshore wind activities, as there is existing evidence and examples of ports catalysing and supporting regional economic growth around offshore wind (IPPR North, 2016; DfT, 2019; Wind Europe. 2017a; Dawley et al, 2019).

Port authorities, therefore, are becoming increasingly important actors in shaping how critical port infrastructures can potentially adapt and support the emergence of offshore wind (IPPR North, 2016; DfT, 2019). To explore this element of port adaptation and diversification in greater depth, the thesis will utilise EEG to explore a range of factors and drivers influencing the decision-making of port authorities, including the role of intra and extra regional actors, the existing port asset base and broader institutional environments (Martin, 2010; Maskell & Malmberg, 1999; Notteboom, 2016).

Sub-national government agencies across various countries are becoming involved in harnessing and valorising port infrastructure to catalyse port adaptation and diversification into offshore wind, alleviate economic decline and create new regional paths (IPPR North, 2016; AfW Cuxhaven, 2017; Dawley, 2014; Martin, 2010). However, the extent to which decision-making and spending powers, legitimate political authority are decentralised, strongly mediates the capacity of sub-national government agencies to support port adaptation and diversification around offshore wind (Rodríguez-Pose and Gill, 2003; Ćetković et al, 2016; Martin, 2010). The strong inter-relation to sub-national economic policy and strategies means that it is critical to study port adaptation and diversification in the context of regional economic development (IPPR North, 2016; Humber LEP, 2016; DfT, 2019). Therefore, the research undertaken in this thesis will look to offer insights that may to inform the decision-making and future strategies of port authorities and local and regional government agencies, with regard to supporting port diversification into offshore wind and enable new regional economic development. This is particularly pertinent to the Humber Local Enterprise Partnership (LEP) as the project's collaborative partner, who supported this three-year research project funded by the ESRC (Economic Social Research Council).

1.4 The Thesis

The research will aim to make key empirical, theoretical and methodological contributions to EEG and existing research on port diversification and governance. The overall **aim** of the thesis is to better understand and assess processes of port adaptation and diversification. This aim will be explored answering the following **research questions**:

1. **What forms of port diversification have been developed by port authorities and associated local institutions?**

2. **In what ways do port ownership and governance models shape a port's capacity to adapt?**
3. **How do multiscalar institutional environments enable and/or constrain port adaptation?**

The thesis investigates and conducts an international comparative analysis of two port case studies, the Humber Ports case (consisting of the Port of Hull and Port of Grimsby in the UK), and the Port of Cuxhaven case in Germany. As such, the research aims to answer calls in economic geography and EEG to conduct more rigorous international comparative work across different geographical settings, whilst examining causal mechanisms, agents, structured relations and multiscalar networks (Pike et al, 2016a; Evenhuis, 2016). In terms of research methods, the research will obtain primary data by conducting a range of semi-structured interviews in the UK and Germany, which will be subsequently coded and analysed to identify key themes relating to the research questions. The collection and analysis of the primary data and international comparative analysis will be supplemented by a range of primary and secondary data sources, in the form of academic publications, government reports, industrial strategies, corporate documents, policy documents, planning reports and news articles.

1.5 Thesis structure

Chapter 2 reviews EEG as a theoretical framework and explains the relevance of several related concepts and ideas in EEG, including adaptation, diversification and path creation, with the aim of better understanding the process of port adaptation and diversification. The chapter subsequently explores the role of institutions and port ownership and governance, explaining their importance for investigating port adaptation and diversification. Finally, the chapter concludes by arguing the most important concepts drawn from EEG and institutional economic geography for understanding port adaptation and diversification, and then provides an analytical framework for clarifying and investigating the process of port adaptation and diversification. The central contribution of the chapter is the provision of a better understanding of how key arguments in EEG and institutional economic geography can enable us to more deeply comprehend how port adaptation and diversification unfolds.

Chapter 3 outlines and justifies the methodology for undertaking a comparative analysis of the two case studies, the Humber Ports case (Port of Hull and Port of Grimsby) and the Port of Cuxhaven case. Essentially, the chapter argues for a robust, international comparative analysis of evolutionary port cases on multiple scales, in order to operationalise and develop key research ideas and methods within EEG (Pike et al, 2016a). The chapter begins by outlining the thesis' ontological and epistemological positioning, and subsequently discusses the multiple case approach, case selection criteria, empirical focus of the cases and outlines the port cases themselves. Chapter 3 also includes discussions on the selected research methods to obtain relevant primary and secondary data, and the subsequent data analysis process.

Chapter 4 provides an overarching understanding of how ports and the offshore wind industry have evolved and how they are becoming increasingly interdependent, thus establishing a strong contextual foundation for more clearly understanding the adaptation of the port cases over time. Chapter 4 begins by explaining the evolution of ports across global and European context and then drills down to discuss the national contexts of the port case studies. The chapter focuses upon the explaining the evolution of UK and German ports sector. As this thesis also focuses heavily upon the offshore wind sector, Chapter 4 outlines the evolution of offshore wind globally and in a European context. Chapter 4 explains how the UK offshore wind market was created and then outlines how the UK offshore wind industry has emerged and its subsequent evolution. The chapter does the same for the German context, explaining how the German offshore wind was created and then outlining the German offshore wind industry has developed and evolved. Subsequently, the chapter summaries and contextualise the project case studies, the Humber Ports case and the Port of Cuxhaven case.

Chapters 5 and 6 then move onto the empirical analysis of the case studies and deliver an important contribution to the thesis by underlining and drawing out the most important findings within the overall evolution and adaptation of the port cases, thus providing a rich empirical platform for more deeply analysing the main conceptual themes in Chapter 7. Chapter 5 will provide an empirical analysis of the Port of Cuxhaven's diversification into offshore wind. Chapter 5 is structured by four key episodes of adaptation which shaped and influenced the Port of Cuxhaven's diversification into offshore wind. These episodes are

‘Preformation and planning: 2003-2005’, ‘Emergence and growth: 2006-2012’, ‘Uncertainty and disinvestment: 2011-2014’ and ‘Revival and expansion: 2014 onwards’. The chapter will then provide a conclusion for Chapter 5, discussing the most important findings in relation to the project’s research questions.

Chapter 6 analyses the Humber Ports’ diversification into offshore wind. Chapter 6 is structured by three key episodes of adaptation which shaped and influenced the Humber Ports’ diversification offshore into wind. The episodes are ‘Path origins and growth: 2006-2011’, ‘Disruptions and divergent sub-regional paths: 2011-2013’ and ‘Path realisation: 2013 onwards’. In similarly to Chapter 5, Chapter 6 will conclude with the most significant findings in relation to the project’s research questions.

Chapter 7 delivers a comparative perspective, critically analysing how the port case studies have been shaped by the processes of adaptation, diversification and path creation in distinctive ways, drawing upon the most important findings and themes from Chapters 5 and 6. Essentially, Chapter 7 directly contributes to the thesis and wider literature base by uncovering a deeper understanding of port adaptation and diversification by comparatively analysing rich empirical data, whilst interweaving the key theoretical ideas from the fields of EEG, institutional economic geography and port studies emerging from Chapter 2. More specifically, Chapter 7 uses analytical lenses connected to the analytical framework included in Chapter 2 to compare the empirical analysis, including the national institutional and market environments, port visions and strategies, infrastructural and material asset bases, port governance models and investment approaches, corporate strategies of offshore wind firms and inward investment, and regional path outcomes.

Chapter 8 provides a range of conclusions to the thesis and overall research process, underlining which port case better adapted and diversified to support the offshore wind industry and wider regional path, whilst drawing together the main empirically informed conceptual contributions of the thesis. The chapter will begin by outlining contributions as a result of conducting an international comparative analysis of port adaptation and diversification into offshore wind. The contributions of Chapter 8 include the unpacking and defining of how port adaptation is operationalised, identifying the ‘who’, ‘what’, ‘where’ and ‘why’ factors underpinning port adaptation, the recognition and analysis of key causal episodes underpinning port adaptation, and the roles of strategic port visions, agency, port governance models and the institutional environment in shaping port adaptation. Drawing upon the contributions and main empirical findings, the chapter will provide some recommendations to port authorities and government organisations for enabling port diversification and new regional growth paths. Then the chapter will consider the potential opportunities and directions for future study.

Chapter 2 Literature Review: providing a new analytical lens for understanding port adaptation

2.1 Introduction

The chapter will inform three interconnected research questions, aiming to analyse the adaptation of two port sites. To provide a strong theoretical platform for an improved understanding of the port adaptation and diversification process, the first two-thirds of the chapter introduces Evolutionary Economic Geography (EEG) as the overarching theoretical framework and explores the position of institutions in EEG. This part of the chapter focuses upon important theoretical debates around regional path creation, adaptation and diversification, whilst interweaving the relevance of EEG concepts and institutions in examining port adaptation, as the key focus of study. The final third of the chapter concentrates more directly on how the consideration of EEG, institutions and governance, can enable an enhanced understanding of the port adaptation and diversification process around a new regional sector, which is highlighted by the analytical framework. The chapter is structured by area of literature to provide the reader with a deep understanding of the broader discussions and interrelation between path creation, adaptation, diversification and institutions, before moving onto directly explaining how they can support a greater comprehension of how port adaptation and diversification unfolds.

EEG provides a theoretical framework for analysing and discussing adaptation, change and regional economic evolution (Pike et al, 2017; Grabher, 2009). The thesis will draw upon the EEG framework to examine how port authorities and associated local institutions harness infrastructural and material assets to catalyse the adaptation of ports, and ultimately influence a new regional path (Martin & Sunley, 2006; Martin, 2010; Maskell & Malmberg, 1999). Secondly, literature examining the role of institutions and governance in adaptation and regional industrial change is important for investigating how institutions on multiple scales, alongside market and industrial policy environments, shape how the process of port adaptation and diversification occurs (Martin, 2010; 2000; Gertler, 2010). In close connection to discussions of institutions in EEG, it is important to consider how the governance and ownership of ports shapes the capacity of port authorities and associated institutions to actively influence the port adaptation and diversification process (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Monios & Wilmsmeier, 2016).

2.2 Evolutionary Economic Geography (EEG)

EEG has gained prominence over the last decade through the formulation of concepts such as path creation, diversification, branching, adaptation, adaptability and adaptive capacity (Martin & Sunley, 2006; Pike et al, 2010; Martin, 2010). The discussion will draw upon adaptation, diversification and path creation currently applied to the local and regional scale and begin to extend the analytical lens to ports as key sites of adaptation and diversification, and in connection to port authorities as important actors in shaping regional path creation and development.

Path as a process

Certain principles make up EEG to explain how regions and localities (referred to as regions hereafter) unfold and change over time. These include the existence of variety in regions shaping industrial change, the historical continuance or change of regional settings, characteristics and assets, and the uneven capacity of regions or entities to select pathways to adapt, survive and prosper (Boschma & Martin, 2007; Martin & Sunley, 2006; Dawley, 2014). The EEG theoretical framework has continuously advocated that ‘history matters’ when analysing economic change of places, institutions and actors (Martin & Sunley, 2006; MacKinnon, 2008). The concept of *path dependence* conveys this message through its main principles. Path dependence argues that past events, processes and paths in regional economies shape their future trajectories (Pike et al, 2017; Martin & Sunley, 2006). However, path dependence has been argued to be theoretically limited, emphasising regional evolutionary paths to be irreversible and pre-determined by history, alongside overlooking entrepreneurial novelty and socio-institutional agency of various regional actors (Garud & Karnoe, 2001; Martin & Sunley, 2006; Dawley, 2014). More recently, scholars have argued that regional evolutionary paths should be viewed as ‘open’ systems and evolve as a process, forming a constantly interactive system comprising of path dependence, path creation and eventual path destruction (Martin & Sunley, 2006; Boschma & Martin, 2007; Martin, 2010). The ‘path as a process’ perspective in EEG provides a potentially more advanced and comprehensive way of understanding how ports adapt and diversify over time (Martin & Sunley, 2006; Boschma & Martin, 2007; Martin, 2010).

The historical evolution and 'lock-in' of regional assets, institutions, firms, infrastructure, industries, technologies and relations forms a unique regional environment, which in-turn can enable or constrain the capacity of economic actors located within a region to create future paths of growth (Essletzbichler, 2012; Martin, 2010). The initial period of historical economic evolution typically generates a growing industrial pathway, formed by positive externalities and increasing returns, known as 'positive lock-in' (Martin & Sunley, 2006). Eventually, a region's economy becomes dependent upon and locked-in to a particular sector, leading to increasing industrial rigidity because of inflexible industrial specialisation, thus undermining the region's adaptability, competitiveness and performance leading to decreasing returns and negative externalities known as 'negative lock-in' (Martin & Sunley, 2006; Arthur, 1989). The path dependent process of regional 'lock-in' was illustrated by Grabher (1993) through his discussion of the once prosperous coal, iron and steel complex in the industrial Ruhr region in West Germany. The Ruhr region fell victim to rigid industrial specialisation causing negative lock-in, which was framed through three specific dimensions of lock-in: 'functional' (industrial economic relations), 'cognitive' (specific 'world view') and 'political' (industry and state vested interests) (Grabher, 1993; Pike et al, 2017). These dimensions of lock-in severely constrained adaptation as a mechanism for 'escaping' negative lock-in (Martin, 2010). Therefore, adaptation will be analysed in greater depth to better understand how adaptation, as a key concept in EEG, can be utilised to investigate how may ports evolve and escape negative lock-in (Martin, 2010; Pike et al, 2010).

Isaksen (2015) presents four evolutionary processes in EEG which are forms of adaptation, indicating how regions can adapt and evolve: path extension, path exhaustion, path renewal and path creation itself. Firstly, *path extension* is the gradual reproduction of existing economic trajectories within regions, acting as a mechanism for path creation and development. Regional actors carry out incremental technological innovations causing regional industries to continuously prevail and reinforce regional resilience (Hassink, 2010). If constant innovation and continuous resilience fails to materialise, a region may face the prospect of *path exhaustion* caused by technological stagnation and industrial decline (Hassink, 2010). Path exhaustion hypothetically mirrors regional lock-in and processes of path dependence (Martin & Sunley, 2006). By contrast, *path renewal* is closely connected to diversification and the notion of change, thus contrasting path extension's focus upon regional path continuation. The process of path renewal is primarily industry driven through existing firms opting to diversify into new but related industries, alongside the establishment of new firms in a region, thus creating broader regional "industrial specialisation and competence" (Isaksen, 2015, pp588). Moreover, a successful process of path renewal involves intra-regional actors such as firms and government agencies, (re)coupling existing technology and knowledge, alongside infrastructural, industrial, material and natural assets, to extra-regional networks and flows of capital (MacKinnon, 2012a; Coe & Yeung, 2015; Maskell & Malmberg, 1999). Micro-level and meso-level processes of regional change depend upon the natural industrial structures, state-led strategies, institutional settings and distinctive social agency within regions (Steen, 2016; Boschma & Frenken, 2006). Path renewal involves the widening of industrial specialisation in a region through a process of industrial diversification and branching, renewing an existing path (Isaksen, 2015; Boschma & Frenken, 2011). By contrast, path creation is the establishment of new industries and new firms within a region "that have different variants of products", in order to create a new path of growth (Isaksen, 2015, pp588). However, the mechanisms underpinning both path renewal and path creation are not separate as highlighted by Isaksen (2015), who argues that both path renewal and path creation are driven by firms seeking to diversify into new sectors, establish new industries and widen their industrial specialisation. The thesis can draw upon the conceptualisation of path creation by Isaksen (2015), as it is closely related to the notions of diversification and related variety (Martin & Sunley, 2006; Martin, 2010). Considering path creation, as defined by Isaksen (2015), will provide a deeper understanding of how port authorities, occasionally acting as firms, diversify into new market sectors to create a new infrastructural base for establishing new regional industries and paths of growth (Maskell & Malmberg, 1999; Notteboom, 2016).

2.2.1 Adaptation, adaptability and adaptive capacity

Notions of *adaptation* and *adaptability* can shape and influence processes of path dependency and associated regional lock-in, path creation and (un)related variety (Martin, 2010; Pike et al, 2017). Fundamentally, notions of adaptation and adaptability deepens our understandings of the ways regions recover and respond to disruptive economic change and produce diverse adaptive paths (Martin & Sunley, 2006; Martin, 2010; Martin 2012). Firstly, adaptation contrasts with more limited neo-classical approaches, which fail to "adequately explain responses" to disruptive economic change (Pike et al, 2017, pp107). Neo-classical approaches assume that rational decisions will be made by economic actors based on market signals, leading to a state of equilibrium and recovery following disruptive economic change (Pike et al, 2017). However, this adjustment process fails to occur due to imperfect competition, labour immobility, information and externalities, alongside technological differences and geographically uneven access to capital across space (Pike et al, 2017; McCann, 2013; Pike et al, 2010). For instance, old industrial regions are often underperforming in national economies and frequently face multiple adaptability and restructuring challenges following disruptive economic change (Hassink, 2010).

Firstly, *adaptation* has been defined as the renewal of a formerly dynamic and successful development path (Pike et al, 2010). However, a deeper, more sophisticated definition of adaptation by Evenhuis (2016, pp13) views adaptation as an episodic "process of alterations", which allows regions to "cope with changes in the broader [extra-regional] contexts", formed through internal reorganisation of a region, or through a region undertaking a reorientation to extra-regional political-economic contexts (Martin, 2012; MacKinnon, 2017). Adaptation is characterised by a process involving "strong and tightly" interconnected social agents operating in a place-specific economic system, which can absorb and respond to exogenous shocks, then subsequently shapes the movement towards a pre-conceived evolutionary path in a region (Pike et al, 2010, pp62). On the other hand, *adaptability* is the underlying ability of "loosely and weakly" interconnected social agents to be adaptive, which differentiate across various places, to formulate several economic paths (Pike et al, 2010, pp62). Moreover, adaptability focuses upon the competence of social agents to manage and respond to unforeseen future events which ultimately have negative or even damaging economic implications for a regional system or entity (Dawley et al, 2010). Adaptation and adaptability relate the idea of *resilience*, referring to the capability of economic systems or entities to recover to their earlier growth position following a shock or disturbance such as financial crises or technological leaps, or following slow-burn events such as de-industrialisation (Pike et al, 2017; Pike et al, 2010). However, resilience has been criticised as having limited consensus on its actual definition and theoretical origin (Martin, 2012), despite its increasing emergence and attention in academic and policy circles

(Christopherson et al, 2012; Bristow & Healy, 2014; OECD, 2011). Furthermore, Martin (2012) highlights that a regional system or actor can either be *anticipatory* or *reactionary* to disruptive economic shock or slow-burn change (Pike et al, 2010; Monios & Wilmsmeier, 2016). Fundamentally, governance actors, often individuals, can seek to influence paths to take actions in advance (anticipatory) or following (reactionary) external shocks such as market disruptions or technological changes, or slow-burn transitions such as the decline of heavy industries (Pike et al, 2010). Anticipatory or reactive processes will be discussed in greater depth later in this chapter in relation to institutions and governance.

By drawing upon definitions of adaptation by Evenhuis (2016) and MacKinnon (2017), the thesis utilises *adaptation* in a generic sense and views it as the long-term and continual process of change on the basis of existing assets and characteristics, in response to shifting conditions and new challenges in the external institutional environments (Martin, 2010). The thesis will be drawing upon notions of adaptation and adaptive capacity because they conceptualise how ports change over time and respond to changing market and policy conditions (Evenhuis, 2016; MacKinnon, 2017; Pike et al, 2010; Martin, 2010). However, *adaptive capacity* is the geographically differentiated quality and inherent ability of various actors, individuals and institutions to be adaptable and facilitate economic adaptation (Pike et al, 2010, pp62; Dawley et al, 2010; Martin & Sunley, 2015b). The concept of adaptive capacity directly influences the process of port adaptation, as some port authorities and sub-national government organisations have greater adaptative capacity than others to be adaptable and respond to changes in external institutional environments (Pike et al, 2010; Notteboom, 2016; Martin, 2010). Adaptive capacity is the ability of intra-regional actors (firms, individuals, research institutions and government organisations) to modify, renew and adapt a region's industrial structure, labour market, institutional settings and asset base in the face of adversely changing market conditions and policy environments (Simmie & Martin, 2010). In connection to arguments around diversification and path branching, regions which are more diversified have a *strong* underlying adaptive capacity (Pike et al, 2010). This allows for an increased capacity to absorb adverse shocks or slow-burning disruptions in an open system, displaying greater related variety of industries, firms, resources, knowledge bases, institutional connections and physical territorial assets (Pike et al, 2010; Simmie & Martin, 2010). Conversely, a region comprising overspecialised industries, an unrelated economic structure with public institutions unwilling to reconfigure policy and strategies to new ends, have a *weak* adaptive capacity, which disables innovation and entrepreneurship capabilities and creates regional lock-in (Pike et al, 2010; Martin, 2016). Adaptive capacity highlights that institutions could play a more prominent role in discussions of adaptation, as institutions are clearly vital in facilitating resilience, adaptation and diversification in the face of regional shocks or disruptions (Gertler, 2010; MacKinnon et al, 2009).

More broadly, the thesis sees *adaptation* as a key overarching concept for unpacking the long-term change and the creation of new development paths in places. The thesis will be using *adaptation* in a generic sense and in terms of the long-term change of port assets to support new port-related activities, in response to changes and challenges in multiscalar institutional environments (Evenhuis, 2016; MacKinnon, 2017; Martin, 2010). The research also recognises that analysing the *adaptive capacity* of intra-regional actors is fundamentally important in understanding how port authorities and sub-national government agencies adapt and respond to external changes and challenges in the multiscalar institutional environment (Pike et al, 2010; Evenhuis, 2016; Martin, 2010). However, the thesis is not contrasting the overarching concept of adaptation with the notions of adaptability or adaptive capacity. The thesis views the overarching process of port adaptation as being influenced by a process of port diversification which sits at a lower level of abstraction, whilst path creation emerges as an outcome of the port adaptation and diversification process (Pike et al, 2010; Martin & Sunley, 2006; Martin, 2010).

The concepts of adaptation, adaptability and adaptive capacity are key in explaining some of the ways economic actors change and influence regional paths, which are dependent upon certain industries (Pike et al, 2010; Martin, 2010). Although path dependence offers valuable insights in how regions are locked-into specific development trajectories, path dependence theory offers little insight into the mechanisms launching path creation from the path preformation phase (Martin, 2010). This has prompted economic geographers to engage with how regional paths are launched and what are the drivers in the path creation process (Martin & Sunley, 2006; Dawley, 2014). Escaping a locked-in path or a path which is dependent upon a declining industry and into path creation and subsequent path development, has been defined as path 'de-locking' by Martin and Sunley (2006) (MacKinnon et al, 2019; Martin, 2010). Path de-locking mechanisms have been theoretically framed as tools to understand the ways in which regions gain economic momentum and become self-reinforcing through new industries or technologies. Path de-locking mechanisms, especially those defined by Martin and Sunley (2006), are often overlapping, related and contingent, and have also been labelled as mechanisms for path creation following the process of path de-locking (Dawley, 2014; Simmie, 2008). However, a key area of exploration is to identify the actual operation of various path creation mechanisms, whilst exploring wider sets of political economic contexts shaping path creation mechanisms (Dawley, 2014; Simmie, 2012). The latter includes multiscalar institutional contexts and policy environments, as well as the socio-institutional agency of state and non-state actors operating in external networks (MacKinnon et al, 2009; Coe, 2011; Morgan, 2013).

Martin and Sunley (2006) provided five scenarios (indigenous creation, heterogeneity and diversity, transplantation, diversification, upgrading) for regions to avoid becoming locked-in to a declining evolutionary path, which have been subsequently labelled as candidate mechanisms in the creation of new paths of development and growth (Dawley, 2014; MacKinnon et al, 2019). The thesis will be utilising *diversification* and *transplantation* as the underlying mechanisms of adaptation, whilst recognising that broader regional path creation emerging as an outcome of adaptation, diversification and transplantation (Martin & Sunley, 2006; Martin, 2010).

2.2.2 Diversification, branching and transplantation

Diversification, akin to 'path branching' in EEG literature (Boschma & Frenken, 2006; Boschma & Martin, 2007), centres upon firms as key drivers of diversification through a process of increasing a greater variety of industries within a regional economy (Martin & Sunley, 2006). This process of regional diversification is drawn from the notion of corporate diversification of products (Montgomery, 1994), enabling regions to establish a diversified 'portfolio' of industrial specialisation to become increasingly resistant to external economic shocks (Frenken et al, 2007). The supposed diversified portfolio must consist of technologically related industries, otherwise known as *related variety*, which enables heightened opportunities for localised knowledge spillovers and learning (Frenken et al, 2007; Frenken et al, 2005; Neffke et al, 2011). Conversely, *unrelated variety* denotes that regions with unrelated industries and a lack of knowledge spillovers and learning 'protects' regions against sector-specific external shocks through a heightened capacity of unrelated industries, allowing for increased path branching opportunities, thus resisting regional path dependency and negative lock-in (Frenken et al, 2007; Martin & Sunley, 2006). Related variety, unrelated variety and path branching (diversification) are connected to EEG through emphasis upon the evolutionary industrial history of regions (Pike et al, 2017). Thus, the relatedness of technology between industries shapes the future of a region's industrial variety, economic transformation and evolution (Neffke et al, 2011; Dawley, 2014). Interestingly, Neffke et al (2014, pp261) argue that although it is difficult for regions to attract new industries if they're technologically unrelated to existing industrial activities, new regional growth paths "are strongly rooted in the historical economic structure of a region." Therefore, historically influenced industries, firms, government organisations, infrastructure and labour market, shape and influence regional path branching processes (Neffke et al, 2011). The concept of regional diversification and path branching can be used to better understand how ports adapt and support new industries emerging within regions over time (Martin & Sunley, 2006; Pike et al, 2017; Notteboom, 2016).

Path branching and (un)related variety are directly concerned with technological relatedness, learning, knowledge spillovers and expansion within a region, overlooking the relatedness of territorial assets between pre-existing industries within a region (Boschma, 2009; Frenken et al, 2007; Metacalfe et al, 2006). This theoretical issue of path branching will be enriched in this investigation through the incorporation of territorial assets (infrastructural, material, natural, industrial and human) into understandings of diversification (path branching) as a mechanism of adaptation and path creation (MacKinnon et al, 2015; Maskell & Malmberg, 1999; Monios & Wilmsmeier, 2016). Thus, the thesis will utilise the concept of diversification and branching in EEG to explore how port authorities and sub-national government agencies re-orientate infrastructural and material assets to capture new markets (Martin & Sunley, 2006; Martin, 2010 Maskell & Malmberg, 1999). The research will therefore provide a deeper and more comprehensive understanding of how port adaptation unfolds, thus adding to existing literature on port diversification in port studies and transport geography (Notteboom, 2016; Jacobs & Notteboom, 2011; Jacobs & Lagendijk, 2014).

On a different note, the transplantation mechanism acknowledges the potential of locked-in regions dependent upon declining traditional industries, to ‘transplant’ new industries, technologies and associated firms from exogenous sources, which influences a broader process of path creation (Martin & Sunley, 2006; Dawley, 2014). Additionally, the transplantation mechanism conceptually relates to the current sub-field of GPNs, in connection to the established notion of strategic coupling (Coe & Yeung, 2015; MacKinnon, 2012a). The GPN framework seeks to develop understandings of the interactions between regional economies and extra-regional actors such as firms, placing emphasis upon processes of territorial development (Henderson et al, 2002; Coe et al, 2004; Yeung & Coe, 2015). The GPN approach discusses how territorial assets can be harnessed by regional institutions to serve the needs of TNCs or focal firms, this is known as ‘strategic coupling’ (Coe et al, 2004; Dawley et al, 2019). Moreover, the linking of territorial assets to the needs of extra-regional TNCs or focal firms through the strategic coupling process, can effectively launch new regional growth paths (MacKinnon, 2012a; Dawley et al, 2019). Interestingly, certain parallels can be drawn between strategic coupling and the path creation mechanisms of diversification and transplantation.

Diversification highlights that endogenous territorial assets which are inherited from declining industries, can be identified, harnessed and (re)valorised to form new regional paths (Martin & Sunley, 2006). In the same way as transplantation, the diversification of regions may require resources (inward investment, labour and physical assets) from TNCs or focal firms operating in extra-regional networks (Coe & Yeung, 2015; MacKinnon, 2012a). Furthermore, FDI can be a mechanism of path creation, as firms look from the ‘inside - out’ to international flows of capital and new export markets, relating to the diversification mechanism, whilst regions can also attract FDI into related sectors from the ‘outside - in’, linking to the notion of transplantation (Coe & Yeung, 2015; Martin & Sunley, 2006). Diversification and transplantation are the most pertinent of the discussed path de-locking mechanisms because identifying and subsequently entering new markets, using endogenous *and* exogenous resources, is essential for the survival and growth of regions (Martin & Sunley, 2006; MacKinnon, 2012a). Moreover, the GPN approach offers a useful framework for considering the role of extra-regional linkages in catalysing adaptation, diversification and transplantation (Coe et al, 2004; MacKinnon, 2012a; Dawley et al, 2019).

2.2.3 Path Creation

Path creation refers to the emergence of industries, technologies and economic activities forming new regional paths. The creation or 'birth' of new industries can be conceptualised as 'mindful deviation' (Garud & Karnoe, 2001). This involves entrepreneurs or firms acting as innovative micro-economic actors, breaking away from existing industries and technologies that comprise a regional economy and forming new industries and technologies endogenously (Garud & Karnoe, 2001). Firms and entrepreneurs seek to mobilise existing assets, resources and competencies to create new path options, thus deviating from past mistakes and locked-in trajectories (Garud et al, 2010). Simmie (2012) adopts 'mindful deviation' within a hybrid socio-economic model concerning 'knowledgeable agents' and 'niche markets', to explain successful path creation and establishment of the Danish wind industry. This path creation and path establishment process was enabled through the role of government institutions and policies supporting a niche market, which accumulated a critical mass of firms emerging or diversifying into the wind turbine market (Simmie, 2012; Morgan, 2013). Here Simmie (2012) demonstrates how the role of institutions was vital in establishing an enabling institutional environment to catalyse the path creation process (Martin, 2010; Gertler, 2010). The dynamic role institutions play in shaping processes of adaptation, diversification and path creation will be explored further in this chapter.

Martin (2010) offers a useful insight into clearly conceptualising path creation, which has been through defining stages within an alternative path dependent model explaining regional industrial evolution (Figure 2.1). The path 'preformation phase' consisting of existing technologies, knowledge, competencies and place-specific economic structures forms the basis of path creation (Martin, 2010). The 'path creation phase' follows, closely aligned to arguments of Garud and Karnoe (2001) regarding purposeful socio-institutional agency and action, comprising of entrepreneurial activity, experimentation and localised competition creating a new emerging pathway (Martin, 2010). Next the 'path development phase' succeeds, based upon the development of local increasing returns and a network of externalities to support an emerging path (Martin, 2010). Following this phase, the path can move in two contrasting directions, either towards a 'stable state' formed through increasing rigidification of networks and actors leading to stasis, or towards a 'dynamic process' forming industrial and technological renewal leading to adaptation (Martin, 2010).

However, a more comprehensive model is required for greater exploration of processes and mechanisms which shape and trigger the initial stages of industrial and path evolution (Martin, 2010). Interestingly, Martin (2010) argues that 'enabling' or 'constraining' environments shape the creation and emergence of new industries and technologies. The former establishing a dynamic regional path through adaptive processes and the latter counteracting local industrial and technological evolution (Martin, 2010; Dawley et al, 2015). This theoretical argument will be explored in greater depth later in this chapter through thematic discussions of institutions, governance, policy and networks.

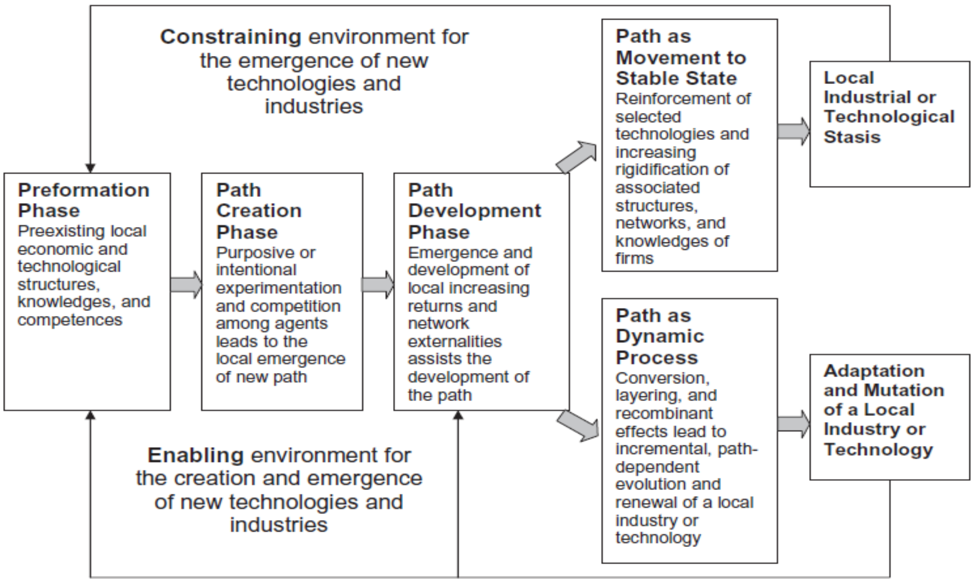


Figure 2.1: Toward an alternative path dependence model of local industrial evolution
Source: Martin, 2010, pp21

Notions of path creation typically focus upon the role of endogenous factors and agents in creating new industries and technologies, centring upon the local and regional scales in analysing industrial evolution (Neffke et al, 2011). Although endogenous factors and actors (high-level knowledge base, capital investment, research institutions, universities, firms and entrepreneurs) are crucial for path creation, they're occasionally lagging or completely absent in specific regions (Isaksen, 2015; Isaksen & Trippl, 2016). Therefore, peripheral regions in advanced countries are dependent upon starting path creation with a path 'preformation phase' which is deficient in formation, alongside constraining initial conditions (Isaksen & Trippl, 2016; Martin, 2010; Simmie, 2012). Consequently, peripheral regions often require exogenous resources such as the inward movement of trans-national corporations (TNCs) and inward investment, alongside policy instruments (incentives and subsidies) initiated by regional, national and supranational government organisations to catalyse path creation through certain sectors (Isaksen, 2015; Morgan, 2013; Dawley et al, 2015). The multiscalar approach has been relatively unexplored throughout the theoretical formulation of path creation (Martin, 2010), although multiscalar processes fundamentally shape the institutional and policy environment for adaptation, diversification and path creation (Martin, 2010; Essletzbichler, 2012b; Martin, 2000). Therefore, introducing discussions of multiscalar actors and institutions will strengthen and enhance the concept of path creation.

As previously discussed, endogenous or territorial assets are crucial foundations for founding industrial evolution in the initial path preformation phase of the path creation process (Neffke et al, 2011; Martin, 2010). The thesis will draw upon the notions of assets to better understand how port authorities and sub-national government agencies harness and valorise infrastructural and material assets of ports, in order to stimulate the port adaptation process (Martin, 2010; Maskell & Malmberg, 1999; Notteboom, 2016). The infrastructural and material assets of ports are crucial in supporting new industries requiring port and quayside access, and for driving the regional path creation process (Martin, 2010; MacKinnon et al, 2019). Examples of territorial assets are clearly evident in the path preformation phase, including technology, knowledge base and competences (Figure 2.1) (Martin, 2010). Territorial assets have been neatly categorised aligning to capabilities and attributes: natural assets (physical resources and built environment); infrastructural and material assets; industrial assets (technology and firm capabilities); human assets (knowledge base, labour competences and costs); and institutional assets (rules, routines and norms) (Maskell & Malmberg, 1999). However, territorial assets must be identified, harnessed and valorised to capture new growth paths through assertive and strategic action by individual actors or organisations (Maskell & Malmberg, 1999). Moreover, territorial assets comprised within the path preformation phase or initial conditions of a locality, strongly influence the capabilities of actors and government agencies to launch new growth paths and characterise previous path trajectories of economic development (Martin, 2010; Simmie, 2012). Actors and government agencies in regions may lack endogenous resources or financial capacity to harness territorial assets (Isaksen, 2015; Morgan, 2013). If so, actors and associated government agencies must establish interactions with lead firms or TNCs operating in global production networks (GPNs) and pursue extra-regional flows of capital, including Foreign Direct Investment (FDI) (Coe et al, 2004; Coe et al, 2008). Thus, regional evolution is shaped by complex interactions between local and regional actors and global networks (Coe & Yeung, 2015; Coe et al, 2004). Moreover, there is an emerging need in the GPN framework to more deeply consider specific strategies of lead firms and specialised suppliers in shaping processes of adaptation, diversification and path creation (Yeung and Coe, 2015; MacKinnon et al, 2018). Therefore, the thesis will analyse the strategies of lead firms and specialised suppliers in the UK and German offshore wind industry, to better understand how they influence processes of port adaptation, diversification and path creation (MacKinnon et al, 2018). As such, path creation needs to look beyond but also consider endogenous assets (knowledge base, skilled labour market, technology base, physical), in launching new growth paths (Binz et al, 2016).

Drawing upon work of Martin & Sunley (2006), Martin (2010) and MacKinnon et al (2019), the project defines path creation as a process which unfolds to enable the growth of a new industry in a region, as an outcome of underlying processes of adaptation and diversification, which is shaped by the pre-existing nature of regional assets, actors, institutions and competencies (Maskell & Malmberg, 1999; Pike et al, 2010). The thesis' definition and use of path creation is inspired by the notion of the "opportunity space" Grillitsch and Sotarauta (2018, pp8), who argue that "some regional growth paths are more likely than others", as they're highly influenced by a relationship between inherited assets, actors, institutions and competencies, and agency, whereby the recognition of future paths matters too (Martin, 2010). This definition and use of path creation differs from the perspective of Grillitsch and Trippl (2016, pp10) who see path creation as a form of path development, occurring as the "emergence and growth of entirely new industries based on new technologies and scientific discoveries". Grillitsch and Trippl (2016, pp10) distinguish path creation as a form of path development with "path branching", defined as the "development of a new industry based on competencies and knowledge of existing related industries" and "path importation", defined as the "setting up of an established industry that is new to the region (e.g. through foreign firms)". By contrast, the thesis sees 'path branching' and 'path importation' conceptually overlapping with diversification and transplantation as defined by Martin and Sunley (2006), which can act as mechanisms of path creation.

Diversification emerges as the most important mechanism influencing path creation (Martin & Sunley, 2006). In connection to ports, the thesis sees diversification as the re-orientation of a port's business portfolio and asset base to serve new markets and activities, which drives incremental port adaptation and can lead to path creation as an outcome (Martin & Sunley, 2006; Maskell & Malmberg, 1999). Transplantation is the other important mechanism, but the project is specifically concerned with transplantation in the context of diversification, thus demonstrating that path de-locking mechanisms are highly interrelated and are occasionally symbiotic (Martin & Sunley, 2006). The chapter sees diversification and transplantation as the most applicable regional path de-locking mechanisms, serving as potential mechanisms for enabling processes of port adaptation and broader regional path creation, through catalysing the "breeding [of] new industries" at port sites (Isaksen & Trippl, 2016, pp3; Martin & Sunley, 2006).

2.3 Institutions and governance

This section of the chapter discusses the role of institutions and governance in discussions of path creation, diversification and adaptation. There is a growing discussion and analysis of the role institutions play in the adaptation of localities and regions, which was previously overlooked in the EEG theoretical framework (MacKinnon et al, 2009; Martin, 2010; Gertler, 2010). Institutions are critical in influencing industrial policy contexts, market conditions and the governance of ports, which shapes the adaptation and diversification of ports into new sectors (Martin, 2010; Notteboom, 2016).

It is important to attempt to define the 'institution', despite divergent perspectives within economic geography (Rodríguez-Pose, 2013; Gertler, 2010). A consistent agreement upon defining the institution is that institutions are 'systems of rules' (Hodgson, 2009; Hodgson, 2006). Moreover, as a part of what is termed the 'institutional turn' multiple scholars have argued how the "economy is an instituted process" (Amin, 2001, pp1238; Martin, 2000; Philo & Parr, 2000). The fortunes of local and regional economies are shaped by both indigenous institutions operating within regions and exogenous institutions operating 'at a distance', including national policy organisations, international market regulators and in some regions, practices of powerful business elites managing TNCs (Amin, 2001). However, a broader and more definitive definition of institutions is given by Meric Gertler (2010; 2004).

Gertler argues that institutions are actively formed socially and politically, and characterised by "formal regulations, legislation, and economic systems" alongside "informal societal norms that regulate the behaviour of economic actors", which essentially form the "attitudes, values, and expectations of individual economic actors" (Gertler, 2010, pp7-8). These institutional characteristics, norms and positions subsequently influence the economic decisions made by individual economic actors (Gertler, 2010).

2.3.1 Institutions in Evolutionary Economic Geography

On a different note, institutions shape norms, conventions and routines to increase the adaptive efficiency of territories and shape the adaptive capacity of economic actors to react, change and evolve within multiscalar economies (Rodríguez-Pose, 2013; Pike et al, 2010; Martin, 2010). There has been an emerging trend in institutional economic geography to reconstitute discussions around institutions with greater alliance to EEG, in order to deepen understandings of how institutions interact, adapt and evolve (Gertler, 2010; Boschma & Frenken, 2009; Jessop, 2001). Institutions are becoming a growing influence upon shaping EEG in relation to adaptation, diversification and path creation (MacKinnon et al, 2009; Martin, 2010; Gertler, 2010). Academics have acknowledged this theoretical issue, emphasising that institutions must play a more pivotal role in EEG's conceptual development (MacKinnon et al, 2009; Essletzbichler, 2009; Cumbers & MacKinnon, 2011). Understandings of evolutionary paths are largely focused upon firms and technologies, therefore the incorporation of diverse institutions and actors can broaden, develop and enhance firm-centric accounts (MacKinnon et al, 2009; Morgan 2013; Smith, 2015). A recent empirical account by Dawley (2014) discusses the ways multiscalar non-firm actors, including regional development organisations, national policy organisations, research institutions and entrepreneurs have enabled path creation and subsequent adaptation in the North East of England through the offshore wind industry. Another dynamic account by Simmie (2012) explores how the creation of the Danish wind power industry was mechanised by various non-firm institutions and individuals, including engineers and scientists at universities, government organisations, farmers, volunteers and enthusiasts. These two empirical examples demonstrate how the dynamic social agency of various non-firm actors, alongside the institutional contexts of regions and nations, are important in shaping path creation and adaptation (Pike et al, 2009; Essletzbichler, 2009). Moreover, these examples highlight how various institutions and individuals strive towards a common form of adaptation in regions, emphasising the necessity "public-private strategic leadership" in path creation and adaptation (Bailey et al, 2010, pp462). However, path creation and adaptation processes are also influenced by institutions, actors and policy environments on multiple spatial scales (Martin, 2010; Gertler, 2010). Therefore, the multiscalar institutional environment and associated institutional arrangements will be discussed next.

Interestingly, Martin (2000) distinguishes between 'institutional arrangements' and the 'institutional environment' which shape the spatial economy, drawing upon work originating in mainstream economics (North, 1990). The institutional environment refers to both an informal system consisting of norms, customs, routines, cultures, practices and corporate behaviour, and a formal system consisting of rules, regulations and laws "which constrain and control socioeconomic behaviour" (Martin, 2000, pp80). Institutional arrangements refer to specific organisations which are governed and influenced (evolution, functionality, overall existence) by the institutional environment they inhabit (Martin, 2000; 2010). However, the institutional environment and institutional arrangements are constantly interacting and modifying each other, thus producing varying local economic outcomes across space, generating place-specific 'institutional regimes' (Martin, 2000). Furthermore (Martin, 2010) distinguishes between a 'constraining' institutional environment and an 'enabling' institutional environment based upon inherited assets, skills, competences and experiences, which shape path creation, development and adaptation processes. The notions of constraining and enabling institutional environments will be adopted within the project, as they are important concepts for investigating the influence of external actors and institutions upon path creation, diversification and adaptation (Martin, 2010; Pike et al, 2010). These conceptual ideas drawn from EEG look beyond the rather limited notions of 'historical accidents' or 'chance' as mechanisms for shaping path creation and path dependence processes (Arthur, 1989; David, 1994). A local industrial path formed through a constraining institutional environment produces a "self-reproducing form" creating an economic reality of continuity and stasis which is vulnerable to market shifts and competition, consequently leading to possible decline (Martin, 2010, pp21). Secondly, a local industrial path formed through an enabling institutional environment generates a more open process to allow change, dynamic evolution, industrial and technological renewal and incremental adaptation (Martin, 2010). Nevertheless, Martin (2010) also argues that the pace of adaptation varies from one local industry to another and evolves over time.

Although Martin (2010) bases his arguments upon the local and regional scales, he also notes that shifting market and regulatory environments evident on multiple spatial scales also influence regional path creation, diversification, adaptation and evolution. This contrasts with the view of Boschma and Frenken (2009) who argue that if institutions play a key role in path creation and adaptation, it will be in an endogenous manner through a process of collective action (Maskell & Malmberg, 2007). However, as Martin (2010) suggests, the influence of actors, institutions, strategies and policies formulated at the national or supra-national scales are also vital in path creation and adaptation processes (Dawley et al, 2015). As Dawley et al (2015) support, regional industrial change and path creation processes are influenced by vertical (selective) policies, based upon industrial sectors, and horizontal (functional) policies, whereby states actively shape markets, infrastructure and regulatory frameworks, which both enable and constrain path creation, path development and adaptation (Chang et al 2013; Martin, 2010). The evolutionary political economy approach to EEG developed by Dawley et al (2015) demonstrates how local and regional path creation is enabled or constrained by strategies formulated by national state organisations (Morgan, 2013; Martin, 2010). Moreover, development agencies and state organisations on the regional scale, alongside the policies, strategies and initiatives they design and implement, are also significant actors and tools shaping the institutional environment and the subsequent evolution of institutional arrangements (Morgan, 2013; Dawley et al, 2015; Martin, 2000). In support of these arguments, Gertler (2010, pp6) highlights that the reproduction of institutions, actors and industries at one geographical scale is undoubtedly constrained and shaped by “institutional architectures that are erected at other geographical scales.” Importantly, the thesis will discuss the institutional environment and institutional arrangements through a multiscalar approach to theoretically analyse institutional change, path creation, diversification and adaptation.

In some instances, national, regional and local organisations can work jointly and collaboratively to support a common economic development mission and form important institutional arrangements around a particular city, project or case (Martin, 2000; Wood, 1999; Cox, 1998). This kind of collective action reflects the building of a ‘growth coalition’ like those historically formed in US cities such as Houston, Milwaukee, San Diego and San Francisco, which emulate actions of an ‘entrepreneurial state’ aiming to heighten the capacity of localities to (re)develop and grow (Gotham, 2000; Fineberg, 2016; Mazzucato, 2013; Wood, 1999; Cox, 1998). These growth coalitions and collective local political action around economic development in the US was in response to processes of urban decline, deindustrialisation and economic restructuring in the 1980s, as local actors were attempting to shape the futures of their respective localities (Gotham, 2000; Cox & Muir, 1988; Cox, 1998). In the context of US growth coalitions and urban redevelopment, private developers and interests aimed to attract investors for short-term returns on real estate development, which was enabled by local and city government agencies prioritising urban redevelopment policies and empowering developers through tax-concessions, grants, low-interest loans and liberalising land-use regulation (Gotham, 2000; Wood, 1999; Mazzucato, 2013). Job creation and industrial growth within and around ports can be shaped by joint growth coalitions, with these positive outcomes featuring in their core missions. Originally, the discussions of growth coalitions did not perceive them as being multiscalar (Gotham, 2000; Cox & Muir, 1988; Cox, 1998). However, the thesis recognises the importance of exploring how actors within joint growth coalitions work together across multiple scales and shape processes of adaptation and diversification, which can lead to job creation and industrial growth as positive path outcomes (Notteboom, 2016; Martin, 2010; Pike et al, 2010).

To drive new regional paths and organise coalitions, actors should have the necessary agency to “act or intervene” (MacKinnon et al, 2019, pp122; Martin, 2010). Grillitsch and Sotarauta (2018) outlined three types of agency demonstrated by actors. The first is ‘innovative entrepreneurship’, whereby firms and entrepreneurs seek to break with existing paths and create new paths, based upon the concept of ‘mindful deviation’ (Garud and Karnøe, 2001; MacKinnon et al, 2019). The second is ‘institutional entrepreneurship’, wherein an institution’s existing rules, norms and practices are incrementally changed for an alternative set of rules, norms and practices, which can drive a new path creation agenda (Grillitsch and Sotarauta, 2018; MacKinnon et al, 2019). ‘Place leadership’ is another form of agency, occurring when actors demonstrate the necessary leadership capacity to advocate new paths across “institutional and organisational divides”, in order to attract other actors and interests (Grillitsch and Sotarauta, 2018, pp14; MacKinnon et al, 2019). The project will draw upon these concepts to better understand the actors and the agency they exercise, which shape the processes of path creation, adaptation and diversification.

2.3.2 Institutional adaptation and change

First and foremost, Martin (2000, pp80) highlights that institutions enable the continual reproduction and continuity of economic activity across time and space because institutions are “characterised by inertia and duality”, thus emphasising the long-term adaptation of institutions. In connection to this perspective, David (1994) emphasises that institutions and places are mutually reinforcing and shaping each other over time (Martin, 2000; North, 1990). Moreover, David (1994) suggests that institutions are ‘carriers of history’, whereby institutions respond to the changing environments in which they inhabit and continually reproduce themselves through actions of individuals, whilst being constantly influenced by previous practices, norms and routines. Institutions are never static in arrangement and structure, as they constantly react and respond to the spatial settings or contexts, institutional environments and occasional shocks to their structures (Hollingsworth & Boyer, 1997; Martin, 2000).

However, in contrast to these arguments, the evolution and change of an institution can be explained through “historical ruptures or openings”, referring to convulsive exogenous shocks to the institutional system prompting change, and “gradual and incremental change” through internal developments (Streeck & Thelen, 2005, pp18). This perspective emphasises that adaptive change within institutions is influenced by both endogenous and exogenous influences, in tandem with dynamic social agency and strategic action (Streeck & Thelen, 2005; Bailey et al, 2010). Mechanisms of institutional change has strong linkages to the notion of adaptation, as institutions are realigning themselves through the alteration of endowed assets and resources to adapt to changing contexts, settings and environments. This is the theoretical perspective adopted for this project, due to the dynamic interplay between multiscalar endogenous and exogenous factors and processes which occur through key historical moments. To expand upon this argument, the discussion will move onto explain some of the key mechanisms catalysing incremental institutional change and adaptation.

In the academic fields of historical sociology and political science, there have been developments to move away from notions of path dependence and stable institutional forms, to focus upon how institutions change over time on the microeconomic scale through certain mechanisms of change (Martin, 2010; Boas, 2007, Streeck & Thelen, 2005). The institutional change mechanisms outlined below fundamentally relate to notions of path creation, diversification, transplantation and adaptation as they essentially create new economic realities and paths through enabling incremental change (Martin, 2010; Boschma & Frenken, 2011; Martin & Sunley, 2006). The first of these mechanisms is known as a 'layering' process, whereby an institution add new rules or 'layers' incrementally, thus gradually changing the nature of the institution over time (Martin, 2010; Boas, 2007). If this process of change occurs it can set in motion dynamics which can alter an evolutionary path, creating differential growth (Streeck & Thelen, 2005). These dynamics of institutional change involve new layers of arrangements being implemented on top of existing institutional structures and arrangements (Thelen, 2003; Shickler, 2001).

The second mechanism is known as a 'conversion' process, defined as when an institution's existing arrangements, structures, rules and procedures are reoriented, realigned and modified to serve new functions and purposes (Martin, 2010; Boas, 2007). The process of conversion is set in motion when individuals within institutions are faced with a new set of problems and the institutional arrangements or form needs to be realigned to serve new goals and new ends (Thelen, 2003). The overall redirection of an institution through the conversion process may be in response to changing interests of external institutions (state policies and strategies, market conditions), or fluctuating internal power relations (Streek & Thelen, 2005; Thelen, 2003; Dawley, 2014). Moreover, conversion has clear links to the process of path creation, the diversification mechanism and adaptation, as the process of conversion occurs in response to shifts in the external institutional and policy environment (Boas, 2007; Martin, 2010; Martin & Sunley, 2006). Additionally, Boas (2007) and Thelen (2003; 2004) emphasise that these two mechanisms of incremental institutional change often interact and coexist. The process of conversion is reflective of the realignment of infrastructural and material port assets, enabling the diversification of ports into new markets (Maskell & Malmberg, 1999; Martin & Sunley, 2006; Notteboom, 2016). In this sense, the conversion of port assets can be argued to be a form of adaptation and diversification (Maskell & Malmberg, 1999; Pike et al, 2010).

Another mechanism of institutional change is known as ‘recombination’ (Martin, 2010). This process involves the recombination and redefining of existing institutional resources with new resources to produce a completely new institutional arrangement and structure (Martin, 2010; Dawley, 2014). For example, an institution’s resources may have been depleted or are incompatible with new market conditions or multiscalar policy environment, therefore individuals can exercise human agency and strategic action to recombine existing assets or resources to create a new path for the institution (Dawley, 2014). As previously discussed, multiscalar institutions shape and constrain economic activity and action, whilst evolving over time (Gertler, 2010; Martin, 2010).

2.3.3 Multiscalar governance and policy

The role of the state has morphed from providing into providing a complex multiscalar governance system, with an overarching and prominent national scale of governance (Labao et al, 2009; Brenner, 2004; Jones, 2001). Throughout the literature on institutions and governance, a key argument stands out which highlights a ‘qualitative shift’ from government to governance on multiple spatial scales (MacKinnon, 2012b; Jessop, 1997; Cox, 2009). Jessop (1997) outlined three key processes of state reorganisation within a highly influential account (MacKinnon, 2012b). Firstly ‘denationalisation’ has occurred through a ‘upwards’ rescaling (transfer of functions, responsibilities and powers) from the national level to the supra-national level and through a ‘downwards’ rescaling from the national level to sub-national organisations and agencies (Jessop, 1997; MacKinnon, 2012b; Cox, 2009). The second state process of ‘destatisation’ has occurred through states relocating functions ‘outwards’ to quasi-state agencies operating at arms-length to the national government, private institutions or interests and voluntary organisations (Jessop, 1997; MacKinnon, 2012b). The third state reorganisation process is the internationalisation of policy regimes, based upon the increasing interconnections between individuals, local, regional and national state institutions in different countries. This highly complex form of governance enables policy transfer processes to take place between countries and subsequent policy adaptation to occur, according national political-economic environments (Jessop, 1997; MacKinnon, 2012b; Hall & Soskice, 2001). These state rescaling and reorganising activities represent a qualitative shift in the role of the state through a ‘transformational’ process, demonstrating a complex reorganisation and adaptive process facilitated by national state governments (MacKinnon, 2012b; Peck, 2001; O'Neill, 1997). However, throughout institutional economic geography, questions regarding the influence of political and multiscalar governance upon regional development and growth have been largely unheeded (Hanssen et al, 2011; Tomaney, 2014; Hassink et al, 2019).

Governance on sub-national and sub-regional spatial scales allows for effective implementation of development strategies in a place-sensitive manner and efficient deployment of local and regional institutional resources (Rodríguez-Pose, 2013; Pike & Tomaney, 2009). For governance to occur on sub-national spatial scales a process of devolution is required, which has been marked a global trend of devolution and decentralisation of power (Rodríguez-Pose & Gill, 2003; Armstrong & Taylor, 2000). Devolution involves the decentralisation (transfer) of power from central government to sub-national government organisations, thus allowing the latter to gain financial and human "resources", political "authority and responsibility", and "strong subnational legitimacy" (Rodríguez-Pose & Gill 2003, pp335). Political, fiscal and administrative decentralisation from national scales to local and regional scales is an ongoing, continuously changing and global phenomenon, whereby nation states seek to improve socio-economic development outcomes at lower spatial scales (Tomaney, 2014). The complex process of devolution demonstrates the ongoing power of state governments to shape and transform institutional environments and arrangements in regions (MacKinnon et al, 2009; Martin, 2010). This has been viewed as incrementally 'unfolding' in the UK context through rounds of state restructuring and rescaling processes (MacKinnon, 2015; Shaw & MacKinnon; 2011; Pike et al, 2012). Newly transformed institutional arrangements following devolution of power and resource can heighten a region's institutional capacity to catalyse path creation and adaptation (MacKinnon et al, 2009; Martin, 2010; Martin & Sunley, 2006). This catalytic process would be operationalised through local and regional state (and non-state) institutions connecting territorial assets to wider production networks and flows of capital investment, thus enabling strategic coupling (Coe & Hess, 2011; MacKinnon, 2012a; Coe & Yeung, 2015). Therefore, by incorporating extra-regional networks, local state (and non-state) institutions increase the possibility of generating path creation and adaptation processes (Amin, 1999; Coe & Hess, 2011; Martin & Sunley, 2006).

Additionally, the devolution of power and resources often enables the ability of sub-national and sub-regional state organisations and development agencies to strategically mobilise non-state actors such as firms, universities and research institutions in order to successfully govern economic “manifestations of uneven development” (Labao et al, 2009, pp8; Pike & Tomaney, 2009). As previously demonstrated throughout discussions of empirical examples, the collective mobilisation of regional and sub-regional state (and non-state) actors is crucial for catalysing path creation, diversification, transplantation and adaptation (Simmie, 2012; Neffke et al, 2011; Fornahl et al, 2012; Dawley, 2014). The thesis will seek to add to these empirical examples by exploring the ways devolved local and regional governance institutions are important for catalysing port adaptation within a multiscalar governance approach (Hanssen et al, 2011; Martin & Sunley, 2006). To gain a greater understanding of the roles regional institutions and governance play in shaping adaptation, diversification and path creation, the chapter must explore the role of multiscalar policy environments (Martin, 2010; Dawley et al, 2015).

Institutions “make behaviour, rather than simply reflecting it” (Peck & Theodore, 2007, pp745; Hall & Soskice, 2001). The policies macro and meso level institutions implement differ between nation states, due to the nature of capitalism being diverse across space (Hall & Soskice, 2001). Therefore, the corporate strategies devised by firms and similar private or private-public institutions, run parallel to the predominant institutional structures of the political economy, which vary between liberal market economies (LMEs) and coordinated market economies (CMEs) (Hall & Soskice, 2001). In LMEs firms organise their economic activities and corporate strategies in alignment with competitive markets. By contrast, in CMEs, firms operate with an agenda of constructing strategic partnerships and collaborations, whilst relying heavily upon non-market actors, such as the state, to build core economic competencies. Moreover, Hall & Soskice (2001, ppp6-7) focus upon five spheres, namely industrial relations, vocational training and education, corporate governance, inter-firm relations and employees, in which firms must develop relationships to settle “coordination problems central to their core competencies” (Peck & Theodore, 2007). However, the ways in which firms carry out this process are fundamentally shaped by coordinating state and non-state institutions, whose institutional character is irrepressible and differs between LMEs and CMEs (Hall & Soskice, 2001).This theoretical perspective is very important for analysing the governance, adaptation and diversification of particular institutions operating in varying political-economic settings, together with differing multiscalar institutional environments and policy contexts (Hall & Soskice, 2001; Martin, 2010; 2000).

The original discussions of the varieties of capitalism by Hall & Soskice (2001), have been critiqued by Peck and Theodore (2007), who argue that Hall & Soskice (2001) were too focused upon defining varieties in the national scale of governance. Furthermore, Ćetković et al (2016, pp4) add to this critique and argue that CMEs and LMEs can be 'simple', when the "state structure is centralized and governing is concentrated in a single authority", or 'compound', when states "feature multiple authorities." On a related note, path creation and adaptation processes within regions are often stimulated, shaped and controlled by centralised state organisations constructing vertical (national industrial strategies) and horizontal (legal, regulatory, infrastructure, R&D, market) policy environments (Dawley et al, 2015; Chang et al, 2013; Hall & Soskice, 2001). In addition, local and regional state organisations also implement policies, strategies and initiatives on the regional scale to support various non-state economic actors, which subsequently shapes path creation and adaptation in regions (Dawley et al, 2015; Morgan, 2013). Therefore, multiscalar governance systems often construct policy environments which can enable or constrain path creation, industrial diversification and adaptation within regions (Martin, 2010; Boschma & Frenken, 2011; Dawley et al, 2015).

2.4 Port governance

The core focus of the thesis is to gain a deeper and more advanced understanding of how the process of port adaptation unfolds, whilst simultaneously exploring how port authorities as key actors influence local and regional path creation as an outcome of port adaptation. Path creation, diversification and adaptation have all been applied to exploring the 'region' as a socio-economic entity in EEG. However, they can also be applied to ports as overlooked institutions and economic actors in processes of local and regional path creation because ports are actively involved in shaping processes of path creation, diversification and adaptation by harnessing and valorising port assets for new industries emerging within regions (Notteboom, 2016; MacKinnon et al, 2009; Morgan, 2013; Maskell & Malmberg, 1999). Port adaptation, diversification and evolution is dependent upon "past decisions, processes and institutional contexts", whilst future decisions and "proactive strategies by various stakeholders" may enable a port to branch towards new development paths (Monios & Wilmsmeier, 2016, pp247; Notteboom, 2016). Consequently, certain actions taken by strategically affiliated governance actors shape the adaptation or conversion of port-related assets and a port authority's overall adaptive capacity (Streeck & Thelen, 2005; Pike et al, 2010). For ports to fully capitalise upon extra-regional market opportunities and inward investment, governance actors in ports and associated local institutions should define clear trajectories of adaptation through dynamic leadership and decision-making activities (Bailey et al, 2010; Notteboom, 2016).

It is important to consider ports as key actors within discussions of local and regional path creation because as institutions, ports are fundamentally different to firms. Therefore, ports provide a new conceptual and empirical vehicle to view and analyse how ports as important actors contribute to occurrences of local and regional path creation. Firstly, ports have a different physical and human asset base to firms, referring to the infrastructural, industrial material assets located within the port, alongside the specialised labour operating within the port (Maskell & Malmberg, 1999; Alderton, 2008). Secondly, the ways in which ports are governed through distinctive governance models, with evidence of state intervention in some instances, clearly differs to the ways firms are governed, operating as privatised entities operating for profit through directly trading goods or services (Verhoeven, 2010; Alderton, 2008). Thirdly, ports are deeply rooted in various localities and regions in terms of their physical geography, economic purpose as gateways for trade and commerce, alongside the numerous sunk costs in port infrastructure and associated assets (Alderton, 2008; Musso et al, 2006). This distinctive embeddedness contrasts the key characteristic of firms and TNCs operating in a multiscalar economy, as these private institutions can freely move and relocate to seek higher profits, cheaper labour and improved state incentives (Coe & Yeung, 2015; Smith, 2015).

2.4.1 Port policy and state governance

Interestingly, Debrie et al (2013) emphasise that ports operate in multiscalar institutional environments (regulatory, legal, industrial, market), which are controlled and shaped by governance decisions made most commonly at the national level by government institutions

(Martin, 2010). In many countries with market-orientated political-economic systems, transport ministries exercise various executive responsibilities to control ports including policy-making, legislation, international relations, economic affairs and auditing procedures (World Bank, 2016). Consequently, transport ministries or departments operating in central governments often design and control the multiscalar policy environment, whilst shaping broader political-economic contexts in which ports operate (World Bank, 2016; MacKinnon et al, 2009). However, small to medium sized ports in states which have avoided national port privatisation policies are often governed by lower tiers of government or operate as independent bodies, following the decentralisation of power from centralised government departments (Debrie et al, 2007). Multiple legislative, legal, industrial and market-based factors shape the unique ways port authorities govern themselves (Debrie et al, 2013; Notteboom et al, 2013; Martin, 2010). By drawing upon existing understandings of institutions in EEG, the thesis aims to provide a more advanced understanding of how multiscalar institutional environments shape governance models and diversification strategies of port governance actors (port authorities and sub-national government agencies), which allows us to better understand how port adaptation unfolds (Martin, 2000; 2010; Gertler, 2010; Pike et al, 2010; Notteboom, 2016; Figure 2.4).

The thesis is particularly concerned with the institutional arrangements of port authorities and associated local and regional institutions as key actors in undertaking the conversion of physical assets, then subsequently shaping the port as a key site of adaptation and diversification (Boas, 2007; Martin & Sunley, 2006). The conversion of port-related (infrastructural, industrial, material) assets can enable the diversification of ports towards new or emerging markets (Boas, 2007; Maskell & Malmberg, 1999; Martin & Sunley, 2006). By applying conversion in this manner, the project empirically develops conversion and moves beyond abstract theoretical uses of conversion (Boas, 2007; Thelen, 2003; 2004). Strategically affiliated governance actors with local and regional institutions can adapt and realign territorial assets to serve new markets, in order to fit the interests of focal firms and TNCs operating in extra-regional networks (Boas; 2007; Streek & Thelen, 2005; Coe & Yeung, 2015). Consequently, local and regional government institutions and development agencies work in association and strategic alignment with ports for adaptation to occur (Rodriquez-Pose, 2013; Todtling, 2011; Pike et al, 2010). A governance process involving the coordinated planning, design and implementation of bottom-up strategies and initiatives to catalyse new port developments is increasingly important (Moglia & Sanguineri, 2003; Todtling, 2011). Territorially specific port governance models and processes within port authorities or operators, shape how ports adapt, diversify and succeed (Debrie et al, 2013; Meersman & Voorde, 2010). Therefore, the chapter needs to analyse and discuss how different governance models, functions, strategies and decision-making processes shape the adaptation of ports (Debrie et al, 2013; Verhoeven, 2010; Martin, 2010).

2.4.2 Port governance models

Ports are governed by port authority models established by national or regional state institutions depending upon each national political-economic framework (World Bank, 2016). There have been several scholars in recent years attempting to theorise how ports are governed and subsequently interact with external public institutions in order to understand how port governance changes over time and subsequently shapes port performance, development and adaptation. Firstly, Baltazar and Brooks (2007) provide an interesting 'Matching Framework' account of port governance in their analysis of Canadian ports. The 'Matching Framework' is made up of three interacting features consisting of an operating *environment* fluctuating in political and economic certainty, an established *strategy* for ports competing in certain markets and a *structure*, defining the degree to which decisions are made centrally or autonomously by individual ports (Figure 2.2) (Baltazar & Brooks, 2007; Viera et al, 2014):

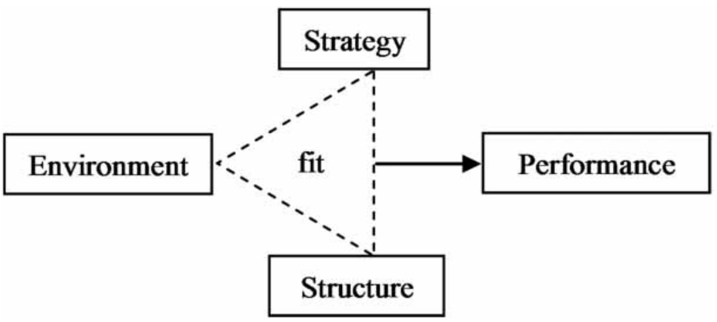


Figure 2.2: The 'Matching Framework' port governance model
Source: Baltazar & Brooks, 2007, pp384

This rather simplistic model was critiqued and developed by an account by Brooks and Pallis (2008), which argued that the formulation, change and reform of port governance models is because of ‘external environments’. Pre-reform and post-reform external environments consist of highly influential national port policies and regulations from national government institutions, alongside business development strategies implemented by private port operators, shifting markets and external focal firms or TNCs (Brooks & Pallis, 2008). Therefore, external environments consisting of exogenous port markets and policy frameworks set by national governments, as defined by Brooks and Pallis (2008), intrinsically influence the microlevel governance decisions made within an individual port to alter port governance models, long-term development strategies and subsequently enable or constrain a port’s industrial path (Martin, 2010).

The notion of ‘external environments’ made by Brooks and Pallis (2008) is linked to Martin’s (2010) account, of how (external) multiscalar policy environments and institutional arrangements shape local path creation, institutional governance, diversification and adaptation. The thesis will theoretically combine these accounts which present a gap for empirical investigation (Brooks & Pallis, 2008; Martin, 2010). The account by Brooks and Pallis (2008) argues that historical formulation, change and reform of port governance models is shaped by multiscalar institutions, national political-economic contexts and policy (legal, legislative, industrial, market) environments (Brooks & Pallis, 2008; Martin, 2010; Ng & Pallis, 2010). Subsequently, this complex governance process shapes the port as a key site of diversification, and the incremental building of adaptation capacity of a port authority (Martin & Sunley, 2006; Notteboom, 2016).

On a global scale, there have been two trends of devolution and privatisation, in order to transfer power from national state institutions to local or regional state institutions or remove state ownership and management of ports, the latter being particular evident in the UK (Debrie et al, 2007; Petitt, 2008). Throughout the 1990s there was widespread privatisation in the global ports industry catalysing the emergence of private port operators, essentially acting as TNCs to operate ports across regions, nations and even continents (Oliver & Slack, 2006). The majority of national governments across the globe have followed the devolution trend with the exception of some developing and undeveloped states, thus creating unique port governance models which differ from state to state (Debrie et al, 2007; World Bank, 2016).

To better understand these trends, Brooks and Cullinane (2007b) formulated a range of port ownership, management and control combinations following devolution of power to lower tiers of government or privatisation of ports (Table 2.1). 'Ownership' is simply the legal possession of port land, infrastructure and superstructure, alongside the responsibility of providing capital investment (Brooks & Cullinane, 2007b; Table 2.1). 'Management' refers to central management activities including development planning, financing, maintenance of infrastructure, real estate management and general port operations (Brooks & Cullinane, 2007b; World Bank, 2016; Table 2.1). 'Control' relates the allocation of governing control to a port authority following the decentralisation of power and resources, or the allocation of governing control to a private body (Brooks & Cullinane, 2007b). This control encompasses decision making on investment approvals, conceiving and implementing a range of policies (financial, tariff, labour), strategic usage of assets and resources, licencing users, employees or agents, power to obtain and analyse port information, and responsibility for full recovery of port-related costs (World Bank, 2016; Brooks & Cullinane, 2007b). Finally, port authorities have varying levels of accountability in terms of their responsibility for enabling broader local and regional development. This may take place through investment into port (infrastructural, industrial, material, natural) assets, which influences the wider development and growth of connected port-related industries in the adjacent locality or region (Langen, 2007).

	Port Governance Dimensions		
Governance Characteristics	**Public: Central - Local**	**Mixed: Public- Private**	**Private**
Ownership	Central government or Local government body	Government owned (federal, regional or municipal). Trust (local): Independent statutory body (established by public legislation).	Private body
Management	Central government or Local government body	Private body: via concession, lease agreement or public-private arrangement. Trust (local): Independent statutory body.	Private body

Control	Central government <u>or</u> Local government body	Government body (federal, regional or municipal) <u>or</u> private body (corporatised entity, state owned). Trust (local): Independent statutory body (influenced by local stakeholders).	Private body

Table 2.1: Allocation of port governance practices following decentralisation of control
Source: Adapted from Brooks & Cullinane (2007b)

International examples of the port governance model classifications in Table 2.1 would include the Port of Colombo as Public (Central), the Port of Shanghai as Public (Central - Local), the Port of Sunderland as Public (Local), the Port of Rotterdam as Mixed (Public - Private), the Port of Liverpool as Private and the Port of Tyne as a Trust port. However, the fact remains throughout the literature on ports that categorising and comparing port governance remains challenging as all ports operate in varying political, economic, social and fiscal environments (Suykens & Van de Voorde, 1998; Brooks & Pallis, 2008). Despite this ongoing challenge, Suykens & Van de Voorde (1998), provide an insightful account which acknowledges the differing political, economic, social and fiscal environments between nation states and regions, especially in Europe, which is discussed below (Hall & Soskice, 2001). Complementing this account, Verhoeven (2010, pp251) recognises the need for geographically sensitive definitions of governance models. He argues that ports are not single units and are shaped by complex interactions with multiple private and public actors on multiple scales, thus creating a very complex array of both internal and external "economic, societal and public policy stakeholders." In addition, Alderton (2008) points out that ownership categories, such as state ownership, autonomous bodies, municipal ownership or private ownership, may be a combination of two or three of these categories. The discussion will now move onto to discuss port governance models in Europe based upon Suykens & Van de Voorde (1998) and several other associated accounts.

The 'Anglo-Saxon' port governance model, as termed by Suykens & Van de Voorde (1998), is aligned to port authorities being 'independent' private organisations responsible for port ownership, management and control, outlined 'Private' in Table 2.1 (Brooks & Cullinane, 2007b). Additionally, trust ports align to the Anglo-Saxon port governance model, as they're essentially 'independent' statutory bodies created through a legislative Act of Parliament

(Baird & Valentine, 2007; Suykens & Van de Voorde, 1998). Trust ports consist of no shareholder ownership, receive no UK government funding and operates on a commercial basis for multiple stakeholders (Baird & Valentine, 2007). However, unlike private ports, trust ports are characterised by mix of public-private ownership, management and control practices, unique to the UK port governance context (Table 2.1) (Brooks & Cullinane, 2007b; Baird & Valentine, 2007). In the UK, the Anglo-Saxon model is clearly evident as there is no centralised port regulator controlled by the state, therefore responsibilities have been decentralised to private and independent interests (World Bank, 2016; Petitt, 2008). Moreover, especially in the current UK political-economic climate, there has been a lack of public financing for port infrastructure provision following rapid privatisation of the ports industry in the 1980s and 1990s causing some opposition to total private ownership, management and control over investment decisions (Baird, 2004). The governance processes, investment strategies and practices within a private port are profit-based, flexible and market-orientated, thus public involvement in producing plans and development strategies for private ports is often minimal or totally absent (Brooks & Cullinane, 2007b; World Bank, 2016). The Anglo-Saxon port governance model heavily relies upon high levels of revenue and finance (Verhoeven, 2010). Although this model certainly brings some economic benefits such as readily available capital for (re)investment into port-related assets, it can also lead to decreasing levels of investment due to risk averse investment strategies (Verhoeven, 2010; Monios & Wilmsmeier, 2016). Decreasing investment into assets can occur if the port is underperforming because of an economic shock, such as disinvestment from a partnered firm(s) or is undergoing radical internal change through governance reform (Verhoeven, 2010; Brooks & Cullinane, 2007b). Additionally, privately owned, managed and controlled ports often make investments based on past, current or certain future market developments, thus operating like a firm in the traditional sense rather than a port (Verhoeven, 2010).

A differing port governance model termed by Suykens and Van de Voorde (1998) is the 'Hanseatic model', aligned to a tradition of local, mainly municipal, public governance found in Northern Europe and Scandinavia. Although the operation and management of some Hanseatic ports has been privatised in recent years, Hanseatic ports still tend to be municipally owned, whilst others continue to be operated by the public port authority. This governance trend demonstrates a reality found in Northern Europe and Scandinavia, whereby ports maintain characteristics of public institutions as well as private enterprises (Verhoeven, 2010; Suykens & Van de Voorde, 1998). Therefore, as seen in Table 2.1, the complex governance models found in Hanseatic ports can range from public or mixed governance models (Brooks & Cullinane, 2007b; Suykens & Van de Voorde, 1998). The Hanseatic port governance model also has greater access to public financing and support, therefore a port operating through this governance model will have a different adaptive capacity than a port adopting an Anglo-Saxon or Free Port governance model (Suykens & Van de Voorde, 1998; Notteboom, 2016). Moreover, Hanseatic ports are more likely to work in cooperation with other regional ports, in contrast to Anglo-Saxon ports which tend to become embedded within national level port monopiles (Brooks & Cullinane, 2007b; Brooks, 2004). For example, state ministers, port managers and other key actors from Bremen, Lower Saxony and Hamburg meet annually to hold a port development dialogue to discuss current port planning strategies from each regional port, alongside other important port and industry related topics (Notteboom, 2016). This example is also supported by Notteboom et al (2013), wherein they argue that there's strong political control over the Hanseatic port governance model (strategic planning and development) by local, regional and federal state authorities in Northern Europe, using the examples of Hamburg and Antwerp to establish their arguments.

An alternative model to private, trust or municipally owned ports is the 'free port' governance model. A free port or zone is designated by a state government and remains under full sovereignty of the state, however imported and exported goods are not subject to customs laws and limits (Alderton, 2011). The main European examples of free port governance models is at the Port of Rotterdam and the Port of Hamburg (Alderton, 2011). Despite free port governance models being completely absent in the UK port policy framework, a report by the Sunak (2016) has suggested that reforming some of the governance models of some ports in Northern England may present lucrative political, economic and manufacturing opportunities for ports willing to undergo port governance reform. Due to the absence of custom laws on port authorities and companies located within a free port or zone, the free port model presents a compelling economic case for firms to relocate within free port boundaries to undertake manufacturing activities (Sunak, 2016). This has been billed as a radical response to the numerous trade deals formulated as a result of the UK leaving the European Union (EU) (The Telegraph, 2016).

The existing literature on port governance models provides an insight into how port adaptation and diversification can be shaped by how ports are owned and governed by port authorities and broader sub-national and national government bodies (Verhoeven, 2010; Suykens & Van de Voorde, 1998). However, the thesis will turn to literature on the role of multiscalar institutions and varieties of capitalism to obtain a more advanced understanding of how the ownership and governance of ports are influenced by distinctive forms of capitalism and institutional arrangements (Hall & Soskice, 2001; Peck & Theodore, 2007; Martin, 2010). For example, the Anglo-Saxon port governance model reflects the market orientated and profit driven variety of capitalism in the UK as an LME (Liberal Market Economy), meaning the majority of ports are privately owned and organise their corporate strategies in alignment with competitive port markets (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Hall & Soskice, 2001; Peck & Theodore, 2007). By contrast, the Hanseatic port governance model reflects the agenda of constructing strategic partnerships and collaborations between public institutions and industry in a CME (Co-ordinated Market Economy), meaning port authorities in CMEs typically rely on non-market actors, such as the state, for ownership and financial resources (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Hall & Soskice, 2001; Peck & Theodore, 2007).

2.4.3 Port adaptation and diversification

Existing literature in port studies and transport geography, considers port adaptation and diversification to be exclusively shaped by port governance models and internal governance activities of port authorities, which will be explored in this section (see Notteboom, 2016; Debrie et al, 2013; Notteboom & Jacobs, 2011; Jacobs & Lagendijk, 2014). However, to provide a more comprehensive grasp of how processes of port adaptation and diversification unfold, the thesis will utilise the concepts of adaptation, diversification and path creation from EEG and the role of multiscalar institutional environments and governance in shaping port adaptation and diversification.

Certain port governance models and in particular the key governance actors (senior individuals and boards) within ports will operate differently in relation to one another, in terms of directing institutional change and designing diversification strategies, thus altering each port's capacity to adapt and create new growth paths (Debrie et al, 2013; Notteboom, 2016). Port governance actors can either instigate proactive or reactive responses to external policy or market changes, subsequently shaping the conversion of infrastructural, industrial, material and natural assets (Monios & Wilmsmeier, 2016; Pike et al, 2010; Brooks & Pallis, 2008; Boas, 2007). Notteboom (2016) discusses how building the adaptive capacity of a port is an incremental process, driven by an overall port authority mission, ambitions for future port development, current territorial assets and resources, and existing capacities (Figure 2.3). This incremental process is fundamentally controlled by unique port governance models, which can either enable or constrain the port adaptation process (Notteboom, 2016; Debrie et al, 2013). However, the model proposed by Notteboom (2016) has some limitations and overlooks some factors relating to the thesis' perspective on port adaptation and diversification, inspired by concepts and ideas from EEG and the role of institutions. In particular, Figure 2.3 lacks focus regarding the specific governance actors who are initiating the diversification of infrastructural, industrial, material and natural assets on port sites, to ultimately deepen the adaptive capacity of a port.

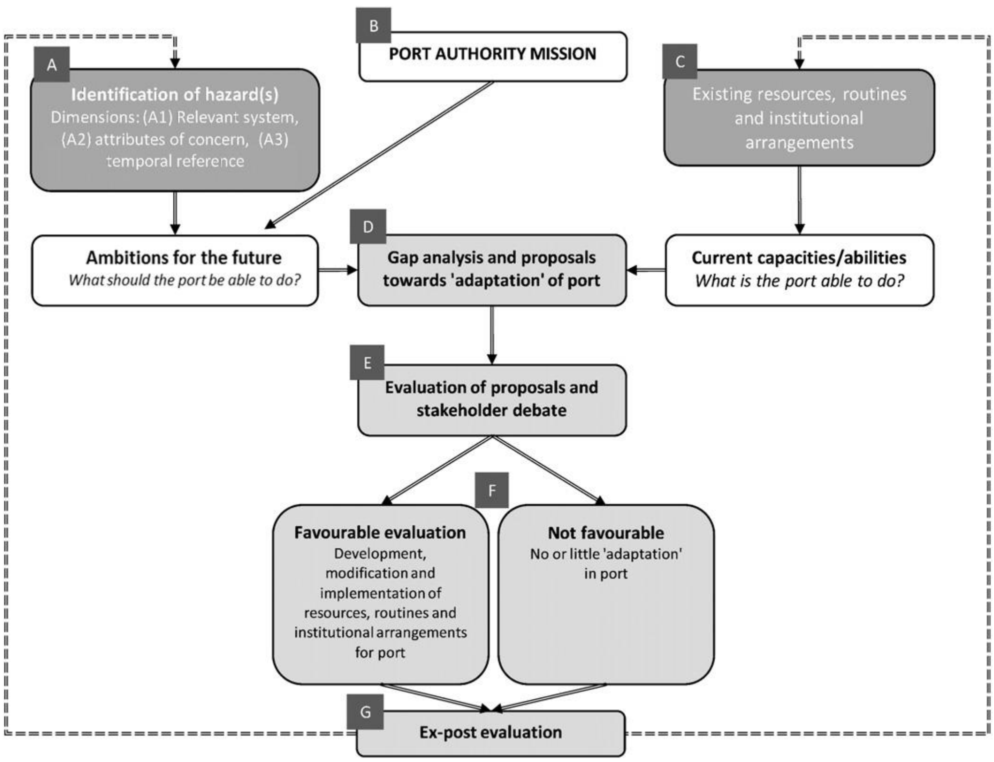


Figure 2.3: The process of adaptive capacity building by a port authority
Source: Notteboom, 2016, pp297

In relation to the Notteboom (2016) framework, the building of adaptive capacity and the activity of adaptation itself can be reconstituted as a process of change which takes places through key 'critical junctures' over time (Jacobs & Notteboom, 2011). Critical junctures are formed based on tactical decisions made by key governance actors, relating to the conversion of territorial (infrastructural, industrial, material) assets to align with new market opportunities through a process of strategic coupling, as previously discussed (Jacobs & Notteboom, 2011; Buitelaar et al, 2007; MacKinnon, 2012a). The thesis will draw upon Notteboom's (2016) notions of a strategic 'port authority mission', ambitions or strategies for future port development, alongside the existing resources which drive existing adaptive capacity of a port. Moreover, the research will principally adopt the idea of a strategic mission or 'vision', which is strongly influenced by the "governance model under which [a port] operates and the legislative [and] economic…environment in which [a port] operates" (Brooks, 2004, pp174). These lines of analysis will be harnessed in partnership with the dynamic concept of critical junctures formulated Jacobs & Notteboom (2011).

In tandem with this adaptive capacity building process, the strategic decisions made by TNCs and focal firms to provide inward investment into a port's infrastructural, industrial, material and natural assets cannot be overlooked as important factors in shaping critical junctures of port adaptation (Coe & Yeung, 2015; Jacobs & Notteboom, 2011). Furthermore, the strategic efforts made by key governance actors within ports in terms of attracting exogenous inward investment or FDI, alongside fiscal resources from government bodies, is also an important governance process catalysing port adaptation, diversification and eventual critical junctures (Jacobs & Notteboom, 2011; Coe & Yeung, 2015; Smith, 2015). However, diversification is the key mechanism in forming a critical juncture in a port's adaptation process, creating a new growth path (Jacobs & Notteboom, 2011; Martin & Sunley, 2006). Drawing upon the role of institutions play in shaping evolutionary processes, the thesis understands port diversification as essentially key governance actors endeavouring to diversify the port in an intentional direction, based upon new or emerging market opportunities and shaped by multiscalar institutional environment (Brooks & Pallis, 2008; Martin, 2010; Gertler, 2010).

A port's overall infrastructure, alongside its adjacent industrial assets and facilities, are key components in the supply, assembly, installation, operation and maintenance networks embedded within Europe's offshore wind industry (ESPO, 2016). This means that ports are crucial institutional 'nodes' and spaces of economic activity within Europe's offshore wind industry (Hess, 2004; Coe & Yeung, 2015; Dawley et al, 2015). The offshore wind industry currently presents a burgeoning market environment for port authorities in the UK and Europe to diversify into, through the conversion of infrastructural, industrial, material and natural assets, enabled by strategic planning and decisions made by key governance actors (Guardian, 2016; Boas, 2007; Brooks & Pallis, 2008). Therefore, offshore wind is a major market for ports to diversify into, align existing resources and assets towards and base adaptation strategies upon, to ultimately create a new growth path (Notteboom, 2016; Martin & Sunley, 2006). However, in relation to the previous discussion of port governance models, ports operating under the Anglo-Saxon model tend to be more focused on profit maximisation, reflecting their dependence on private revenue and finance, compared to higher levels of public support and finance in the Hanseatic ports (Verhoeven 2010; Suykens & Van de Voorde, 1998). This has emerged as a significant barrier to diversification into the offshore market in the UK context given the high levels of investment required to enhance port infrastructures to industrial standards (Dawley et al, 2015).

Chapter 2 has considered a range of literature from the areas of EEG (Evolutionary Economic Geography), institutions and governance, and current literature on port governance and diversification. A central aim of the research is to identify and apply concepts and ideas found in EEG and in discussions on institutions and governance, to help inform existing understandings of port adaptation and diversification in port studies and transport geography. However, the research will only draw upon certain concepts and ideas from the areas of EEG, institutions and governance, in order to provide a more comprehensive and deeper understanding of how port adaptation and diversification processes unfold, which will inform an analytical framework for grasping processes of port adaptation and diversification.

The research will apply adaptation as a concept from the sub-field of EEG, recognising it as an overarching process by which ports evolve over a long-term period, in response to external changes and challenges in policy and market environments (Pike et al, 2010; Martin, 2010). The research will draw upon diversification as a concept from EEG, applying it as an underlying process by which ports harness and valorise assets to capture new market opportunities, which drives the broader process of port adaptation and change (Martin &

Sunley, 2006; Pike et al, 2010; Maskell & Malmberg, 1999). The thesis will also utilise the concept of transplantation as a concept for explaining how external firms from new markets invest and move into port sites, thus influencing the port adaptation and diversification process (Martin & Sunley, 2006). However, the research is concerned with transplantation in the context of diversification occurring, meaning it will be excluded from the analytical framework (Martin & Sunley, 2006; MacKinnon, 2012a). The thesis will also use the concept of path creation, to help identify the broader regional outcomes of the port adaptation and diversification process (Martin & Sunley, 2006; Martin, 2010; MacKinnon et al, 2019). Furthermore, the research will draw upon the notion of territorial (infrastructural and material, industrial, natural, institutional, human) assets, which is emerging as an important idea in EEG and can support the explanation of how port assets influence processes of port adaptation and diversification (see Dawley et al, 2018; MacKinnon et al, 2019). To better understand how port adaptation and diversification are catalysed, the research will draw upon the notion of 'conversion' found in literature discussing institutional change (Boas, 2007; Streeck & Thelen, 2005; Thelen, 2003; Martin, 2010). However, the thesis uses conversion in a different way in comparison to its traditional understanding and application in exploring institutional change, by recognising it as a distinctive mode of investment which re-orientates existing assets to support new activities and thus catalyses the diversification of ports into new markets (Boas, 2007; Martin, 2010). The research aims to add to existing understandings of how port adaptation and diversification are stimulated, by identifying 'expansion' as a mode of investment which enables the construction of new port assets and the diversification of ports into new market activities (Martin, 2010; Notteboom, 2016).

To provide further theoretical clarification to these concepts utilised within the thesis, their contrasting levels of abstraction require a deeper explanation. The concepts of path creation, adaptation and adaptive capacity (supporting adaptation), are at the highest level of abstraction (Pike et al, 2010; Martin & Sunley, 2006; Martin, 2010). It is important to note that path creation emerges as an outcome of port adaptation and is therefore not the main conceptual focus of the thesis, which is to better comprehend the underpinnings of port adaptation and diversification (Notteboom, 2016; Martin, 2010). The process of diversification sits at a lower level of abstraction than adaptation, due to its more tangible focus upon diversifying assets for new market purposes (Martin, 2010; Maskell & Malmberg, 1999). The process of transplantation sits at the same level of abstraction as diversification due to its focus upon firms (Martin & Sunley, 2006). However, as transplantation is purely a process of firm implantation occurring in tandem with diversification means it is not the primary focus of the thesis, which is primarily concerned with obtaining a more granular understanding of the underpinnings, drivers and causality of port adaptation and diversification (Notteboom, 2016; Martin, 2010; Coe & Yeung, 2015). Conversion and expansion sit at the lowest level of abstraction given their nature as distinctive modes of investment for changing assets on greenfield or brownfield land, which influence the processes of diversification, adaptation and adaptative capacity sitting at higher levels of abstraction (Boas, 2007; Martin, 2010; Maskell & Malmberg, 1999).

2.5 An analytical framework for port adaptation and diversification

The thesis is seeking to develop an analytical framework to investigate the processes of port adaptation and diversification. Broader regional path creation emerges as an outcome of port adaptation and diversification. The analytical framework provides a foundation for investigating the actors who are "actually (doing the) evolving in the economic landscape", together with the important processes and mechanisms facilitating adaptation and path creation, whilst interconnecting multiscalar "research objects, subjects and levels" (Pike et al, 2016a, pp129; Martin, 2010). Ports exist as key *sites* of adaptation and diversification, whilst port authorities and (sub)-regional government agencies simultaneously operate as important intra-regional *actors* in shaping port adaptation and diversification. Figure 2.4 demonstrates the analytical framework for analysing port adaptation and diversification. Figure 2.4 proposes an analytical framework to explore the adaptation and diversification of port sites by port authorities and associated government organisations, who subsequently catalyse, initiate and implement the adaptation and diversification of port assets. The overall adaptation and diversification process is strongly influenced by ports and (sub)-regional government agencies operating as key intra-regional actors. In a broader sense the port exists as a key site which is the focus of adaptation and often neglected throughout EEG literature, which focused upon the adaptation of firms, regions and technologies (Pike et al, 2016a).

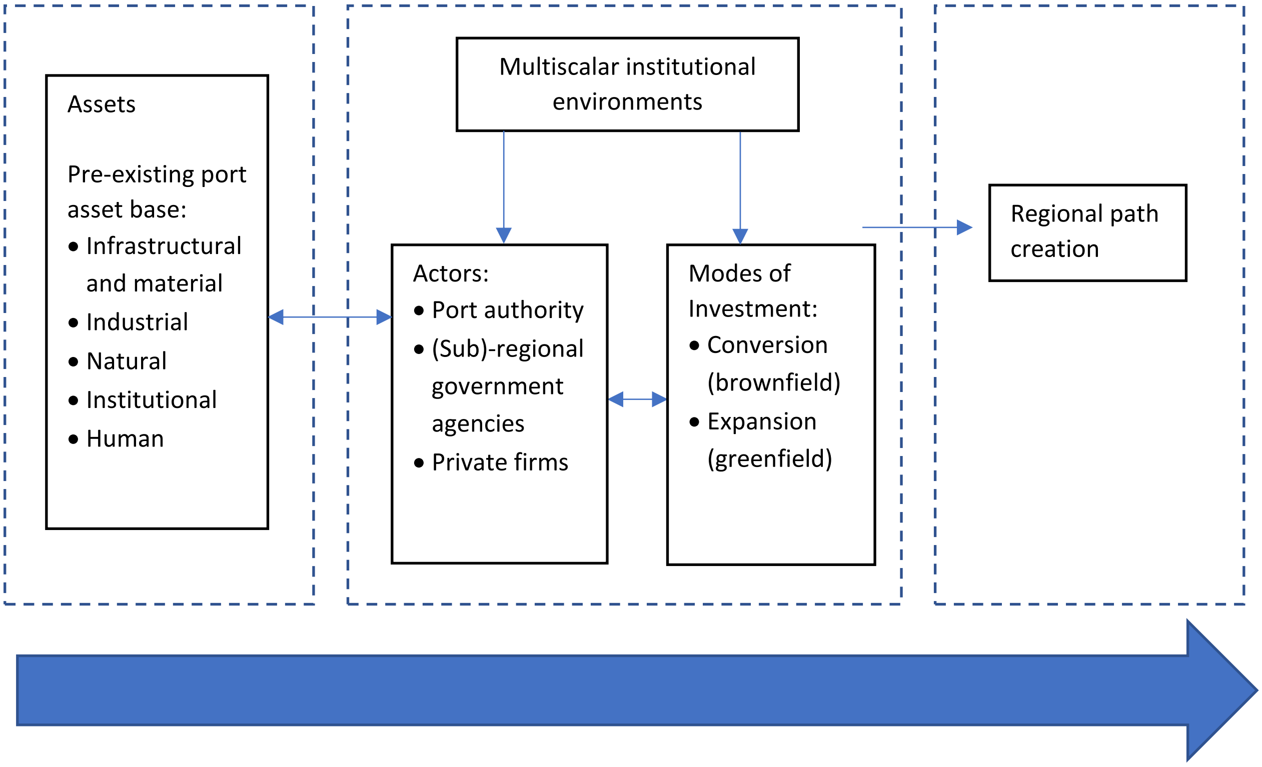


Figure 2.4: An analytical framework for analysing port adaptation and diversification
Source: Author

In Figure 2.4, the 'assets' are a port's pre-existing port asset base, formed of infrastructural and material, industrial, natural, institutional and human assets (see Maskell & Malmberg, 1999; MacKinnon et al, 2018). However, this thesis will focus upon the diversification of the infrastructural, material and industrial assets of the port (Maskell & Malmberg, 1999; MacKinnon et al, 2018). The key 'actors' are the port authority, (sub)-regional government agencies and private firms from a new market, who strategically determine and shape which assets are diversified to serve new market-orientated purposes. The existing nature of the assets influence which 'modes of investment' are selected by the key actors. The modes of investment comprise of conversion (investment provision for the changing of existing infrastructural, material and industrial assets for new uses on brownfield land) and expansion (investment provision for the growth of new infrastructural, material and industrial assets for new uses on greenfield land). The mode of investment made by the port authority is fundamentally shaped by the port governance model, as this influences the port authority's overall vision, investment approach, powers, responsibilities and resources. As actors, port authorities, (sub)-regional government agencies and private firms are all influenced by and sit within multiscalar institutional environments. The multiscalar institutional environments, consisting of market, institutional, policy, legislative and legal arrangements, essentially enable and/or constrain the capacity of actors to instigate the key 'modes of investment'. Ultimately, broader regional path creation emerges as an outcome of the interaction between the elements within the analytical framework and a port's overall adaptation and diversification.

2.6 Conclusion

Chapter 2 has recognised the key roles of actors and agency in EEG and therefore the research will unpack the interactions between port authorities, national and sub-national government agencies and offshore wind firms, to provide a more advanced understanding of the causality of port adaptation and diversification (Martin, 2010; Gertler, 2010; Steen & Hansen, 2018; Grillitsch & Sotarauta, 2018). Chapter 2 has also highlighted the importance of drawing upon and informing existing literature on port governance models, by considering how varying forms of capitalism and governance shape how port authorities are owned and governed across different national contexts, which influences how port adaptation and diversification occurs (Hall & Soskice, 2001; Peck & Theodore, 2007; Verhoeven, 2010). Finally, Chapter 2 has emphasised the importance of drawing upon discussions on the varieties of capitalism, as distinctive national institutional arrangements and environments enable and constrain how port authorities, sub-national government agencies and firms interact and drive port adaptation and diversification (Hall & Soskice, 2001; Peck & Theodore, 2007; Martin, 2010; Notteboom, 2016).

Chapter 3 Methodology

3.1 Introduction

This chapter describes, explains and justifies the research design, case study approach, comparative case studies and qualitative methods selected to explore and answer the following **research questions**:

1. **What forms of port diversification have been developed by port authorities and associated regional institutions?**
2. **In what ways do port ownership and governance models shape a port's capacity to adapt?**
3. **How do multiscalar institutional environments enable and/or constrain port adaptation?**

The analytical framework's principal aim is to clarify and emphasise the 'who', 'what', 'where' and 'why' questions in connection to 'doing' evolution in the economic landscape (Martin, 2010; Pike et al, 2016a). The purpose of the analytical framework is to identify and explore key sites, research objects, actors and mechanisms 'doing' the evolving of the research objects, and articulate an overall outcome (Martin, 2010; Pike et al, 2016a). This approach clarifies the analytical focus and attempts to connect research objects, subjects and levels together (Pike et al, 2016a).

The overall **aim** of the thesis is to better understand and assess processes of port adaptation and diversification, based upon the role of local institutions harnessing and valorising inherited and geographically specific port-related assets. By exploring two comparative port case studies, the research seeks to address key challenges of comparative work within EEG research (Pike et al, 2016a; Coe, 2011; Grabher, 2009). The principal challenges include ensuring rigour and robustness of theoretical frameworks and concepts through broadening the type and scope of comparative case studies in EEG research, moving beyond examining and comparing 'typical' research objects in EEG (firms, industries and networks), as well as conducting EEG research in different spatial contexts beyond the regional or city-region scales (Pike et al, 2016a; Ward, 2010).

The chapter is structured by the following sections around ontological and epistemological positioning, research design (including the case study approach, the empirical focus and case study selection), methods of data collection including ethics, data analysis and ending with a short conclusion.

3.2 Ontological and Epistemological positioning

In connection to the research questions, the thesis needs to obtain specific knowledge and evidence to better understand how unique forms of port conversion and diversification have been established, how the governance of ports shapes their capacity to diversify into new markets, and how external environmental factors shape port diversification and adaptation.

Pike et al (2016) discuss the need for EEG research to investigate comparative cases from different geographical settings, examining causal mechanisms, agents, structured relations and multiscalar networks. This approach involves a "deep contextualisation" of objects, mechanisms, actors, human agency and networks in relation to the economic development case(s) under investigation, which may be endogenous or exogenous to the case(s) itself (Pike et al, 2016a, pp132; Martin & Sunley, 2015a). Essentially, the qualitative methodological approach developed by Pike et al (2016) applies EEG concepts, mechanisms and notions to empirical cases to better understand the underlying causality of evolution in the economic landscape (Peet, 1998; Martin, 2010). This EEG methodological approach developed by Pike et al (2016) is central to the project's approach and largely reflects a *critical realist* position (Peet, 1998). Therefore, the critical realist position supports the approach the research is taking, as it similarly suggests that exploring causality, human agency, structured relations and networks in the socio-economic landscape is crucial for fully understanding empirical cases (Peet, 1998; Graham, 2005).

A critical realist position fundamentally sees that real, concrete social entities or objects "have causal powers, which can be evoked under certain circumstances" and are "interrelated through causal mechanisms", arguing that social science research must be undertaken through actual, concrete research (Peet, 1998, pp166; Bhaskar, 1978; 1979; Sayer, 1984). Originally devised by Bhaskar (1978) and further developed by Sayer (1984;

1992), critical realism sees concrete (social) objects, which vary in scale from multinational corporations to a household, as being embedded and as a part of wider structures and relations (Peet, 1998; Sayer, 1991). In particular, critical realism is concerned with the internal, causal powers of objects or knowledgeable agents and “their ways of acting”, otherwise defined as mechanisms (Peet, 1998, pp170; Sayer, 1984). The effects of causal powers and mechanisms are shaped by and dependent upon external and contextual, contingent conditions constituted within wider structures and relations (Peet, 1998; Sayer, 1984; Yeung, 1997). Critical realism was devised to counter the problem of applying “theory at the concrete level without due regard for contingent mediations” (Sayer, 1985, pp270; Barnes et al, 2007). To do this, critical realism recognises and captures a reality of multiple layers comprised of structured relations, mechanisms and outcomes embedded within an open system, forming an exclusive discourse and language (Peet, 1998; Barnes et al, 2007). Moreover, critical realism attempts to reconcile the important relationship and bridge the gap between theoretical and empirical research within critical realism and human geography (Yeung, 1997; Pratt, 1995). Fundamentally, critical realism must act as a philosophical guideline in the process of selecting appropriate (multiple) methods, in order to conduct empirical research in human and economic geography (Yeung, 1997; Pratt, 1995).

Interestingly, critical realism can be situated in contrast with various philosophical standpoints. Originally, the formation of critical realist thought drew inspiration from Marxism, as it is similarly concerned with exploring the relations between and human agency of individuals, which underpin and shape socio-economic phenomena (Bhaskar, 1978; 1979; Peet, 1998). Also, critical realism partly aligns to positivist thought, as both positions perceive social objects and human action to be as a result of real causes (Peet, 1998; Eridisngha, 2012; Graham, 2005). However, positivism is concerned with exploring a singular empirical reality, whereas critical realism argues that there’s a “layered reality” of relations, mechanisms and outcomes (Barnes et al, 2007, pp7). Furthermore, linkages between empiricism and critical realism are evident as both philosophical standpoints underline the need for observing and collecting empirical evidence to formulate causal explanations of reality (Graham, 2005). However, critical realism contrasts interpretivist thought, as interpretivism views concrete entities or objects as socially constructed and aims to find meanings in human behaviour, rather than alluding to causal power and mechanisms as factors in forming social objects and events (Peet, 1998; Eridisngha, 2012). Therefore, the project seeks to utilise and integrate a critical realist position through an approach suggested by Pike et al (2016), by exploring causal mechanisms, human agency, actors, relations and structures which are underpinning and influencing socio-economic ‘research’ objects, processes and events (Peet, 1998).

On an important note, the thesis is conducting an empirical investigation of comparative cases through collecting rich primary data which is theoretically informed by multiple concepts, notions and mechanisms situated in EEG (Pike et al, 2016a). This will involve trying to uncover the complexities of unique mechanisms and human agency, which shape the structured relations between social objects and actors (Pike et al, 2016a; Peet, 1998; Taylor, 2016). Consequently, the thesis will take a *critical realist* ontological and epistemological position, as the project is seeking to better understand the causal mechanisms, human agency and relations, actors and networks which underpin and shape real socio-economic objects, events and phenomena (Peet, 1998). Additionally, this position also interconnects with a growing epistemological and methodological issue in EEG, whereby scholars are seeking to “bridge theory with empiricism” through comparative studies, in order to separate “place-bound (evolutionary) properties from universal ones” (Kogler, 2015, pp709). By taking a critical realist philosophical position, the project will gain deeper insights into how causal mechanisms, human agency, and the structured relations between actors operating within multiscalar networks, underpin and shape port adaptation, diversification and regional path creation (Peet, 1998; Pike et al, 2016a). Moreover, Pike et al (2016) argue it is important to take a comparative case study approach through an EEG perspective over a period of time, thus taking a longitudinal approach as opposed to a snapshot comparison, to better understand the influence of multiscalar actors, settings and national contexts across different cases. As such, the project takes a comparative case study approach to investigate the similarities and differences between multiscalar factors (causal mechanisms, human agency, actors, structured relations and networks) and national contexts shaping port adaptation, diversification and regional path creation, across different port cases.

3.3 Research design

3.3.1 Case study approach

Case studies have been recognised as a research approach to investigate social phenomena within its actual everyday context and to explore 'how' and 'why' social phenomena works (Yin, 2014). Case studies are often used in tandem with different qualitative research methods, whilst being sensitive to geographical contexts on different spatial scales (Siggelkow, 2007; Baxter, 2010). Essentially, case study investigations enable the rigorous investigation of a contemporary phenomenon (the 'case' or 'cases') within real-world settings (Yin, 2014). Moreover, case studies attempt to identify the "in-depth nuances" of the case(s) and the "contextual (social, economic and political) influences" upon the case(s) (Baxter, 2010, pp81; Yin, 2014). In relation to the aims of the research project and methodology, the guiding principle of the case study approach concerns the requirement to 'get inside' the case(s), to better understand the port adaptation process through 'close dialogue' with key actors, economic agents and organisations (Clark, 1998). In particular, close dialogue is about the researcher gaining a deeper understanding of a respondent's circumstances and opinions "against (preconceived) informed expectations", which is guided by defined questions and points of references in the theoretical literature (Clark, 2007, pp191).

A general and common misunderstanding within social science research is that one cannot generalise based on case study analysis (Flyvbjerg, 2006). Flyvbjerg (2006) strongly argues case study research can contribute to theoretical and (social) scientific development through providing in-depth and context dependent knowledge (Yin, 2009; Silverman, 2013). Flyvbjerg (2006, pp228) goes onto argue that the "force of example is underestimated" in the social sciences. Meaning that case study analysis can contribute to the enhancement and progression of social science through in-depth explorations of case(s), to identify hidden realities by accessing knowledge existing "behind closed doors" (Flyvbjerg, 2006, pp228). Furthermore, the case study approach typically involves an "intensive" research technique, asking 'how' processes work in cases, 'why' these processes occur, 'what' actors 'do' within cases and 'what' mechanisms and processes catalyse changes in the object(s), actors and contexts comprising a case study (Bradshaw & Stratford, 2010, pp71; Platt, 1988). Intensive research seeks to ‘challenge’ theory by engaging with diverse empirical cases, which is marked by a process of moving between “theoretical explanations and cases, revising explanations along the way” (Barnes et al, 2007, pp5; Sayer & Morgan, 1985). Thus, the intensive research technique embedded within the case study approach seeks to uncover causal mechanisms and processes shaping certain objects, actors and events (Barnes et al, 2007; Pike et al, 2016a). This is principally what the intensive research technique and case study approach adopted within the project endeavours to ascertain.

Case studies are concrete, specific and are bounded within time and space, despite being highly complex in certain instances (Taylor, 2013; Stake, 2005). Through this lens, case studies are also viewed as a ‘space’ of interrelationships and networks made up of multiple actors and multiple institutions (Taylor, 2013). Moreover, the case study as a ‘space’ is also viewed as a product of geographically differentiated historical and social relations which produce place-specific outcomes (Massey, 2005; Taylor, 2013). This conceptual perspective in the literature directly relates to the project’s philosophical and methodological position of critical realism. This is because the project is aiming to better understand the causal mechanisms underpinning and shaping port adaptation, diversification and regional path creation, which transpire within place-specific structures and networks of related agents and institutions (Peet, 1998; Massey, 2005; Taylor, 2013). Moreover, the project’s case study approach aligns with contemporary approaches within EEG when investigating local and regional cases, by exploring research objects, subjects and multiscalar levels, whilst “capturing agency and context” through a “deep contextualization” of “sociospatial relations, mechanisms and processes” (Pike et al, 2016a, pp139; Barnes et al, 2007).

As EEG is a relatively youthful sub-field within economic geography, it is still developing a substantial body of empirical work focused upon comparing cases of various economic activities situated in different (international) geographical contexts (Pike et al, 2016a; Grabher, 2009). This connects to a broader methodological condition within economic geography and EEG, which is to make empirical studies “more comparable, transparent, and cumulative” (Boschma & Frenken, 2009, pp156). In EEG, comparative case studies have been underutilised, are increasingly demanded throughout the literature and used in a relatively narrow manner through certain research objects including firms, industries, cities and networks (Pike et al, 2016a; Coe, 2011). A comparative case study approach through an EEG perspective should account for the influence of multiscalar actors, settings and national contexts across different cases (Pike et al, 2016a). Therefore, the project utilises a comparative case study approach to broaden the existing type and scope of comparative cases in EEG, through comparing two port cases with differing multiscalar actors and national contexts. Additionally, the project utilises a comparative case study approach to conduct EEG research across diverse spatial contexts by providing an alternative research object, the port as a site of adaptation.

Existing comparative studies of port adaptation and evolution between (and within) nations and regions tend to examine the internal arrangements of port authorities and analyse trends in quantitative data. (Notteboom, 2016; Jacobs & Lagendijk, 2014; Wang & Ducruet, 2013; Ducruet & Itoh, 2016). Less attention has been paid to investigating and comparing the underlying contexts, influences, key governance actors and mechanisms underpinning port adaptation, diversification and regional path creation across two cases (Yin, 2014; Pike et al, 2016a).

To tackle the theoretical and methodological issues in EEG and port studies, the thesis will articulate contrasting but comparable findings between cases within different international settings (Pike et al, 2016a). This will be enabled by an embedded local and regional comparative case study approach (Barnes et al, 2007; Pike et al, 2016a). A *distended* case approach explores the "situational (local) depth" of policy networks to understand processes shaping local objects, subjects and settings, without sacrificing the "'low-flying' network-centric" approach, which seeks to understand the transnational mutuality of policy contexts across multiple sites (Peck & Theodore, 2012, pp25). Similarly, the thesis' local and regional comparative case study approach will be open to broader linkages between case study sites and multiscalar (extra-regional and intra-regional) actors, operating within global production networks (GPNs) (Barnes et al, 2007; Pike et al, 2016a; Coe et al, 2015). The thesis' case study approach contrasts with the traditional, tightly bound local and regional case study approach which overlooks the role of linkages and relationships between the case study and external institutions, actors and networks (Barnes et al, 2007). The research needs to be open to elements of a distended case study approach as it compares different policy networks, institutional environments and settings between the comparative cases (Martin, 2010; Hall & Soskice, 2001; Peck & Theodore, 2012). Ultimately, research will gain a deepened understanding of the cases in question and to theorise a broader framework to investigate port adaptation, diversification and regional path creation on local and regional scales across different localities (Berg, 2012; Pike et al, 2016a; Peck & Theodore, 2012).

Fundamentally, the thesis' multiple-case method compares different sites, objects, actors, mechanisms and outcomes between distinctive (international) geographical settings on local and regional spatial scales, through an intensive research approach (Yin, 2014; Pike et al, 2016a; Barnes et al, 2007). Moreover, the thesis' multiple-case approach also explores port cases as 'spaces' of interrelated networks and agents through an intensive style, to uncover place-specific contexts, settings, mechanisms and processes shaping port adaptation, diversification and regional path creation (Taylor, 2013; Massey, 2005; Baxter, 2010). Ultimately, by investigating the comparative cases through a deep contextualisation of structured relations, networks, mechanisms and processes, it enables the researcher to get "behind closed doors", through close dialogue with key individuals and actors (Pike et al, 2016a; Flyvberg, 2006, pp228; Clark, 2007). However, this chapter also needs to clarify the empirical focus of the multiple-case research design within an embedded, local and regional case study (Yin, 2014; Pike et al, 2016a; Barnes et al, 2007).

3.3.2 Case study selection

Defining what the actual case is within each case is, is very important for the methodology as a whole (Berg, 2012). Importantly, Pike et al (2016) discuss the notion of a 'site' and spatial context of adaptation as being a city or city-region. However, the role of infrastructure and physical assets within a site of adaptation is overlooked within the EEG literature and plays an important role within this thesis, which is investigating the infrastructural and material nature of the port as site of adaptation. The empirical focus and the unit of analysis within the project's comparative case approach is upon the port as a *site* of adaptation. The port complex is a site where processes of port adaptation and diversification take place and are revealed, within a boundary comprised of certain *assets*, encompassing the pre-existing port (infrastructural, industrial, material and natural) asset base (Maskell & Malmberg, 1999). These include brownfield and/or greenfield quayside land, quays, river berths, manufacturing facilities, office buildings, transfer systems and cranage. However, the port complex is also a site which is where key actors operationalise the process of port adaptation. This means that project's focus is also upon the site within (or outside) the port complex, where internal governance processes occur including strategic planning and key decision-making activities, which ultimately enables the process of port adaptation occur. This process is carried out through a dialogue between various actors, typically formed by the port authority and associated government organisations. Moreover, the port complex is the focus of the research which is under empirical investigation, as opposed to a city, region, industry, firm or network (see Pike et al, 2016a). Secondly, the empirical focus also includes the *actors* 'doing' the adaptation, conversion and diversification of port-related infrastructural assets on the physical port site, through certain underlying *mechanisms*. The actors are port authorities and associated government organisations (local authorities and development agencies). Therefore, this focus upon actors allows the thesis to uncover the role, operation and key forms of agency, which shapes and influences comparative processes of port adaptation and diversification (Grillitsch & Sotarauta, 2018; Notteboom, 2016). In this sense, outlining the empirical focus here clarifies 'what' (site and assets) and 'who' (actors) is being studied within the comparative case study approach, which are shaped by place-specific contemporary policy networks and the varying histories of localities (Pike et al, 2016a; Peck & Theodore, 2012; McMichael, 1990). Therefore, the research selects cases which have corresponding units of analysis (site, assets and actors), to enable a clear and efficient process of comparison (Yin, 2014; Barnes et al, 2007).

To fully understand the critical phenomena underpinning each case study, the cases themselves must be relevantly and accurately selected (Stake, 2005; Yin, 2014). Interestingly, Flyvberg (2006) offers a range of strategies for selecting case studies. However, the project adopts Flyvbjerg's (2006) *information-orientated selection* approach to selecting case studies because the project requires particular cases to provide relevant and appropriate information, in order to draw clear and accurate comparisons. The project's case study selection requirement directly aligns to the definition of 'information-orientated selection' approach by Flyvbjerg (2006, pp230), which involves selecting "cases…on the basis of expectations about their information content". The project's comparative case selection partly relates to what Flyvbjerg (2006) defines as 'critical cases', which essentially are exemplary comparative cases enabling the project to gain a better understanding of the port adaptation process.

The comparative cases were selected based upon certain criteria which were supported by indicators across the comparative cases (Table 3.1). The criteria for case study selection was the process of port diversification into offshore wind activity, the role of the port in the offshore wind industry (and in associated offshore wind production networks), the broad typology of port governance models and the national institutional arrangements and conditions in the UK and Germany (Table 3.1). Case comparability is an important methodological concept used to identify elements of commonality between cases, to enable a balanced, accurate and successful case study comparison (Yin, 2014). Therefore, clear rationale concerning comparability which underpins case study selection, alongside the purpose case study serves, will now be fully described, explained and justified (Yin, 2014; Stake, 2005).

The first selection criterion relates to diversification, wherein the timing and longevity of diversification into offshore wind and the infrastructural assets and facilities related to offshore wind industry, determined the case study selection (Table 3.1). The first reason for selecting the Humber Ports case is that it diversified into the offshore wind industry in 2007 when O&M first was established at the Port of Grimsby (PoG) by Centrica's commitment, who further expanded in 2010 (BBC News, 2007; Wind Power Offshore, 2014). Moreover, Siemens established a new blade manufacturing facility at the Port of Hull (PoH) and Ørsted opened its new O&M base at the PoG (Siemens, 2016a; Humber Business, 2016). Similarly, the PoC case was selected because the Port of Cuxhaven (PoC) diversified into offshore wind in 2006 and has further constructed its infrastructural asset base for offshore wind, thus enabling interesting comparisons (Table 3.1) (Offshore Base Cuxhaven, 2017a). The PoC originally diversified into offshore wind in 2006 through the establishment of the Offshore Base Cuxhaven (OBC) and the Cuxhaven Steel Construction (CSC) in 2007, the latter manufactured foundation structures and components for offshore wind turbine generators (Offshore Base Cuxhaven, 2017a; 2017b; 2017c). This initial episode of diversification was followed by AMBAU establishing itself at the PoC in 2008, manufacturing towers, monopiles, components, and jacket-piles for offshore wind turbines (Offshore Base Cuxhaven, 2017a). The diversification process has been extended by Siemens' nacelle manufacturing facility, which began construction in 2016 and was completed in 2017 (Siemens Gamesa, 2017).

The second selection criterion is the role of the port in the offshore wind industry and more specifically, the role of the port in offshore wind production networks (Table 3.1). There are three key roles ports play in the offshore wind industry. Ports can serve as sites to support the manufacturing of turbine components, to facilitate the pre-assembly and offshore installation of turbines and to provide an onshore base for the operation and maintenance (O&M) of offshore wind projects (The Crown Estate, 2010a). This criterion allows the research to draw interesting comparisons between each case's port diversification and adaptation into offshore wind activities (Notteboom, 2016).

The Humber Ports case was selected due to its prominent manufacturing role in the offshore wind industry and connection to Siemens' offshore wind production network. The Siemens blade manufacturing facility at the Port of Hull is intrinsically linked to the nacelle manufacturing facility at the PoC, both important parts of Siemens' offshore production network (Siemens, 2016a; 2016b; Coe & Yeung, 2015). Similarly, the PoC also has an important role in supporting manufacturing activities and in Siemens' offshore wind production network following the construction of a nacelle manufacturing facility, opened in mid-2017 (Siemens, 2016b; Coe & Yeung, 2015). This is an important criterion for enabling a port diversification and adaptation comparison as the project can draw upon similarities and linkages to the Humber Ports case, as it comprises the Siemens blade manufacturing facility at the PoH (Siemens, 2016a; 2016b; Notteboom, 2016).

The Humber Ports case was also selected because of the evidence of pre-assembly and installation activities at the Port of Hull and O&M activities at the Port of Grimsby (The Crown Estate, 2010; ABP, 2017a; 2017b). The research can draw similar comparisons between the Humber Ports case and PoC, as the PoC also demonstrates a similar form of port diversification as there is evidence of installation and O&M occurring at the PoC since the formation of the OBC in 2006 (Offshore Base Cuxhaven, 2017a; 2017b).

Thirdly, the port cases were selected upon their distinctive port governance practices (ownership, management and control) and differing governance models as the third criteria, relating to 'Anglo-Saxon' (private) and 'Hanseatic' (mixed) port governance (see Table 2.1) (Brooks & Cullinane, 2007b; Suykens & Van de Voorde, 1998). The research will investigate four key factors of port governance across the two cases: relationships with central government, legal and statutory frameworks, financial capability and management culture (Verhoeven 2010). The Humber Ports have a distinctive governance model, operating through an Anglo-Saxon (private) governance model (Table 2.1) (Suykens & Van de Voorde 1998; Petitt, 2008). As a result, clear comparisons can be made between the Humber Ports case and the PoC, which operates in a different way, through a Hanseatic (public) governance model (Table 2.1) (Brooks & Cullinane, 2007b; Suykens & Van de Voorde, 1998). As such, this provides scope to compare and contrast the Humber Port's Anglo-Saxon (private) port governance model and practices with the PoC's Hanseatic (public) port governance model and practices, in relation to enabling and/or constraining port adaptation (Brooks & Cullinane, 2007b; Suykens & Van de Voorde 1998; Notteboom, 2016). By investigating distinctive governance practices embedded within this unique private governance model, the project can capture the underlying mechanisms, influences and forces within the port authority, shaping the conversion and diversification of the Humber Port's port-related infrastructural assets. As a result of this, key policy and planning insights can be identified relating to enabling and/or constraining contexts underpinning the Humber Port's diversification into the offshore wind industry (Peck & Theodore, 2012; Haughton & Allmendinger, 2015; Martin, 2010).

The final selection criterion is the national institutional arrangements of the country in which the port case was situated and diversifying into offshore wind (Table 3.1). There are distinctive national institutional arrangements and environments which influence and shape how ports adapt and diversify into offshore wind (Martin, 2010; Martin, 2000; Notteboom, 2016). The Humber Ports case was selected because it is situated and operates in the UK which has a Liberal Market Economy (LME), meaning ports are typically privately owned and organise their corporate strategies based upon market signals and national offshore wind policy focuses upon creating an enabling market environment to attract investment from project developers and foreign manufacturers (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Hall & Soskice, 2001; Peck & Theodore, 2007). In contrast, the PoC was selected because it is located and operates in Germany, which has a Coordinated Market Economy (CME), meaning the majority of ports are publically owned and national offshore wind policy is centred upon enabling the manufacture and export of turbine components to overseas markets such as the UK, whilst creating an attracting market for offshore wind projects (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Hall & Soskice, 2001; Peck & Theodore, 2007). Moreover, this selection criterion allows the comparison of centralised institutional arrangements and governance in the UK to the decentralised federal system of governance in Germany, which have contrasting characteristics and capacities to influence and shape the adaptation and diversification of the port cases (Hall & Soskice, 2001; Peck & Theodore, 2007).

To ensure strong and balanced case comparability and to enable the comparative research approach to function, two case study criteria were allowed to vary and two were allowed to remain constant (Yin, 2014). The first selection criteria remained constant to allow similar processes of diversification to be compared which have similar episodic timings and evolution. The second selection criteria remained constant across the two cases to allow the research to compare similar roles of ports within the offshore wind industry across different national and regional contexts. The third selection criteria varied across the two cases because the research required a deeper understanding of how different port governance and ownership arrangements shaped port adaptation and diversification (Suykens & Van de Voorde, 1998; Verhoeven, 2010). The final selection criteria varied across the two cases to allow the research to more deeply understand how contrasting national institutional arrangements in the UK and Germany influenced the port adaptation and diversification process (Hall & Soskice, 2001; Peck & Theodore, 2007).

Criteria	**Evidence for each case study**
Process of diversification	*Humber Ports case* Diversified into offshore wind in 2007, at an early phase of the offshore wind industry in the UK. O&M facilities constructed by Centrica (announced and began in 2007, completed in 2010). Additional O&M operators constructed and completed facilities since 2007. O&M hub constructed by Ørsted (announced in 2015, completed in 2019). Siemens blade manufacturing and turbine assembly facility constructed (began 2014, completed in 2016).
	Port of Cuxhaven

	Diversified into offshore wind in 2006, at an early phase of the offshore wind industry in Germany. Construction of port infrastructure since 2006 to support manufacturing, installation and O&M activities (heavy duty platform). Evidence of O&M activities (Offshore Marine Management, 2011). Manufacturing activities from a series of firms (Cuxhaven Steel Construction, AMBAU, Siemens). Siemens nacelle manufacturing facility began construction in 2016 (completed in 2017).
Role of port in offshore wind industry (and in offshore wind production networks)	*Humber Ports case* Strategic manufacturing hub for Siemens as leading blade producer, installation port base and flagship O&M hub. Siemens and Ørsted offshore wind production networks.
	Port of Cuxhaven Internationally leading manufacturing hub for a wide range of offshore wind components and strategic base for installation and O&M activities. Siemens' offshore wind production networks.
Port governance model	*Humber Ports case* Privately owned and operated by ABP.
	Port of Cuxhaven Publically owned and operated by the State of Lower Saxony.
National institutional arrangements	*Humber Ports case* UK is a liberal market economy (LME) featuring private port ownership and light-touch policy for port development. UK offshore wind sector heavily influenced by the market activity of project developers and manufacturers Centralised governance arrangements *Port of Cuxhaven case* Germany is a co-ordinated market economy (CME) featuring public port ownership and responsibility for port development.

	German offshore wind sector strongly shaped by the manufacture and export of turbine components Decentralised governance arrangements

Table 3.1: Case study selection criteria
Source: Author; Hall & Soskice (2001)

Whilst influenced by the PhD's collaborative partner (Humber Local Enterprise Partnership (LEP), the selection of the Humber Ports case study was based upon an array of detailed evidence and collaborative discussions with the Humber LEP, which emphasised the Humber Ports case as the UK case study choice. The evidence was identified through exploring secondary data (port industry reports, strategic economic plans, government policy documents), preliminary fieldwork consisting of industry and policy workshops with important actors in attendance and through discussions with key individuals at the Humber LEP. As a result of evidence-based research, short listing process and the strong collaborative partnership with the Humber LEP, certain ports *within* the Humber Ports case were selected. Consequently, the UK case study in question is the 'Humber Ports', comprising the Port of Hull (PoH) and the Port of Grimsby (PoG). The Humber Ports case will be compared to an international comparative case study, the Port of Cuxhaven (PoC) located in Lower Saxony, Germany. As such, the project can explore varying forces, mechanisms, actors and offshore wind production networks shaping port adaptation across two port cases: the Humber Ports and the PoC (Notteboom, 2016; Coe & Yeung, 2015). A range of international candidate cases in the North Sea basin were considered and short listed in partnership with the Humber LEP and through exploring secondary data. These included the Port of Bremerhaven (Germany), the Port of Esbjerg (Denmark) and the Port of Oostende (Belgium) because of their varying levels of investment into assets and facilities, current offshore wind activity, scope of port-related infrastructural assets and planned site development for offshore wind. The Port of Bremerhaven was rejected due to the emerging examples of offshore wind firms disinvesting and the research required a case supporting port diversification into offshore wind and successful path creation. The Port of Esbjerg was rejected as it was already an established offshore wind port and the research required a case study undergoing a similar process of diversification to enable clear comparisons (Table 3.1). The port of Oostende was rejected as it was highly concentrated on supporting O&M and installation activities and had no evidence of existing or future manufacturing activities (Table 3.1). The Port of Cuxhaven

(PoC) was selected because it allowed the project to make relevant and accurate case comparisons with the Humber Ports case, corresponding to the case study selection criteria (Table 3.1). Furthermore, a counter-factual case exploring how a port failed to diversify into offshore wind and support new path creation was not considered as the project's collaborative partner, the Humber LEP, was interested in better understanding how a North Sea port can successfully support offshore wind as a new regional industry. Moreover, at the time of selection and given the emerging stage of the global offshore wind industry, there were no comparative examples to provide long-term evolutionary insights into how ports have unsuccessfully diversified (Notteboom, 2016).

The PoH and the PoG were selected following a process of exploring secondary data and discussing short listed ports with the Humber LEP, determining that these two ports are most relevant comparative cases *within* the Humber Ports case for a number of different reasons. This process revealed the port-related infrastructural assets (available port land, quays and facilities) and market factors (amount of current or planned investment and planned site development) at each candidate port site, would enable diversification into offshore wind in the near future (BVG Associates, 2016). The collated evidence demonstrates that the Humber Ports make an interesting and compelling comparative case, corresponding to the case study selection criteria (Table 3.1). A series of underlying parallels with the Humber Ports case led to the selection of the PoC, which were identified following an evidence-based research process and short listing a series international comparator ports in discussions and meetings with the Humber LEP (Table 3.1).

3.3.3 The comparative cases

The research undertakes an international comparative analysis of the Humber Ports case (featuring the Port of Hull and the Port of Grimsby on the Humber Estuary) and the Port of Cuxhaven, which sits at the mouth of the River Elbe in Lower Saxony, Germany.

There are four major ports managed and operated by Associated British Ports (ABP) including the Port of Hull (PoH), Port of Grimsby (PoG), Port of Immingham and Port of Goole. ABP are the dominant port owner and operator on the Humber Estuary (ABP, 2016). Currently, the Port of Immingham and the Port of Goole have not diversified into offshore wind activities, therefore these ports are not of interest within this project (ABP, 2017c; 2017d). The four ABP Humber Ports operate alongside one planned port project (Able Marine Energy Park), which are all located on the Humber Estuary. The Able Marine Energy Park (AMEP) is a fully consented project and if its greenfield site were to be developed with an array of infrastructural assets, it could emerge as an important port site on the Humber Estuary, acting as a base for various offshore wind activities (Able UK, 2017). Importantly, Triton Knoll Offshore Wind Farm Ltd have displayed interest in catalysing the input of public and private investment to fully develop the AMEP site, to ultimately support manufacturing, installation and O&M activities relating to various North Sea offshore wind projects (including Triton Knoll) (Humber Business, 2017a; Able UK, 2017).

These ports and potential port sites on the Humber Estuary vary in origins, scale of the port complex, scope of offshore wind activity, infrastructural and material assets and levels of investment, although collectively they all adopt private governance models (Table 2.1) (Brooks & Cullinane, 2007b; World Bank, 2016; Pettit, 2008). The chapter has justified the selection of the Humber Ports case study within this research methodology and overall project, emphasising that the project takes particular interest in the PoH and the PoG, which wholly form the Humber Ports case. However individually the PoH and the PoG have unique characteristics and settings including specific infrastructural assets and facilities, scale and size, location on the Humber Estuary (opposing banks), port governance structures, management contexts and offshore wind activities.

The research is focused upon two ports located on the Humber Estuary, namely PoH and the PoG, which merge to form a single comparative case study - the ‘Humber Ports case’. The PoH is currently owned and operated by ABP, the dominant private port company on the Humber Estuary (ABP, 2016). Consequently, the PoH adopts an Anglo-Saxon (private) port governance model, which is unique to the UK when situated in Europe’s port governance and policy contexts (Table 2.1) (Suykens & Van de Voorde 1998; Petitt, 2008). The PoH’s historical path trajectory has been shaped a variety of key governance actors, beginning as a fishing and whaling port (Robinson & Hart, 2014; BVG Associates, 2017). Currently, the PoH has an emerging role in the offshore industry, operating as an installation port (providing facilities for the staging, pre-assembly and loading of turbine components) and manufacturing port (Siemens, 2016a). The PoH plays an intrinsic role in UK and Northern

European offshore wind production networks through the Green Port Hull (GPH) site (Siemens, 2016a; Notteboom, 2016; Coe & Yeung, 2015). The GPH site currently comprises important infrastructural, industrial and material assets serving the offshore wind industry (Maskell & Malmberg, 1999; Green Port Hull, 2017a). Specifically, the GPH site at the PoH's 'Alexandra Dock' is comprised of the Siemens blade manufacturing facility and a load-out area for pre-assembling offshore wind components for offshore installation (Siemens, 2016a). Importantly, the project is investigating the conversion and diversification of GPH set within the Humber Ports case. GPH has been branded as a collaborative project between Hull City Council, East Riding of Yorkshire Council, Associated British Ports (ABP) and Siemens Wind Power, aiming to position the PoH as the key port complex on the Humber for renewable energy, principally offshore wind (Green Port Hull, 2017a).

As with the PoH, the PoG is currently owned and operated by ABP, functioning as a private port operator (ABP, 2016). Consequently, the PoG adopts an Anglo-Saxon (private) port governance model, which is unique to the UK when situated in Europe's port governance and policy contexts (Table 2.1) (Suykens & Van de Voorde 1998; Petitt, 2008). Additionally, Grimsby Fish Dock Enterprises Ltd lease the PoG's east dock known as the 'Fish Dock' from ABP for fishing activities and small-scale offshore wind activities (O&M and logistics) thus signifying a key site of diversification and highlighting the PoG's distinctive governance model and settings (Port of Grimsby east, 2017; Grimsby Fish Market, 2017).

The PoG developed as an important fishing port in the UK from the mid-19th century onwards and the fishing industry has played an important part in shaping the PoG's historical trajectory and current industrial context (Grimsby Telegraph, 2012; 4AllPorts, 2017; BVG Associates, 2017). Currently, the PoG is emerging as a distinctive port within Ørsted's offshore wind production networks, establishing itself as a burgeoning O&M base on the Humber Estuary (ABP, 2017b; Humber Business, 2016; Coe & Yeung, 2015). Importantly, Ørsted are further developing its O&M facilities at the PoG in the 'Royal Dock', to enable the PoG to transform into a large O&M hub on the UK's east coast (Ørsted, 2016; Humber Business, 2017b). This episode of the PoG's adaptation and diversification is part of Ørsted's £6bn commitment to the Humber region by 2019 (Humber Business, 2016; Notteboom, 2016). This section will now consider the Port of Cuxhaven (PoC) case, which provide an international comparison to the Humber Ports case.

Firstly, in terms of port governance, the PoC adopts a Hanseatic (public) port governance model (Table 2.1) (Brooks & Cullinane, 2007b; Suykens & Van de Voorde, 1998). This is because the PoC is owned and controlled by the Lander (Lower State of Saxony) and the port and associated land is owned, operated and managed by Niedersachsen Ports GmbH & Co. KG as a special purpose company, which is fully owned by the Lower State of Saxony (European Commission, 2016; Niedersachsen Ports, 2009; Brooks & Cullinane, 2007b; World Bank, 2016).

The PoC historical path trajectory began with the fishing and cruise industries and evolved into supporting general cargo and container handling activities, thus making the PoC an important port in Northwest Germany (4AllPorts, 2017; BVG Associates, 2017). However, the PoC's contemporary path trajectory has been underpinned by a series of investments into infrastructural, industrial and material assets forming the Offshore Base Cuxhaven (OBC) (Offshore Base Cuxhaven, 2017a; 2017b; Siemens, 2016b; Maskell & Malmberg, 1999). The OBC is comprised of two terminals with quay areas specialised for supporting offshore components and heavy lifting, jack-up installation vessels, a mobile and crawler crane, a heavy-lift crane, a gantry crane, pontoons and other related commercial, logistics and industrial areas (Offshore Base Cuxhaven, 2017b; 2017c). However, the Port of Cuxhaven still supports a range of other sectors and handles a range of products including Ro-Ro (roll-on, roll-off) cargoes, containers, automobiles, heavy loads, project cargoes, break bulk (especially forest and steel products) (Cuxport 2017a; 2017b).
The PoC has adapted and diversified into functioning as a prominent manufacturing, installation and O&M port in the offshore wind industry (Offshore Base Cuxhaven, 2017a; 2017b; Siemens, 2016b; Notteboom, 2016). To achieve these important roles, the PoC has adapted and diversified its infrastructural, material and industrial assets (offshore terminals, jack-up installation vessels, cranage, heavy-load quays, commercial, industrial and logistics areas) at the OBC since the mid-2000s, to support and stimulate offshore wind activity (Offshore Base Cuxhaven, 2017b; Siemens, 2016b; Maskell & Malmberg, 1999). The research is directly comparing the adaptation and diversification of the OBC at the PoC, to the Humber Ports case (Offshore Base Cuxhaven, 2017a, 2017b; Maskell & Malmberg, 1999).

Evidence of the PoC's diversification includes the construction of the OBC from 2006 onwards, which forms an integral part of the PoC case, the establishment of the Cuxhaven Steel Construction GmbH (CSC) at the PoC in 2007 and the establishment of AMBAU at the PoC in 2008 (Offshore Base Cuxhaven, 2017a; 2017b). In 2016, AMBAU took over CSC's construction site (AMBAU, 2016). Moreover, OMM (Offshore Marine Management) based its O&M facility at the PoC in 2011 (Wind Power Monthly, 2011). Additionally, STRABAG committed to building a facility to produce foundations at the PoC 2009, although it disinvested from the German offshore wind market in 2013, therefore the facility was never built (STRABAG, 2009; 2013). Most importantly, Siemens constructed a nacelle manufacturing facility which opened in mid-2017, and produced its first nacelle in January 2018 (Siemens, 2016b). This will further establish the PoC as an important port site within offshore wind production networks in Northwest Europe (Siemens, 2016b; Coe & Yeung, 2015). Furthermore, there's evidence of an emerging supply chain firms (STUTE Logistics) and offshore wind manufacturing firms (Nordmark and Muehlhan) in Cuxhaven and supporting the PoC, thus further supporting the argument that the PoC is an established port base for the offshore wind industry (HWG, 2017; AfW Cuxhaven, 2017).

3.4 Methods of Data Collection

The research adopted a multi-method approach to data collection to ensure rigour and to access the most pertinent secondary and primary data. A multi-method approach draws upon two or more methods and sources of information throughout the course of data collection to ensure analytical rigour, robustness and validity, and to maximise understandings of the research questions (Valentine, 2005; Punch, 2014). The project's research questions required the investigation of actors and institutions shaping and influencing port adaptation, diversification and regional path creation. Therefore, rich qualitative data and complimentary quantitative data was obtained through a corroborative mixed-method approach, which provided insights into the human agency (decision-making, negotiations and relationships) of the actors and institutions involved in these processes (Yeung, 2003; Hughes, 1999). This method of data collection contributes to a growing body of literature calling for the enhancement and development of the methods of data collection within EEG research (Pike et al, 2016a).

3.4.1 Secondary Data

This thesis provided a deep-seated and robust contextual backdrop of secondary materials for each case study, constructed from multiple information sources (Bradshaw & Stratford, 2010; Tyrrell, 2016). The exploration of the substantial body of secondary was of high importance, as it provided important contemporary knowledge in preparation for conducting interviews with elite individuals across different localities (Punch, 2014; Odendahl & Shaw, 2001). Secondary data provided the thesis with geographical, historical, socio-economic, market, industrial and policy contexts to support the eventual analysis and comparison of the two port case studies (Clark, 2005).

My comparative case selection was informed by literature on port adaptation, diversification and governance, the current realities and contexts of the ports and associated organisations in question and the analytical framework from the previous chapter, which are all aligned to the thesis' aims and research questions. The exploration and research of secondary data and discussions with the project's Collaborative Partner along with other key actors, facilitated the selection of the Humber Ports case and the 'mapping' of the relations and connections between relevant actors (principally firms), associated institutions and regions, through an unfolding research process (Markusen, 1994). This process was important in understanding and building an 'organisational ecology' of the respective case study regions (Dicken, 2011**;** Coe & Yeung, 2015). The organisational ecology of the respective case study regions is formed and shaped by various institutional conditions, contexts and settings (Dicken, 2011**;** Coe & Yeung, 2015). Underpinning a region's organisational ecology are the impacts of multiple global production networks (GPNs) upon regions, revealing the intrinsic intersections between (intra-regional and extra-regional) firms and regions (Dicken, 2011; Coe & Yeung, 2015). Interestingly, Coe & Yeung (2015) expand upon this, arguing that a wide range of corporate actors (lead firms, local firms, generic suppliers, subsidiaries of externally owned firms, logistics firms) are found within a region's organisational ecology (Dicken, 2011). Through an unfolding research process, the size and ownership of different firms and associated organisations present within a region can be mapped, reflecting "different modes of incorporation into global production networks" (Markusen, 1994; Coe & Yeung, 2015, pp180; Dicken, 2011). This incremental, unfolding process ultimately determined the selection of the relevant firms and associated organisations for empirical investigation within each case study.

The ever-changing ports and offshore renewables sector (principally offshore wind) in the UK and Northwest Germany, possesses a rich body of secondary material in the form of government reports, industrial strategies, corporate documents, policy documents and planning reports. This secondary material was obtained from a range of private and public sources on multiple spatial scales including BVG Associates, Local Enterprise Partnerships, Chambers of Commerce, Renewable UK, the Crown Estate, corporate websites, and various government departments in the UK and Germany. Moreover, historical and socio-economic secondary data provided an important contextual backdrop to the case study localities was sourced from news websites and public archives. In addition, secondary data was obtained from local, regional and national news agencies and industry focused websites, delivering contemporary updates on the port case studies, inward investment reports and project developments in the offshore wind industry. These sources are port authority, port operator and offshore wind industry websites, alongside the *Financial Times*, *BBC News*, *Offshore Wind.biz*, *4AllPorts, 4C Offshore, Humber Business*, the *Hull Daily Mail* and the *Grimsby Telegraph*. Furthermore, valuable secondary data in the form of industrial strategies, local and regional government plans and port reports was sourced from various industry and policy workshops and meetings in the Humber region. Overall, the secondary data provides balanced and valuable information regarding the state of industry, market, government, academic and policy arenas connected to the port case studies, the offshore wind industry and national renewable energy arrangements. Table 3.3 provides the most relevant examples of secondary data which was explored and included within the research:

	Government publications	Media publications	Policy publications
International	• European Commission (2014) *Guidelines on State aid for environmental protection and energy 2014-2020.* • European Commission (2017) *Mobility and Transport: The Pillars of the TEN-T policy.*	• Port Economics (2017) *Revisiting port governance and port reform: a multi-country examination.* • Financial Times (2017) *UK wind farm costs fall almost a third in 4 years*.	• United Nations (2015) *Review of Maritime Transport 2015*. • World Bank (2016) *Port Reform Toolkit: Alternative Port Management Structures and Ownership Models.*
UK	• Department for Business, Energy and Industrial Strategy (DBEIS) (2017) *Contracts for Difference: Allocation Framework for the Second Allocation Round.* • Department of Energy and Climate Change (DECC) (2015) *Contracts for Difference (CFD) Allocation Round One Outcome.* London: Department of Energy and Climate Change (DECC).	• Grimsby Telegraph (2016) *From a small town to the world's largest fishing port*. • Humber Business (2017) Permission sought for key quay changes to Grimsby's Royal Dock.	• Department of Energy and Climate Change (DECC) (2009) *UK Ports for the Offshore Wind Industry: Time to Act.* • Department of Energy and Climate Change (DECC) (2012) *Electricity Market Reform: Policy Overview*.
Germany	• Federal Ministry for Economic Affairs and Energy (BMWi) (2016) *2017 revision of the Renewable Energy Sources Act.* • Federal Law Gazette (2006) *Act to accelerate planning procedures for*	• Cuxhavener Nachrichten (2007) *Stabbert: "A historic day for Cuxhaven?"* • Cuxhavener Nachrichten (2009b) *Strabag Offshore Wind within reach.* Available	• Niedersachsen (2016) *Der Hafen Niedersachsen 2020: Ein Perspektivpapier.* • Federal Ministry of Transport and Digital Infrastructure (BMVI) (2016) *National Strategy for Sea and Inland Ports 2015.*

	infrastructure projects.		

Table 3.2: Indicative examples of secondary data sources
Source: Author

3.4.2 Primary data: Interviewing Elites

The secondary data documents snapshots and outlines of events, issues and challenges connected to (firm and non-firm) actors and institutions (Tyrell, 2016). However, the interview as a research method attempts to uncover the in-depth and underlying contextual information, which shape events, issues and challenges associated with (firm and non-firm) actors and institutions (Valentine, 2005). The method of interviewing in the research forms a crucial part of the process of data collection which provides primary data. The primary data is important in the data collection process as it adds to and works in tandem with the secondary data (Bryman, 2012; Tyrrell, 2016). The interview as an investigative method is the most prominent in qualitative research, seeking to access participant's perceptions, opinions, agency and involvement in connection to certain subjects, events and situations (Punch, 2014; Hughes, 1999). Fundamentally, the interview allows the research to identify the underlying story and series of events to better understand how socio-economic phenomena came to be, or occur (Dunn, 2010; Hughes, 1999). The thesis can move beyond gaining simple closed answers to research questions through forming open-ended response options, to gain a deeper understanding of what is relevant to the participant and why (Dunn, 2010). The interview method is framed as a mechanism to collect relevant qualitative data within the case study approach, in order to analytically compliment and 'get inside' the port cases (Clark, 1998; Baxter, 2010). As such, the interview process in this thesis involved a 'close dialogue' with participants connected to or operating within the selected port cases (Clark, 1998; 2007). This enabled the thesis to access a deeper understanding of the forces, influences and processes underpinning investment decisions, planning and strategies shaping infrastructural asset adaptation and diversification (Schoenburger, 1991; Pike et al, 2016a).

In order to do this, the thesis accessed and engaged with participants who hold senior management and executive positions operating in both firm and non-firm contexts, thus exploring research sites, assets and actors from the perspective of 'elite' interviewees (Neal

& Mclaughlin, 2009). The research investigated elite actors aligned to Desmond's definition (2004, pp264), who stated that elites are individuals with an influential status within social, economic and political spaces, upholding control over "human, capital, decision-making and knowledge resources." Fundamentally, the process of interviewing elites provides a dynamic mechanism to identify strategic relationships *between* key (firm and non-firm) actors and institutions, alongside the underlying influences shaping strategic decision-making processes *within* key (firm and non-firm) actors and institutions (Schoenburger, 1991; Hughes, 1999; Pike et al, 2016a). However, interviewing elites poses fundamental methodological challenges within this thesis and in (Evolutionary) Economic Geography, in connection to accessing participants and the uneven power dynamics occasionally present between the interviewer and elite interviewee (Harvey, 2010; 2011; Schoenburger, 1991).

When interviewing an elite participant, the methodological approach must accommodate fluctuating discourses and quickly adapt to the every-changing power dynamics between the researcher and the elite participant (Ward & Jones, 1999; Woods, 1998). Therefore, a semi-structured interview approach was adopted, which allowed for continuous flexibility and greater freedom to fine-tune control and power dynamics throughout the interviews (Warren, 2001; Baxter, 2010). The semi-structured approach to interviewing is structured by a pre-formulated list of topics enabling a series of open-ended questions to be formed within each interview (Bryman, 2012; Warren, 2001). The pre-formulated list of topics associated with the series of open-ended questions were continuously adapted before each interview, in respect to the specialist knowledge, information and views aiming to be obtained from each individual interviewee (Warren, 2001). Moreover, asking open-ended questions and following up with close-ended questions (if required), enabled a conversational interview style, which is what the research set out to achieve (Harvey, 2010). Essentially, a semi-structured interview approach embracing open-ended questions is crucial for interviewing elites, as it is important to encourage the interviewee to accurately contribute specialised knowledge of utmost relevance to the topics and themes in question (Kezar, 2003; Odendahl & Shaw, 2001; Bryman, 2012).

The research adopted a 'purposive sampling' technique to ensure the selection of elite individuals and organisations which were directly relevant to answering the research questions (Bryman, 2012). As such, the research questions provided guidelines for selecting specific organisations and individuals to sample (Bryman, 2012). Moreover, the selection of the elite interviewees was underpinned by their historical or current experiences regarding specific research topics, themes or question(s) (Mikecz, 2012; Longhurst, 2016). Furthermore, once a base of participants was secured and the interview process was underway, the 'on-site' technique of 'snowballing' accessed additional interviewees within public and private sectors (Longhurst, 2016). This technique involved using one contact to recruit another contact into the research process (Valentine, 2005).

The key participants principally included port authority management, directors, representatives of leading firms and industry associations, and officials from local authorities and relevant organisations, in addition to local politicians and experts (academics, consultants). The research undertook 40 interviews with a total of 44 participants in the UK and Germany. In each case study locality, the research targeted organisations responsible for national port management and development, alongside creating and implementing national port policy, strategy and legislation. These included the Department for Transport (DfT) in the UK, and the Federal Ministry for Transport and Digital Infrastructure in Germany. On the sub-national scale in the UK, the project targeted Local Enterprise Partnerships and Local Councils responsible for port issues in specific localities in the Humber. On the sub-state (sub-Lander) scale in Germany, the project targeted the Economic Development Agency of Cuxhaven and the Ministry for the Economy, Labour and Transport of Lower Saxony which are responsible for port issues in particular localities in Northwest Germany. In addition, the research targeted certain industry and trade groups including Team Humber Marine Alliance representing organisations predominately located on the Humber Estuary and WAB (Wind Energy Agency) representing organisations across Northwest Germany. Both organisations aim to bring various actors including port authorities, research institutions and offshore engineering companies together, enabling them to collaborate on port-related projects, developments and activities. Influenced by the historically informed nature of EEG research, the research casted back its interview focus to address the longitudinal role of organisations and institutions, which have over time shaped the current actors connected to the comparative case studies (Pike et al, 2016a).

Access to elite interviewees in the UK was assisted through collaborative industry organisations connected to the project's collaborative partner, the Humber Local Enterprise

Partnership (LEP). The research methodology required participation of overseas interviewees in order to make important case study comparisons and gain an in-depth understanding of the international case study (Yin, 2014). Fortunately, the process of identifying and accessing 'foreign' elites as an 'outsider' in relation to industry and policy networks was less complex as originally envisaged, as foreign elites in Northwest Germany operate in clearly identifiable institutions, organisations and firms (Herod, 1999). The range of interviewees across the case study sites, including their corresponding organisations, location of the organisations, the positions held by the interviewees and the interview dates, can be found in the Appendix. Sources for quotes included within Chapters 5 and 6 are labelled as the interviewees' current or former role, followed by their current or former organisation, which correspond directly to the interviewee tables included in the Appendix. I have labelled the interviewees' current or former roles and organisations to reflect their relevance to the empirical analysis of the comparative cases.

3.4.3 Ethics

To abide by strong ethical guidelines, confirmation of informed consent was obtained allowing the interviewees to know exactly what they're agreeing to participate in, whilst giving each interviewee the chance to opt out of participation (Dowling, 2010). Also, a guarantee of confidentiality was offered to the participants and participants were provided with information outlining my academic background, the thesis' research aims and the topics covered within the interview (Dowling, 2010). Maintaining confidentiality is vital as elite individuals can be easily identifiable in industry and policy networks, and may have discussed sensitive business information or controversial political views in the interview (Odendahl & Shaw, 2001; Smith, 2006). Therefore, it was important not to accentuate personal accounts through direct quotations, or past and current organisational positions or affiliations, unless informed consent was required to conduct research (Odendahl & Shaw, 2001; Smith, 2006). Furthermore, the research abided by accuracy ethics, ensuring that the qualitative data obtained is not fabricated in any way (Christians, 2000). The research project was subject to an ethical review and has received ethical approval from Newcastle University.

The positionality of myself as the researcher in connection to conducting interviews with elite participants was important in order to establish trust, build rapport and most importantly, abide by strong ethical principles underpinned by confidentiality, anonymity and transparency (Mikecz, 2012; Smith, 2006). My interviews were with elite interviewees operating in positions of influence in the public and private sectors, consequently I upheld the anonymity of participants, necessitating that no information included in the thesis could jeopardise individual or organisations' identities or standpoints (Odendahl & Shaw, 2001; Dowling, 2010). Furthermore, as Yeung (2003, pp457) rightly questions, "how does an economic geographer combine his/her multiple roles as a trusted enrolee of the actor network [when researching], an independent critical scholar" and as a public citizen, producing findings to support relevant policy outcomes, whilst maintaining a certain level of "civil consciousness"? The personal actions taken throughout my research aimed to address and negotiate this multifaceted and thorny ethical issue in economic geography research.

3.5 Analysis

In terms of managing and storing vast quantities of qualitative data from key documents and interviews, I stored documents and transcripts in systematic folders in the data processing stage of the project, to avoid "drowning in data" (Berg, 2012, pp53). Essentially, by utilising this data management and storage technique throughout the stages of data processing (management and storage) and data analysis addressed multiple core concerns and objectives. These included ensuring high-quality accessibility to vast amounts of qualitative data, facilitating the systematic coding of interview transcripts using a common format and script in Microsoft Word, alongside retaining and protecting qualitative data and any data analysis undertaken throughout and after the PhD project (Berg, 2012). Importantly, the data from interview recordings and transcripts were stored in a single and secure location to avoid unwanted access to sensitive information.

After conducting a range of qualitative interviews across the case study localities, a common format and script allowed overlapping coding processes to occur, which supported the analysis and identification of patterns among and between respondents and groups (Bradshaw & Stratford, 2010; Cope & Kurtz, 2016). The production of analytical codes directly reflected thematic topics and categories corresponding to the research questions, forming a clear organisational structure for the analysis chapters (Cope & Kurtz, 2016; Bryman, 2012). Firstly, an *open coding* process involved identifying codes emerging from the data by "getting as close to the material as possible", whilst ensuring codes are not directly influenced by theory and concepts at this stage (Crang, 2005, pp222; Strauss & Corbin, 2008). Subsequently, analytical connections between codes based upon recurring themes and topics were produced which established succinct categories, known as *axial coding* (Strauss & Corbin, 2008). Fundamentally, axial coding involved putting the qualitative data back together again, by "linking [categories] to contexts, consequences, patterns of interaction [among actors] and causes", following the splitting of qualitative data into codes through the 'close' open coding process (Bryman, 2012, pp569; Crang, 2005; Cope & Kurtz, 2016). As a result of the coding processes, the categories were linked to and uncovered contexts, consequences, patterns of interaction [among actors] and causes (Bradshaw & Stratford, 2010; Bryman, 2012). Interconnections were identified between multiple respondents and organisations, enabling the detection of the contexts, influences, forces and causal mechanisms underpinning port adaptation across the case study sites (Barnes et al, 2007; Pike et al, 2016a; Bradshaw & Stratford, 2010).

Furthermore, the empirical analysis of the comparative case studies was structured around key causal episodes of port adaptation and diversification into offshore wind. These key causal episodes were identified and created by analysing and grouping a series of smaller events which occurred closely in time and were related in terms of their overall characteristics and purpose. The key causal episodes strongly shaped the adaptation and diversification of the port cases, and the formation of distinctive regional paths. The smaller events or sub-episodes within the episodes were identified by the overall coding process, which highlighted these smaller events as critical in shaping the evolution, adaptation and diversification of the case studies. The start and end times of episodes and smaller events were identified in the primary and secondary data and characterised by when a period of pre-formation and planning, investment(s), disinvestment(s) or stable activity began and ended in time. Finally, the changes between episodes and smaller events were explained in an evolutionary manner through short introduction and conclusion sections included within each episode, as well as brief introductory or concluding sentences within smaller events, discussing how each change was shaped by a previous episode and/or small event.

3.6 Conclusion

This chapter has sought to identify and justify the research project's methodological approaches and comparative case studies, whilst providing relative alternatives and relevant critiques. Based upon the research design I considered in section 3.3 for an international comparison of two case studies (directly discussed in section 3.4) and using the methods of data collection outlined in section 3.5, I will utilise the analytical framework (Figure 2.4) to investigate, analyse and compare the diversification of the Humber Ports and the Port of Cuxhaven into offshore wind. The analytical chapters of the thesis are structured by distinctive levels of critical analysis. Firstly, the empirical analysis unfolds in Chapter 5 (Port of Cuxhaven case) and Chapter 6 (Humber Ports case) and is structured around key episodes of port adaptation and diversification into offshore wind evident in the comparative cases. Subsequently, Chapter 7 deepens the level of analysis and compares the most important factors emerging from Chapter 5 and Chapter 6 in relation to answering the project's research questions, and the most significant in influencing and driving the evolutionary offshore wind paths within the comparative case studies.

Chapter 4 Context chapter: the evolution of ports and emergence of the offshore wind industry

4.1 Introduction

The main purpose of this chapter is to provide a deeper understanding of the overall context and adaptation process of UK and German ports diversifying into offshore wind. This chapter will also position the exploration of the adaptation of the two comparative port cases, thus supporting the further explanation and justification of the case studies within the Methodology chapter. The chapter illustrates the importance of the historical, political, market, policy and governance contexts underpinning the comparative port cases. This comparative historical information informs and supports the EEG (Evolutionary Economic Geography) perspective which the research is adopting, in order to investigate the process of port adaptation (Pike et al, 2017; Notteboom, 2016; Jacobs & Notteboom, 2011). This chapter will discuss the evolution and current arrangement of ports and the offshore wind industry through addressing their governance, market, industry and policy arrangements, positioned within the European context. Exploring the European context of ports and the offshore wind industry reveals the UK and Germany as the most significant national cases of port diversification into offshore wind. Finally, the chapter explains the important market opportunity offshore wind creates for UK and German ports, before focusing in more directly on the two port case studies.

4.2 Evolution of ports and port governance

Several supra-national governing bodies shape the governance and market activity of ports. These mainly include the World Bank, UN, EU, OECD, ESPO (European Sea Ports Organisation), IAPH (International Association of Ports and Harbours) and AIVP (Association Internationale Villes et Ports) (Port Economics, 2017; World Bank, 2016; United Nations, 2015). The main supra-national organisation governing European ports is the EU, whereby the European Commission and Parliament sets out policy, legislation and strategies shaping multiple aspects of EU ports, including state aid, port infrastructure, port labour, investment rules, operations and connectivity between European ports (European Commission, 2017a).

However, as Brooks et al (2017) and others argue, the most important actors in global port governance are national government departments or bodies (Brooks & Cullinane, 2007a). Moreover, different levels of port governance reforms across Europe have been implemented by national governments that has shaped the capacity of ports to adapt and develop (Brooks et al, 2017; World Bank, 2016; Brooks, 2004). The global trend of port governance in the 21st century context is that most national governments form policies, strategies and instruments to “govern ports in a way that makes them more profitable and efficient, and, increasingly, [in] a way that makes them more sustainable” (Brooks et al, 2017, pp8). To support the decision-making process and strategies of governments shaping the future adaptation, diversification and development of ports across Europe, organisations like the OECD and ESPO often provide policy recommendations (OECD, 2014; 2016; ESPO, 2016). The main EU policy shaping the future development and adaptation of European ports is the ‘TEN-T’ (Trans-European Transport Network) infrastructure policy, implemented in January 2014 with a budget of €24.05 billion up to 2020 (European Commission, 2017b). The TEN-T policy aims to continue financing key port-related infrastructure projects across Europe through the Connecting Europe Facility (CEF) funding instrument (European Commission, 2017c). This policy framework influenced contemporary examples of European ports strategically adapting infrastructure to increase capacity and competitiveness include the Port of Rotterdam’s new offshore centre (offshore wind, decommissioning and oil & gas), the Port of Antwerp (liquid bulk and container-handling), and the Port of Amsterdam (general cargo and cruise) (Notteboom, 2016; Jacobs & Notteboom, 2011; Port of Rotterdam, 2017; Port of Antwerp, 2017; Port of Amsterdam, 2017). The chapter will later discuss the national context of UK and German port governance in greater detail.

Ports handle 74% of goods and services entering and leaving Europe by sea, with the other 26% of goods and services entering and leaving by air and land transport (European Commission, 2017a; Mangan et al, 2008). In 2015 ports within the EU handled 3.8bn tonnes of seaborne goods, which is a large increase of 10.8% compared with 2009, marking a low point in global trade (Eurostat, 2017). However, ports within EU countries vary within their national contexts in terms of seaborne good handled between 2005-2015, highlighting the changing nature of EU ports and global trade (Eurostat, 2017). National seaborne trade (EU countries) has been affected by the slowdown of international trade following the global financial crisis in different ways, with only some countries regaining capacity in terms of gross weight of seaborne trade (Eurostat, 2017).

The European ports system has a distinctive hierarchy in terms of tonnage handled and thus financial revenue (World Bank, 2016). In 2018, the largest five European ports in terms gross weight of tonnage handled are Rotterdam (441 million tonnes), Antwerp (212 million tonnes), Hamburg (117 million tonnes), Amsterdam (99 million tonnes) and Algeciras (88 million tonnes) (Eurostat, 2020). The Humber Ports case, including the Port of Hull and Port of Grimsby, are small to mid-tier ports, with the Port of Hull handling approximately 9.7 million tonnes per year and the Port of Grimsby handling approximately 1.1 million tonnes per year (ABP, 2017a; 2017b; Eurostat, 2019). On a similar scale, the Port of Cuxhaven handles approximately 2.7 million tonnes per year (Port of Hamburg, 2014; Eurostat, 2019). This statistic which is lower than the Port of Hull due to its main market focus upon the offshore wind industry, as opposed to container handling and general bulk cargo (Port of Hamburg, 2014; AfW Cuxhaven, 2017; 2018c; ABP, 2017a). The Humber Ports and the Port of Cuxhaven are included amongst a number of small to medium sized ports handling between 1 – 10 million tonnes per year, as marked by the white and yellow circles in Figure 4.1:

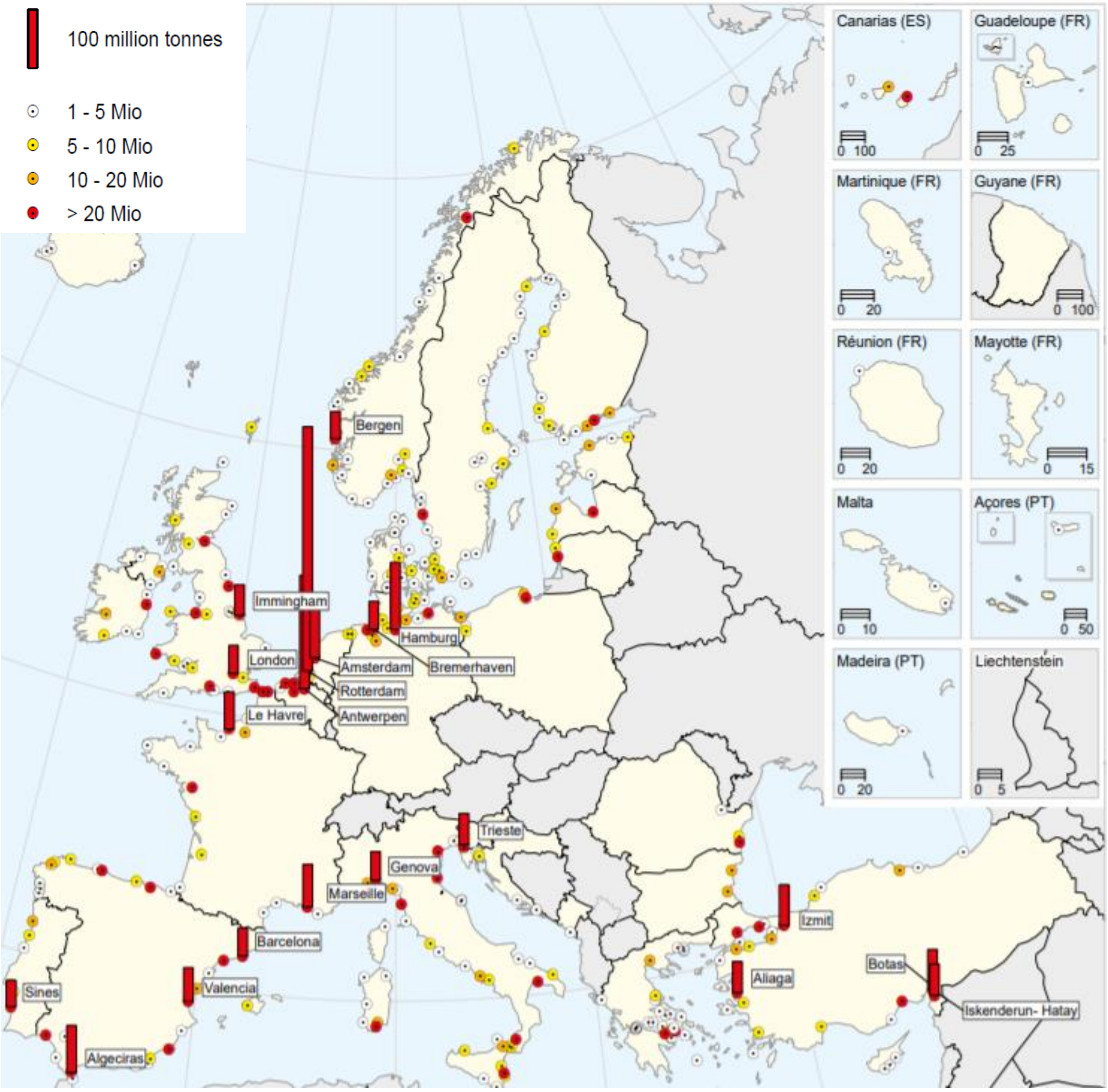


Figure 4.1 Main European ports by gross weight of freight handled 2017
Source: Eurostat, 2019

4.2.1 Evolution of UK Ports

As stated in Chapter 2, the unique governance arrangements of ports are important in shaping how ports adapt and diversify their infrastructural assets, in order to seize new market opportunities (Debrie et al, 2013; Notteboom, 2016; Maskell & Malmberg, 1999). However, the ways in which ports are owned and governed differs between countries in Northwest Europe, with some port authorities and associated government organisations adopting an 'Anglo-Saxon' governance model (private ownership and operation) or a 'Hanseatic' governance model (public ownership and operation) (Table 2.1) (Suykens & Van de Voorde, 1998; Verhoeven, 2010). By adopting certain port governance models, port authorities shape the adaptation and diversification in distinctive ways (Table 2.1) (Suykens & Van de Voorde, 1998; Verhoeven, 2010). Additionally, the national policy environment consisting of port policies, industrial strategies and regulatory frameworks unique to each state, essentially enable and/or constrain the capacity of governance actors to instigate mechanisms of port adaptation and diversification to seize new market opportunities (Notteboom, 2016; Martin, 2010). These varying national policy frameworks and strategies influence and shape the activities of UK and German ports, which are contextualised in sections 4.3.1 and 4.4.1.

UK Port Market

The wide-ranging scope of the UK port market in 2015 is contextualised by Figure 4.2, summarising the vast array of UK port traffic (imports and exports). The UK port market is broadly focused and specialised in a variety of different fields, depending upon the type of cargo each port's infrastructure can handle (DfT, 2015b; Asteris & Collins, 2007). In 2015, the largest UK ports in terms of traffic (imports and exports) are the Port of Immingham (55 million tonnes), London Thames Gateway (45.4 million tonnes), the Port of Milford Haven (37.7 million tonnes) the Port of Southampton (37.6 million tonnes) and the Port of Felixstowe (28 million tonnes) (ABP, 2017c; DfT, 2015b). As a result of the success and capacity of some of these ports, the port authorities owning and operating them have decided against adapting and diversifying their infrastructural asset base to seize new market opportunities beyond customary port-related activities, such as conventional cargo handling (Notteboom, 2016; Jacobs & Notteboom, 2011). However, certain ports in Figure 4.2, such as the Port of Grimsby and the Port of Hull, have decided to adapt and diversify into new markets because of emerging opportunities, such as offshore wind (BVG Associates, 2016).

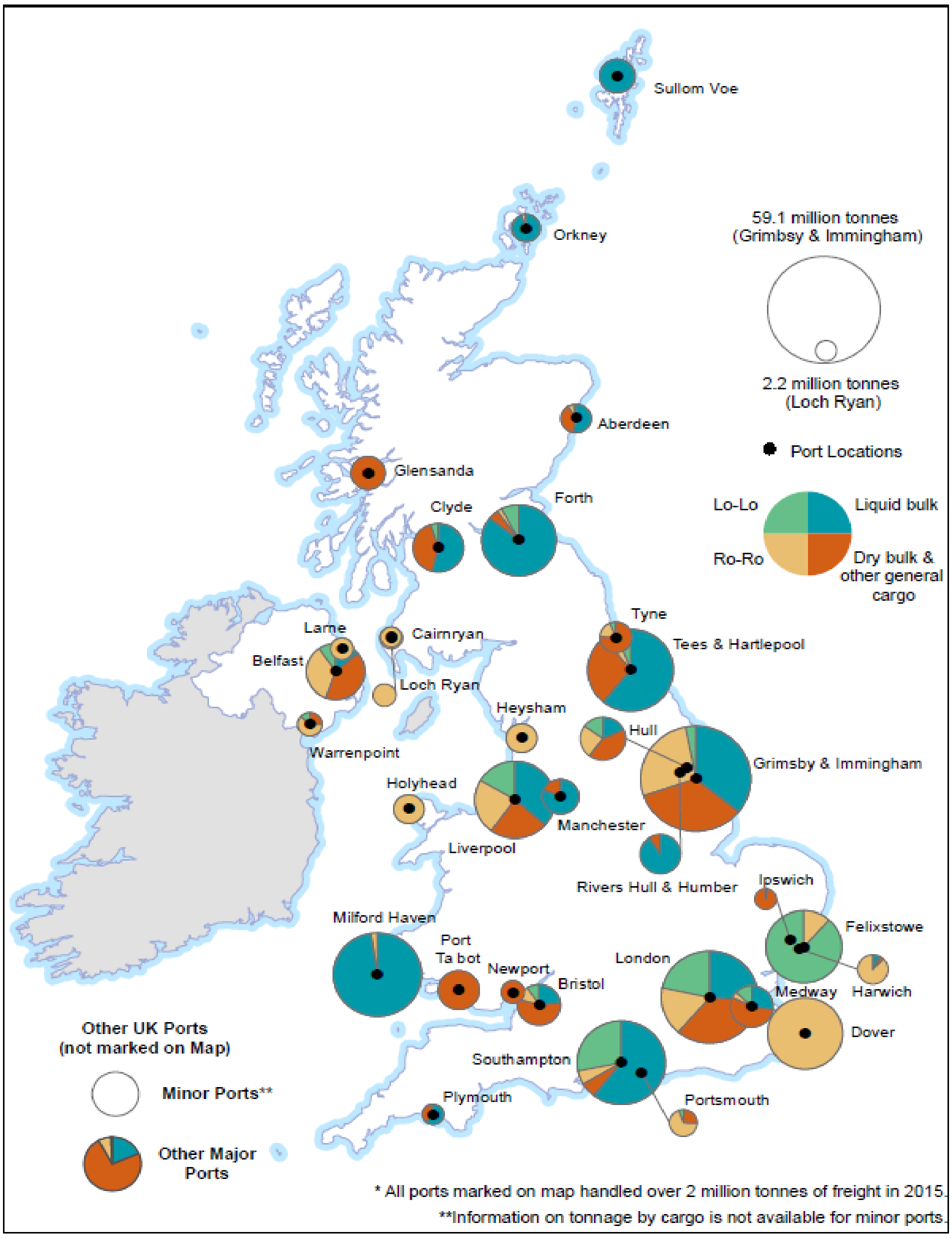
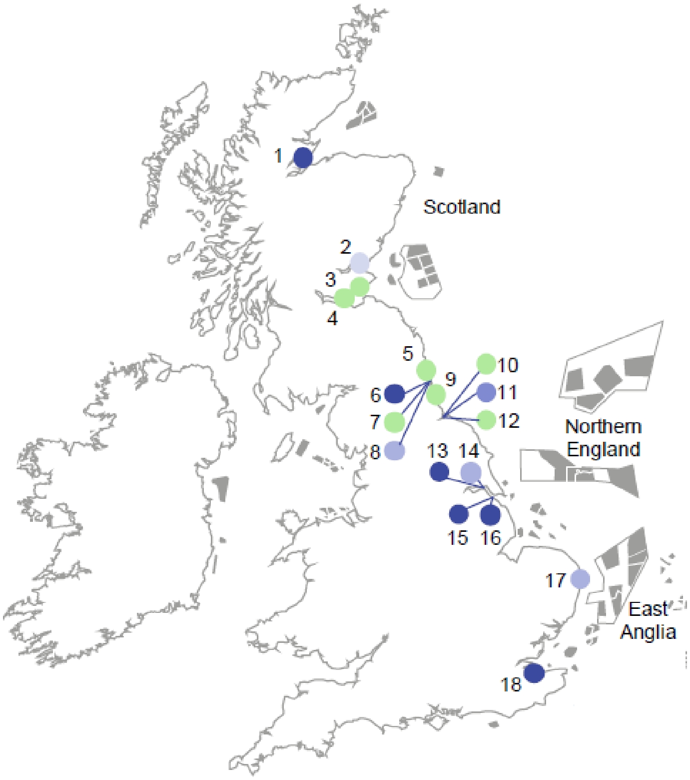


Figure 4.2: UK major port traffic by cargo type 2015
Source: DfT, 2015

In reference to Figure 4.2, an emerging market trend surpasses the 'traditional' port market of handling bulk cargo (liquid and dry), Ro/Ro cargo, Lo/Lo containers and accommodating passenger vessels (DfT, 2015b). This emerging trend within the UK port market has been established by some ports handling specialist components and goods connected to the renewable energy industry, specifically for wind, biomass, wave and tidal activities (Renewable UK, 2017b; Financial Times, 2016). In particular, the offshore wind market highlights a viable option for certain UK ports to capitalise upon through adapting and diversifying their infrastructural, industrial and material assets (IPPR North, 2016; Wind Europe, 2017a; Notteboom, 2016; Maskell & Malmberg, 1999).

The UK's offshore wind market has grown dramatically in the past few years, especially since 2010 onwards in terms of offshore wind capacity installed, currently standing at 5GW (BVG Associates, 2017; 2016). Ports around the UK have identified new development opportunities relating to the growth of the offshore wind industry. For example, the Port of Belfast has adapted and diversified its infrastructural assets and facilities through installing a purpose-built terminal for offshore wind staging (installation and pre-assembly) activities (Belfast Harbour, 2013; Notteboom, 2016). However, the critical mass of new development opportunities is focused upon the UK's east coast ports (BVG Associates, 2017). The UK's east coast ports are set to benefit extensively from the planned and expected growth of the UK's offshore wind market, with the UK government aiming to support another 10GW of installed capacity throughout the 2020s (BVG Associates, 2017; DBEIS, 2016). UK ports involved in the offshore wind industry have differing functions and are involved in diverse markets: acting as sites for manufacturing activities, bases for assembling and installing wind turbines, and bases for operation and maintenance (O&M) activities (BVG Associates, 2016; 2017; IPPR North, 2016). An array of ports on the UK's east coast have been identified and are emerging as key port sites for manufacturing activities serving the offshore wind industry (Figure 4.3) (BVG Associates, 2016; IPPR North, 2016; Wind Europe, 2017a). On an important note, Figure 4.3 was created as a market projection of potential port capacity to accommodate offshore wind manufacturing and staging (pre-assembly and installation) activities, and does not reflect the current market reality of port sites in the offshore wind market (BVG Associates, 2016). In reference to Figure 4.3, 'staging' activities simply mean ports supporting the offshore installation of wind turbines equivalent to "one large offshore wind farm per year (approximately 100 complete 8MW turbines per year)" (BVG Associates, 2016, pp12). Within Figure 4.3, only the Nigg Yard, the Port of Blyth, the Port of Hull (Alexandra Dock) and the Port of Great Yarmouth are involved in offshore wind manufacturing and/or staging activities.



1	C	Nigg Yard	10	M	Hartlepool
2	S	Dundee	11	S2	Seaton
3	M	Methil	12	M	Middlesbrough
4	M	Rosyth	13	C	Alexandra Dock (Hull)
5	M	Blyth	14	S1	Albert Dock (Hull)
6	C	North Shields	15	C	Killingholme
7	M	Wallsend	16	C	Immingham
8	S1	Neptune Energy Park	17	S1	Great Yarmouth
9	M	Sunderland	18	C	Sheerness

Map of headline regions and UK east coast ports (M - Manufacturing only, S - Staging only, S1 - Staging plus one manufacturing activity, S2 - Staging plus two manufacturing activities, C – Staging/manufacturing cluster).

Figure 4.3: Potential UK east coast port sites for offshore wind manufacturing and staging activities
Source: BVG Associates, 2016

In addition to UK east coast ports operating as sites for offshore wind manufacturing and staging (pre-assembly and installation) activities, some UK east coast ports also operate as important bases for O&M (operations and maintenance) activities associated with offshore wind projects, which are either fully commissioned or currently under construction, as of September 2017 (Table 4.1). However, the involvement of UK ports in the offshore wind industry is sometimes episodic in nature following the completed construction of offshore wind projects, as further O&M activities can be carried out from a different port with greater capacity and capability. By contrast, other UK ports appear to be establishing a move to a permanent position in the offshore wind industry, supporting continuous manufacturing, staging and O&M activities for offshore wind projects.

Port	Offshore wind projects served (O&M)
Port of Buckie	Beatrice (Demonstrator Project)
Port of Peterhead	Hywind Scotland Pilot Park
Port of Methil	Levenmouth (Demonstrator Project)
Port of Blyth	Blyth Array 2 (Demonstrator Project)
Teesport	Teesside
Port of Hartlepool	Teesside
Port of Grimsby	Humber Gateway Lynn Inner Dowsing Lincs Westermost Rough Race Bank Hornsea Project One
Port of Great Yarmouth	Scroby Sands Dudgeon
Port of Lowestoft	Greater Gabbard
	East Anglia ONE
Port of Harwich	Galloper
Port of Ramsgate	London Array Thanet
Brightlingsea Harbour	Gunfleet Sands Gunfleet Sands 3 (Demonstrator Project)
Wick Harbour	Beatrice
Whitstable Harbour	Kentish Flats Kentish Flats Extension
Wells Harbour	Sheringham Shoal

Table 4.1: UK east coast port sites serving Operations and Maintenance (O&M) activities
Source: 4C Offshore, 2017

UK Port Governance

The governance of ports is important to consider as various government policies, frameworks and strategies, alongside port governance models, have the potential to enable and/or constrain a port authority's capacity and decision-making process with regard to adapting and diversifying into new market activities (Notteboom, 2016; Monios, 2017; Brooks & Cullinance, 2007b).

National port policy designed and implemented by the UK government has remained reasonably unchanged since 1945, enabling relative stability in the UK ports sector (Monios, 2017; Brooks et al, 2017; Pettit, 2008). However, there have been demands from industry and government to establish a port regulator to "ensure appropriate levels of capacity provision and service quality" within the UK ports (Brooks et al, pp4; Monios, 2017). To fully understand the current context of national port governance in the UK, the changing nature of national port policy must be contextualised (Pettit, 2008; Goss, 1998).

Before the Second World War there was no coherent approach to port development or a national port planning agenda, meaning there was no clear connection between port authorities and the UK government (Pettit, 2008; Owen, 1948). As such, there were four principal forms of port ownership and governance prior to the Second World War: statutory trusts, municipal undertakings, railway companies and privately-owned ports (Pettit, 2008). These port ownership and governance contexts currently exist in the UK (statutory trusts, municipal ownership and privately-owned ports), thus reflecting an 'Anglo-Saxon' port governance context wherein port responsibilities are decentralised to private and independent interests, as there is no centralised port regulator controlled by the state (Table 2.1) (Brooks & Cullinane, 2007b; Pettit, 2008; Suykens & Van de Voorde, 1998).

However, following the Second World War, a series of UK government Acts were implemented shaping the ownership, management and control of ports nationally (Goss, 1998; Pettit, 2008; Monios, 2017). According to Goss (1998), there has been no uniform port policy in the UK since 1945, arguing there has simply been a shift from central port planning to privatisation from the early 1980s (Baird & Valentine, 2007). Firstly, the Transport Act (1947) nationalised railway companies and the ownership of UK ports was transferred to the

British Transport Commission (BTC). Next the Transport Act (1962) dismantled the BTC and the ownership of ports and commercial docks was transferred to the British Transport Docks Board (BTDB). A major event in UK ports policy was the Harbours Act (1964) which established a National Ports Council (NPC) aiming to create a centrally planned ports industry. However the NPC failed to gain acceptance and full recognition from the UK government or ports themselves (Baird & Valentine, 2007; Goss, 1998). Notably, the NPC launched Harbour Revision Orders (HROs), which still exist as an important policy tool for enabling the change of legislation governing the management of a port (DfT, 2016). Essentially, HROs are secondary legislation used to change the use of port assets (infrastructure and facilities), through the state authorising applications made by port authorities to strategically diversify port assets (DfT, 2016). HROs are therefore important tools used by actors (port authorities and associated government agencies) to enable port developments and expansions, and must be confirmed by the Secretary of State for Transport or the MMO (Marine Management Organisation) "to whom order-making powers have been delegated" (DfT, 2016, pp30; Baird & Valentine, 2007; Monios, 2017). Moreover, the Department for Transport (2016, pp30) state that the HRO is only made if the individual (Secretary of State for Transport or individual at MMO) is satisfied that the HRO will:

- "secure the improvement, maintenance or management of the harbour in an efficient and economical manner; or
- facilitate the efficient and economic transport of goods by sea; or
- be in the interests of the use of sea-going ships for leisure purposes".

Therefore, HROs are crucial elements within the UK's port policy environment which ultimately enables port adaptation, by allowing port authorities to change the use of a port's infrastructural assets and facilities (Notteboom, 2016; Jacobs & Notteboom, 2011; Debrie et al, 2013).

Moreover, certain port authorities in the UK have various statutory duties established under numerous legislative Acts implemented by the UK government, thus shaping their contemporary administrative and operational functions (Table 4.2) (DfT, 2016; Alderton, 2008). Importantly, these duties only apply to port authorities which are acting as the 'Statutory Harbour Authority' on an estuary (DfT, 2016).

Duties	Description
Open Port Duty	• Harbour, dock or berth must be open to anyone for the shipping and unshipping of goods and the embarking and landing of passengers. This is subject to payment of the rates and other conditions set by local legislation for that port.
Conservancy Duty	• Locating and marking best navigable channels • Placing and maintaining navigational marks. • Keeping 'vigilant watch' for any changes in the sea or riverbed, moving or renewing navigation marks as appropriate. • Channel(s) must be regularly dredged, or information must be provided if advertised channel depth has not been maintained. • Keeping proper hydrographic and hydrological records. • Ensuring that hydrographic information is published in a timely manner. • Providing regular returns and other information about the authority's local aids to navigation as the relevant General Lighthouse Authority may require.
Environmental Duty	• Harbour authorities have a general duty to exercise their functions regarding nature conservation and other related environmental considerations.
Civil contingencies Duty	• Civil protection in the event of an emergency that threatens serious damage to human welfare, the environment or security.

Table 4.2: UK Statutory Harbour Authority Duties
Source: DfT, 2016, pp28-30; Alderton, 2008

Another major event in UK ports policy was the Transport Act (1981), which abolished the NPC and transferred powers to the Department of Transport (DfT) and British Ports Association (BPA). In 1982, the second part of the Transport Act (1981) transferred port facilities formerly administered by the BTDB to a statutory company called Associated British Ports (ABP). Shortly after, ABP was privatised in 1983 through a process of selling 51.8% of shares to the public and the remaining 48.2% of shares to the private sector in 1984. In the years following this privatisation event, ABP's value increased from £60M in 1983 to £490M in 1990. Since its privatisation, ABP has grown into the UK's leading port authority and operator, with a network of 21 ports across England, Scotland and Wales.

Conversely, 'trust ports' are independent statutory bodies formed by individual acts of Parliament. Trust ports are governed by a board of Trustees, aiming to enhance the state of the port to meet the requirements of users and local stakeholders (Baird & Valentine, 2007). However, the Ports Act (1991) acknowledged that trust ports were neither public nor private, and compelled UK trust ports to privatise on a national scale in the early 1990s. The Act essentially gave the government power to induce privatisation through transferring municipally owned ports and trust ports to a company formed under the Companies Act (Pettit, 2008). This Act lead to the privatisation of several ports including Teesport, Medway, Tilbury, Forth, Clyde, Ipswich and Dundee (Baird & Valentine, 2007). However, some UK ports are still owned and governed as trust ports which have decided not to privatise despite demands from the UK government and remain independent statutory bodies, thus highlighting a distinctive port governance practice undertaken by existing trust ports of opposing privatisation (Monios, 2017). Examples include the Port of Tyne, the Port of Dover, the Port of London Authority, Belfast Harbour, the Port of Aberdeen, the Port of Milford haven and others (Monios, 2017). In similarity to privately owned ports, trust ports also adopt an 'Anglo-Saxon' port governance model, operating as 'independent' statutory bodies created through a legislative Act of Parliament, which is unique to the UK's port governance context (Table 2.1) (Baird & Valentine, 2007; Suykens & Van de Voorde, 1998; Verhoeven, 2010).

The Labour government of 1997 – 2010 adopted a light-touch approach to forming UK port policy, which was an extension of the legislative environment established under the Conservative government of 1979-1997 (Monios, 2017; Headicar, 2009). Effectively, the Labour government enabled the "pre-existing policy of a market-based ports industry" following the publication of a series of documents (Pettit, 2008, pp723; Monios, 2017). The *Modern Ports: A UK Policy* (DETR, 2000) confirms this approach taken by the Labour government of the time. Its successor is the *National Policy Statement for Ports* (Dft, 2012) and was originally designed by the Labour government in 2009/10 and published under the Coalition government (Monios, 2017). According to Monios (2017, pp84), this document confirmed the UK government's long-term perspective stretching back to the early 1980s, that it's not the responsibility of "government to plan and build ports, but simply to approve or reject development proposals".

As Monios (2017) summarises, the governance of UK ports including decisions for investment into port infrastructure for expansion, is the responsibility of trust, private or municipal port authorities (Goss, 1998; Pettit, 2008; DfT, 2012). Moreover, the light-touch approach from the UK government in regard to implementing ports policy and the laissez-faire state intervention in port ownership and operation, reflects the liberalised political economy of the UK (Hall and Soskice, 2001). Furthermore, this approach taken by the UK government undoubtedly shapes the 'Anglo-Saxon' port governance model evident within the UK, as a result of the UK having no centralised port regulator and laissez-faire approach, therefore responsibilities have been decentralised to private and independent interests (Table 2.1) (Baird & Valentine, 2007; Suykens & Van de Voorde, 1998; Pettit, 2008).

However, considering the market-based ports industry that the UK government had established, the Department for Energy and Climate Change (DECC) published an insightful report in 2009 titled *UK ports for the offshore wind industry: Time to Act*. This report catalysed placing greater industrial emphasis upon increasing an insufficient port capacity for offshore wind activity, to enable emerging UK and European offshore wind manufacturers, developers and operators to be based within UK ports (DECC, 2009). In essence, this report demonstrates the indirect involvement the UK government has in deciding the future of ports (Monios, 2017; Goss, 1998). Interestingly, since this report was published, an array of offshore engineering companies, research consultancies and think-tanks have stated the growing importance of ports to the UK economy, and their importance for stimulating and supporting new industrial activities like offshore wind (IPPR North, 2016; BVG Associates, 2016; Renewable UK, 2017b; Wind Europe, 2017a).

4.2.2. Evolution of German Ports

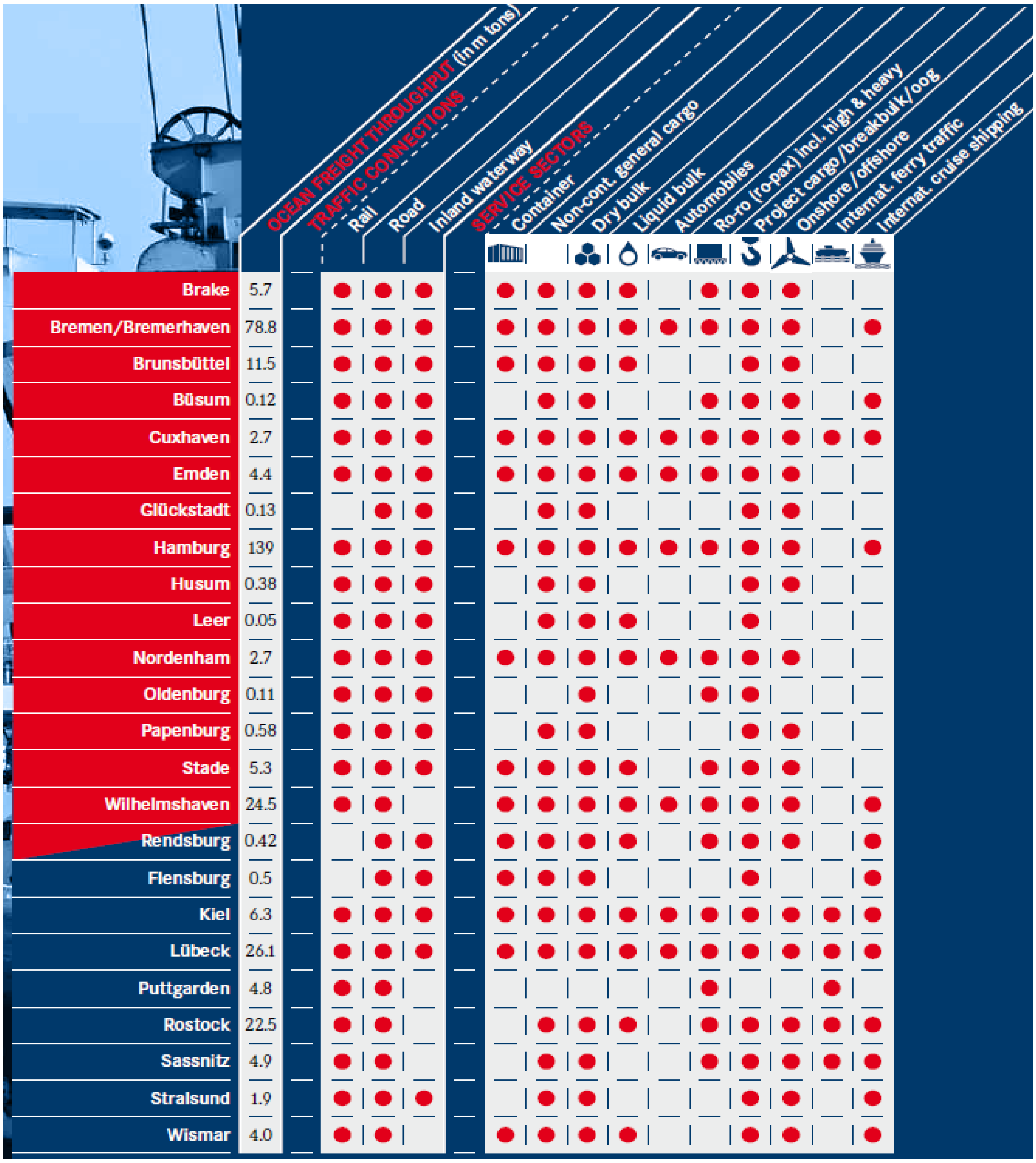
The geography of Germany's port sector contrasts with that of the UK, with a greater number of inland ports (currently at 250) and a port system split between two distinctive coastlines in Northern Germany, the majority of ports being located on the North Sea coast (Figure 4.4) (GTAi, 2016):

Figure 4.4: Germany's Major Ports
Source: BMVI, 2015

The process of the German government and numerous private actors investing into port infrastructure remains vitally important for increasing Germany's seaport's size, scale and handling capacity (BMVI, 2016; 2017). This principle has been fully supported by the Ministry of Transport and Digital Infrastructure (BMVI), which also stated that the infrastructural capacity of Germany's seaport's may have to increase to handle a growth of "269 million tonnes [of cargo] in 2010 to 468 million tonnes [of cargo] in 2030" (BMVI, 2016, pp17).

The ports of Hamburg and Bremen/Bremerhaven are the largest, multifunctional ports acting as important transport and logistics hubs, both located in Northwest Germany (Port of Hamburg, 2014; Alderton, 2008). Both the Port of Hamburg and the ports of Bremen and Bremerhaven handle all types of cargo including Ro/Ro cargo (including automobiles), containers, general and bulk cargo, dangerous goods and project cargo, whilst providing services for offshore energy activities (Bremenports, 2017a; 2017b). Furthermore, a port emerging as an important transport hub is the purpose-built Port of Wilhelmshaven, the only deep-water port in Germany, loading and discharging the world's largest container vessels (City of Wilhelmshaven, 2012; Port of Hamburg, 2014; Alderton, 2008).

Figure 4.5 summarises the diverse German port market, defining the maritime flows and industrial sectors each German port is connected to (Port of Hamburg, 2014). The German port names highlighted in red are located on the North Sea coast, the Port of Rendsburg (highlighted in red and blue) serves markets and vessels linked to both German coasts, and port names highlighted in blue are located on the Baltic Sea coast (Figure 4.4; Figure 4.5).



Port	OCEAN FREIGHT THROUGHPUT (in m tons)	TRAFFIC CONNECTIONS: Rail	Road	Inland waterway	SERVICE SECTORS: Container	Non-cont. general cargo	Dry bulk	Liquid bulk	Automobiles	Ro-ro (ro-pax) incl. high & heavy	Project cargo/breakbulk/oog	Onshore/offshore	Internat. ferry traffic	Internat. cruise shipping
Brake	5.7	●	●	●	●	●	●	●		●	●	●		
Bremen/Bremerhaven	78.8	●	●	●	●	●	●	●	●	●	●	●		●
Brunsbüttel	11.5	●	●	●	●	●	●	●			●	●		
Büsum	0.12	●	●	●		●	●			●	●	●		●
Cuxhaven	2.7	●	●	●	●	●	●	●	●	●	●	●	●	●
Emden	4.4	●	●	●	●	●	●	●	●	●	●	●		
Glückstadt	0.13		●	●		●	●				●	●		
Hamburg	139	●	●	●	●	●	●	●	●	●	●	●		●
Husum	0.38	●	●	●		●	●				●	●		
Leer	0.05	●	●	●		●	●	●			●			
Nordenham	2.7	●	●	●	●	●	●	●	●	●	●	●		
Oldenburg	0.11	●	●	●			●			●	●			
Papenburg	0.58	●	●	●		●	●				●	●		
Stade	5.3	●	●	●	●	●	●	●		●	●	●		
Wilhelmshaven	24.5	●	●		●	●	●	●	●	●	●	●		●
Rendsburg	0.42		●	●	●	●	●	●		●	●	●		●
Flensburg	0.5		●	●	●	●	●				●			●
Kiel	6.3	●	●	●	●	●	●	●	●	●	●	●	●	●
Lübeck	26.1	●	●	●	●	●	●	●	●	●	●	●	●	●
Puttgarden	4.8	●	●							●			●	
Rostock	22.5	●	●			●	●	●		●	●	●	●	●
Sassnitz	4.9	●	●			●	●			●	●	●	●	●
Stralsund	1.9	●	●	●		●	●				●	●		●
Wismar	4.0	●	●		●	●	●	●			●	●		●

Figure 4.5: Market activities of German ports
Source: Port of Hamburg, 2014

Over the past 15 years, German ports have been developed as key sites for the pioneering development of offshore wind, highlighting a burgeoning market beyond 'traditional' port-related activities and the changing role of ports in Northern Germany (GTAi, 2017; Port of Hamburg, 2014; Alderton, 2008; Wind Europe, 2017a). Since the early 2000s, the German port market has experienced a shift towards and growth of conducting onshore and offshore port-related activities which supported and accommodated European offshore wind activities and operations, highlighting a strong drive by industrial leaders involved in port and offshore wind activities (Figure 4.5) (Bruns & Ohlhorst, 2011; GTAi, 2017; BMWi, 2015).

The pioneering role of the German offshore wind industry enabled the establishment of German port activities in particular sections of the offshore wind industry, primarily within high-value manufacturing activities (BWMi, 2015). German ports pioneered the development of appropriate infrastructure and facilities for firms to install, operate and maintain pilot projects such as 'Alpha Ventus' and 'Baltic 1', clearly reflecting an industrial drive into offshore wind (BMWi, 2015; Bruns & Ohlhorst, 2011; Markard & Petersen, 2009l; Alpha Ventus, 2015). Specifically, some German ports are adapting and diversifying into offshore wind as a result of the restructuring of the offshore wind industry in Germany and more broadly in Northwest Europe (BMWi, 2017; Martin, 2010). German ports are becoming more important for manufacturing, installation and O&M (operations and maintenance) activities as a result of their physical setting in Northwest Europe, highly developed infrastructural asset bases and connections to offshore wind production networks (BMWi, 2017; BMWi, 2015). Moreover, spare facilities have become available over time resulting from broader processes of deindustrialisation in Germany, which have been strategically converted and diversified to support offshore wind activities (Notteboom, 2016; BMWi, 2017; BMWi, 2015).

The geography of Germany's offshore wind industry is centred upon the North Sea basin, allowing ports located on Germany's North Sea coast to capitalise upon various market opportunities by utilising their physical setting and natural assets, whilst accordingly adapting their (infrastructural, industrial and material) asset base (see Figures 8, 9 and 10) (BMWi, 2015; GTAi, 2017; Wind Europe, 2017a; Maskell & Malmberg, 1999). Although the geography of Germany's North Sea coast has motivated port authorities to adapt and diversify their asset bases to support the offshore wind industry, it plainly contrasts with the UK's longer coastal length and larger area of seabed for installing and constructing offshore wind projects, which is an important natural asset in enabling the UK to generate a strong market draw (BMWi, 2016; DBIS, 2014). Furthermore, German ports have adapted and diversified their infrastructural assets to enable the export of turbine components to major overseas markets, in particular the UK, as a result of its rapid market expansion and strong market draw (Notteboom, 2016; BMWi, 2015).

O&M is another activity which some German ports are involved in. This activity is recognised as a diverse set of port-related activities common across all European offshore wind markets, which is comprised of onshore logistics, offshore logistics, turbine maintenance, export cable and grid connection, array cable maintenance, foundation maintenance, and back office administration and operations (GL Garrad Hassan, 2013; Niedersachsen Ports, 2014; Wind Europe, 2017a).

The manufacturing of turbine components within German ports is situated alongside other related offshore wind activities, due to demands from the industry which emphasise logistical efficiency (BMWi, 2015). Therefore, some German ports operate as multifunctional offshore wind bases, conducting a range of offshore wind related activities, including O&M, pre-assembly and installation activities, and the manufacturing of offshore wind turbine components (BMWi, 2015; BVG Associates, 2017). Examples of German ports heavily involved in a range of offshore wind activities (manufacturing, installation and O&M) include the ports of Cuxhaven, Bremerhaven, Stade and Nordenham, whilst Wilhelmshaven is growing into a multifunctional complex (Figure 4.6) (GTAi, 2017; Niedersachsen Ports, 2014). The Port of Wilhelmshaven is a key example of an important O&M base, conducting activities such as retrofitting and equipping of jack-up vessels, cable ships and supply unit services, whilst functioning as a strategic base for offshore wind energy companies and port logistics service providers (Figure 4.6) (GTAi, 2017; Niedersachsen Ports, 2014).

Figure 4.6: German Ports involved in offshore wind activity
Source: GTAi, 2017

German Port Governance

Germany's port governance and policy environment shapes processes of port adaptation and diversification into new market activities, through policies supporting state ownership of ports and significant state investment into port infrastructure, whilst emphasising the critical role of ports in the offshore wind industry (BMVI, 2016; Notteboom, 2016; Debrie et al, 2013; Brooks & Pallis, 2008). Currently the Ministry of Transport and Digital Infrastructure (BMVI) is responsible for creating and implementing national port strategies, policies and legislation (BMVI, 2016; Debrie, 2010). The most recent *National Strategy* for German port governance and development was published in 2016, replacing the previous National Strategy published in 2009 (BMVI, 2016; 2017). The German government have stated the latest National Strategy is the national port policy framework for the next decade, aiming to support all relevant stakeholders involved (BMWi, 2017; BMVI, 2016). There are various policy criteria outlined by the German government for updating the National Strategy for German ports (BMVI, 2016; 2017). The policy criteria outlined below reflects the changing nature of Germany's port activity and market settings, together with the growth of the offshore wind industry, and the broader political, economic and social conditions within Germany and the EU (BMVI, 2016, pp6; 2017; Wind Europe, 2017b; Ubbels, 2005):

- “maintenance and upgrading of transport and port infrastructures, and superstructures
- fiercer international and European competition between ports
- new EU initiatives in the ports sector
- offshore wind energy
- technological developments (automation of cargo handling, IT)
- environmental protection and climate change mitigation
- alternative fuels
- security (especially cybersecurity)
- demographic change.”

Importantly, each National Strategy is developed and implemented in a co-operative way, through intense integration and coordination between several actors including the federal government, the states, ports, firms, trade unions and trade associations (BMVI, 2016; 2017). However, the federal government has ultimate control over how the policy measures and mechanisms it creates are implanted, expecting “the states and local (municipal) authorities, the ports sector and trade unions to similarly implement the measures addressed to them” (BMVI, 2016, pp41). The federal government is also responsible for road, rail and water transport connections to German ports, nautical management and port planning external to port land, therefore the federal government provides funding for maintaining and improving port channels, alongside road and rail access routes (Ubbels, 2005; BMVI, 2016). The approach taken by the federal government of establishing ports policy and taking strategic intervention in the ports industry (state ownership, management and investment), reflects Germany’s characteristic co-ordinated market economy, through the government working alongside port authorities to design and implement policy (Hall and Soskice, 2001). Furthermore, the public ownership and operation of German ports mirrors the ‘Hanseatic’ port governance model, whereby ports receive considerable financial and political support from the federal government and German states (or *Lander*) (Suykens & Van de Voorde, 1998; Verhoeven, 2010).

Below the scale of the federal government, the Lander develop and implement policies for ports and port development in collaboration with municipalities, port authorities and port operators, with municipalities and port authorities having greater power in deciding specific changes to port infrastructure and land development (Debrie, 2010; BMVI, 2017). Furthermore, municipal governments within the Lander play a secondary role within Germany's overall port governance system (Debrie, 2010; Ubbels, 2005). The Free Hanseatic City of Hamburg, the Free Hanseatic City of Bremen (including Bremerhaven), Lower Saxony (Niedersachsen), Schleswig-Holstein and Mecklenburg-Vorpommern, are the main Germen states with policies and strategic plans for seaport governance, management, development and expansion.

The State of Lower Saxony (Niedersachsen) has 39 seaports, 15 of them are fully owned by the state government, 21 are fully owned by municipalities and Nordenham is the only privately-owned seaport, belonging to 'Rhenus-Midgard' (Niedersachsen, 2017). In terms of implementing the National Strategy for ports, the State of Lower Saxony has "expressly committed to close and trustful cooperation with the federal government" to implement national policy framework, in order to strengthen Lower Saxony's seaports (Niedersachsen, 2016, pp11; Ubbells, 2005). In the latest port development strategy for Lower Saxony's ports, named *The Ports of Lower Saxony 2020: A Perspective Paper*, the state government stated that Lower Saxony's ports will aim to capitalise upon certain growth markets including the energy sector, automotive sector, container handling and agricultural products (Niedersachsen, 2016). Furthermore, the State of Lower Saxony and its municipalities are port owners and strategically invest into port infrastructure, in order to capitalise on emerging market opportunities (Niedersachsen, 2016; BMVI, 2016; Ubbells, 2005). A key example of this is the State of Lower Saxony investing over 250 million euros into the ports of Cuxhaven and Emden since the mid-2000s, thus capitalising upon the growth of offshore energy industries (including offshore wind) (Niedersachsen, 2016).

So far the chapter has discussed the overall context and the changing role of Global, European, UK and German ports. The evolution of German ports is pinned around ports adapting and diversifying their industrial functionality and infrastructural assets, as a result of port governance actors shifting the focus, scale and significance of port market portfolios towards accommodating and supporting the bourgeoning offshore wind industry

(Notteboom, 2016; Jacobs & Notteboom, 2011; Wind Europe, 2017b). However, in relation to overall German port activity, offshore wind only represents a limited amount of value in relation to the overall traffic and markets that German ports are connected to. The emergence of the offshore wind has provided a new marketplace for ports to capitalise upon (Wind Europe, 2017a; 2017b). Therefore, the chapter will now move onto discuss the manner in which the offshore wind industry has emerged and developed to create new market opportunities for ports.

4.3 Offshore Wind: A New Opportunity for Ports

The ways in which particular ports have adapted and captured market share within offshore wind reflects the broader growth of the European offshore wind industry, which created a range of industrial and market opportunities for certain ports and catalysed port diversification into offshore wind (Wind Europe, 2017a; 2017b; Notteboom, 2016). Section 4.3 will provide a profile of the evolution and change of offshore wind across the European, UK and German contexts, which create differentiated opportunities for ports to adapt and diversify.

The emergence and growth of the UK and German offshore wind industries have been shaped by broader climate change, renewable energy transition and industrial decarbonisation policies and strategies. In the UK, the *Climate Change Act (2008)* provided an important step in providing a framework for UK climate change policy, statutory targets for decarbonisation and established the Committee on Climate Change as an independent body to advise the Government on climate change and renewable energy (House of Commons Library, 2020). The Act has been subsequently supported by the *Low Carbon Transition Plan (2009)* to tackle climate change, introduce new low carbon technologies and transform the lives of individuals (HM Government, 2009). More recently, the UK has introduced the Clean Growth strategy which set out specific financial mechanisms and initiatives for enabling the UK's renewable energy transition and decarbonisation (DBEIS, 2017a). In Germany, the *Energiwende* or 'energy revolution' is an ongoing climate change and decarbonisation strategy adopted by the German government (Stefes, 2016). In 2010, the German government set out its 'Energy Concept', a strategy which outlined how Germany could secure a clean and renewable energy supply, setting out a roadmap up until

2015 (GTAi, 2020). Building upon this important strategy and the German government's new commitment to phase out nuclear energy following the 2011 Fukushima disaster, the German government published the *Climate Action Plan 2050*, which outlines the process for achieving its climate targets in response to the Paris Agreement, across the strategic areas of energy supply, construction and transport, industry and business, agriculture and forestry (BMU, 2016). As such, these wider policies and strategies to address key issues of climate change and decarbonisation, has set the political and legislative platform for the growth of offshore wind in the UK and Germany (GWEC, 2016; IRENA, 2012; Stefes, 2016; Dawley, 2014).

The European offshore wind industry operates as the leading global market, creating a range of industrial and market opportunities for North Sea ports to adapt and diversify into, including manufacturing, installation and O&M (operations and maintenance) activities (Wind Europe, 2017a; Notteboom, 2016). Consequently, a number of North Sea ports responded to these industrial and market opportunities and diversified to attempt to capture inward investment and offshore wind activities (BVG Associates, 2016; Wind Europe, 2017a; 2017b). From 2014 to 2015, offshore wind doubled its market share to 24% of all wind power installations (offshore and onshore) in Europe, capitalising upon 34% (13.2billion) of renewable energy investment in Europe (EWEA, 2016). The offshore wind industry is geographically centred upon the European market with nearly 88% of all offshore wind installations located off the coast of ten European countries at the end of 2016 (GWEC, 2016; Wind Europe, 2017b). Within Europe, the North Sea basin currently has 72% of installed capacity, followed by the Irish Sea (16.4%), the Baltic Sea (11.5%) and the Atlantic Ocean (0.04%) (Wind Europe, 2017b). The remaining 12% of all offshore wind installations are located largely off the coast of China, Japan, South Korea and the United States, highlighting a range of emerging international markets (GWEC, 2016).

The European Commission has established a governance framework for the offshore wind industry through *Guidelines on State Aid for Environmental Protection and Energy*, establishing a range of market-based schemes for EU nations to meet 2020 energy and climate change targets (GWEC, 2016; European Commission, 2014). However, there are growing concerns from port authorities invested in Europe's offshore wind industry, demanding a market support regime from the EU and national governments to ensure a stable pipeline of offshore wind projects and increased market certainty (Wind Europe, 2017a). As such, regulatory governance frameworks implemented by the EU and national governments enable and/or constrain the process of ports adapting and diversifying into offshore wind activities (Notteboom, 2016; Debrie et al, 2013; Martin, 2010).

Within Europe's offshore wind industry Denmark is a pioneer, becoming the first country in the world to install wind turbines offshore at the 'Vindeby' offshore wind farm in 1991 (Danish Energy Agency, 2015). Denmark, as the industry's early leader and technological pioneer, currently has 1,271.3MW installed capacity making Denmark the third largest in Europe (GWEC, 2016). However, Denmark has since been overtaken by the UK (5066.5MW) and Germany (3294.6MW) in the past decade (GWEC, 2016; Garud & Karnoe, 2003; Simmie, 2012). Germany is also a early pioneer of wind energy with offshore demonstration projects installed throughout the 1980s and early 1990s, underlining how there was an industry drive for offshore wind in Germany from an early stage of technological development (IRENA, 2012; GWEC, 2016). This early industry drive has since catalysed the incremental adaptation and diversification of German ports into a range of port-related activities supporting the offshore wind industry (Notteboom, 2016; BMWi, 2015). Conversely, the UK's offshore wind industry emerged from 2001 onwards before experiencing rapid growth from the mid to late 2000s, and has since become a market draw for exporters based in Germany and other countries (IRENA, 2012; GWEC, 2016; Dawley et al 2015). The industrial leaders are Denmark, Germany and the UK in terms of installed capacity, with Belgium and the Netherlands succeeding them (Table 4.3):

Country	**BE**	**DE**	**DK**	**ES**	**FI**	**IE**	**NL**	**NO**	**PT**	**SE**	**UK**	**Total**
No. of farms	5	18	12	1	2	1	6	1	1	5	27	80
No. of turbines	182	792	513	1	9	7	184	1	1	86	1,454	3,230
Capacity Installed (MW)	712	3294.6	1,271.3	5	26.3	25.2	426.8	2.3	2	201.7	5,066.5	11,034

Table 4.3: European countries by offshore wind farms, turbines and capacity installed MW
Source: GWEC, 2016, pp47; Wind Europe 2017b.

The majority of offshore wind turbine manufacturing firms in Europe are based in Germany (Wind Europe, 2017b; GWEC, 2016; BMWI, 2015). The leading and most important offshore wind turbine manufacturer at the end of 2016 in terms of market share is Siemens based in Germany (67.8%), followed by MHI Vestas Offshore Wind based in Denmark (16.4%), Senvion based in Germany (6.2%) and Adwen based in Germany (5.2%) (Wind Europe, 2017b). Conversely the manufacturers of wind turbines foundations are based in a range of European countries (Wind Europe, 2017b). In terms of leading foundation manufacturers in Europe at the end of 2016 (installed foundations), these include Sif based in the Netherlands (22.3%), Bladt based in Denmark (19.7%), EEW based in Germany (18.8%) and Smulders based in Belgium (12.7%) (Wind Europe, 2017b). The chapter will now explore the context of UK offshore wind as an important national case in the context of European offshore wind.

4.3.1 UK Offshore Wind Industry

Offshore wind in the UK began in the early 1990s, growing into the world's largest market with over 5GW of operational capacity by 2016 (GWEC 2016; IRENA, 2012). However, despite the UK having the largest offshore wind market, it has an absence of industry leaders, highlighting a strong market draw for European and Scandinavian firms (GWEC, 2016; Wind Europe, 2017b). The chapter will now explore how and why this has occurred through discussing the creation of the UK offshore wind market and the context of the UK offshore wind industry, since the initial emergence of offshore wind in the UK in the early 1990s.

The initial development and growth of the UK offshore wind industry began through small but important pilot projects, originating in the North East of England (Dawley, 2014). This initial industrial footing was catalysed by the implementation of the NFFO (Non-Fossil Fuel Obligation) in England and Wales in 1990, stimulating a small amount of developer interest through two bidding rounds in 1990 and 1998 (Markard & Petersen, 2009). Further state-led support from the Labour government in 1997 enabled offshore wind to become quickly recognised by the UK government and industry as an important renewable energy option throughout the 2000s (Dawley, 2014; DBIS, 2014). This recognition was underpinned by the UK's underlying assets listed below, enabling it to ultimately grow into the leading nation in Europe's offshore wind industry (Dawley, 2014; DBIS, 2014; Maskell & Malmberg, 1999):

- UK possesses a competitive advantage in its natural resource asset base (shallow continental shelf, extensive coastline and high wind speeds).
- UK's port-related infrastructural, industrial and material asset base can support offshore wind development, including manufacturing, installation, operation and maintenance (O&M) activities.
- UK's industrial, infrastructural and labour market competences relating to offshore oil and gas fabrication, and other port-related engineering activities.

Building upon the UK's overall infrastructural, industrial, material and natural asset base, a selection of UK ports strategically adapted and diversified their territorial assets to capture new market opportunities, and play unique roles in Europe's offshore wind industry (Wind Europe, 2017a; Notteboom, 2016; Notteboom et al, 2013; Maskell & Malmberg, 1999).

The offshore wind market has been governed in parallel with energy market regulation implemented by the UK government since the early 1990s and the introduction of the NFFO. As such, the NFFO paved the way for the introduction and implementation of the Renewables Obligation (RO) in 2002, a support mechanism which required suppliers (power generators) to "increase their uptake of renewable energy" by meeting targets of renewable energy power generation set by the RO (Bradshaw, 2010, pp205; IRENA, 2012). Renewable Obligation Certificates (ROCs) are issued to suppliers for the eligible renewable electricity they generate, and suppliers subsequently gain a subsidy for each ROC produced, currently at £45.58 (per ROC) for 2017/18 (IRENA, 2012; Ofgem, 2017). Despite slow market development initially, the implementation of 'banding' from 2009, wherein the UK government provided greater financial support for costlier renewable energy technologies, such as offshore wind, through permitting suppliers to receive 2 ROCs from 1MWh generated instead of 1 ROC (IRENA, 2012). Fundamentally, this shift in the policy mechanism for renewable power generation catalysed the rapid expansion of the offshore wind sector from 2009 onwards.

The current scale, scope and geographical development of the UK's offshore wind market has been catalysed and structured through rounds of development governed by the Crown Estate (and Crown Estate Scotland). The Crown Estate operates as an autonomous business established by an Act of Parliament and is responsible for the management of the UK's seabed, licensing 'rounds' for offshore wind farm projects and granting exclusive rights to develop particular projects (The Crown Estate, 2017a; Crown Estate Scotland, 2017). In 2000, the UK government announced Round 1 would consist of 18 projects of up to 30 turbines around the UK coast and ultimately licensed 13 projects, currently generating 1.2GW (IRENA, 2012; The Crown Estate 2017b). Round 2 followed in 2003, with the Crown Estate licencing 16 projects with a total generating capacity of just under 6 GW (IRENA, 2012; The Crown Estate, 2017b). However, following the *UK Offshore Energy Strategic Environmental Assessment (SEA)* in 2009, Round 3 projects were identified and thus catalysed an acceleration in the UK's offshore wind market through large scale deployment (Dawley, 2014; Crown Estate, 2017b). This identification comprised of an array of offshore wind across 9 zones in UK Territorial Waters which were ultimately licensed in January 2010 (IRENA, 2012; The Crown Estate, 2017b; The Crown Estate, 2010b). The rapid growth of the offshore wind market, despite various consenting delays and uncertainty throughout Round 3, has enabled the UK to deploy 27 wind farm projects and a cumulative capacity of over 5.1GW by the end of 2016 (GWEC, 2016; Wind Europe, 2017b; Table 4.3).

Following the election of the Coalition Government in 2010, the UK government launched Electricity Market Reform (EMR) aiming to increase the capacity and volume of renewable energy to meet climate targets, increase inward investment into low carbon technology such as offshore wind, whilst aiming to decrease costs for consumers (DECC, 2012). As part of the EMR, the Coalition Government introduced the Levy Control Framework (LCF) to control the costs of supporting electricity generated from low carbon technology by establishing a restricted budget available for renewable energy. The latest announcement made by the UK government states that funding for the low-carbon energy schemes will be capped at £7.6 billion in 2020/21 (2012 prices) (NAO, 2016). The UK government announced in 2016 that they will support offshore wind projects and other less established renewable energy technologies up to 2025/26 with a LCF (Levy Control Framework) budget of £730 million established under the CfD framework (NAO, 2016).

Primarily underpinning the EMR was the introduction of the Contracts for Difference (CfD) framework which succeeded the RO mechanism. Essentially, CfD operates based upon a pre-agreed 'strike price' as an administrative guide, with suppliers (power generators) receiving the difference between this ‘strike price’ and the wholesale price on the electricity market (DECC, 2012). Under the first FIDeR round (Final Investment Decision Enabling for Renewables) enabling round in 2014 (in 2012 prices), strike prices for offshore wind were set at £155 per MWh for 2014/5, decreasing to £140 per MWh by 2018/19 (DECC, 2014a). Following this, the ‘awarded’ prices for suppliers was lower, standing at £119.89 for Scottish Power Renewables (UK) Limited and £114.39 for Neart na Gaoithe Offshore Wind Limited (DECC, 2015). Under the second CfD allocation round announced in April 2017 (in 2012 prices) strike prices for offshore wind were originally set at £105 per MWh for 2020/21 and £100 per MWh for 2021/22 (DBEIS, 2017c). However, between April and September 2017, the UK government introduced lower ‘awarded’ prices as the offshore wind market continued to grow and costs for suppliers continued to reduce (Financial Times, 2017). Consequently, strike prices in the second CfD allocation round for offshore wind were awarded in September 2017 at £74.75 per MWh for 2021/22 to Triton Knoll Offshore Wind Farm and £57.50 per MWh for 2022/23 to Hornsea Project 2 and Moray Offshore Wind Farm (East) (DBEIS, 2017c). More recently, the third CfD allocation round in 2019 strike prices for offshore wind were awarded in September 2019 at £39.65 per MWh for 2023/23 to Doggerbank Creyke Beck A P1, Forthwind and Sofia Offshore Wind Farm Phase 1, and at £41.61 per MWh for 2023/24 to Doggerbank Creyke Beck B P1, Doggerbank Teeside A P1 and Seagreen Phase 1 (DBEIS, 2019b).

In 2018 the UK government and the OWIC (Offshore Wind Industry Council) announced an ambitious estimate of installing 30GW of turbine capacity by 2030, which was confirmed through a ‘Offshore Wind Sector Deal’ in March 2019 (Renewable UK, 2018; Humber Business, 2019; DBEIS, 2019a). Within the Offshore Wind Sector Deal, the UK government committed to providing up to £557m for CfDs, whilst confirming a third CfD allocation round in May 2019, future allocation rounds will occur every 2 years thereafter and that the Crown Estate and the Crown Estate Scotland will provide a new seabed leasing round in 2019 (DBEIS, 2019a).

However, the EMR process, encompassing the CfD framework, has been seen by some actors within the UK offshore wind industry to be lengthy and catalysed market uncertainty throughout the 2010s, demonstrated by certain offshore wind projects being cancelled or delayed (BVG Associates, 2017). Despite some market uncertainty, five of eight offshore wind projects were granted contracts in the Final Investment Decision Enabling Round (FIDeR) in 2013/14, two contracts to offshore wind projects in the first CfD round granted in 2014/15, three contracts to offshore wind projects in the second CfD round granted in 2017 and six contracts to offshore wind projects in the third CfD round granted in 2019 (DECC, 2014b; DECC, 2015; DBEIS, 2017b; 2017c; BEIS, 2019b). These projects have been awarded under a regime which promotes competition for financial support reflecting the UK's highly liberalised political economy, especially since the election of the Coalition Government in 2010 and the Conservative Government in 2015 (Hall & Soskice, 2001).

The UK government is continually aiming to create an appropriate policy framework to enable the offshore wind market to develop and expand, through employing the CfD (Contracts for Difference) mechanism as an outcome of the EMR (Electricity Market Reform) (DECC, 2012; DECC, 2015; DBEIS, 2017b; 2017c). Moreover, the Crown Estate Licencing Rounds underpin the organisation and expansion of the UK offshore wind. However, the LCF (Levy Control Framework) essentially constricts the UK's offshore wind market development, as it sets a limited annual budget for all renewable energy levy-funded schemes. The chapter will now explore the UK offshore wind industry and the main policies that shape it, thus highlighting its potential to stimulate port adaptation and shape new regional industrial paths.

Influencing Industrial Paths

The rapid growth and expansion of the UK offshore wind market prompted the UK government to place emphasis upon growing the UK's industrial competence, capacity and scope in offshore wind through policy actions focused upon market support, to build a competitive and innovative UK supply chain (HM Government, 2013). Underpinning this strategy was that the vast majority of content within the UK's offshore wind supply chain for turbine installations originate in Germany (Siemens, Senvion, Adwen) and Denmark (MHI Vestas), as a result of a strong industry drive by leading firms such as Siemens (OWIC, 2014; Wind Europe 2017a). The main policy publication for setting a strong industrial target to move towards generating 50% of value from UK content was the *Offshore Wind Industrial Strategy* (OWIS) (HM Government, 2013). To achieve this target, the OWIS recommended some key policy actions. Firstly, that the 'Offshore Wind Investment Organisation' should market the UK offshore wind industry to attract greater volumes of Foreign Direct Investment (FDI), due to the absence of turbine manufacturing and other related activities in the domestic supply chain. Secondly, to increase capacity of existing (domestic) firms in the offshore wind supply chain and to enable the diversification of new firms with clear capacity to enter the offshore wind supply chain, 'GROW: Offshore Wind' must provide financial grants and market support packages tailored to individual companies. GROW: Offshore Wind was a three-year government-backed programme founded in 2013 with £20M RGF (Regional Growth Fund) funding, aiming to enable the ability of firms in England to exploit various opportunities offered by the UK offshore wind market (HM Government, 2013). Thirdly, OWIS recommended a key action to be taken by the 'Technology Strategy Board' to provide £46 million of funding between 2013-2018 to establish the Offshore Renewable Energy (ORE) Catapult, simulating and directing national R&D, component testing and cost reduction activities (HM Government, 2013). ORE Catapult is based in Glasgow and includes high-end demonstrating and testing facilities in the North East of England, which have largely been developed and modelled to emulate the Fraunhofer model of Technology and Innovation Centres (TICs) in Germany (BVG Associates, 2014; Hauser, 2014). The interaction of various institutions, industry bodies and strategies arranged by the OWIS, aimed to establish an institutional environment consisting of certain policies and organisations (GROW: Offshore Wind, RGF, ORE), to enhance the industrial development of the domestic supply chain for offshore wind (BVG Associates, OWIC, 2014; Martin, 2010).

Currently the functioning of the UK offshore wind industry is dominated by one key activity which is operations and maintenance (O&M) (GL Garrad Hassan, 2013). Essentially, O&M covers a range of different interconnected onshore and offshore activities including offshore and onshore logistics, back office administration and operations, establishing export cable grid connections, turbine maintenance, array cable maintenance and foundation maintenance (GL Garrad Hassan, 2013). The owner of each offshore wind project procures the O&M provider and some owners often provide the O&M services themselves (GL Garrad Hassan, 2013). The foremost actor conducting O&M activities is Ørsted, who is an industry pioneer in terms of O&M resulting from developing high-level in-house capabilities as one of the first movers into the offshore wind industry (GL Garrad Hassan, 2013; HM Government, 2013). Other key actors conducting O&M activities in the UK include Siemens, E.ON, Centrica, RES, and CWind.

The process of pre-assembling wind turbines and installing an offshore wind project is another key function within the UK offshore wind industry (Crown Estate, 2010a). This process is comprised of several interacting activities including export-cable laying, foundation installation, array-cable laying, offshore substation installation, onshore pre-assembly of turbine components and turbine installation (Crown Estate, 2010a). Due to the complexity of this process, a vast array of large energy and engineering companies and SMEs are involved in conducting the range of interacting activities. However, the main actors involved in the pre-assembling of turbine components and installation process for the UK offshore wind industry are Siemens, Ørsted, A2SEA and E.ON.

The manufacturing of turbine components is an important industrial function within the offshore wind industry (The Crown Estate, 2010). However, the UK is less established in manufacturing turbine components in comparison to its O&M, pre-assembly and installation capacity (BVG Associates, 2016). This current industry context emphasises how the UK is providing a large market draw for European turbine manufactures such as Siemens and MHI Vestas to export turbine components (Wind Europe, 2017b). This industrial context is further supported by the future market outlook of offshore wind as the UK is expected to add considerable offshore wind installed capacity from 2017 – 2021 (Figure 4.7) (Wind Europe, 2017b).

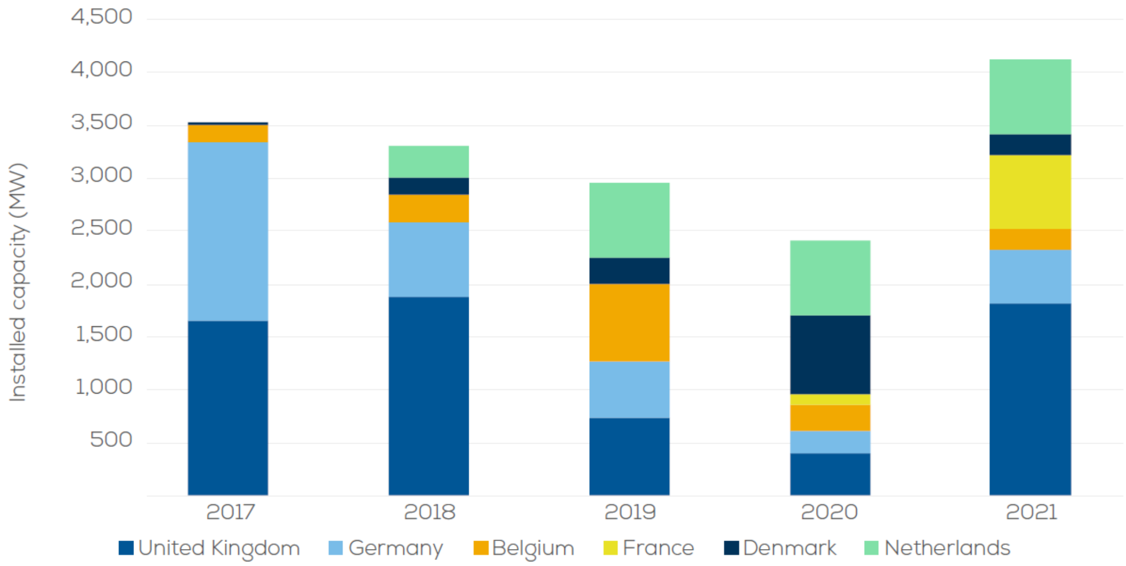


Figure 4.7: European offshore wind market outlook
Source: Wind Europe, 2017b

Thus far, the chapter has outlined the important UK context for offshore wind in terms of market creation and industry context, emphasising its capacity to shape new industrial paths. However, the German context for offshore wind offers some important and interesting comparisons in terms its market creation and industrial context, in relation to German ports adapting and diversifying into the offshore wind industry and influencing new regional industrial paths in Germany.

4.3.2 German Offshore Wind Industry

Offshore wind in Germany began much later than the UK, emerging in 2010, and has become the world's second largest offshore wind market with 4.1GW installed by 2016 (GWEC, 2016; Markard & Petersen, 2009). In addition, Germany comprises key industrial leaders such as Siemens (turbine component manufacturer), EEW (manufacturer of turbine foundations) and Innogy (offshore wind project developer), thus highlighting an industrial drive of offshore wind since its emergence in Germany (GWEC, 2016; Wind Europe, 2017b). The chapter will explore how and why offshore wind emerged in Germany through outlining the creation of the German offshore wind market and Germany's offshore wind industry context.

Germany has been the European pioneer for onshore wind technology since the 1970s and currently the onshore wind market dominates the offshore wind market in terms of capacity installed, inward investment and levels of employment (GWEC, 2016; O'Sullivan, 2014). However, in addition to industrial competencies in onshore wind activities, Germany has grown into the second largest market for offshore wind power with 4.1GW installed by the end of 2016, despite only having two pilot projects installed by the end of 2007 (GWEC, 2016; Markard & Petersen, 2009). This rapid market growth of offshore wind was catalysed by the recognition that offshore wind technology could provide a scalable solution to reach Germany's renewable energy targets and low-carbon transition, a policy regime named 'Energiewende' (Buchan, 2012). The initial development and growth of Germany's offshore wind market was shaped by the 'Federal Offshore Wind Strategy' (*Strategie der Bundesregierung zur Windenergienutzung auf See*) in 2002 (Bruns & Ohlhorst, 2011). This strategy aimed for 500MW to be installed by 2006, 3,000MW to be installed by 2010 and up to 25,000MW installed by 2025/30 (Bruns & Ohlhorst, 2011). These ambitious state-led targets catalysed a strong drive from industry leaders and prompted firms into action from the mid-2000s, as they recognised that the federal government was willing to provide long-term market support (Bruns & Ohlhorst, 2011).

Following growing political scepticism of nuclear energy and increasing demand for decarbonisation in the late 1980s, the first Electricity Feed-in-Act (StrEG) (1991) was the first industrial policy mechanism which ensured a fixed rate for renewable energy projects to feed into Germany's national grid (IRENA, 2012; Lema et al, 2014; Stefes, 2016). Essentially, StrEG enabled the first, important (although limited) growth of Germany's wind energy market, through setting a feed-in-tariff at 90% of the average retail electricity price for wind producers (Stefes, 2016). Moreover, the German government also supported the wind energy market through various loan programmes to subsidise developers purchasing turbines and are "mostly operated by the [state-owned] KfW Development Bank" (Lema et al, pp36). A notable example of this type of funding programme is the Offshore Wind Energy Loan Programme (2011), financed by the KfW Development Bank, which has funded the Global Tech I and Butendiek offshore wind projects.

The fundamental policy framework for the industrial development of wind energy was laid down by Germany's Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz) or 'RESA' in 2000, acting as a lever for a range of infant technologies through providing targeted incentives (BWMi, 2015; Stefes, 2016). As such, the RESA sets a fixed price for producers to alleviate the impact of decreasing energy prices within Germany's energy market, underpinned by market incentives (feed-in-tariffs) for renewable energy sources (Wüstenhagen & Bilharz, 2006; Stefes, 2016). The RESA policy has been revised in 2004, 2009, 2011, 2014 and 2017 reflecting Germany's changing energy market, shifting costs of renewable energy technologies for consumers and the need for greater industry support for costlier renewable energy technologies, such as offshore wind. Importantly, the 2009 revision of the RESA policy focused upon providing higher feed-in-tariffs for offshore wind (an increase from 9.1 to 15.4-euro cent per kWh), reflecting the industrial and financial challenges experienced by developers underpinned by installing turbines in deeper waters and at more distance offshore sites (Markard & Petersen, 2009). The increased feed-in-tariffs implemented through the RESA (2009) also enabled firms to overcome these barriers and ultimately enable the development of Alpha Ventus, which was connected to the grid in 2009 (Markard & Petersen, 2009; TenneT, 2018). Moreover, the revision of the RESA in 2014 adjusted the offshore wind expansion targets to align with industrial development whilst regulating the expansion of offshore wind energy until 2030 (BMWi, 2015). The revised RESA (2014) set binding targets, stating that cumulative installed capacity of offshore wind will amount to 6.5GW by 2020 and rising to 15GW by 2030, thus allowing the government to predict costs to the German consumer whilst providing a secure pipeline of projects for manufacturers, developers, operators and ports within the offshore wind market (BMWi, 2014; 2015). This form of policy realisation and market security within the offshore wind industry is what industrial actors (manufacturers, developers, operators and ports) within the UK offshore wind market are demanding (GWEC, 2016; Wind Europe, 2017a). In addition, the revised RESA (2014) introduced the 'acceleration model' aimed at offshore wind developers, providing initial financial support of 19.4 euro-cent per kWh for eight years instead of twelve depending upon distance from the coast and water depth (BMWi, 2014; 2015). Following this the 'basic rate' is paid for at least the first 12 years of operation (15.4-euro cent per kWh). The acceleration model applies to offshore wind projects (or 'plants') due to commence operation until the end of 2019 (BMWi, 2014; 2015).

The revised RESA (2017) stated new targets of adding 500MW of installed offshore wind capacity between 2021/22, 700MW per year between 2023 and 2025, and 840MW added per year from 2026 onwards (BMWi, 2016). The main factor underpinning the revised RESA (2017) is an auction process for offshore sites based upon releasing them for tender, thus pursuing a centralised framework similar to those implemented by the UK, Denmark and the Netherlands (BMWi, 2016). This auction process is underpinned by the market being able to deliver 15GW of installed capacity by 2030. The German government will examine various offshore sites to be auctioned for projects, enabling a process of 'dovetailing' with electricity grid connections (BMWi, 2016). The site auctions will take place on a 'transitional' basis amongst the offshore wind projects already in the planning stage until 2026 (BWMi, 2016). Furthermore, the new centralised framework in Germany allows the Federal Maritime and Hydrographic Agency (BSH) to undertake site surveying and grid connection activities, as opposed to offshore wind developers taking on substantial costs associated with these important planning and development activities (BWMi, 2016; Lema et al, 2014).

Importantly, the revisions made to the RESA policy framework by the German government aimed to provide an appropriate policy environment for various industrial actors (manufacturers, developers, operators and ports) to further support, enhance and expand the German offshore wind industry (BMWi, 2017; Martin, 2010). The German government established this through financially and politically supporting the development of costlier renewable energy technologies such as offshore wind, in order to develop a prominent, domestic offshore wind market within Europe (BMWi, 2015). Additionally, the renewable energy policies and funding mechanisms implemented by the German government has aimed to create new industrial paths for various German localities based upon the offshore wind industry (BMWi, 2017; 2015; 2014; Simmie et al, 2014). Germany's Energiwende policy regime and the historical revisions made to the RESA, reflects the co-ordinated market economy of Germany, whereby the role of the German government has been important in shaping the initial growth and development of the offshore wind market (Hall & Soskice, 2001; Stefes, 2016). However, the latest revision of the RESA in 2017 reflects an interesting regime change through implementing the new tendering and auction process, highlighting the liberalisation of the framework typically found in liberal market economies such as the UK (BMWi, 2016; Hall & Soskice, 2001).

Influencing Industrial Paths

Resulting from widespread critique of nuclear energy and oil crisis in the late 1970s, the German government and small-scale entrepreneurs focused efforts upon generating power from alternative (renewable) energy sources, mainly wind power (Bruns & Ohlhorst, 2011; IRENA, 2012). Following unsuccessful projects to fully launch wind energy technology on a national scale, the German government initially decided against pursuing onshore wind energy technology, despite some early small-scale success from entrepreneurs, innovators and enthusiasts (Bruns & Ohlhorst, 2011; IRENA, 2012). Government policy for the industrial and technological development of wind energy in Germany preceded the market support mechanisms implemented from the early 1990s onwards, as previously discussed (IRENA, 2012; BMWi, 2015). The earliest, although unsuccessful, state-led R&D programme named GROWIAN (Groß-Wind-Anlage, Large Scale Wind Turbine) was launched in 1976 aiming to establish world leading onshore wind technology and ended in the late 1980s due to unstable operation and considerable budgetary problems (Bruns & Ohlhorst, 2011).

However, the Federal Maritime and Hydrographic Agency (BSH) launched the Alpha Ventus research programme in 2001 in tandem with the launch of the RESO in 2000 to support the renewable energy market, which provided an offshore demonstrator site. Importantly, the Federal Offshore Wind Strategy (2002) forged a new policy phase for industrial development of Germany's offshore wind market, setting market objectives and strategies for future offshore wind development (Bruns & Ohlhorst, 2011; IRENA, 2012). The Federal Offshore Wind Strategy (2002) highlighted the importance and research output of the Alpha Ventus programme, which catalysed the establishment of the 'German Offshore Wind Energy Foundation' in 2005, a public-private body to oversee the Alpha Ventus programme and manage long-term R&D support (IRENA, 2012). The opening of the Alpha Ventus offshore test site in April 2010 underpinned a research initiative called 'Research at Alpha Ventus' (RAVE), which is based at the 'Fraunhofer Institute for Wind Energy and Energy Systems Technology' (IWES), aiming to connect R&D outputs to the broader development of Germany's offshore wind industry (IRENA, 2012; Hauser, 2014).

Alongside the federal government supporting the offshore wind industry, the Lander and municipalities also have different financial support instruments and resources (Schonberger & Reiche, 2016). For instance, the 'Land' (German state) can deliver valuable support for the offshore wind activities through providing specialised port infrastructure, which is typically publically owned by the state or municipality (Debrie et al, 2013; Verhoeven, 2010; Wind Europe, 2017a). Moreover, the Land can finance particular investments required by actors within the offshore wind industry, which can be used alongside funding from the EU and German development banks (Schonberger & Reiche, 2016). Finally, in regard to Germany's long-lasting R&D capacity in wind technology, research organisations such as 'ForWind' in Oldenburg, IWES in Bremerhaven and 'Deutsches Windenergie-Institut' in Wilhelmshaven have been (or are currently) dependent on funding provided by the Lander.

However, the initial limited growth of Germany's offshore wind market throughout the 2000s was underpinned by a range of complex industrial and technical challenges related to Germany's problematic coastal and physical settings (Bruns & Ohlhorst, 2011). Firstly, Germany's comparatively short North Sea and Baltic Sea coasts constrains the potential scale and scope for constructing offshore wind farms. Secondly, Germany confined its offshore wind projects to its 'Exclusive Economic Zone' (EEZ) meaning that developers and vessels had to negotiate rougher and deeper waters 12 nautical miles off its coast, in order to successfully install turbines and establish connection to Germany's national electricity grid. Underpinning this was the 'National Park' status of large areas of coastal land and waters, especially on the North Sea coast (Bruns & Ohlhorst, 2011). Consequently, a series of market, spatial planning and licensing policies were implemented throughout the 2000s and 2010s, including the RESA (2009) policy to increase the feed-in tariffs, to tackle these major technical problems, overcome financial barriers and enable the successful construction of offshore wind projects in German waters (Bruns & Ohlhorst, 2011; Markard & Petersen, 2009). Furthermore, the future outlook of Germany's offshore wind is positive in terms of installed capacity, with 23 projects shortlisted to compete for 3.1GW to be awarded in 2017/18 and ultimately delivered by 2025 (see Figure 4.7) (Wind Europe, 2017b).

Germany's current offshore wind industrial context contrasts to that of the UK, whereby there has been an industrial drive of offshore wind in Germany since the early 2000s, leading to a superior capacity for turbine manufacturing activities (Lema et al, 2014; BMWi, 2015). At present Germany is home to Europe's leading manufacturers and suppliers of offshore wind turbines, whereby approximately one third are manufacturing firms and two thirds provide installation, deployment and O&M services (Lema et al, 2014). Siemens is the world's largest manufacturer of offshore wind turbines, alongside Senvion, Adwen and MHI Vestas (Lema et al, 2014; BMWi, 2015; Wind Europe, 2017b). Turbine manufacturers based in Germany, in particular Siemens with a 67.8% market share across Europe, dominate the UK offshore wind market because of the absence of UK turbine manufacturers and component suppliers, which creates a market draw for German exporters of turbine components (OWIC, 2014; BWMI, 2015; Wind Europe, 2017b).

Pre-assembly and installation activities are carried out by transnational utility and engineering companies such as Siemens, Ørsted, Vattenfall and E.ON, alongside a range of SMEs carrying out a various interrelated installation and O&M activities (BMWi, 2015; The Crown Estate, 2010a). In resemblance to the UK offshore wind industry, transnational energy and engineering companies (in particular Ørsted and Siemens) are the dominant actors carrying out O&M activities for German offshore wind projects. In parallel with the functionality of O&M activities in the UK offshore wind industry, transnational utility and engineering companies conduct O&M activities alongside various project owners, (often subsidiaries of transnational companies), which also provide O&M services for individual projects (Lema et al, 2014; The Crown Estate, 2010).

As a result of the industrial context of Germany's offshore wind industry, the current geography of Germany's operational, consented and planned offshore wind farms are concentrated in the North Sea (Figure 4.8, Figure 4.9) (BMWi, 2015; Wind Europe, 2017b).

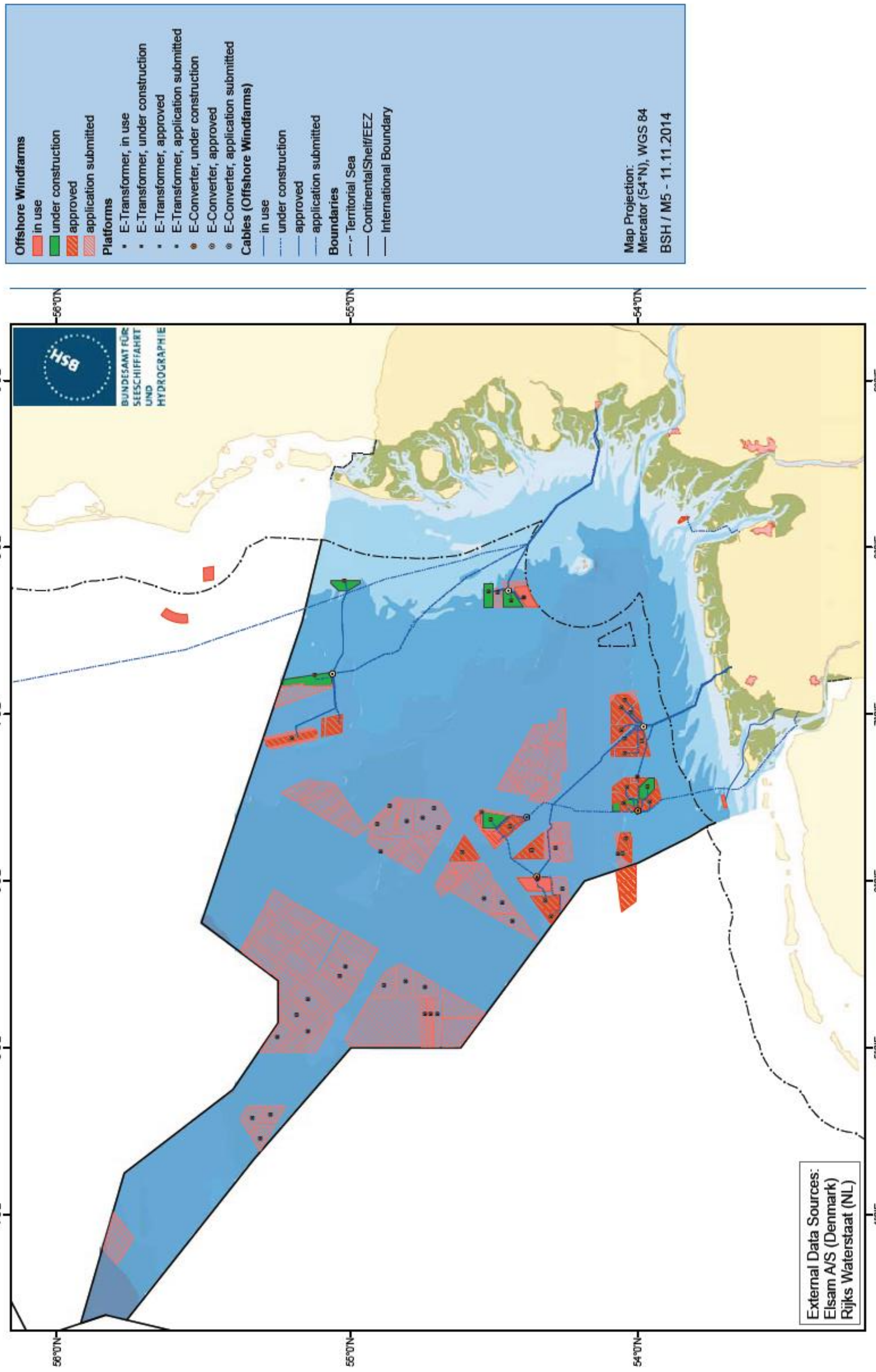


Figure 4.8: Germany's North Sea Offshore Wind Farms (November 2014)
Source: BMWi, 2015

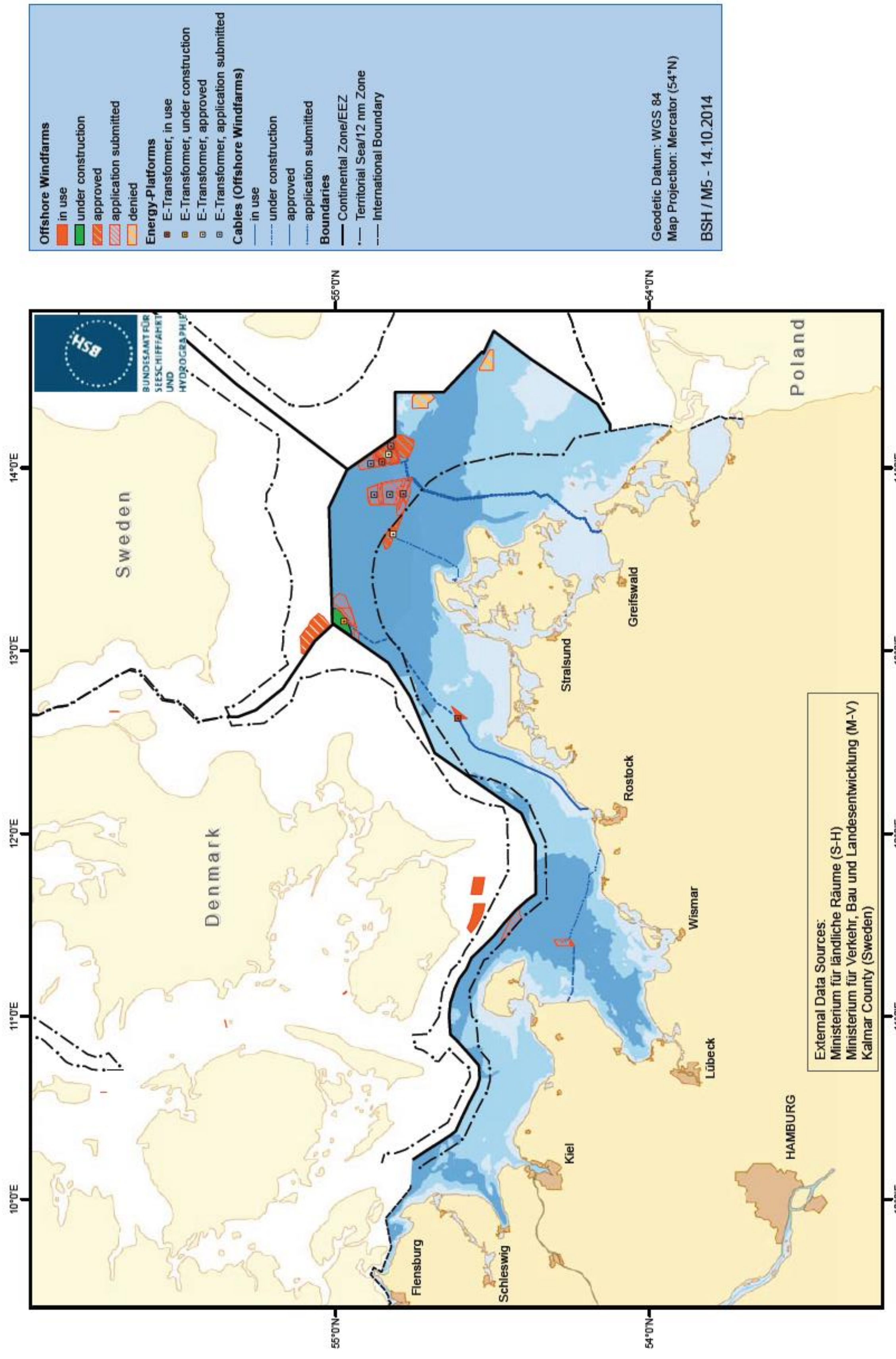


Figure 4.9: Germany's Baltic Sea Offshore Wind Farms (November 2014)
Source: BMWi, 2015

4.4 Project case studies

The chapter has revealed the UK and Germany to be important national cases in relation to investigating processes of port adaptation and diversification into Europe's bourgeoning offshore wind, which are clearly evident in both national cases (Notteboom, 2016; BVG Associates, 2016; BMWi, 2015). Within these two national cases, the thesis is exploring two comparative port cases on the sub-national scale, the 'Humber Ports' case and the 'Port of Cuxhaven' case. The research is focusing upon these two comparative port cases based upon important criteria which is outlined and justified in greater depth and detail within Chapter 3. To fully support the explanation and justification of the comparative port cases set out in Chapter 3, a more detailed context of the comparative port cases adapting and diversifying into offshore wind will now be outlined, in relation to the significance of the UK and Germany as prominent national cases within Europe.

4.4.1 Humber Ports Case

In relation to the context of ports and offshore wind in the UK, the Humber Ports case represents the most important example of UK ports adapting and diversifying into the UK offshore wind industry, especially through the examples of growing component manufacturing capacity at the Siemens blade manufacturing facility in the Port of Hull (PoH) and Ørsted's strengthening O&M base at the Port of Grimsby (PoG) (see Figure 4.3).

The Humber Ports case is comprised of the PoH and the PoG, which are currently owned and operated by Associated British Ports (ABP), operating as the UK's largest port operator (ABP, 2016). The Humber Ports case will now be referred to as the 'Humber Ports' for ease of this discussion. The Humber Ports are located on the River Humber on England's east coast, with the PoH on the north bank and the PoG on the south bank, the latter is located nearer to the mouth of the River Humber where it enters the North Sea. The Humber Ports (PoH and PoG) were previously publically owned and operated by the British Transport Docks Board until its privatisation in 1981, wherein their ownership and operation was fully transferred to ABP (Pettit, 2008). The port authority within the Humber Ports case, namely ABP, adopts a 'Anglo-Saxon' port governance model consisting of private ownership and operation, which distinctively contrasts with the port governance model at the Port of Cuxhaven (PoC), a

Hanseatic port governance model comprising public ownership and operation (Table 2.1) (Suykens & Van de Voorde, 1998; Verhoeven, 2010; ABP, 2016).

Importantly, the adaptation and diversification of the Humber Ports has enabled an heightened role and increased scale of O&M (Ørsted, Centrica, E.ON, Siemens, RES), installation and manufacturing activities (Siemens) to emerge at the Humber Ports (Figure 4.3; Table 3.1) (ABP, 2016b; Siemens, 2016a). Thus, the Humber Ports are involved in important offshore wind production networks principally through the activities of Siemens and Ørsted, which has enabled the Humber Ports to play an important port role in the offshore wind industry (Siemens, 2016a; Humber Business, 2016; Coe & Yeung, 2015). The Humber Ports first diversified into the offshore wind industry in 2007 when Centrica began constructing facilities to conduct O&M activities from the PoG, with O&M activities beginning in 2010 (BBC News, 2007; Wind Power Monthly, 2014; Table 3.1). The Humber Port's diversification into the offshore wind industry has been extended by the episodes of Siemens constructing its manufacturing facility at the PoH and subsequently producing turbine blades since late 2016, alongside Ørsted constructing its new O&M base at the PoG's 'Royal Dock' since 2016 (Siemens, 2016a; Humber Business, 2016).

4.4.2 Port of Cuxhaven Case

The PoC is located on Germany's North Sea coast at the mouth of the Elbe River. Operating as one of Germany's most important ports, the PoC is owned by the state of Lower Saxony and operated by Niedersachsen Ports GmbH & Co. KG, a publically owned port operator for all ports within Lower Saxony (Niedersachsen Ports, 2009; European Commission, 2016; BMVI; 2015). The PoC has been owned and operated by the State of Lower Saxony since the Second World War, and still operates as a port which is public owned and operated, thus adopting a 'Hanseatic' port governance model (Suykens & Van de Voorde, 1998; Verhoeven, 2010; European Commission, 2016). As previously mentioned, this port governance model and arrangement contrasts with that of the Humber Ports, which adopts an 'Anglo-Saxon' port governance model comprised of private ownership and operation (Table 2.1) (Suykens & Van de Voorde, 1998; Verhoeven, 2010; ABP, 2016).

In connection to the context of Germany's ports and offshore industry, the PoC is a leading port involved within the offshore wind industry with its dedicated infrastructural, individual and material asset base at the Offshore Base Cuxhaven (OBC) (GTAi, 2017; AfW Cuxhaven, 2018a; 2018f; 2018g). However, in comparison to the Humber Ports case, the PoC is one of many German ports providing reputable bases to accommodate and support Germany's offshore wind industry through a range of port-related activities (Figure 4.6) (GTAi, 2017; BMVI, 2016; BMWi, 2015). The PoC has adapted and diversified its infrastructural asset base over time to create a significant role and scale of offshore wind in port's business portfolio (AfW Cuxhaven, 2018a; 2018f; 2018g). The scale of offshore wind within the PoC's business portfolio is relatively similar to the Humber Ports case, with O&M firms (Offshore Marine Management), alongside installation and manufacturing firms (Siemens, AMBAU) all evident at the Port of Cuxhaven. However, the PoC's has slightly greater turbine manufacturing capacity than the Humber Ports case with the turbine foundation and monopile manufacturing capabilities of AMBAU (GTAi, 2017). Essentially, these firms and the offshore wind activities they conduct has enabled the PoC to play important roles in the offshore wind industry, thus paralleling the roles of the Humber Ports case in the offshore wind industry. Furthermore, the PoC is plugged into similar offshore wind production network as the Humber Ports case (Coe & Yeung, 2015). This is made evident by the Siemens nacelle manufacturing facility at the PoC producing and assembling turbine components which are then transported to the Siemens blade manufacturing facility at the PoH for additional assembly activities (Siemens, 2016a; 2016b). In contrast to the Humber Ports case, the PoC first diversified into offshore wind when it began constructing heavy duty platform in 2006 (completed 2008) for offshore wind installation and O&M activities, which was then supported by a dedicated offshore terminal for manufacturing, installation and O&M activities (Offshore Terminal I) from 2007 (completed 2009) (Offshore Base Cuxhaven, 2017b; AfW Cuxhaven, 2018a). Additionally, and in contrast to the Humber Ports case, the PoC has adapted and added a greater amount of infrastructural assets and facilities including the 'Offshore Terminal II' in 2009 (completed 2012), dedicated commercial and industrial areas for offshore wind activities in 2014, and the Siemens nacelle manufacturing facility in 2016 (completed 2017) (Offshore Base Cuxhaven, 2017b; AfW Cuxhaven, 2018a).

4.5 Conclusion

In conclusion, German ports adapted and diversified to increase their capacity to support the industrial drive of offshore wind in Germany since the early 2000s, as German energy and engineering firms required port facilities to support the export of turbine components to overseas markets such as the UK, who created a market draw (BMWi, 2015; BMVI, 2017; Wind Europe, 2017a). Moreover, German ports may not have developed the appropriate industrial functions, capacity, infrastructural assets and facilities if the offshore wind industry was not driven as strongly and effectively as it was (BMWi, 2015). Therefore, the industrial and market requirements of ports can vary between countries depending upon the demands placed upon them by the offshore wind industry (Wind Europe, 2017a; 2017b). Essentially, both UK and German ports were responding to the demand of the offshore wind industry and the creation of a new market (Wind Europe, 2017a; 2017b). In parallel with the UK port governance context, German port authorities are important in shaping and instigating port diversification, in order to seize new and emerging market opportunities (Debrie et al, 2013; Notteboom, 2016; Jacobs & Notteboom, 2011).

This chapter has outlined and explained the interrelated and multiscalar historical, political, market, policy and governance arrangements underpinning each comparative port case study and the broader institutional environments in the UK and Germany, which enables and constrains the port adaptation process (Martin, 2000; 2010). Firstly, the chapter discussed the evolution of ports, concentrating upon the governance and market contexts connected to the adaptation of UK and German ports operating within the broader European port environment. Secondly, the chapter examined the evolution of the offshore wind industry which fundamentally drove the adaptation and diversification of ports into offshore wind within the European context, by creating a range of industrial and market opportunities. Interrelated to the ports discussion, the chapter explored the market creation and industry contexts influencing the evolution and current arrangement of the UK and German offshore wind industry. Importantly, the chapter uncovered the UK and Germany as prominent national cases for investigating port adaptation and diversification into offshore wind activities (Notteboom, 2016; Jacobs & Notteboom, 2011; Wind Europe, 2017b). Lastly, the chapter considered and outlined the context of the project's two comparative cases, which was informed by uncovering the national port and offshore wind settings of UK and

Germany. The Humber Ports case (the Port of Hull and the Port of Grimsby) in the UK and the Port of Cuxhaven case in Germany will be described, explained and their selection justified in Chapter 3.

Chapter 5 Port of Cuxhaven case: adaptation and diversification into offshore wind

5.1 Introduction

This chapter explores the evolution and adaptation of the PoC (Port of Cuxhaven) into offshore wind and is framed by the analytical framework (see Figure 2.4). The PoC's adaptation and diversification was undertaken to achieve a distinctive goal and serve a new purpose as a port, which was to support and create a new regional path around the offshore wind industry. This chapter is structured by key causal episodes, which enables a clear and more advanced understanding of the PoC's temporal evolution, adaptation and diversification into offshore wind (Figure 5.1). Each episode is made up of a number of elements, highlighting distinctive phases of port adaptation which stimulate and support the regional path creation process (Figure 5.1). These elements are organised around port diversification and modes of investment, which enable and stimulate processes of port adaptation and subsequent regional path creation around the offshore wind industry. These modes of investment include conversion and expansion, which drive and shape the physical construction of port assets upon 'brownfield' port land and 'greenfield' port land (see Figure 2.4). The chapter analyses how key firm and non-firm actors shaped and drove distinctive modes of investment to enable the valorisation of infrastructural and material assets, alongside how these modes of investment and activities were shaped and influenced by particular port governance and ownership arrangements and multiscalar institutional environments (see Figure 2.4).

The chapter begins with the preformation and planning stage of the PoC's adaptation and diversification between 2003 - 2005, which originally catalysed a new growth path into offshore wind. This first episode encompasses the Offshore Master Plan's design and launch underpinned by a long-term strategic vision which was key in attracting and enabling the demonstration effect of a test turbine field. It reveals how the PoC's change of governance arrangements, served to heighten the importance of offshore wind within PoC's business portfolio and prioritised state-led investment for the expansion of port infrastructure to attract new firms to realise the Offshore Master Plan's long-term vision. The chapter then discusses the early growth and expansion of the PoC between 2006 - 2012. This second episode is centred around the physical construction of a new infrastructure base on brownfield and greenfield land for attracting new manufacturing and pre-assembly offshore wind activities, supporting a new regional path around the offshore wind industry. This was driven by a number of phased construction projects, which were underpinned by a series of proactive and reactive investments for the expansion of infrastructure. The third episode then moves to 2011, as the PoC endured an episode of disinvestment and uncertainty between 2011 - 2014, marking a stark contrast to the previous episodes of diversification and expansion. This third episode discusses the reduction of O&M and manufacturing activities at the PoC through the disinvestments of three different firms, namely OMM (Offshore Marine Management), STRABAG and CSC (Cuxhaven Steel Construction). The final and fourth episode explores how the PoC experienced an episode of revival and renewed expansion from 2014 onwards, caused and driven by previous episodes, and shifting from a phase of disinvestment and uncertainty. This includes the transplantation of Siemens and its suppliers into the PoC, AMBAU's acquisition of CSC's former assets and the further construction of the Offshore Terminal 2.

Figure 5.1: Port of Cuxhaven four causal episodes
Source: Author's own work

5.2 Preformation and planning: 2003-2005

This preformation and planning episode draws attention to key actors identifying the novelty of offshore wind and emphasising the future of offshore wind in Germany which was yet to form. This was primarily enabled a long-term port strategy designed to capitalise upon the embryonic Germany offshore wind industry. Few North Sea ports had identified and subsequently changed governance settings to take full advantage of job creation and investment opportunities. As such, this episode involved the Niedersachsen government, the

AfW and later Niedersachsen Ports (NPorts) strategically identifying how the port's business portfolio and the pre-existing asset base could be diversified to support the offshore wind industry, through entrepreneurial state-led investments for the expansion of port infrastructure to support offshore wind activities (Notteboom, 2016; Figure 2.4). This process was catalysed by the PoC's shift in governance and ownership arrangements, allowing NPorts as the new port authority to utilise greater decision-making powers, responsibilities, resources and new individuals to heighten the importance of offshore wind within its business portfolio and make future infrastructure investments in a more entrepreneurial manner (Verhoeven, 2010; Notteboom, 2016). This episode is made up of three elements, namely the PoC's forming new port vision for offshore wind, the construction of test turbines demonstrating the market potential of offshore wind and the PoC's strategic governance change.

5.2.1 New vision for port diversification into offshore wind: 2003

The first element within the episode of the PoC's adaptation and diversification into offshore wind ultimately enabled the transplantation of new firms and investment from non-firm actors, which drove the new valorisation of infrastructural, material and industrial assets upon brownfield and greenfield land (Notteboom, 2016; Maskell & Malmberg, 1999).

The AfW (Economic Development Agency of Cuxhaven), the City of Cuxhaven, Niedersachsen Bank (as the organiser of government grants and loans), and the State of Niedersachsen (from now referred to as 'Niedersachsen' and/or the 'Niedersachsen government') through the 'Ports and Shipping Administration of the State of Lower Saxony' (PSALS), were a coalition of actors aiming to provide the PoC with a new purpose through diversifying the port's business portfolio and asset base into offshore wind (Wood, 1999; Cox, 1998; Martin & Sunley, 2006; AfW Cuxhaven, 2017). The coalition of actors had a common strategic and material interest in the PoC, aiming to create economic opportunities, jobs and industrial growth (Wood, 1999; Cox, 1998; AfW Cuxhaven, 2017). The coalition formed in the early 2000s around the formation of an 'Offshore Master Plan' (OMP) in 2003 (AfW Cuxhaven, 2017; 2018a). The coalition of actors only comprises state-owned public bodies with a common long-term vision relating to creating new jobs and economic opportunities, whilst operating and directing the PoC like a landlord through the devolution of decision-making power, responsibilities and resources to the port authority of the PoC (Mazzucato, 2013; Brooks & Cullinane, 2007b; Baltazar & Brooks, 2007; Wood, 1999; Cox, 1998). This coalition of actors worked jointly and grew closer over time as they worked around phased infrastructure construction projects and investments (AfW Cuxhaven, 2017; 2018a). However, the formation of this coalition of actors and the OMP was influenced by previous decisions and strategic actions taken by other Lander and Niedersachsen regarding the Port of Wilhelmshaven's future development (JadeWeserPort, 2018).

In the early 2000s, the Lander of Hamburg, Bremen and Lower Saxony, alongside the Wilhelmshaven Port Management Association who conducted market analysis and feasibility studies of the container market in 1998 and 2000, realised that container vessels were growing in scale and container traffic to the Port of Hamburg would be limited due to the River Elbe's physical size (JadeWeserPort, 2018; Senior Executive interview, Cuxport). Port officials and politicians from the State of Hamburg informed Niedersachsen and the State of Bremen about the new demand for a deepwater terminal to handle larger container vessels and future traffic (JadeWeserPort, 2018; Senior Executive interview, Cuxport). Cuxhaven and Wilhelmshaven were considered, and the "States of Lower Saxony and Bremen had to make up their mind, and the decision was in favour of Wilhelmshaven for a number of reasons" (Senior Executive, Cuxport). Consequently, Niedersachsen realised they had "to convince a new market that it was serious…to develop the PoC", which was further driven by pressure from the AfW to create a new economic future for the PoC (Senior Executive, Cuxport; Cuxhavener Nachrichten, 2009a; AfW Cuxhaven, 2017). Therefore, a vision for the PoC's diversification into the offshore wind market emerged in response to Niedersachsen's decision to award the Port of Wilhelmshaven with investment for a new deepwater container terminal, in the form of an Offshore Master Plan (OMP) (JadeWeserPort, 2018; Notteboom, 2016; AfW Cuxhaven, 2017; Niedersachsen, 2003):

> "The Offshore Master Plan was based upon the decision that the state promised us to develop a base for offshore wind at Cuxhaven. This was the key reason the OMP started " Former Senior Director, former AfW.

The OMP was important in establishing a new long-term port vision for the PoC and for creating a new industrial path for Cuxhaven, which catalysed future port adaptation and diversification into offshore wind (Notteboom, 2016; AfW Cuxhaven, 2017):

> “In the early 2000s the offshore wind came about and the state government, the city government and the port decided that Cuxhaven should be developed as an offshore base…because Cuxhaven was a very poor region economically and needed new economic life” Senior Executive, Cuxport.

Subject	**Aims**
New port concept	• Port of Cuxhaven development for production of components, and the assembly and the shipment of offshore wind turbines.
Heavy-load platform	• Platform for handling extremely heavy components up to 500 tons will be set up at the eastern end of the existing Cuxport terminal. • A heavy crawler crane and heavy load road required for transporting individual heavy components.
Expansion of further berth (now known as Offshore Terminal 1)	• The heavy-duty platform may be supplemented by a second berth. • A second heavy-duty berth can be used by heavy equipment.
Industrial and commercial area (B110)	• In the first phase of construction 20ha will be developed. (50ha would ultimately be constructed). • New construction of infrastructure to support companies seeking to manufacture and assemble turbine components.
Location for test turbines	• Designation of five development location for the erection of prototype test turbines, which should be marketed to turbine manufacturers.
Financing of port development	• State of Lower Saxony will make the necessary financial preparations and investments.
Implementation (2003)	• The expansion plans for the five prototype locations are available and expansion can begin at the same time as the firm allocation. • In a second step, the heavy-duty platform and road and should be realised according to future market demand. • The expansion of the terminal via a heavy-duty road to a second heavy-duty platform (now known as Offshore Terminal 1).
Future vision	• Cuxhaven offers an excellent base for the future market of offshore wind energy. • The consistent expansion of the offshore base will provide new economic impetus and will bring sustainable growth and more employment to Cuxhaven.

Future steps	• Further assembly and storage areas will be built behind the second heavy-duty platform and around the 'Baumronne tributary'. • The remaining areas (25 ha) of the industrial park B110 will be developed.

Table 5.1: Content summary of the Offshore Master Plan
Source: Niedersachsen, 2003

A key factor which enabled the decision to diversify into offshore wind was the pressure of inter-port competition in Northern Germany and has been acknowledged as a key issue for Germany's ports sector by the Federal government (Senior Academic Advisor, BMVI; BMVI, 2016). The PoC operated as a short-sea multipurpose port serving a range of port markets including fishing, automobile handling, containers, bulk cargo, Ro/Ro (Roll-on/Roll-off) and heavy-load cargo (steel and forest products) (Cuxport, 2017b). Consequently, it was in direct competition with other ports internationally and neighbouring ports in Northern Germany. Following the decision to grant investment for a new container terminal at the Port of Wilhelmshaven, lobbying and political pressure by key individuals in Cuxhaven, Niedersachsen realised that it needed to provide state-led investment for the expansion of port infrastructure at PoC (Manager interview, NPorts). Therefore, Niedersachsen put the PoC at the forefront of their ports portfolio to foster its diversification into offshore wind and to compete on a larger scale in these port markets in the future (Senior Director interview, Cuxport; Cuxhavener Nachrichten, 2009a, AfW Cuxhaven 2017; Notteboom, 2016). Subsequently, the 'OMP' was developed through the coalition of actors (AfW, City of Cuxhaven, Niedersachsen and NPorts) with the common strategic goal of utilising the PoC as a key infrastructural asset base for offshore wind (AfW Cuxhaven, 2017; Maskell & Malmberg, 1999). This was realised by these actors undertaking market research internally and utilising important strategic ideas from a dynamic individual within the AfW, who was previously working at the State of Bremen (Senior Director interview, Cuxport; AfW Cuxhaven, 2017).

The Niedersachsen government had overall ownership and control of the PoC in 2003, including operations, management, investment, development and planning (Brooks & Cullinane, 2007; World Bank, 2016). Hence, Niedersachsen had the necessary oversight over the PoC's functionality, development and management to instigate the strategic change of direction through diversifying the port's business portfolio and asset base (Martin & Sunley, 2006; Maskell & Malmberg, 1999; Notteboom, 2016). However, Cuxhaven lacked available land and infrastructure to stimulate new economic activities and regional path creation in offshore wind (Senior Financial Officer interview, Niedersachsen Bank; Maskell & Malmberg, 1999; Martin, 2010). As a result, the AfW and the City of Cuxhaven regularly met with Niedersachsen and exerted pressure upon the high-level officials at Niedersachsen to take continuous action on behalf of Cuxhaven.

Actions of the coalition also evolved as a strategic response to the new national-level Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz) or 'RESA' which was passed in 2000 (BMWi, 2015; Stefes, 2016). This RESA was an instrumental national-level framework which created an enabling market climate for local non-firm actors to take risks and attract turbine manufacturers, by setting clear installed capacity targets and feed-in-tariffs for developers (Martin, 2010; BMWi, 2015; Stefes, 2016). The RESA set a fixed price for offshore wind developers to alleviate the impact of decreasing energy prices within Germany's energy market, underpinned by market incentives (feed-in-tariffs and installed capacity targets) for offshore wind developers and manufacturers (Wüstenhagen & Bilharz, 2006; Stefes, 2016). Ultimately, Niedersachsen realised that Germany's offshore wind industry would eventually form and grow due to increased project development and orders from developers, leading to the escalating activity of manufacturers, thus driving the long-term vision underpinning the 'OMP' (Martin, 2010; AfW Cuxhaven, 2017; Wüstenhagen & Bilharz, 2006; Stefes, 2016):

> "Yes, we definitely reacted to it [RESA] and we decided to develop Cuxhaven as a base for the offshore wind industry" Senior Officer, Niedersachsen.

However, following the launch of this new vision and strategy for the PoC, its realisation still required decisive inward investment from pioneering firms within the early German offshore wind industry (AfW Cuxhaven, 2017).

5.2.2 Demonstration effect of test turbines: 2004-2005

The PoC catalysed an important demonstration effect by exhibiting a new renewable technology, the Offshore Master Plan's (OMP) long-term vision and the port's assets and capacity to the German offshore wind market (Niedersachsen, 2003; AfW Cuxhaven, 2017)

The erection of test turbines demonstrated that an offshore wind related project could be managed and implemented at the PoC (AfW Cuxhaven, 2017). The erection of the offshore test turbines marketed the PoC as a key port site and physical location for offshore wind firms in the German offshore wind industry. The PSALS (Ports and Shipping Administration of the State of Lower Saxony), Niedersachsen Bank, AfW and the City of Cuxhaven marketed a large greenfield area adjacent to Cuxport as a potential site for offshore wind turbine testing and development (Niedersachsen, 2003). These state and local actors were willing to work with firms to decide what physical form an offshore wind development or activity on the port site would take (Niedersachsen, 2003; AfW Cuxhaven, 2017).

The PoC's public land ownership situation highlights the governance and ownership complexities of a port adopting the Hanseatic port governance model, as Niedersachsen was the majority landowner and the City of Cuxhaven also owned land within the port limits in 2004 (Table 2.1; Suykens & Van de Voorde, 1998; Verhoeven, 2010; AfW Cuxhaven 2017). The public ownership of port land by state and local non-firm actors provides a common basis and rationale for adapting infrastructure through a long-term investment strategy, evident in the OMP (Niedersachsen, 2003; AfW Cuxhaven, 2017). Essentially, the City of Cuxhaven was strongly involved in the diversification of the PoC from the outset due to owning areas of land within the PoC, whilst working alongside the PSALS and AfW to configure and launch the 'OMP' (Verhoeven, 2010; AfW Cuxhaven, 2017). Consequently, the City of Cuxhaven created the opportunity for turbine manufacturers (Enercon, REpower/Senvion, DeWind/DSME) to erect and test 5 turbines who were actively seeking port sites (AfW Cuxhaven, 2017):

> "…the idea behind the turbines was that we [offshore wind industry] did not have proven technology. So we needed test turbines. But you need space to build them. Then the City of Cuxhaven gave the opportunity for turbines developers to erect them here [PoC]" Manager, NPorts.

The German offshore wind industry was in its early stages in 2004/5 and a range of onshore turbine manufacturers were looking at how they could capitalise upon a future offshore wind market, which was being created by the RESA as a critical national-level framework (Martin, 2010; Wüstenhagen & Bilharz, 2006; Stefes, 2016). Enercon, REpower/Senvion and

DeWind/DSME accepted the City of Cuxhaven's invitation to test their prototype offshore turbine technology for reliability and performance, in order to convince potential offshore wind developers to place orders for their components (AfW Cuxhaven, 2017). However, there was uncertainty from the manufacturing firms and the state and local government organisations regarding their physical longevity, as manufacturers were given a timescale of 15 years "but 15 years could have been too long for the manufacturers, nobody knew" Senior Financial Officer, Niedersachsen Bank. Nevertheless, the demonstration effect helped the PoC's market profile and elevated its presence as a key site and location within the German offshore wind industry:

> "They [City of Cuxhaven] gave land to some big companies to build up test turbines. It was not only good marketing, but it was also a good approach, it showed the offshore wind market anything was possible at the port" Senior Director, Cuxport.

Before the PoC could fully harness the demonstration effect, changes to the PoC's governance served to alter its evolution and adaptation from 2005 onwards by further establishing and expanding its business portfolio in offshore wind, reflecting the PoC's growing interest in Germany's offshore wind market (AfW Cuxhaven, 2017; Niedersachsen Ports, 2017).

5.2.3 Change of governance and consolidation of port vision: 2005

In 2005, the PoC underwent a fundamental change of governance and management and began to operate more like an arms-length public body, thus creating more operational autonomy for the new port authority (Debrie et al, 2013; Verhoeven, 2010). This change of governance was driven by Niedersachsen (State of Lower Saxony) as the key actor aiming to create a new port authority to operate as a vehicle for spending public money and accessing EU funding. Niedersachsen understood that the European Commission had grant programmes such as the ERDF which could be better accessed if they formally established a publically-owned, arms-length public body, as the European Commission preferred to transfer funds directly to these types of companies (Manager, NPorts). Furthermore, Niedersachsen also realised through internal research that the European Commission was looking deeper into port competition rules and spending public money on new port developments, therefore if Niedersachsen "formed a 'private' port company, at least in practice… it could at least partly spend state money with no notification to the European Commission" Senior Policy Officer, BMVI. The change of governance formed a public port governance structure operating state-wide, with the main headquarters in Oldenburg and devolved branch offices across six ports which are also responsible for managing island supply ports, typical of a Hanseatic port governance model (Manager interview, NPorts; Verhoeven, 2010; Suykens & Van de Voorde, 1998; Table 2.1).

On January 1st, 2005 Niedersachsen Ports (NPorts) was founded as a public port infrastructure company responsible for the 15 ports of Niedersachsen (Niedersachsen Ports, 2017). Many of the core activities previously carried out by the Ports and Shipping Administration of the State of Lower Saxony (PSALS) were transferred to NPorts' headquarters in Oldenburg and to a separate NPorts office in Cuxhaven (Niedersachsen Ports, 2017; Niedersachsen, 2016). These included the development, construction and maintenance of port infrastructure, the strategic planning and designing of the PoC's future development and marketing of the port's physical asset base (Niedersachsen Ports, 2017; Niedersachsen, 2016). Therefore, despite having a large degree of autonomy, NPorts Cuxhaven was now part of a wider corporate group of NPorts (Niedersachsen Ports, 2017; Niedersachsen, 2016). Niedersachsen is responsible for making strategic decisions regarding the governance, future market direction and capacity of their ports in Lower Saxony, reflecting activities of a port owner within the Hanseatic Port governance model (Suykens & Van de Voorde, 1998, Brooks & Cullinane, 2007b; Table 2.1).

However, there was a range of rationale and effects of Niedersachsen's policy to alter their ports and to form a new arms-length public port authority for the PoC within a wider corporate group of NPorts. Niedersachsen wanted its ports to lessen their 'dependence upon state money' for infrastructure investments, whilst enabling their ports to have a greater ability to access EU funding and borrow from private banks to invest into new port infrastructure, thus becoming more financially efficient (Senior Officer interview, Niedersachsen,). Niedersachsen realised that a new arms-length port authority would have a greater ability to receive and spend grant funding from the European Union (ERDF) as it was essentially a publically-owned private company, thus avoiding strict State Aid restrictions and consequently heightening the PoC's ability to adapt and diversify (Senior

Policy Officer interview, BMVI; Niedersachsen Ports; European Commission, 2014; Pike et al, 2010).

This important decision made by Niedersachsen proved to be successful as NPorts was since awarded substantial amounts of EU funding from 2005, enabling NPorts in Cuxhaven to make key investments for converting and building new infrastructure (AfW Cuxhaven, 2018c). On a broader scale, other German State governments such as Bremen and Hamburg were changing their ports into arms-length public ports, realising the EU was “going to look deeper into port competition questions” (Senior Policy Officer interview, BMVI). Therefore, Niedersachsen wanted to follow this trend and remain competitive by altering the governance of their ports (Niedersachsen, 2009). The PoC was now organised to receive and utilise state and EU (ERDF) grants, alongside private finance, to invest into port infrastructure more effectively and with less spending restrictions from the EU (Senior Policy Officer interview, BMVI). Therefore, this shift and change of the PoC’s governance structure and arrangement served to underpin and facilitate the diversification into offshore wind but remained intrinsically shaped by the national and supra-national government organisations (Martin, 2010; Debrie et al, 2013; Brooks & Cullinane, 2007b; Notteboom, 2016).

NPorts wanted to employ new industry specialists from the private sector “with greater experience” and knowledge of the ports sector and other related sectors, such as offshore wind, to catalyse the PoC’s diversification (Manager interview, NPorts). This drove NPorts in Cuxhaven to be a more commercially-led and flexible port authority by shifting the port’s mission, market portfolio and infrastructural asset base towards supporting offshore wind, rather than simply operating as a bureaucratic administrative body of Niedersachsen which was content with upholding traditional port activities (Debrie et al, 2013; Brooks & Pallis, 2017; Notteboom, 2016). Thus, the change to a devolved structure of NPorts enabled a new shift in responsibility, power and resources (human and financial) from the state to the local level, which altered the overall entrepreneurial management, mission and vision of the PoC (Debrie et al, 2013; Jacobs & Notteboom, 2011).

> “…they [NPorts] actually have the self-understanding of ‘we need to do something to boost the local or regional economy through developing the port and so forth’. It really depends on the mission given to whatever port authority is given the

> responsibility [from Niedersachsen] and their own individual drive" Senior Director, ZDS.

This transfer of power, responsibility and financial resources to an arms-length public port authority with a dedicated local office, meant that NPorts could work jointly and more closely with AfW and the City of Cuxhaven, as it had new individuals with expertise in port development for offshore energy and greater power and resources to do so (Debrie et al, 2013; Baltazar & Brooks, 2007). At key moment of the PoC's adaptation, the AfW and the City of Cuxhaven have put necessary pressure upon NPorts and Niedersachsen to make important decisions to provide investment, diversify and build new infrastructural assets (Maskell & Malmberg, 1999).

Although power, responsibility and financial resources were devolved from the state level to various port offices, the Niedersachsen government was still the owner of NPorts (Niedersachsen Ports, 2009). In relation to this devolution of power, responsibility and financial resources, Niedersachsen had ultimate control over the overall direction of its ports and final say on important decisions regarding investment provision and infrastructure adaptation, typical of a Hanseatic port governance model (Debrie et al, 2013; World Bank, 2016; Suykens & Van de Voorde, 1998; Table 2.1). Therefore, Niedersachsen began to work with NPorts to strategically consolidate and reinforce its broader mission and vision to diversify into offshore wind:

> "They were very involved in the development, the state really wanted offshore wind to happen at the port… the politicians said, 'we want this development to happen'. The state said to NPorts 'we want you to invest your money to support offshore wind'" Former Senior Director, former AfW.

This was a crucial element of the episode in shaping the PoC's adaptation and diversification into offshore wind and stimulating regional path creation process (Notteboom, 2016; Martin, 2010; Figure 2.4). Moreover, this element of the episode catalysed the diversification of the PoC into offshore wind as it enabled the consolidation and reinforcement of the Offshore Master Plan (OMP) through a change of governance structure and arrangement (AfW Cuxhaven, 2017; Debrie et al, 2013; Notteboom, 2016). The OMP indicated that offshore wind was the key industry to diversify into and prompted the PoC to concentrate upon diversifying its business portfolio and asset base to support offshore wind activities (AfW Cuxhaven, 2017; Notteboom, 2016; Maskell & Malmberg, 1999). However, to enable the overall adaption and diversification of the PoC into offshore wind, state-led investments for the expansion of new large-scale infrastructure on greenfield land and the transplantation of offshore wind firms, were critical.

5.3 Emergence and growth: 2006-2012

The erection of the test turbines produced a fundamental demonstration effect upon the German offshore wind market, seizing the interest of key firms and shaping this episode of adaptation and diversification. This demonstration effect highlighted the novelty and market potential of offshore wind and consequently drove the new construction of port infrastructure (docks, quays and adjacent quayside areas, berths and Ro/Ro ramps forming the port's physical platform) and superstructure (buildings, facilities, warehouses and cranage built above and fixed onto the infrastructure), by firm transplantation and state-led investments for the expansion of infrastructure on greenfield land (Jacobs & Lagendijk, 2014; Maskell & Malmberg, 1999; Martin & Sunley, 2006).

This episode highlights the importance of investments for infrastructure expansion, largely provided by the Niedersachsen government as the long-term owner of NPorts, and the power, responsibilities and financial resources of NPorts to take proactive entrepreneurial risks, in order to attract new offshore wind firms. This episode is around the PoC establishing an infrastructural base to attract future investment to help stimulate the creation of the regional offshore wind path. Ultimately, new manufacturing and pre-assembly activities at the heavy-load platform, industrial and commercial areas, the Offshore Terminal 1 (OT1) and Offshore Terminal 2 (OT2) underpinned the PoC's adaptation and diversification, thus stimulating a regional path creation process around the offshore wind industry (Martin, 2010; Jacobs & Notteboom, 2011; Notteboom, 2016). The new regional path creation process is clearly visible in new and increased employment within the offshore wind industry at the PoC through the transplantation of new manufacturing firms and the steady growth of local and regional offshore wind supply networks connected to new firms within the PoC (Martin, 2010; Dawley, 2014). This episode was made up of two elements of phased infrastructure projects to support offshore wind activities, namely the construction of the heavy-load platform and the valorisation of new quayside infrastructure through a series of phased projects (Offshore Terminal 1, Offshore Terminal 2, Industrial and Commercial Areas), in order to support offshore wind activities.

5.3.1 A market statement: converting the heavy-load platform (2006-2007)

The first element within this episode is around the construction of pre-existing infrastructural and material assets on brownfield land (Boas, 2007; Martin, 2010; Maskell & Malmberg 1999). The City of Cuxhaven, AfW and NPorts aimed to make a large statement to the German offshore wind market to attract new offshore wind firms and inward investment. The City of Cuxhaven provided a ‘proactive’ €7.5M investment for converting infrastructure and superstructure, through a proactive strategy expressed within the Offshore Master Plan (OMP) (Niedersachsen, 2003; AfW Cuxhaven, 2018c; 2017; Monios & Wilmsmeier, 2016). Furthermore, the construction of the heavy-load platform was also enabled by Niedersachsen and the EU jointly providing a €6.8M grant to support the construction activities (AfW Cuxhaven, 2018c).

The heavy-load platform and heavy-lift cranage located at the Cuxport multipurpose terminal has been used for the onshore assembly turbines, following its completion in 2007 (AfW Cuxhaven 2018b). In order to obtain these key infrastructural and material assets, pre-existing infrastructure needed to be converted for new usage (Maskell & Malmberg, 1999; Martin, 2010; Boas, 2007). Previously there was a quayside area, a quay wall and cranage only equipped for handling and storing general cargo and containers (Cuxport, 2007). Therefore, these assets required state-led investment to be converted into a heavy-load platform with cranage, which formed attractive port assets for the offshore wind market at this time (Senior Executive interview, Cuxport; Maskell & Malmberg, 1999; Martin, 2010; Boas, 2007).

There was a “gold fever” emanating from offshore wind developers in the mid-2000s (Senior Researcher interview, University of Bremen). This influenced a ‘proactive’ investment by the City of Cuxhaven for infrastructure expansion, supported by EU and Niedersachsen government grants (Monios & Wilmsmeier, 2016; AfW Cuxhaven, 2017). The growing interest, or “gold fever”, coming from developers and non-firm actors was catalysed by the

‘Infrastructure Planning Acceleration Act’ (Gesetz zur Beschleunigung von Planungsverfahren für Infrastrukturvorhaben) implemented in 2006 (Former Senior Director interview, former AfW). This designated TenneT as the transmission system operator responsible for the German North Sea and establishing grid connections, thus taking the responsibility and cost away from developers, whilst accelerating planning and licencing proceedings (Kuhne, 2012; Wong, 2010; Federal Law Gazette, 2006).

The heavy-load platform was a very important marketing tool which subsequently convinced a range of offshore wind manufacturers and developers that the PoC could support offshore wind activities (Former Senior Director interview, former AfW). Ultimately, this new market presence with the heavy-load platform catalysed future state-led investments for the expansion of new port infrastructure on greenfield land for new firms (Notteboom, 2016; Maskell & Malmberg, 1999; AfW Cuxhaven, 2018a).

5.3.2 Establishing new infrastructure to attract future investment (2006 – 2012)

This element of the episode is around the new construction of an infrastructural base by NPorts, Niedersachsen, Cuxhaven and the Cuxhaven Port Development Company (CPDC), which was fundamental to the PoC’s adaptation and diversification to support a new regional offshore wind path (Maskell & Malmberg, 1999; Jacobs & Notteboom, 2011; Notteboom, 2016). The series of state-led investments into the new infrastructural base reflects the ability and financial capacity of NPorts and the CPDC to take entrepreneurial risks using public finance, private bank loans and grants. Importantly, NPorts and the Niedersachsen and Cuxhaven governments deemed constructing new port infrastructure as essential for attracting new firms and future investment.

The construction of new industrial and commercial areas provided a new industrial platform to encourage new offshore wind firms to provide investment for superstructure and catalysed their transplantation (Maskell & Malmberg, 1999; Martin & Sunley, 2006). In tandem with the construction of the 50ha of industrial and commercial areas, heavy-load roads were constructed to enable the transportation of heavy-loads to the heavy-load platform and the future Offshore Terminal 1 (OT1) and Offshore Terminal 2 (OT2) (AfW Cuxhaven, 2017). The new construction of the 50ha of industrial and commercial areas was a ‘reactive’ decision by the City of Cuxhaven to provide a €2.9M investment. This decision was underpinned by interest shown by Cuxhaven Steel Construction (CSC) and BARD, as the parent company of CSC, to establish a new foundation manufacturing facility to supply and support the installation of BARD Offshore I (AfW Cuxhaven, 2018c). This state-led investment was catalysed by combined grants consisting of €2.6M from EU (ERDF) funds and Niedersachsen (AfW Cuxhaven, 2018c; Martin, 2010; Notteboom, 2016). Furthermore, the City of Cuxhaven owned the 50ha of industrial and commercial areas of greenfield land and therefore had the power to make this strategic investment for infrastructure expansion.

CSC approached the Niedersachsen government, City of Cuxhaven and AfW and enabled these actors to take the ‘first step’ of land development within the Offshore Master Plan (OMP) (AfW Cuxhaven, 2017; Former Senior Director interview, former AfW):

> “After talking with Niedersachsen and the guys in Cuxhaven [City of Cuxhaven and AfW] it made us [CSC] think about…how there was lots of available port space in Cuxhaven and if you [CSC] want to make such a factory for foundations and want to build it we need to think seriously about [the Port of] Cuxhaven” Manager, NPorts, former CSC.

Subsequently, CSC decided to transplant their foundation manufacturing operations into the PoC through a €45M investment, supporting their existing component manufacturing operations at the Port of Emden (Maskell & Malmberg, 1999; Cuxhavener Nachrichten, 2007; Martin & Sunley, 2006). CSC’s investment was for a 650T heavy-lift gantry crane, alongside a foundation manufacturing facility and storage facilities to supply components for their ‘BARD Offshore 1’ offshore wind project (Wüstenhagen & Bilharz, 2006; Stefes, 2016; AfW Cuxhaven, 2018d). CSC’s decision to transplant was strongly influenced by its parent BARD, who “totally believed in the offshore wind market and the Federal government subsidies, therefore he [BARD owner] fully funded CSC’s development” (Senior Financial Officer, Niedersachsen Bank interview; Wüstenhagen & Bilharz, 2006; Stefes, 2016).

However, additional quayside infrastructure was required to support CSC’s manufacturing, pre-assembly and installation activities and enable the PoC to operate as an infrastructure base for the offshore wind industry, supporting a regional offshore wind path creation process. The construction of the (Offshore Terminal 1) OT1 was triggered by large state-led investments and motivated new offshore wind manufacturing firms to transplant manufacturing and pre-assembly activities into the PoC and build new superstructure to complete these activities (Martin & Sunley, 2006). Completed in 2009, the OT1's infrastructure included a new quay wall, storage area and three berths for handling heavy-load components, alongside larger jack-up and O&M vessels (AfW Cuxhaven, 2017; 2018d).

After CSC transplanted into the PoC to manufacture foundations, the Niedersachsen government and the EU made a €31.9M state-led investment for the OT1, driving a total investment of €60M completed by NPorts, utilising its own capital and private loans (Cuxhavener Nachrichten, 2007; AfW Cuxhaven, 2018). The state-led investment was part of Niedersachsen's and NPorts' long-term vision and entrepreneurial nature, believing that offshore wind was the future direction of the PoC in-keeping with the 'OMP', which was directing the PoC's diversification (AfW Cuxhaven, 2017; Senior Officer interview, Niedersachsen):

> "The OTI was driven by Niedersachsen… the founder of BARD (CSC) approached Niedersachsen for investment and said he wanted to build components at the PoC and he will bring lots of jobs and new development to the City of Cuxhaven" Manager, NPorts, former CSC.

On a different note, the OT1's construction was crucial in stimulating the interest and eventual transplantation of AMBAU, as a manufacturer of turbine foundations and towers, who also influenced NPorts' and Niedersachsen's decision to invest into port infrastructure, as AMBAU were a promising new port user (Former Senior Director interview, former AfW). The AfW actively pursued AMBAU to catalyse AMBAU's transplantation of manufacturing and pre-assembly activities (AMBAU, 2018):

> "We [AfW] went to see the owner of AMBAU, we said you have much better conditions and infrastructure [50ha and OT1] in Cuxhaven, you have much more land, so he decided to switch from investing in Bremerhaven" (Former Senior Director, former AfW).

AMBAU provided a €48.75M inward investment to build a new production facility on the 50ha industrial and commercial area in 2008 for manufacturing towers, monopiles and transition pieces (AfW Cuxhaven, 2018c; AMBAU, 2018). This was supported by NPorts' and the Niedersachsen government's state-led investment for the OT1, alongside efforts made by AfW, availability of the 50ha industrial and commercial area and 650T gantry crane, and CSC as a co-located firm (Former Senior Director interview, former AfW). Furthermore, Niedersachsen Bank supported AMBAU's transplantation with a €6.63M "individual business investment aid" from the 'Joint Scheme for the Improvement of Regional Economic Structures' (GRW), which utilises Federal and EU funds to support structurally weak regions in Germany (Senior Advisor interview, AfW Cuxhaven; Eurofound, 2018).

In addition to the new construction of the 50ha industrial and commercial area and the OT1 on greenfield port land, an additional construction of a further 100ha of industrial and commercial area took place between 2009 and 2010 (AfW Cuxhaven, 2017; 2018a). The construction of a further 100ha industrial and commercial area and heavy-load roads ultimately motivated new offshore wind manufacturing firms (STRABAG, Siemens and Siemens' suppliers) to transplant into the PoC at a later date (Maskell & Malmberg, 1999; Martin, 2010; Martin & Sunley, 2006). Having the infrastructure constructed for when future firms show interest highlights the proactive investment approach of NPorts, which was fundamental in enabling firm transplantation and catalysing the PoC's adaptation and diversification into offshore wind (Senior Advisor interview, AfW; Notteboom, 2016; AfW Cuxhaven, 2017; Monios & Wilmsmeier, 2016).

The state-led investment for the expansion of the 100ha industrial and commercial area on greenfield land and heavy-load roads was carried out by the Cuxhaven Port Development Company (CPDC) in conjunction with NPorts, set up by the City of Cuxhaven (as direct owner) and Niedersachsen Bank, to develop port land and administer EU (ERDF), Federal and State government funding (CPDC, 2009). NPorts also made a state-led investment for the 100ha industrial and commercial area by providing €13.3M to relocate the 'Baumrönne' tributary and tidal gate structure with a grant of €10M, reflecting its proactive and entrepreneurial strategy (AfW, 2018c). Moreover, the CPDC 'proactively' developed the 100ha industrial and commercial area and heavy-load roads through a state-led investment of €35.6M (using EU, Federal and State grants of around €28.6M), without a 100%

investment commitment from any firms reflecting its willingness to take risks through public finance and grants (Monios & Wilmsmeier, 2016; AfW Cuxhaven, 2018c).

However, underpinning the joint decision made by the City of Cuxhaven, CPDC, AfW and NPorts to construct the new 100ha industrial and commercial area, was the reality that both STRABAG and Siemens were actively searching for North Sea ports to establish future manufacturing and installation operations from 2009 onwards (Cuxhavener Nachrichten, 2009b; Senior Financial Officer interview, Niedersachsen Bank):

> “The building of this area (100ha industrial and commercial area) was vital. The City of Cuxhaven really drove this move, to be prepared for firms and to talk to the potential investors (STRABAG and Siemens) and to try to convince them to come to Cuxhaven” (Senior Executive, Cuxport).

Interest shown by STRABAG and Siemens in the emerging German offshore wind market was stimulated by the Federal government’s attractive feed-in-tariffs and future installed capacity targets set out in the RESA 2009 (Wüstenhagen & Bilharz, 2006; Stefes, 2016; Markard & Petersen, 2009; BMWi, 2015). Moreover, CSC and AMBAU had already established operations in the PoC (Cuxhavener Nachrichten, 2007; AMBAU, 2018). Therefore, interest shown by STRABAG and Siemens, the existence of CSC and AMBAU and previously valorised port assets, influenced the collective decision made by City of Cuxhaven, CPDC and NPorts to construct the new 100ha industrial and commercial area and “the quayside area was practical for offshore wind and they knew which areas needed to be changed” (Senior Financial Officer interview, Niedersachsen Bank; Maskell & Malmberg, 1999).

However, further quayside infrastructure was required to attract future offshore wind activities onto the 100ha industrial and commercial area and enable the PoC’s adaptation and diversification into offshore wind (AfW Cuxhaven, 2017; Notteboom, 2016). Consequently, the ‘Offshore Terminal 2’ (OT2) was new built between 2010 and 2012. The construction of the OT2 catalysed decisions made by STRABAG and later Siemens and Siemens’ suppliers to provide investment for constructing new facilities for testing, manufacturing and pre-assembly activities in the PoC, as they could utilise existing and industry-leading port infrastructure (AfW Cuxhaven, 2017).

The initial state-led investment by NPorts for the construction of sub-berths 9.3 and 9.4 at the OT2, based upon STRABAG's loading and installation requirements, prompted STRABAG to begin constructing their new facilities for testing gravity base foundations on a section of the 100ha industrial and commercial area (AfW Cuxhaven, 2018a; STRABAG, 2009). This was also catalysed by the Federal government, who provided a €8.5M grant for STRABAG's test facility construction between 2010-2011, thus highlighting an 'enabling' institutional and market environment for STRABAG (Martin, 2010; STRABAG, 2015). Following this, STRABAG announced an overall €500M planned investment for potentially constructing their overall superstructure for testing, assembling and manufacturing turbines, and purchasing specialised installation vessels and cranage (The Engineer, 2012).

However, the Niedersachsen government, NPorts and AfW had a grander vision laid out in the Offshore Master Plan (OMP), which went beyond STRABAG's infrastructure requirements (AfW Cuxhaven, 2017; Notteboom, 2016; Jacobs & Notteboom, 2011). NPorts made a state-led €65M investment for the OT2, with €35.75M in public grants largely from Niedersachsen (AfW Cuxhaven, 2018c; 2018e). This enabled the construction of 4 berths, a new quay wall, increased draft and heavy-load quays at the OT2 (AfW Cuxhaven, 2018c; 2018e):

> "It made total sense for them [PoC] to have some sort of port infrastructure [OT2] ready before the offshore wind market started to build…but it was always a bet on the future" (Former Manager, former Offshore Wind Industry Alliance).

NPorts and the Niedersachsen government took a high-risk investment approach and expressed a shared willingness to make a more proactive and entrepreneurial investment based upon the future activity of developers and manufacturing firms in the German offshore wind market, in order to support a regional offshore wind path by enabling the PoC's adaptation and diversification (Monios & Wilmsmeier, 2016; Notteboom, 2016; Martin, 2010; Jacobs & Notteboom, 2011; Figure 2.4). This state-led investment decision was ultimately influenced and controlled by the Niedersachsen government as NPorts' owner

(Senior Director interview, Federation of German Seaports [ZDS]; Monios & Wilmsmeier, 2016; Debrie et al, 2013).

This episode of the PoC's adaptation and diversification involved the valorisation of an infrastructural base for offshore wind activities, driven by proactive and entrepreneurial state-led investments for the expansion and conversion of infrastructure on greenfield and brownfield land, and firm transplantation (Notteboom, 2016; Maskell & Malmberg, 1999; Martin, 2010; Figure 2.4). The construction of various infrastructural, material and industrial assets was triggered by CSC, AMBAU and STRABAG reacting to increased demand from BARD and offshore wind developers (Maskell & Malmberg, 1999; Cuxhavener Nachrichten, 2007; AMBAU, 2018). This process was underpinned by attractive Federal government feed-in-tariffs and installed capacity targets creating an appropriate market environment for Niedersachsen government, the Cuxhaven Port Development Company (CPDC) and NPorts to prioritise and implement state-led investments for offshore wind activities, alongside substantial efforts made by the AfW to attract CSC and AMBAU to the PoC.

5.4 Uncertainty and disinvestment: 2011-2014

This next episode underlines the significant role of the Federal government in constraining the PoC's adaptation and diversification into offshore wind, shaping the future regional path around offshore wind. This role involved changing feed-in-tariffs, decreasing the installed capacity targets and planning offshore wind projects in certain areas of the German EEZ (Exclusive Economic Zone). Essentially, this created a constraining institutional environment for the offshore wind industry and inhibited the diversification of the PoC into offshore wind (Martin, 2010; Notteboom, 2016). Until 2011 the PoC's adaptation and diversification was underpinned by investment into expanding infrastructural, material and industrial assets on greenfield port land (Notteboom, 2016; Maskell & Malmberg, 1999; Figure 2.4). Conversely, this episode highlights a period of uncertainty and disinvestment at the PoC between 2011 and the important decision taken by Siemens for its transplantation from 2014 onwards, moving from the previous episodes of diversification, investment and expansion (Martin, 2010; Siemens, 2016b). This episode is made up of two components around the reduction of O&M activities and the reduction of manufacturing and pre-assembly activities at the PoC.

5.4.1 Operations and Maintenance reduction: 2011-2013

This element of the episode is around the reduction of O&M activities in the PoC, underpinned by the disinvestment of OMM (Offshore Marine Management). This disinvestment process was primarily driven by the Federal government changing feed-in-tariffs and installed capacity targets for offshore wind, alongside offshore wind projects being designated at extensive distances from the PoC by the BSH (Federal Maritime and Hydrographic Agency), making it unattractive, impractical and expensive for O&M activities (BMWi, 2014; BSH, 2014). OMM decided to transplant into the PoC in 2011 to provide grid cable installation and maintenance, substation platform operations and support services, becoming the primary O&M firm in the PoC (Rhenus Logistics, 2011). At the time of its transplantation, the German offshore wind market was burgeoning following the installation and launch of Alpha Ventus in 2010, supported by an enabling market environment driven by feed-in-tariffs and installed capacity targets for prospective developers and manufacturers (BMWi, 2015; Stefes, 2016; Martin, 2010).

Following OMM's approach to Cuxport, Cuxport offered OMM to rent existing quayside space, ro/ro ramps, berths and convert existing buildings on the 'Steubenhöft Terminal' at a lower price than the Port of Bremerhaven (AfW Cuxhaven, 2018h). This was underpinned by the offshore wind industry being "more mature" at the Port of Bremerhaven, meaning there were a greater number of firms and less quayside space which stimulated higher rental prices, thus influencing OMM's decision to provide investments of "over 500,000 Euros" (Senior Director interview, OMM):

> "Rent was two or three times as much than Cuxhaven. We didn't want to go there… and the infrastructure and the existing buildings were there at Cuxhaven" Senior Director, OMM.

NPorts charged low rents and dues as a result of the long-term vision of the 'OMP', aiming to support new offshore wind activities, job creation and "not to see a return or profit" via rent or dues, which reflects NPorts' proactive nature to support new firms and its Hanseatic port governance model (Former Senior Director, former AfW; AfW Cuxhaven, 2017; Verhoeven, 2010; Table 2.1).

However, OMM disinvested in 2013. Firstly, this was based upon an important policy decision made by the Federal government in 2013 to reduce offshore wind installation capacity targets from 10GW by 2020 to 6.5GW by 2020, set out in the revised RESA (Renewable Energy Sources Act) in 2014 (BMWi, 2014; 2015; reNEWS, 2013a). This policy change forced developers to "put their investment plans on hold" (Senior Director interview, OMM). Consequently, smaller O&M providers like OMM forecasted that O&M contracts would reduce in demand and they would be forced out of the German offshore wind market (BMWi, 2014; 2015; reNEWS, 2013a; Wind Europe, 2017b):

> "I admit we were a little bit early for the [German] market. We were paying to rent the [port] land and we were waiting for the market to hurry up and form…this caused us problems" Senior Director, OMM.

Furthermore, this change of policy was primarily based upon low grid connections from offshore wind projects to areas of high electricity consumption and the capacity of the grid network operator (TenneT) to install grid connections by 2020 (Senior Director interview, Germany Trade and Invest; BWMi, 2015; 2016; Lema et al, 2014).

Secondly, OMM entered the O&M market at the wrong geographical location at the PoC, as other port locations had "shorter distances to the offshore wind parks" (Senior Director interview, Cuxport; GTAi, 2017). This is crucial for developers as they're primarily concerned with reducing the sailing distance to reduce O&M time and costs (Group Manager interview, Fraunhofer IWES; Wind Europe, 2017a). However, the majority of the designated offshore wind projects in the German EEZ were more accessible from the ports of Bremerhaven, Emden, Nordenham, Norden, Heligoland and Eemshaven (Former Manager interview, former Offshore Wind Industry Alliance; BSH, 2014). Thus, PoC was disproportionality affected due to its poor geographical proximity (BSH, 2014). This demonstrates how the BSH's planning policies for designating offshore wind projects shaped the activity of O&M service providers such as OMM and O&M activities at the PoC (Martin, 2010; OMM, 2018; Martin, 2010).

5.4.2 Reduction of manufacturing activities: 2013

The offshore wind policy changes and broader industrial activities occurring on a national scale directly constrained the adaptation and diversification of the PoC into offshore wind, by influencing the disinvestment decision made by OMM and contracting the PoC's O&M activities within the offshore wind industry (Notteboom, 2016; BMWi, 2014; BSH, 2014; Figure 2.4). However, firms conducting manufacturing and pre-assembly activities were also constrained by offshore wind policy changes and regulatory decisions, alongside the technological and supply chain evolution of offshore wind, thus directly constraining the PoC's diversification and shaping the future regional offshore wind path. This element of the episode will discuss the reduction of the PoC's offshore wind manufacturing and pre-assembly activities, exemplified by the cases of STRABAG and CSC.

STRABAG's initial investment into test facilities was catalysed by the state-led investment commitments from the Cuxhaven Port Development Company (CPDC) and NPorts for newly constructing the 100ha industrial and commercial area and sub-berths 9.3 and 9.4 at the OT2 (STRABAG, 2009; AfW Cuxhaven, 2017; 2018c; 2018e). Moreover, STRABAG committed to building a test facility after they identified a potential market for gravity-base foundations, which was "based upon the EEG at the time and promises of future capacity" following higher feed-in-tariffs and installed capacity targets released in the RESA (2009) (Manager interview, NPorts; BMWi, 2015; Stefes, 2016; Markard & Petersen, 2009).

Unfortunately for STRABAG the offshore wind industry was changing rapidly in the early 2010s as developers and manufacturers were avoiding purchasing expensive gravity-base foundations with an unproven installation method (Senior Consultant interview, 8.2 Consulting AG; Renewables Consulting Group, 2017). Therefore, STRABAG deemed their planned €500M investment into a new manufacturing facility, including a €200M-€250M investment into a specialised catamaran for offshore installation, as financially unfeasible (Notteboom, 2016; STRABAG, 2013; The Engineer, 2012):

> "The vessel was in the range of the hundreds of millions. 200 to 250 million Euro. We [STRABAG] thought about it, to invest in such a vessel is difficult if you don't have a viable business case, it wasn't sensible" Group Manager, IWES, former STRABAG.

On a different note, the BSH refused to grant permission for full-scale offshore installation of their gravity-base as they “did not see a business case for STRABAG”, despite BSH granting STRABAG permission to test their gravity-base foundations at an offshore test site named ‘Albatross I’ (Group Manager interview, IWES; The Engineer, 2012). This legal and regulatory setting for installing gravity-base foundations offshore “didn’t support STRABAG…[and] it was always considered as a problem”, thus contributing to STRABAG disinvesting from the PoC and leaving their test facility in place at the PoC (Group Manager, IWES; STRABAG, 2013; Martin, 2010).

NPorts were newly constructing the sub-berth 9.3 featuring a ro/ro ramp and the adjacent sub-berth 9.4 for STRABAG’s installation and logistics solution for their proposed gravity base foundations and turbines, forming the first infrastructural assets of the OT2 (AfW Cuxhaven, 2017; 2018e). However, because of STRABAG disinvesting from the PoC, the construction of sub-berths 9.3 and 9.4 was halted due to NPorts and Niedersachsen losing confidence in the potential of the offshore wind market providing future port users for the OT2 (STRABAG, 2013):

> “The STRABAG group decided to stop their project at the time the infrastructure was nearly completed and because of this… Niedersachsen Ports in cooperation with the state decided to close the quay [sub-berths 9.3 and 9.4]… we stopped construction” Senior Officer, Niedersachsen.

Although STRABAG had disinvested from the PoC, NPorts still possessed industry-leading infrastructural and material assets at the OT2 which could be fully completed to support future offshore wind firms (AfW Cuxhaven, 2017; 2018f; Maskell & Malmberg, 1999; Notteboom, 2016). Thus, STRABAG’s disinvestment and disuse of port infrastructure catalysed new opportunities for offshore wind firms and the PoC, as STRABAG vacated important quayside areas at the OT2 and 100ha industrial and commercial area which were later capitalised upon (AfW Cuxhaven, 2017; 2018a). However, STRABAG were not the only manufacturing firm to disinvest from the PoC in this period, highlighted by the story of CSC.

Conversely, there are various factors and broader external processes underpinning CSC’s rationale to disinvest and consequently constrain the PoC’s adaptation and diversification into offshore wind (Martin, 2010; reNEWS, 2013b; Notteboom, 2016). In 2012 BARD began to experience financial difficulty and began planning to disinvest in 2013 (reNEWS, 2013b). This was caused by BARD attempting to produce every turbine component, using untested installation methods and unproven technology for manufacturing components, thus driving up costs of BARD Offshore 1 and CSC's operations (Senior Executive interview, Cuxport):

> "BARD misunderstood how complex everything is in the industry. They went too quickly as a whole, as a turbine manufacturer and as a project developer" Senior Consultant, 8.2 Consulting AG.

BARD's financial difficulty was also caused by heightening competition between manufacturers to supply developers in the offshore wind industry, the component design evolution, and developers ordering cheaper and high-quality components from specialised manufacturers (Senior Consultant interview, 8.2 Consulting AG; Lema et al, 2014). As such, BARD could not compete within this market, resulting in BARD disinvesting from the PoC and its bankruptcy, after BARD went over budget for BARD Offshore 1 by €1.1BN (Senior Executive interview, Cuxport; 4C Offshore, 2018; reNEWS, 2013b; Martin, 2010; Gertler, 2010).

> "It became more difficult for them [BARD] to plan ahead and invest. The bigger problem for the industry is uncertainty. 'We [Germany] needs more capacity, we need less capacity, it's too expensive, oh it's not too expensive now let's build' and for developers it's hard to make plans" Senior Consultant, 8.2 Consulting AG.

The reduction of offshore wind activities was strongly influenced by shifting policy and market settings, namely the Federal government's decision to alter installed capacity targets in 2013, the technological change and supply chain evolution in offshore wind which created an alternative market demand of certain turbine components, and the geographic proximity of the PoC to offshore wind projects in the German EEZ (BMWi, 2014; BSH, 2014). As such, OMM, STRABAG and CSC (BARD) reacted individually to these changes of settings, thus constraining the PoC's adaptation and diversification, and shaping a regional offshore wind path (Notteboom, 2016; Martin, 2010). However, this episode has emphasised how the coalition of actors directing the PoC decided to continually support 'OMP' despite the reduction of offshore wind activities, allowing vacant port assets to be ultimately capitalised upon (AfW Cuxhaven, 2017; Fineberg, 2016; Wood, 1999).

5.5 Revival and expansion: 2014 onwards

The revival and expansion of offshore wind activities at the PoC from 2014 onwards supported a regional path forming around the offshore wind industry, as firm-led investments capitalised upon an infrastructural asset base created by various state-led investments to expand infrastructure on greenfield land over time, which were catalysed by NPorts responding to an enabling institutional environment established by the Federal government, positive market signals for offshore wind and NPorts' new decision-making powers, resources, responsibilities and public grants (Martin, 2010; BMWi, 2015; Niedersachsen Ports, 2009). The key theme emerging from this episode is how a strong coalition of actors, namely Niedersachsen, NPorts, AfW and the Cuxhaven Port Development Company (CPDC), worked together to ultimately realise the long-term vision of the 'Offshore Master Plan' of establishing the PoC as an infrastructural base for supporting offshore wind activities. This episode of the PoC's adaptation and diversification is driven and shaped by the transplantation of a firm onto greenfield port land which expands the existing infrastructural base, ending the previous episode of uncertainty and disinvestment, thus enabling the diversification and expansion of the PoC into offshore wind set out in the 'Offshore Master Plan' (Niedersachsen, 2003; AfW Cuxhaven, 2017; 2018a; 2018f; Figure 2.4). The transplantation of Siemens acted as an anchor investment, as a lead turbine manufacturer, which directed and catalysed the diversification and conversion of port assets to support offshore wind activities from 2014 onwards (Martin & Sunley, 2006; Notteboom, 2016; Figure 2.4). This episode is made up of two distinctive elements around firm-led investments by Siemens, Siemens' suppliers and AMBAU into establishing new manufacturing activities at the PoC, and subsequent state-led investments to further expand the infrastructure base on greenfield land for offshore wind activities.

5.5.1 New firm-led investments into manufacturing activities: 2014 onwards

This element of the episode is around the transplantation of Siemens who provided a €200M investment in 2015 for the new construction of manufacturing facilities (Martin & Sunley, 2006; AfW Cuxhaven, 2017; Siemens, 2016b; 2017). However, in addition to Siemens' transplantation into the PoC, Siemens' supply chain was established within the PoC through further firm transplantation and AMBAU strategically decided to acquire CSC's former assets and expand within the PoC (AfW Cuxhaven, 2017; 2018e). These firm-led investment activities essentially enabled the PoC's adaptation and diversification into offshore wind, thus stimulating and shaping the future regional path around the offshore wind industry by creating employment at new offshore wind firms within the PoC and connecting the PoC to growing offshore wind supply networks embedding locally and regionally.

In the early 2010s Siemens decided to concentrate their production of components and installation of turbines at certain North Sea ports, namely the Port of Hull and the PoC, to drive down costs and offshore wind project timescales (Siemens, 2015; 2017). This was enabled by Siemens providing new and improved transport and logistics operations using purpose-built vessels and Ro/Ro ramps, avoiding the cost-intensive heavy-lifting and shipping of components (Siemens, 2015; 2017). Therefore, Siemens required a port location with heavy-load quays, a Ro/Ro berth, large areas for construction of manufacturing facilities and locating suppliers, good access for large transportation vessels and was close to all European offshore wind markets (Siemens, 2015; Siemens Gamesa, 2017). Importantly for the PoC, its OT2 and 100ha industrial and commercial area fitted Siemens' new demands (Researcher interview, Technical University of Hamburg; AfW Cuxhaven, 2017):

> "This was one of the big factors we could show Siemens, the infrastructure was ready for them, not everything but most of the infrastructure…they could be ready to produce and ship out turbines quickly" Manager, NPorts.

Despite previous efforts from STRABAG, the City of Cuxhaven as land owner and NPorts as the port authority to convince the turbine owners (Enercon, REpower/Senvion, DeWind/DSME) to relocate their test turbines erected between 2004 – 2005 in the PoC, as a result of STRABAG's interest for constructing a new manufacturing plant, their removal was eventually enabled by the discussion "heating up" between Siemens and the coalition of actors in 2014 (Former Senior Director, former AfW; Cuxhavener Nachrichten, 2013, Wood, 1999). These discussions resulted in the Niedersachsen government proactively providing a state-led €37M investment to relocate the test turbines from an area adjacent to the OT2 for

Siemens' transplantation, a process managed by the City of Cuxhaven (Former Senior Director, former AfW; Monios & Wilmsmeier, 2017; AfW Cuxhaven, 2018c).

The removal and relocation of test turbines, which were erected between 2004- 2005, aligned to Siemens' main investment rationale, which was the punctual deliverability of port infrastructure to enable Siemens' prompt construction of superstructure (HWG, 2018; Siemens Gamesa, 2017). Additionally, STRABAG had disinvested and vacated the semi-complete OT2 and the 100ha ICA, therefore part of the infrastructure was already constructed and delivered (AfW Cuxhaven, 2017; 2018e, 2018f):

> "[Sub-] berth 9.3 was probably 50% ready for them [Siemens] …what we had to build before Siemens came was only the heavy-load ramp at [sub-] berth 9.3 which was about 50% completed" Manager, NPorts.

In addition, substantial efforts made by the coalition of actors, in particular the AfW, influenced Siemens' attraction to the PoC, as opposed to the Port of Bremerhaven as a rival port competitor (Notteboom, 2016; Fineberg, 2016; Cox, 1998). Siemens visited the PoC several times between 2008 and 2015 (Manager interview NPorts):

> "We [AfW Cuxhaven] coordinated the Siemens investment from the beginning…every agency was on the table and Siemens said 'this is my plan'… then every agency told Siemens information. We had 25 people and we met every 4 weeks" Former Senior Director, AfW Cuxhaven.

Moreover, Siemens' transplantation and new construction of superstructure was not constrained by any legal, environmental or industrial obstacles, allowing completion of superstructure construction within two years (Senior Officer interview, Niedersachsen; HWG, 2018). This reflects the considerable efforts made by AfW, the City of Cuxhaven and the NLWKN (Department for Waterway, Coastal and Nature Conservation of the State of Lower Saxony) (NLKWN, 2018):

> "In Lower Saxony we had no development at the PoC that went to court, every project was given the official approval order without any contact with the courts, there have been no objections" Senior Officer, Niedersachsen.

Siemens were also attracted by NPorts' ability to access grants to provide state-led investments for infrastructure expansion on greenfield land, resulting from the PoC's change of governance arrangements in 2005 (Manager interview, NPorts; AfW Cuxhaven, 2018c; 2018e). In contrast, the State of Bremen, formed a policy to attract private investment to construct its planned 'Offshore Terminal Bremerhaven' (OTB), contrasting Niedersachsen's strategy of driving state-led investments (Senior Manager interview, BIS Bremerhaven; Bremenports, 2011; Brooks, 2004). This difference in policy inhibited the OTB's construction due to absent private investment. This absence of private investment has been influenced by the OTB development being legally challenged by German environmental groups since its conception (Project Manager interview, BIS Bremerhaven; Senior Policy Officer interview, BMVI).

However, in order for Siemens' new manufacturing and installation solution at the PoC to be operational, on-site suppliers were required within the PoC to support Siemens' new nacelle manufacturing facility, which was previously selected for the Port of Hull in the Humber Ports case (Siemens, 2016b; 2017). The eventual transplantation of Siemens' suppliers into the PoC who provided investment to build new superstructure, enabled the PoC's adaptation and diversification into offshore wind and supported the new regional path around the offshore wind industry through providing new employment and further augmenting the local offshore wind supply network (Notteboom, 2016; Martin & Sunley, 2006). This was primarily driven by Siemens' transplantation catalysing new demand for suppliers and logistics services to support their port-centred manufacturing and logistics operations from the PoC (Siemens, 2016b; 2017):

> "Siemens wanted suppliers to be settled next to them because they needed a short route and cost-effective approach for moving the [turbine] parts and components" Senior Advisor, AfW Cuxhaven.

This new port demand triggered a reaction from the City of Cuxhaven, the AfW and the CPDC (Cuxhaven Port Development Company) to extend and enhance the 'OMP', by designating a 11ha 'supplier park' (AfW Cuxhaven, 2017). This supplier park was delineated and newly constructed within the larger 100ha industrial and commercial area by the CPDC which cost €1.28M, supported by grant funding of €768,000 from the Niedersachsen government (AfW Cuxhaven, 2017; 2018c).

As CPDC owned the land of the supplier park and operates as a publically-owned private port development company (CPDC, 2009). The City of Cuxhaven is the majority shareholder of the CPDC and the CPDC is arranged as a GmbH, which is officially a limited liability company (GTAi, 2018; CPDC, 2009). This institutional arrangement allowed the CPDC to receive and spend large public grants from Niedersachsen to newly construct the supplier park and avoid infringing upon EU State Aid rules (European Commission, 2014; Martin, 2000; CPDC, 2009):

> "It [CPDC] was set up to receive the money from the EU and the State government, we needed a GmbH set up for this" Former Senior Director, former AfW.

Furthermore, another enabling ownership arrangement was the reorganisation of land ownership in 2009 between NPorts (as subsidiary of the Niedersachsen government) and the CPDC (as subsidiary of the City of Cuxhaven), to allow each non-firm actor to have their "own coherent land plot for firm settlements and negotiations" (Senior Advisor interview, AfW Cuxhaven; Martin, 2010 Niedersachsen Ports, 2017; AfW Cuxhaven, 2017). This reorganisation of land ownership and governance meant that land for the Siemens facility, Siemens' optional area and the supplier park was owned by the CPDC forming part of the larger 100ha ICA, although outside the PoC's officially delineated limits (Niedersachsen Ports, 2017; AfW Cuxhaven, 2017). This enabled Siemens and its suppliers to identify distinct and coherent plots of land to organise their transplantation, investment and construction activities with the CPDC (Senior Advisor interview, AfW Cuxhaven; Niedersachsen Ports, 2017; AfW Cuxhaven, 2017).

The first of the Siemens suppliers to commit was STUTE Logistics who provide inbound and outbound logistics services for Siemens' components, value-added activities (such as lubrication of small parts for components) and storage services (AfW Cuxhaven, 2018i; STUTE Logistics, 2017). The transplantation of STUTE Logistics in 2016 was supported by a €4.69M investment into fixed assets (Senior Advisor interview, AfW Cuxhaven; AfW Cuxhaven, 2018c). Niedersachsen Bank provided STUTE Logistics with €490,920 "individual business investment aid" from the 'Joint Scheme for the Improvement of Regional Economic

Structures' (GRW), corresponding to 10% of STUTE Logistics' overall investment (Senior Advisor interview, AfW Cuxhaven; Eurofound, 2018).

Nordmark, the second supplier to commit in 2016, required a new production facility in close proximity to produce large component parts for Siemens and to support Siemens' new port-centred manufacturing and logistics operations (Nordmark, 2016; Siemens, 2016b; Cuxhavener Nachrichten, 2016). A €3.65M grant from the GRW supported Nordmark's €18.85M investment for constructing a new production facility and offices at the supplier park (Senior Advisor, AfW Cuxhaven; AfW Cuxhaven, 2018c; Nordmark, 2016; Eurofound, 2018). The transplantation and construction of new superstructure by Nordmark was also driven and catalysed by the construction of the 100ha industrial and commercial area and heavy-load roads, and the construction and designation of the 11ha supplier park (AfW Cuxhaven, 2017, 2018a; 2018c).

Subsequently, Nordmark decided to award Muehlhan a long-term contract for protective coating services after conducting ITT (invitation-to-tender) rounds "with several coating companies" (Senior Director, Nordmark; Muehlhan, 2018). Nordmark had established a good business relationship with Muehlhan, who had the "best prices and conditions" and were considered a "German company who understood German bureaucracy and rules" (Senior Director, Nordmark; Muehlhan, 2018). Muehlhan invested €17.2M for constructing a coating facility within the supplier park and for transportation equipment (Muehlhan, 2018; AfW Cuxhaven, 2018c). Muehlhan's transplantation and new construction activities was caused by Nordmark's demand which was catalysed by component orders from Siemens, thus further enabling the PoC's adaptation and diversification into offshore wind (Senior Director interview, Nordmark). In addition to Siemens' suppliers transplanting into the PoC, AMBAU expanded its operations and presence within the PoC through the acquisition of CSC's former assets following its disinvestment.

AMBAU's €30M acquisition of superstructure was driven by CSC disinvesting in 2013 (AMBAU, 2016; reNEWS, 2013; AfW Cuxhaven, 2018c). Following CSC's disinvestment, AMBAU rented CSC's former production hall for storage from the City of Cuxhaven, as the leaseholder (AfW Cuxhaven, 2017; Senior Advisor interview, AfW Cuxhaven). AMBAU's eventual acquisition of CSC's superstructure from private banks and expansion in 2016 was primarily caused by NPorts and the City of Cuxhaven working together and setting low rental costs for the production hall and storage area, stimulating AMBAU's interest to rent these facilities between 2013 and 2016 (Manager interview, NPorts; AMBAU, 2016):

> "They [AMBAU] were always thinking 'OK, CSC has already gone bankrupt, maybe eventually we can take this over when the banks lower the price'… so they could take over the whole site at a cheap price after renting first" Senior Executive, Cuxport.

Moreover, the internal corporate decision-making at AMBAU which underpinned its acquisition activities after a period of renting CSC's former production hall and storage facilities, assisted the PoC to end its period of uncertainty and disinvestment (AMBAU, 2016).

In addition to the attractive rental agreement, the OT1, the 50ha industrial and commercial area and CSC's former production hall, storage facilities and 650T quayside gantry crane fitted AMBAU's needs of extra storage areas, extra quayside cranage for heavy-lifting and additional berths for jack-up-vessels, in order to consolidate and heighten its manufacturing and pre-assembly capacities at the PoC (AfW Cuxhaven, 2017; AMBAU, 2016). Furthermore, the rental agreement for AMBAU's former manufacturing plant had expired and this also prompted AMBAU to rethink the strategic capacity of their current production facilities (AMBAU, 2018; 2016):

> "In the end AMBAU decided it was better to be at a purpose-built facility [OT1] rather than a former shipyard which was not really perfect" Senior Executive, Cuxport.

In similarity to Siemens' new manufacturing and logistics operations, AMBAU's decision for consolidating their manufacturing activities and acquiring superstructure in the PoC was also driven by AMBAU's strategy of cost reduction, through removing the transportation of components between their plants (AMBAU, 2016). Essentially, the corporate decision-making and strategies of firms like AMBAU and Siemens enable port adaptation and stimulate regional path creation processes (Notteboom, 2016; Jacobs & Lagendijk, 2014). Siemens, Siemens' suppliers and AMBAU reacted to broader changes in policy, market demand, technological innovation and supply chain evolution within the offshore wind industry, allowing port authorities to capitalise upon a new market such as offshore wind (Wind Europe, 2017a; Martin, 2010).

5.5.2 Further state-led infrastructure investment: 2016 - 2018

This element of the episode is around the new expansion of infrastructure on greenfield land, namely the OT2, enabled by state-led investments (AfW Cuxhaven, 2017; 2018e; Figure 2.4). Despite the disruption of construction which followed STRABAG's disinvestment jeopardising the Offshore Master Plan (OMP), the AfW, NPorts and the Niedersachsen government decided to complete the OT2, to capitalise upon the long-term growth potential of the German offshore wind market (Manager interview, NPorts; AfW Cuxhaven, 2017; 2018e). Moreover, the new construction activities were enabled by key decisions to provide state-led investments to complete the OT2 without final inward investment decisions from firms, reflecting the proactive and entrepreneurial nature of NPorts and its ability to access and use grants, private bank loans and public finance (Notteboom, 2016; Monios & Wilmsmeier, 2016; AfW Cuxhaven, 2018e).

The sub-berth 9.3 was around "50% complete" before STRABAG disinvested (Manager interview, NPorts; STRABAG, 2013). Moreover, Siemens required a heavy-load ro/ro ramp instead of using heavy-lift cranage (Siemens Gamesa, 2017). Therefore, Siemens visited the PoC to assess sub-berth 9.3 and requested NPorts to complete construction (Manager interview, NPorts; AfW Cuxhaven, 2017; 2018e). Furthermore, NPorts had the capacity to demonstrate to Siemens that planning permission for construction was in place since 2012, which was originally for STRABAG's planned large-scale production and installation of gravity-based foundations (NLWKN, 2018; 2012; STRABAG, 2015):

> "The planning was there and in the short-term Siemens could start construction. This was definitely a reason Siemens came, they didn't want any obstacles, any legal obstacles…" Former Senior Director, former AfW.

Consequently, NPorts provided a €9.5M state-led investment, wholly funded by the Niedersachsen government, to complete the sub-berth 9.3 with heavy-load ramp (European Commission, 2016; AfW Cuxhaven, 2018c; 2018e; Maritime Journal, 2016). This state-led investment was evidently a reactive decision to the infrastructure demands of Siemens (Monios & Wilmsmeier, 2016; Siemens Gamesa, 2017). However, the investment policies and long-term vision of Niedersachsen and NPorts evident within the ‘OMP’ advocated this state-led investment (Maritime Journal, 2016; AfW Cuxhaven, 2017; Niedersachsen, 2016; Notteboom, 2016):

> “I would say 60-70% of the ramp was ready when Siemens signed the contract…Siemens said ‘OK we can believe your promise. We can believe this’. And because of this Siemens made the decision to come to Cuxhaven” Manager, NPorts.

However, NPorts in conjunction with the Niedersachsen government, took a more entrepreneurial and proactive strategy to complete the OT2 which expanded the ‘OMP’ (AfW Cuxhaven, 2017; Maritime Journal, 2017; Monios & Wilmsmeier, 2016; Notteboom, 2016). This state-led investment strategy was based upon renewed interest from offshore wind developers and manufacturing firms, which was underpinned by future offshore wind projects planned for the North Sea, in addition to having existing planning permission for the OT2 (Maritime Journal, 2017; Niedersachsen, 2016; NLWKN, 2010; 2016; 2018):

> “The port infrastructure and industrial areas are needed for further production and maintenance of turbines. Ports in Niedersachsen need more work to build up more turbines in the German North Sea…to get more jobs and attract companies” Senior Officer, Niedersachsen.

Importantly, new changes in the RESA framework and market support regime implemented by the Federal government, notably the adding of 500MW of installed offshore wind capacity between 2021 and 2022, 700MW per year between 2023 and 2025, and 840MW added per year from 2026 onwards, enabled the renewed interest from offshore wind developers and manufacturing firms (BMWi, 2016).

NPorts invested €600,000 to construct new surfaces on the quayside infrastructure at sub-berth 9.2 (Maritime Journal, 2017; AfW Cuxhaven, 2018c). The sub-berths 9.4 and 9.5 were created, and €7M was provided by NPorts to newly construct infrastructure at sub-berth 9.4 to handle jack-up vessels (NLKWN, 2018; AfW Cuxhaven, 2018e). A deeper approach to sub-berth 9.5 was built to support jack-up vessels (Senior Advisor interview, AfW Cuxhaven;

NLWKN, 2018). NPorts invested €3.5M, utilising EU 'ad hoc aid', facilitating the construction of a heavy-load quay at sub-berth 9.1 (Maritime Journal, 2017; AfW Cuxhaven, 2018c; European Commission, 2017d; European Union, 2017). These state-led investments occurred despite revised and stricter EU regulations being placed upon public investments into ports and airports since 2017 (Manager interview; NPorts; European Union, 2017; European Commission, 2016; 2017d).

On the whole, the PoC's revival and expansion into offshore wind since 2014 was driven by the transplantation of Siemens, Siemens' suppliers (STUTE Logistics, Nordmark and Muehlhan) and AMBAU's acquisition of CSC's former assets, and further state-led investments for the expansion of infrastructure from the Niedersachsen government and NPorts. These distinctive investments were influenced by the continued provision of feed-in-tariffs from the Federal government, the increased installed capacity targets outlined in the RESA 2017 and planned offshore wind projects in the North Sea catalysing demand from offshore wind developers, Siemens' new port-centred demand for manufacturing activities, and the previous disinvestment of CSC and STRABAG allowing new port assets to be constructed by Siemens, Siemens' suppliers and NPorts and existing assets to be acquired by AMBAU (BMWi, 2016). Furthermore, following the PoC's change of governance in 2005, NPorts had the power, resources and financial capacity to make proactive state-led investments to expand port infrastructure on greenfield land, by utilising public finance, private bank loans and grants from the EU and Niedersachsen.

More specifically, Siemens' distinctive transplantation was catalysed by investments for the expansion of infrastructure at the OT2 and 100ha ICA, reflecting the long-term vision in the Offshore Master Plan (OMP) (AfW Cuxhaven, 2017). Siemens transplantation was also facilitated by the disinvestment of STRABAG who vacated the OT2 and 100ha industrial and commercial area allowing Siemens to harness these infrastructural assets and the Port of Bremerhaven's constrained competitiveness. The transplantation of Siemens' suppliers and the OT2's further construction, was influenced by the continued provision of feed-in-tariffs and increased installed capacity targets set by the Federal government (RESA, 2017), port land ownership arrangements, a long-term strategic vision and state-led investments laid out in the 'OMP' and Siemens' port-centred demand. CSC's disinvestment and AMBAU's previously low rental agreement formed an attractive economic opportunity for AMBAU, enabling its acquisition of CSC's former assets and consolidation of activities within the PoC.

5.6 Conclusion

This chapter discussed the different phases of the PoC's adaptation and diversification into offshore wind through four distinctive episodes. The chapter looked across four key causal episodes to better understand how the evolutionary process of port adaptation unfolded at the PoC (Notteboom, 2016; Martin, 2010).

Firstly the Federal government created an enabling and constraining institutional environment for offshore wind through adapting the RESA since 2000, which was underpinned by installed capacity targets and feed-in-tariffs, thus creating an appropriate market environment for the Niedersachsen government, NPorts and the City of Cuxhaven to make proactive port infrastructure investments to attract firms (BMWi, 2015; Monios & Wilmsmeier, 2016). However, the Federal government's reduction of installed capacity targets for offshore wind in 2013 strongly influenced the decisions made by OMM, STRABAG and CSC to disinvest, which underpinned the PoC's period of uncertainty and disinvestment (BMWi, 2015; reNEWS, 2013b; STRABAG, 2013). As such, the Federal government has enabled the market environment in which NPorts and the City of Cuxhaven could capitalise upon offshore wind through the introduction of clear installed capacity targets and feed-in-tariffs incentives *and* constrained it, through the reduction of installed capacity targets in 2013, marking distinctive changes in RESA policy and shifts in broader political perspectives (BMWi, 2015; Martin, 2010). However, the Federal government continued to provide feed-in-tariffs and increased the installed capacity targets in the RESA 2017, which enabled a continued and eventual renewal of interest from offshore wind developers and manufacturing firms from 2014 onwards (BMWi, 2016). At the same time, the Niedersachsen government has provided an enabling market environment for NPorts and the City of Cuxhaven through instances of large state-led investments for the expansion and conversion of port infrastructure (AfW Cuxhaven, 2018c; Martin, 2010). Furthermore, Niedersachsen had large financial resources and considerable power to actively change the PoC's governance and ownership (Niedersachsen Ports, 2009; Debrie et al, 2013). Moreover, Niedersachsen embraced a joint approach on the local scale with NPorts, the City of

Cuxhaven, the Cuxhaven Port Development Company (CPDC) and the AfW to ultimately realise the OMP, thus facilitating the PoC's adaptation and diversification into offshore wind (Notteboom, 2016). This coalition of actors responded to the evolution of the German offshore wind market by inputting new ideas and strategies for essential port infrastructure into the OMP (Niedersachsen, 2003).

Secondly, the Offshore Master Plan (OMP) stands out as an important port strategy and vision designed to adapt and diversify the PoC as a base for offshore wind and has been extended and deepened over time, aligning to the evolution of the offshore wind industry (Niedersachsen, 2003; AfW Cuxhaven, 2017). This distinctive port strategy and vision has broader implications for economic development paths, as the OMP clear catalysed the PoC's future adaptation and diversification into offshore wind (AfW Cuxhaven, 2017; Notteboom, 2016). The OMP reflects the entrepreneurial and proactive nature of NPorts and the Niedersachsen government to invest and physically adapt infrastructural assets for potential firms within the offshore wind market (Monios & Wilmsmeier, 2016). The design and implementation of the OMP has been strongly directed and influenced by a wider coalition of actors with a common interest regarding the long-term adaptation and diversification of the PoC (Cox and Muir, 1988; MacKinnon et al, 2018; AfW Cuxhaven, 2017). The long-term vision built into and emerging from the OMP was key in attracting and launching the test turbine field, demonstrating the market potential and novelty of offshore wind, underlining the future of offshore wind in Germany which was yet to occur (AfW Cuxhaven, 2017). Few North Sea ports in the mid-2000s had the strategic vision and forward-thinking outlook to demonstrate the potential of offshore wind and the opportunity for ports to capitalise upon job creation and investment opportunities associated with the embryonic German offshore wind industry of the time (Niedersachsen, 2003).

Thirdly, the OMP's vision and success was fulfilled by the PoC's change of governance and ownership arrangements (AfW Cuxhaven, 2017; Debrie et al, 2013). The Ports and Shipping Administration of the State of Lower Saxony (PSALS) was changed to NPorts to operate as a new port authority for Lower Saxony, moving beyond the remit of a bureaucratic department of the state government (Niedersachsen Ports, 2009). Decision-making powers, resources and responsibilities were devolved to NPorts Cuxhaven, new individuals with industry and business expertise in port engineering projects were hired, and there was a new long-term vision around investing and building port infrastructure to support future offshore wind activities (AfW Cuxhaven, 2017). This new long-term vision was made possible by this change of governance circumstances as a new management team at NPorts Cuxhaven adopted a new strategic focus, supported by NPorts' central board and Niedersachsen politicians, which heightened the importance of offshore wind within PoC's business portfolio, and prioritised state-led investment for port infrastructure to attract offshore wind firms (AfW Cuxhaven, 2017; 2018c). In terms of governance, NPorts Cuxhaven is a port authority entirely owned by the Niedersachsen government, with powers, resources and responsibilities devolved to NPorts Cuxhaven for business development, infrastructure planning, managing construction activities and developing port real estate (Niedersachsen Ports, 2009; 2017; Niedersachsen, 2017). As a result of Niedersachsen's longevity as the owner of NPorts since 2005, NPorts Cuxhaven has received large state-led grants from Niedersachsen to expand and convert port infrastructure on greenfield and brownfield land through different phased projects, to support future offshore wind activities (AfW Cuxhaven, 2018; 2018c). NPorts Cuxhaven and Niedersachsen's ability and financial capacity in taking entrepreneurial risks using public finance, private bank loans and grants because they deemed port infrastructure investment as essential for attracting new firms and creating new employment opportunities in Cuxhaven, meant that this investment burden was not placed on private investors (AfW Cuxhaven, 2017; 2018c; Niedersachsen Ports, 2017). Therefore, NPorts Cuxhaven has obtained operational flexibility with devolved power, resources and responsibility since the PoC's change of governance in 2005, whilst being supported by the Niedersachsen government as its long-term owner, allowing it to receiving large grants for infrastructure investments (Niedersachsen, 2009; AfW Cuxhaven, 2018c).

Finally, a series of state-led investments for the expansion and conversion of port infrastructure has underpinned the transplantation of firms, namely CSC (BARD), STRABAG, Siemens, Nordmark and Muehlhan (AfW Cuxhaven, 2017). The series of investments for the expansion of infrastructure and episodes of transplantation lead to the realisation of the OMP and the PoC's adaptation and diversification into offshore wind. As such, the PoC's adaptation and diversification into offshore wind was led by port actors (NPorts, Niedersachsen and the City of Cuxhaven), as opposed to being led by external offshore wind firms (Notteboom, 2016). Moreover, the series of state-led investments and firm transplantations were shaped and influenced by the Federal government creating an enabling institutional environment for offshore wind through establishing an appropriate installed capacity targets and feed-in-tariffs, which catalysed investment from project developers, created a pipeline of orders for manufacturing firms and catalysed investment from NPorts, Niedersachsen and the City of Cuxhaven (Martin, 2010; BMWi, 2015).

Chapter 6 Humber Ports case: adaptation and diversification into offshore wind

6.1 Introduction

This empirical chapter explores the adaptation of the 'Humber Ports', encompassing the Port of Hull (PoH) and the Port of Grimsby (PoG), drawing upon theoretical concepts and notions in the analytical framework (see Figure 2.4). The Humber Ports' adaptation and diversification was undertaken by key actors, who were aiming to stimulate a new regional path around the offshore wind industry and provide a new purpose for the Humber Ports.

This empirical chapter is structured by the principal causal episodes of the Humber Ports' temporal evolution. The content of these episodes are organised around key modes of investment (conversion and expansion) from the analytical framework, which stimulate the process of port diversification into the offshore wind industry (see Figure 2.4). The modes of investment drive the physical construction of port assets upon brownfield and greenfield port land (see Figure 2.4). This chapter also focuses upon how upon how the vision and strategies of key firm and non-firm actors were influenced by port governance arrangements and the contexts of external market, industry, regulatory and policy environments (see Figure 2.4). The analysis highlights how the Humber Ports adapted and diversified through two distinctive trajectories of offshore wind manufacturing and O&M (operations and maintenance). The first episode is the origins and initial growth of the offshore wind path, the second episode is the disruptions and divergence between sub-regional paths and the third episode is realisation of the offshore wind path.

The chapter begins with discussing the origins of the Humber Ports' adaptation and diversification into offshore wind. This episode discusses how and why key senior individuals within Hull City Council (HCC) and other actors in Hull decided to diversify the PoH into offshore wind and how a coalition of firm and non-firm actors attempted to attract Siemens' transplantation into the PoH. The first episode also includes the exploration of how and why small-scale O&M activities initially emerged at the PoG through Centrica's transplantation.

These investment activities were shaped by senior individuals at the GFDE (Grimsby Fish Dock Enterprises) and the North East Lincolnshire Council (NELC).

The second episode highlights how the PoH and the PoG, within the Humber Ports case, experienced two divergent trajectories of adaptation and diversification into offshore wind, organised between port two sites. Echoing the disruption of the port adaptation process at the PoC explored in Chapter 5, the Humber region and the PoH also experienced a prolonged period of serious uncertainty and disruption, driven by ambiguity around the ABP and Siemens joint venture. The second episode then explores the underpinnings of Centrica's continued operations at the Fish Dock, and the investments of E.ON, Ørsted (formerly DONG Energy), RES and CWind into the Fish Dock to conduct O&M and marine support activities. These firm investments reflected the governance and organisation of the UK offshore wind industry, as there were a select number of developers who were planning to construct, operate and maintain consented UK offshore wind projects from the PoG. This episode reflects an important finding uncovered in Chapter 5; O&M activities are less affected by growing market uncertainty in comparison to manufacturing activities.

The final episode is the renewed expansion of offshore wind at the Humber Ports from 2013, which drove forward the regional path around offshore wind through the creation of new jobs and expanding the regional supply chain connected to the Humber Ports, centred upon Siemens' inward investment into a blade manufacturing facility at the Alexandra Dock located at the PoH. The final episode then moves onto discuss how and why Ørsted continued to invest into the PoG to create a larger O&M 'hub' at the Royal Dock, with the UK government playing a key role to establish an attractive national market environment for offshore wind.

The three episodes entail the emergence, disruption and expansion of manufacturing and installation activities at the Port of Hull (PoH), and the emergence, continuation and expansion of O&M activities at the Port of Grimsby (PoG). Each episode is made up of distinctive phases of port adaptation (Figure 6.1):

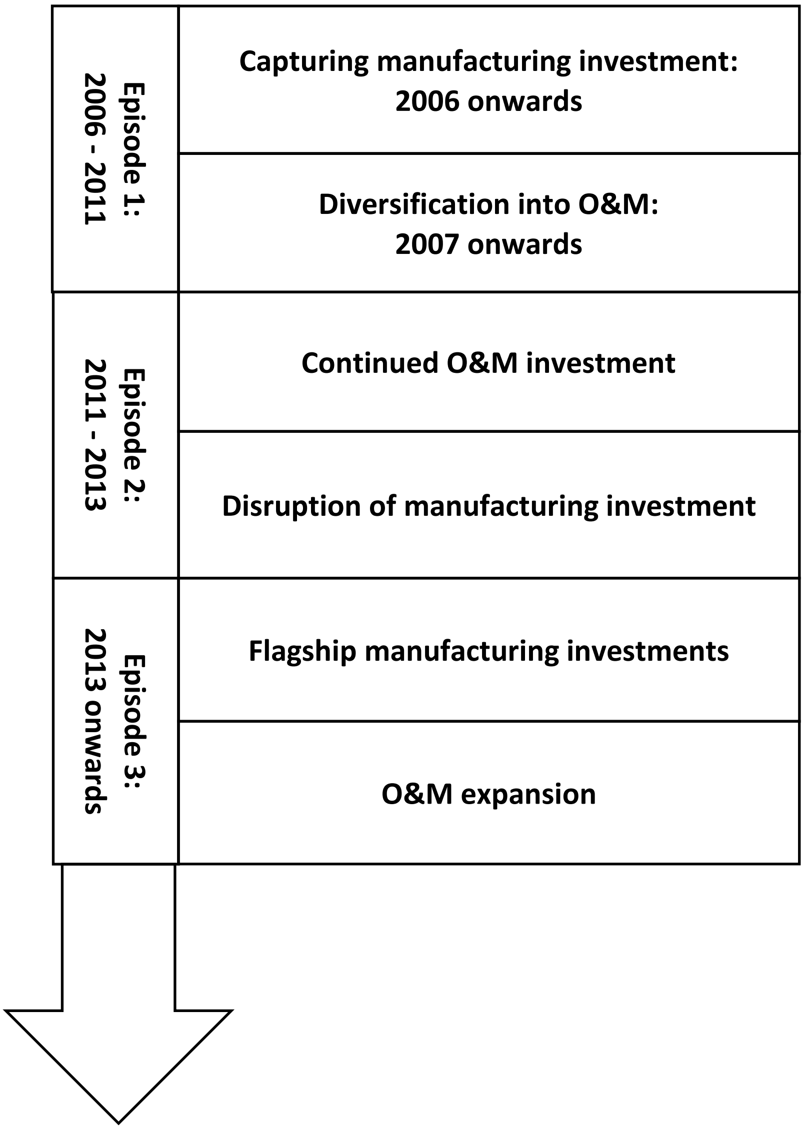


Figure 6.1: Humber Ports three causal episodes
Source: Author's own work

6.2 Path origins and growth: 2006-2011

This first episode will discuss how and why the Humber Ports initially diversified their market portfolio and asset base to support the offshore wind industry, which ultimately stimulated an early regional path around offshore wind (Notteboom, 2016; Jacobs & Notteboom, 2011; Martin, 2010; Figure 2.4). The episode is formed of two distinctive elements which evolve in parallel.

On the North bank of the Humber, the initial diversification of the Port of Hull (PoH) into manufacturing and installation activities emerged from HCC seeking new economic opportunities for Hull and identifying renewables as a potential opportunity through research by IBM Plant Location International (PLI) (Senior Director interview, HCC). The first element largely emerges from this context and discusses the intended diversification of the PoH into offshore wind, which was triggered by Siemens' interest to conduct manufacturing and support installation activities from the PoH's Alexandra Dock. On the South bank of the Humber, the initial diversification of the Port of Grimsby (PoG) into O&M activities was influenced by the strategic interests of individuals at the GFDE (Grimsby Fish Dock Enterprises) aiming to alleviate its dependence upon fish handling and storage activities as a core business within their portfolio. The second element also emerges out of this context and discusses how and why the PoG diversified into the offshore wind sector through supporting O&M activities, which was shaped and driven by the transplantation of Centrica and required the construction of infrastructure and superstructure at the Fish Dock.

The ROC subsidy regulation provided an attractive market climate for developers to prepare and invest into 'Round 1' and 'Round 2' offshore wind projects, clearly designated by the Crown Estate (Ofgem, 2017; The Crown Estate, 2017a; 2017b). The UK government announced an installed capacity target of 33GW by 2020 in 2007 which was further approved in 2009 following the SEA (Strategic Environmental Assessment) for 'Round 3' offshore wind projects, which also drove interest and turbine orders from developers in the early UK offshore wind market (Senior Manager interview, ORE Catapult; DTI, 2007; DECC, 2009). Since 2002, the UK policy environment for offshore wind created an enabling climate for developers to capitalise upon government subsidies via ROCs (Renewable Obligation Certificates), triggering a reaction from ABP at the PoH and the GFDE (Grimsby Fish Dock Enterprises) to attempt to capture investment from component manufacturing firms and developers to conduct O&M activities (Dawley, 2014; DTI, 2007 DECC, 2009; IRENA, 2012). Furthermore, a £60M fund to support turbine manufacturers investing in UK ports was announced in the 2010 Budget subject to EU state aid approval, which further stimulated inward investment interest from offshore wind developers and manufacturing firms (Former Commercial Officer interview, former ABP; Reuters, 2010). However, following the election of the coalition government in 2010, this fund was never created.

6.2.1 Proposed diversification into manufacturing activity: 2006 onwards

The first element of this episode is around how senior executives at ABP in Hull planned to diversify the PoH's existing asset base and portfolio into offshore wind, to gain increased returns for ABP and support the development of future offshore wind projects (Former Commercial Officer interview, former ABP; Notteboom, 2016; Maskell & Malmberg, 1999; Figure 2.4).

The origins of the Humber Ports' diversification into offshore wind at the PoH and new offshore wind path began with ABP (Associated British Ports) identifying a market opportunity to capitalise upon the rapidly growing European container traffic in the mid-1990s, which ultimately ended with the financial crisis of 2008 causing a slowdown in market demand for container handling (Harlaftis & Theotokas, 2010; Kalgora & Christian, 2016). This collapse of demand influenced a coalition of firm and non-firm actors to rethink their strategies around creating new jobs, integrating supply chains and catalysing industrial growth through diversifying the Humber Ports' portfolio and infrastructural asset base (Notteboom, 2016; Jacobs & Notteboom, 2011; Maskell & Malmberg, 1999; Figure 2.4).

The rising demand for container handling and the underutilised Alexandra Dock influenced ABP's new market investigations in the mid-1990s, leading to ABP's senior commercial executives to decide to diversify from general and break-bulk cargo handling into container handling operations, by constructing a deepwater terminal named 'Quay 2000' (Project Manager interview, former ABP; Harlaftis & Theotokas, 2010; University of Hull, 2018; Notteboom, 2016):

> "There was a derelict wooden pier at Alexandra Dock back in 1996, so we started looking at how that could be redeveloped…originally the idea started as 'Quay 2000' and it was going to be a container terminal" Project Manager, former ABP.

ABP eagerly welcomed investment interest from 'Samskip', a global logistics firm and terminal operator. This investment interest led to ABP's joint discussions with Samskip as the principal user of the future container terminal, renamed 'Quay 2005' because of delays (Former Commercial Officer interview, former ABP; Hull City Council, 2000; University of

Hull, 2018). ABP then applied for a parliamentary order to the UK government for a Harbour Revision Order (HRO) to develop the Quay 2005 project for Samskip (DfT, 2006; University of Hull, 2018). HROs are used to change the use of port assets (infrastructure and superstructure) through the UK government authorising applications made by port authorities to strategically diversify port assets (DfT, 2016; Notteboom, 2016; Figure 2.4). The Secretary of State for Transport granted the HRO in April 2006 for the Quay 2005 container terminal and the project would go ahead once ABP had confirmed a reliable terminal user for Quay 2005 (DfT, 2006; University of Hull, 2018). ABP's need for securing a user before it made investments reflects the profit-driven motives of ABP to support its shareholders seeking returns (Former Managing Director interview, former ABP; Verhoeven, 2010; Suykens & van de Voorde, 1998).

ABP needed to construct a new quayside infrastructure outside the pre-existing lock gates to build the Quay 2005 container terminals, allowing vessels to load containers directly from the River Humber (Former Managing Director interview, former ABP). This river terminal construction strategy for Quay 2005 was critical in enabling the PoH to diversify into offshore wind activities, as a river terminal with quayside access was a crucial infrastructural asset for loading and unloading turbine components (DfT, 2006; Mott Macdonald, 2011; University of Hull, 2018).

However, the decrease of European containers flows following the 2008 financial crisis drove the collapse of demand for container handling at North Sea ports (Harlaftis & Theotokas, 2010; Kalgora & Christian, 2016). This triggered Samskip to pull out of the renamed 'Hull Riverside Container Terminal' project in 2008 (formerly 'Quay 2005 project'), leaving ABP with consent through the existing HRO (Harbour Revision Order) and local planning consent from Hull City Council (HCC) to adapt and diversify the PoH, but without a customer to use the planned container terminal (Project Manager interview, former ABP; DfT, 2006; University of Hull, 2018).

The changing conditions of the container market were crucial in shifting ABP's strategic approach for developing the PoH, moving away from the strategy of diversifying into container handling activities and towards diversifying their market portfolio and asset base to support offshore wind (Former Managing Director, former ABP; Notteboom, 2016;

Monios & Wilmsmeier, 2016). In the late 2000s senior figures within ABP created a strategic aim of diversifying and reallocating the use of Alexandra Dock for offshore wind activities, using the justification of ABP avoiding missing out on possible revenue generated from a new market opportunity such as the UK oil and gas market of the 1980s and 1990s (Former Managing Director interview, former ABP; Notteboom, 2016):

> "We needed to…internally within ABP…build up the confidence of other senior individuals that there was a valid market and that there was an opportunity in offshore wind" Former Commercial Officer, former ABP.

This was a challenging activity for senior figures at ABP in Hull, as ABP had previously been concerned with limiting their risk-taking on infrastructure investments, which was based upon securing users to make steady returns from traditional cargo, automobiles and container handling activities (Former Senior Advisor, Green Port Hull; Verhoeven, 2010).

In September 2006 Hull City Council (HCC) commissioned 'IBM Plant Location International', which operates as a consulting service within the IBM multinational corporation, to find new economic opportunities for Hull and identified renewable energy as key economic opportunity, alongside 'Ports and Logistics', 'Pharmaceuticals' and Hull's 'City Centre' (IBM PLI, 2006; University of Hull, 2018). The recognition of these economic opportunities later drove and influenced individuals at ABP to initially plan to diversify the PoH's assets to support offshore wind as an emerging renewable sector (Notteboom, 2016; Maskell & Malmberg, 1999; Figure 2.4):

> "…we [Hull City Council] were looking at potential competencies just about the same time as the banking crisis which as a manufacturing area, hit us particularly hard. So…we brought IBM in for an objective view…" Senior Director, HCC.

The proactive strategy and actions of HCC to identify local economic opportunities for Hull was common amongst most local authorities under the Labour government from 1997 – 2010 (Pike & Tomaney, 2009; IBM PLI, 2006). The absence of a strategic plan directly for the Humber region was also indicative of ABP's economic position, who traditionally aimed to secure long-term contracts with port users to appease its shareholders, as opposed to operating as a key actor for driving economic development in the Humber (Former Commercial Officer interview, former ABP; Verhoeven, 2010; Baird & Valentine, 2007).

The ‘Time to Act’ report published by DECC (Department for Energy and Climate Change) influenced the decision made by senior figures in ABP to reallocate the use of Alexandra Dock and capitalise upon emerging opportunities within the offshore wind industry (Former Commercial Officer interview, former ABP; DECC, 2009). This report on UK ports supporting the offshore wind industry was shaped by the Crown Estate announcing the development zones for Round 3 projects in comparatively close proximity to the River Humber and more broadly, the DECC’s ‘Strategic Environmental Assessment’ (SEA) revealing that up to 33GW of offshore wind capacity could be installed by 2020 (Former Commercial Officer interview, former ABP; DECC, 2009; The Crown Estate, 2010a; 2010b).

Hull City Council (HCC) was a key non-firm actor as it had statutory powers to change the ABP’s HRO remit and usage for activities on the Alexandra Dock from container handling activities to offshore wind activities (which required an approach to the UK government), making the Alexandra Dock an attractive infrastructural asset base for future investors (Senior Director interview, HCC; MacKinnon et al, 2018; University of Hull, 2018; Maskell & Malmberg, 1999). The dynamic working relationship between ABP and Hull City Council from 2008 onwards was crucial in changing the original HRO and bringing together a coalition of private and public actors at different points in time (Dawley et al, 2019; Notteboom, 2016; Wood, 1998; Cox, 1999).

> “The Siemens project was led by HCC very much with ABP, we were driving it. But the LEP’s role was also significant in that Lord Haskins as Chair was very effective at lobbying the government” Senior Director, HCC.

Furthermore, the subsequent introduction of the Humber LEP (Local Enterprise Partnership) in 2011, who were not granted the same authority, resources and development responsibilities as the now abolished Yorkshire Forward, meant that HCC became more entrepreneurial and proactive in attracting Siemens to the Alexandra Dock (Dawley et al, 2019; Pike et al, 2016b). This new role and influence of HCC enabled the PoH site to become more competitive in regard to capturing Siemens’ investment, as it coincided with the rival

AMEP (Able Marine Energy Park) on the south bank of the River Humber losing the political support of Yorkshire Forward following its abolishment (Dawley et al, 2019; Pike et al, 2016b). This account contrasts the role of sub-national government agencies in the PoC case, which revealed a stronger coalition of actors focused upon the adaptation and diversification of one port site to support offshore wind activities (Niedersachsen Ports, 2014; Cox, 1998; Wood, 1999).

Despite a renewed sense of strategic drive from ABP regarding the adaptation and diversification of the Port of Hull (PoH) into offshore wind, the Alexandra Dock's future development was always dependent upon "getting the right deal with a customer for the project", reflecting ABP's commercially driven motives and investment rationale as a private port authority (Commercial Manager interview, ABP; Verhoeven, 2010; Brooks, 2004). ABP required an anchor investment to validate its strategy to change the HRO and enable the conversion of the Alexandra Dock's under-utilised port infrastructure (Notteboom, 2016; Martin, 2010; Figure 2.4). In parallel, HCC identified and began promoting the Alexandra Dock at the PoH as a potential site for attracting an offshore wind turbine manufacturer such as Siemens (Senior Director interview, HCC; Maskell & Malmberg, 1999; Wind Europe, 2017a). This strategic action by HCC was shaped by the loss of the Quay 2005 project following the 2008 financial crisis and the clear need to provide new job opportunities and investment into Hull (Senior Director interview, HCC). Although HCC was promoting and directing the Alexandra Dock as a potential site for offshore wind, there was still an absence of a long-term vision and/or port 'Master Plan' for the Humber ports (Notteboom, 2016; Jacobs & Notteboom, 2011). This was shaped by ABP's control over development within its estate and the limited land availability for expansion around the Humber Ports, as the ports are enclosed by roads, industrial sites and residential areas (Executive Director interview, Humber LEP).

Siemens' original port investment interests in the late 2000s, to establish blade and nacelle manufacturing and turbine assembly facilities at a UK port, simulated engagement and meetings with senior executives at 'Yorkshire Forward', who were aiming to change how the Humber Ports were operating and developing to become more proactive, entrepreneurial and have greater bearing upon regional economic development (Monios & Wilmsmeier, 2016; Debrie et al, 2013; House of Commons, 2010; Assistant Director interview, BEIS):

> “We were trying to get the Humber ports to think about adding value to what went through the port to the local economy, rather than just being a holding place for cargo and cars” Former Executive Officer, former Yorkshire Forward.

Siemens’ search for a UK port site in 2009 spurred local authorities on the North and South banks of the River Humber to engage in close competition to secure Siemens’ investment. This competition diverged the regional support for two rival sites comprising the greenfield AMEP (Able Marine Energy Park) site on the River Humber’s South bank, owned by Able UK, and the Alexandra Dock site on the River Humber’s North bank at the PoH, owned by ABP (Senior Director interview, ABLE; BVG Associates, 2017). This divergence of support partly constrained the potential for forming a strategic coalition of regional firm and non-firm actors concerned with diversifying the Humber Ports’ into offshore wind (Cox, 1998, Wood, 1999; Notteboom, 2016).

Following Siemens’ search of over 100 UK port sites, the AMEP site, championed by Yorkshire Forward and central government, was chosen as Siemens’ preferred site on the Humber and UK (Former Executive Officer, former Yorkshire Forward; House of Commons, 2010). Siemens were attracted to the AMEP site as they could request Able UK to newly construct specialised port infrastructure on a greenfield site, as Siemens were unsure a port layout was suitable to support their future manufacturing and installation of turbines with co-located component suppliers (Senior Director interview, Able UK; MacKinnon et al, 2018).

Siemens’ UK search for a port site and ITT (invitation-to-tender) in 2010 catalysed ABP’s interest in diversifying into offshore wind and prompted ABP and HCC to work together to attract Siemens, thus attempting to shift Siemens’ interest in the AMEP site championed by Yorkshire Forward and central government (Commercial Manager, ABP; House of Commons, 2010; University of Hull, 2018). Throughout negotiations with Siemens, ABP stated that it would only invest to build port infrastructure if Siemens would also be prepared to invest and if Siemens’ activity was commercially viable in securing returns for ABP, which was indicative of ABP assuring investment value for its shareholders (Verhoeven, 2010; Brooks, 2004). Furthermore, “Siemens hadn’t gambled on the UK offshore wind market” until ABP matched Siemens’ investment interest and planned to develop “port infrastructure based on securing a long-term deal with Siemens", as ABP very rarely speculates (Former Managing Director, former ABP).

Senior UK government Ministers and officers who supported the UK offshore wind market through ROC subsidies, put pressure upon senior executives at ABP to validate the UK government's support and sign an MoU with Siemens in 2010, in order to catalyse a new path around offshore wind by creating new jobs and supply chain development in the Humber region (DECC, 2009; Financial Times, 2011; Martin, 2010):

> "If ABP was going to invest and get a bit of this action from the subsidised offshore wind market then the UK government wanted to have some kick-back…and that particular kick-back was the rejuvenation of the Alexandra Dock" (Former Senior Advisor, Green Port Hull).

The MoU was not a legally binding investment commitment or joint venture at this stage and each party could legally pull out of this partnership commitment, making the future adaptation and diversification of the PoH uncertain (Technical Director interview, WSP; HM Government, 2014a; Notteboom, 2016). Siemens' decision to sign the MoU with ABP and UK government in 2011 for its transplantation into the PoH was influenced by a range of criteria, factors and conditions (Former Managing Director interview, former ABP). These included the distinctive scale of existing Alexandra Dock with longest available quay on the Humber, short steaming time from the PoH to respective North Sea offshore wind projects, ABP's willingness to invest and its planned deliverability of port infrastructure, the UK government approval of revised HRO and Hull City Council (HCC) ensured that local planning permission would be in place, and HCC, East Riding of Yorkshire Council, ABP and University of Hull would formulate the £25.7m 'Green Port Growth Programme' supporting skills development, site assembly, business investment advice and grants, research development and innovation (Former Managing Director interview, former ABP; HM Government, 2014a; University of Hull, 2018; MacKinnon et al, 2018).

Siemens were discouraged from transplanting into the AMEP because the 'Development Consent Order' process caused lengthy delays for developing the greenfield AMEP (Former Managing Director interview, former ABP). Siemens were further discouraged by an ongoing high-level legal battle between Able UK and ABP regarding the future development of the AMEP site, which was triggered by ABP in response to heightening competition from Able UK and its AMEP site (BBC News, 2015; MacKinnon et al, 2018; Jacobs & Notteboom, 2011):

> "We lost out on Siemens simply because at that point we didn't have planning for the AMEP…it has been one of the most complicated and hard-fought battles…we had ABP opposing us at every level" Senior Director, Able UK.

Ultimately, Siemens' intent was to build a facility for manufacturing nacelles at the PoH's Alexandra Dock site and a blade assembly plant at the Paull site, both located on the north bank of the Humber and owned by ABP (University of Hull, 2018; Financial Times, 2011; MacKinnon et al, 2018). However, a change of national institutional and political contexts regarding the UK government's commitment to renewable energy and offshore wind resulted in a period of uncertainty and delay around the Humber Ports' adaptation and diversification, and the regional path around the offshore industry wind (MacKinnon et al, 2018; Notteboom, 2016; Martin, 2010; Financial Times, 2014).

6.2.2 Diversification into Operations and Maintenance (O&M): 2007 onwards

The second element of this episode is centred upon how infrastructural and material assets of the 'Fish Dock' at the Port of Grimsby (PoG) were diversified and converted to support O&M activities and created the early regional offshore wind path (Notteboom, 2016; Jacobs & Notteboom, 2011; Maskell & Malmberg, 1999; Martin, 2010; Figure 2.4). The declining fish handling and storage activities was the primary focus of business and infrastructure usage at the PoG's Fish Dock before the arrival of O&M activities (Senior Advisor, Ørsted; BBC News, 2007). However, an enabling policy environment for offshore wind influenced developers to construct offshore wind projects and convince Centrica to transplant into the PoG to conduct O&M activities (DECC, 2009; BBC News, 2007; IRENA, 2012; The Crown Estate 2017b).

The initial diversification of the PoG's asset base and market portfolio into offshore wind began with ABP transferring decision-making powers and responsibilities to the Grimsby Fish Dock Enterprises Ltd (GFDE) as the Fish Dock's operator, including the power to lease port areas from ABP (Martin Boyers interview, GFDE; Debrie et al, 2013). However, ABP's original aim was to enable the adaptation and diversification of the Fish Dock into a fish market and for supporting fish storage and processing activities (Martin Boyers interview, GFDE; Boas, 2007). The GFDE was formed in 1991 by the "fish merchants association, the Grimsby fishing vessel owner association, the marine engineering association, a slipway company, individuals in the seafood industry and North East Lincolnshire Council (NELC)", who jointly decided to create a new economic future for the Fish Dock (Senior Officer interview, North East Lincolnshire Council). The transfer of decision-making powers around business development, planning, strategic use of assets, autonomous investment approval and permitting GFDE to have its own tenants, meant that the GFDE was the main actor for engaging with offshore wind firms interested in transplanting into the PoG from 2007 onwards (Senior Officer interview, NELC; Debrie et al, 2013; Brooks & Cullinane, 2007b). The GFDE adopted a 'proactive' investment strategy as a result of its declining activities in the weakening UK fishing industry, aiming to generate a new dues and rent via O&M operators by utilising existing and constructing new infrastructure at the Fish Dock, which was rented from ABP (Senior Director interview, GFDE; Monios & Wilmsmeier, 2016; BBC, 2007; 2013).

To anticipate and capitalise upon the potential of O&M opportunities within the offshore wind industry and stimulate a future growth path for the wider Humber region the GFDE, NELC (North East Lincolnshire Council) and 'Offshore Wind Power Support Ltd' operating as an offshore wind support firm, formed the 'Grimsby Renewables Partnership' (GRP) in 2008 as part of the NELC (Senior Officer interview, NELC; NELC, 2018). The GRP included ABP as a vital player and was critical for shaping the future market activity of the Humber Ports in offshore wind, as ABP was the PoG's owner and had ultimate control over the PoG's users, asset base, market portfolio, investments and future strategic development (Senior Officer interview, NELC; Brooks & Cullinane, 2007b). The GRP was formed for creating a new vision for the Fish Dock and this vision was strongly influenced by the long-term decline of fishing activities (Senior Director interview, GFDE). The GRP's primary function was centred upon supporting inward investments and marketing the PoG as a key infrastructural asset base to the emerging offshore wind industry (NELC, 2018; Markard & Petersen, 2009; Maskell & Malmberg, 1999; IRENA, 2012).

The GFDE were initially informed of Centrica's activity in the North Sea by a small vessel owner who was conducting a met mast survey for Centrica and confirmed that Centrica was interested in constructing an offshore wind project in close proximity to the River Humber and required a port base (Senior Director interview, GFDE). After Centrica were awarded market support from the UK government via ROCs, Centrica formally approached senior individuals at the GFDE in 2007 to transplant into the PoG to support their 'Lynn' and 'Inner Dowsing' offshore wind projects, which triggered the GFDE to provide investments into refurbishing the Marine Control Office and constructing a new pontoon to support Centrica's O&M activities (Senior Director interview, GFDE; BBC News, 2007):

> "Centrica's met mast survey turned out to be good for developing offshore wind farms… then everything became in our favour. Centrica wanted a port base. We [GFDE] invested on the back of this…I convinced our directors" Senior Director, GFDE.

In addition to Centrica's transplantation, Siemens identified the PoG as a suitable port base for offshore wind and moved a service team into Centrica's facility in 2008 to support the operations of the Lynn and Inner Dowsing projects (Senior Officer, NELC). Furthermore, Centrica provided an additional £3.6M investment in 2012 to add new facilities in the Fish Dock to provide more specialist O&M services (OffshoreWIND, 2012a; MacKinnon et al, 2018). The transplantation of Centrica was an early example of the Humber Ports' diversification into O&M activities at the PoG and supported the creation of a new regional path around offshore wind, which was reflected through new job creation and smaller firms involved in building or commissioning O&M support vessels (Senior Executive interview, Team Humber Marine Alliance; Notteboom, 2016).

6.3 Disruptions and divergent sub-regional paths: 2011-2013

The structure and organisation of this episode is two-fold, with both elements occurring in parallel chronologically which explain divergent sub-regional paths of growth at the port level. The first element concerns the uncertainty and disruption around Siemens' transplantation and ABP's associated investment into the PoH. The second element is around continued O&M activity at the PoG which was catalysed by private investment from offshore wind developers such as Centrica, E.ON and Ørsted, and set within the broader context of planned offshore wind projects nearing the construction phase.

The Humber Ports' initial adaptation and diversification into offshore wind at the PoH (Port of Hull) and the PoG (Port of Grimsby) provided renewed political and economic optimism around Humber region, created a significant opportunity to increase regional employment and grew the regional offshore wind supply chain (Notteboom, 2016; MacKinnon et al, 2018; Financial Times, 2011; BBC News, 2007; 2013; Figure 2.4). However, the Humber Ports' adaptation and diversification and the regional offshore wind was subsequently constrained by the UK's changing offshore wind policy environment, thus creating great uncertainty for developers who were consequently delaying orders to turbine component manufacturers such as Siemens (Financial Times, 2014; Dawley et al, 2015; MacKinnon et al, 2018).

The changing offshore wind policy environment was driven by the Coalition government announcing the Electricity Market Reform (EMR) within its White Paper published in July 2011, which comprised a shift to a CfD (Contracts for Difference) subsidy arrangement based upon a competitive bidding process from 2017 onwards, thus moving away from the ROC (Renewable Obligation Certificate) direct subsidy system (DECC, 2011; DECC, 2012; Dawley et al, 2015). This shifted the institutional landscape and created a constraining institutional environment for offshore wind in the UK, which consequently disrupted investment decisions from project developers, manufacturers and port authorities (DECC, 2011; Martin, 2010; Dawley et al, 2015). The introduction of the EMR created uncertainty by creating a transition to the new subsidy arrangement (Assistant Director interview, BEIS; Dawley, 2014; Dawley et al, 2015). Furthermore, the coalition government also announced a reduced installed capacity estimate from the previous 33GW by 2020 to 8-16GW by 2020 within its *Offshore Wind Industry Strategy* (OWIS), an estimate which could change depending upon a range of factors including unknown levels of cost reduction (DBIS; 2013; HM Government, 2013). This further catalysed and deepened market uncertainty, as developers had unclear estimates and no clearly defined installed capacity target for UK offshore wind project development (DBIS, 2013).

Despite the growing uncertainty around Siemens' transplantation into the PoH and ABP's associated investment, O&M activities at the PoG continued and underwent a period of growth, as developers such as Ørsted planned future offshore wind projects which could be operated and maintained from the PoG (Financial Times, 2014; BBC News; 2013; Ørsted, 2019). This period of O&M activity and growth was influenced by the Crown Estate's designation of Round 3 projects from 2010 onwards and the continued awarding of ROC subsidies to developers, which created an attractive economic opportunity for developing offshore wind projects from UK ports (Dawley, 2014; IRENA, 2012; The Crown Estate, 2017b; Wind Europe, 2017a).

6.3.1 Disruption of investment into manufacturing activity: 2011-2013

The UK government's political and institutional change with the election of a Conservative-led coalition created a different standpoint on UK offshore wind market support and the future estimates regarding the installed capacity of offshore wind turbines, which resulted in a constraining institutional environment for the UK offshore wind market and consequently disrupted the diversification of the Humber Ports into offshore wind (Dawley et al, 2015; DECC, 2012; HM Government, 2013; Martin, 2010; 2000). Essentially, the institutional and policy changes disrupted the scale and speed of investment from developers and the consequent demand for port sites to support the construction of UK offshore wind projects, thus constraining the adaptation and diversification of the Humber Ports into offshore wind (Dawley et al, 2015; HM Government, 2013; Notteboom, 2016). The introduction of the EMR (Energy Market Reform) and Levy Cost Framework (LCF), alongside changes to the installed capacity targets in the OWIS, were the primary driver for influencing Siemens' uncertainty and disrupted their planned investment into the PoH (Dawley et al, 2015; DECC, 2011; DECC, 2012). This subsequently hindered ABP's planned investment to support Siemens' transplantation and constrained the Humber Ports' diversification and the region's offshore wind path development (Martin, 2010; Financial Times, 2014):

> "The period between the [Siemens and ABP] MoU and their Final Investment Decisions was fraught with policy issues and Siemens were on the point of saying 'do you really want this investment?'" Senior Director, HCC.

Consequently, Siemens began searching for alternative continental port sites to manufacture and assemble their nacelle and blade components. This strategy was shaped by Siemens' concerns around the UK government’s long-term ambition regarding the future targets of installed turbines and its long-term commitment to supporting the market through the CfD subsidy system (Regional Manager interview, A2SEA; MacKinnon et al, 2018; DECC, 2011; 2012).

However, Siemens’ major investment delay stimulated firm and non-firm actors to tackle a range of policy, planning, consenting and industrial challenges (Project Manager interview, former ABP). Responding to and solving these challenges was vital to enable the conversion of the Port of Hull’s infrastructural and material assets and capture Siemens’ ‘Final Investment Decision’ (FID) (Boas, 2007; Figure 2.4).

Siemens’ investment delay was born out of the UK’s offshore wind policy and market settings when Siemens carried out their UK port search in 2009/10 and subsequently signed the MoU with ABP and the UK government (The Crown Estate, 2017a; 2017b; Martin, 2010):

> “When Siemens made their commitment to Hull through the MoU there was only ‘Round 1’ allocated and an indication that there would be further rounds to follow but no guarantee. Siemens wanted the right level of government support in the long-term” Commercial Manager, ABP.

ABP, as the private owner and operator of the Humber Ports, required a legal financial commitment through a FID (Final Investment Decision) and a commercially viable business case from Siemens before they would invest to enable the conversion of port infrastructure for Siemens (Former Managing Director interview, former ABP; Brooks, 2004; Figure 2.4). This investment rationale is indicative of ABP’s profit-orientated approach of investing into infrastructure to support typical cargo handling activities for a short to medium term return (Verhoeven, 2010; Brooks, 2004). Despite Siemens’ delay and uncertainty, ABP’s commitment to Siemens through the MoU brought about certain obligations to invest capital for undertaking planning applications, environmental impact assessments and site inspections (Project Manager interview, former ABP; HM Government, 2014a; University of Hull, 2018). However, Siemens and ABP were both actively seeking clarity on UK offshore wind policy post-2020 regarding installed capacity expectations, the future of CfD auctioning rounds and Crown Estate licensing rounds, alongside the long-term strategic commitment of the UK government to the offshore wind industry (Senior Director interview, HCC; DECC, 2012; DBIS, 2013; The Crown Estate, 2017b; Financial Times, 2014):

> "There were some policy issues around the industrial future of offshore wind and guarantees about the future of offshore wind deployment. We were trying to build that national perspective for Siemens and ABP" (Assistant Director, DBEIS).

The investment delay allowed a coalition of local, regional and national actors to work together differently at different points in time to unlock Siemens' transplantation and ABP's investment, whilst lobbying and negotiating with the UK government to clarify the future CfD subsidy rounds and meeting with the Crown Estate to better understand the implantation of future licensing rounds (Assistant Director, BEIS; Cox, 1998; Wood, 1999; Financial Times, 2014).

ABP, Siemens and Hull City Council also formed a 'Joint Project Team' (JPT) to deal with project-based industrial, planning, consenting and regulatory challenges constraining the Siemens and ABP investments and the conversion of Alexandra Dock for offshore wind (University of Hull, 2018; Cox, 1998; Wood, 1999; Boas, 2007). The JPT worked with a range of statutory (MMO [Marine Management Organisation], Environment Agency, Highways England, Historic England, the Crown Estate and Natural England), and non-statutory (RSPC, Yorkshire & Lincolnshire Wildlife Trusts, The Ramblers Association, Trans-Pennine Trail, Sustrans, the Local Access Forum) agencies (Project Manager interview, former ABP; University of Hull, 2018). The 'Single Conversation Group' (SCG) was also formed by the Humber LEP to bring together statutory agencies, Hull City Council, East Riding of Yorkshire Council and the Humber LEP to ensure "planning and regulatory procedures around the Siemens investment were done as speedily as possible", working in parallel with JPT (Assistant Director interview, DBEIS). These two groups were attempting to solve a range of project development challenges to enable Siemens' transplantation and ABP's investment and to support construction activities upon brownfield land (Project Manager interview, former ABP). The formation of the JPT by a group of actors working through technical and planning issues of the Alexandra Dock and the SCG operating as a strategic group of interested parties, demonstrates how a collection of multiscalar firm and non-firm actors responded to Siemens' keen interest as a large inward investor (Cox, 1998, Wood, 1999;

University of Hull, 2018). However, this coalition of actors was temporary in their actions, had overlapping responsibilities for adapting the Alexandra Dock, operated across two distinctive groups, worked on different spatial scales and conducted strategic actions at different points in time (Dawley et al, 2019; Phelps & Wood, 2006; Cox, 1998, Wood, 1999).

A major industrial challenge was around constructing the quay wall at the Alexandra Dock on brownfield land to support the loading of turbine components onto a new specialised vessel owned and operated by 'A2SEA', who influenced the construction of the quay, because "Siemens asked us [A2SEA] what we needed to allow our vessels to do offloading … so ABP's new quay is based upon our requirements" (Regional Manager, A2SEA).

There were also a number of planning, consenting, regulatory and environmental challenges constraining the Alexandra Dock's conversion which required lengthy public consultations supported by the JPT and SCG, resulting in a coastal realignment scheme, public right of way diversion, safeguarding of listed buildings and relocation of pre-existing site users (Boas, 2007; University of Hull, 2018).

> "The bureaucracy, legislation, planning and consenting controls and public objections made it unbelievably hard to deliver this project and very very hard to deliver it in any sort of commercially viable timeframe for Siemens" Project Manager, former ABP.

One of the most critical challenges was the approval of a HRO (Harbour Revision Order) to allow Alexandra Dock at the PoH to support offshore wind activities. This involved adapting the existing HRO for container handling activities for the proposed 'Quay 2005' terminal (DfT, 2006; University of Hull, 2018). Hull City Council (HCC) acted as an important local actor within the coalition of actors through brokering high-level negotiations between ABP, Siemens and the UK government (Senior Director interview, HCC; Notteboom, 2016; Cox, 1998; Wood, 1999). This activity enabled the HRO's approval by the Secretary of State for Transport and HCC 'Outline Planning Permission' to build a wind turbine manufacturing facility at the Alexandra Dock in May 2012 (DfT, 2006; URS, 2012b; Hull City Council, 2012; University of Hull, 2018):

“We worked closely with the statutory agencies because Alexandra Dock was a listed structure… we had to ‘herd the cats’ as it were…we had to work with two Secretaries of State and senior officers, we got them onside by saying… ‘we have a huge opportunity with Siemens and we want to make sure everything goes well’” Senior Director, HCC.

Furthermore, HCC proactively fast-tracked the conversion of the brownfield Alexandra Dock through a ‘Local Development Order’, meaning ABP and Siemens had consent to convert the Alexandra Dock in September 2013, which aligned to Siemens’ required timeframe for constructing their new manufacturing facility (Executive Director interview, Humber LEP; URS, 2012a; 2012b; , University of Hull, 2018):

> “I think is amending existing consent as opposed to going through a new Development Consent Order process like Able had to for their site, actually won us Siemens” Former Managing Director, former ABP.

In addition to HCC, there were also efforts from a coalition of regional and national actors who utilised political agency and provided Hull with leverage to capture and finalise the Siemens’ transplantation and ABP’s investment (Cox, 1998; Wood, 1999; Financial Times, 2011). High-ranking individuals within the Humber LEP, the Team Humber Marine Alliance (THMA) and MPs who had significant standing and relationships with Ministers and senior government officials, lobbied the UK government on behalf of the Humber region’s local authorities, Siemens and ABP (Executive Director interview, Humber LEP; University of Hull, 2018):

> “We had times when things looked a bit uncertain and you need to call on superiors and having those people with political clout was really helpful when there were policy problems” Executive Director, Humber LEP.

The primary purpose of these lobbying activities was to gain clarity over the levels of financial support within future CfD auctioning rounds, the Crown Estate licensing rounds and the long-term commitment of the UK government to supporting offshore wind projects for developers, manufacturers and ports (Executive Director interview, Humber LEP; DECC, 2012; The Crown Estate, 2010a; 2010b).

Clarity around the future of national offshore wind policy and the pipeline of projects for developers was crucial for Siemens and ABP, as Siemens required enough component orders from developers to justify transplanting into the PoH, whilst ABP required Siemens' investment to commercially justify their investment as a private port authority (Former Commercial Officer interview, former ABP; Financial Times, 2014; ; Verhoeven, 2010; Brooks, 2004):

> "It's all about securing industry confidence to kick-start manufacturing because port infrastructure and facilities are pretty expensive and specialised for offshore wind … and the answer is central government" Former Managing Director, former ABP.

Political lobbying and high-level discussions between the UK government and the coalition of regional and national actors led to the Department for Energy and Climate Change (DECC) indicating in March 2013 that a FIDeR (Final Investment Decision enabling for Renewables) Scheme was to award eight renewable energy projects with CfD contracts in May 2014 (DECC, 2013; 2014b). This FIDeR Scheme gave prospective developers some degree of clarity and confidence that the UK government was prepared to support offshore wind investment through the new EMR policy framework (Former Commercial Officer interview, former ABP; DECC, 2012). Nevertheless, it was not until Spring 2014 that offshore wind developers, manufacturers and port authorities knew which renewable energy projects were to be awarded CfDs and could obtain a visible pipeline of orders from project developers (DECC, 2013; 2014b). As such, Siemens' and ABP's investment delays triggered great uncertainty in the Humber region and nationally. However, it allowed a coalition of local, regional and national level actors with overlapping responsibilities and conducting different activities at different times to work together strategically and attempt to capture Siemens' interest to transplant (Cox, 1998; Wood, 1999). This enabled the Humber Ports' diversification and the stimulation of a new path regional offshore wind path (Notteboom, 2016; Martin, 2010; Martin & Sunley, 2006).

6.3.2 Continued investment into Operations and Maintenance (O&M): 2011-2013

Despite the Humber Ports' adaptation and diversification becoming disrupted through the uncertainty of Siemens' and ABP's investment delays, operations and maintenance (O&M)

activities at the ‘Fish Dock’, Port of Grimsby (PoG) continued without interruption as they were less affected by market and investment uncertainty in comparison to manufacturing activities (Notteboom, 2016; Financial Times, 2014). The continued growth of O&M activities at the PoG was driven by developers such as Ørsted planning and investing into future offshore wind projects including ‘Lincs’, ‘Westmost Rough’, ‘Race Bank’ and ‘Hornsea Project One’, which could be operated and maintained from the PoG in the future (Ørsted Hornsea Project One, 2018; Ørsted, 2019). In addition to the arrival and continued operation of Centrica and Siemens’ service team in the PoG, additional developers and O&M operators transplanted into the PoG to conduct O&M activities, which would drive forward the adaptation and diversification of the Humber Ports into offshore wind (Notteboom, 2016; BBC News, 2007; 2013; Centrica, 2012b).

E.ON was the next developer after Centrica to capitalise upon the existing port infrastructure at the Fish Dock and approached the GFDE (Grimsby Fish Dock Enterprises) to transplant O&M operations in 2012 to serve its ‘Humber Gateway’ project (OffshoreWIND, 2012b). E.ON’s transplantation led to a creation of 50 jobs and the construction of new office facilities upon brownfield land, thus developing the region’s offshore wind path (OffshoreWIND, 2012a; Martin, 2010). As part of securing the E.ON investment and future activities, E.ON required the GFDE to construct new pontoon infrastructure and lock gates to allow larger O&M vessels to access the Fish Dock (Senior Advisor interview, Ørsted). These construction activities were enabled by investment from the GFDE and a £500,000 grant from the NELC (North East Lincolnshire Council) through its ‘Change Board programme’ and was originally enabled by close discussions between the GFDE, NELC, E.ON and ABP (Senior Officer interview, NELC; Fishupdate, 2014). Once again firm and non-firm actors worked together strategically to enable E.ON’s transplantation and construct an important infrastructural asset in the lock gates to attract future O&M activities (OffshoreWIND, 2012a; 2012b). The GFDE, NELC and ABP worked in close coordination with interested developers such as Centrica and E.ON to stimulate the growth of O&M activities at the PoG. They formed part of a broader coalition of firm and non-firm actors on national, regional and local scales who were concerned with diversifying the Humber Ports and creating a new regional path around the offshore wind industry (Cox, 1998; Wood, 1999; Notteboom, 2016; Martin, 2010).

Subsequently, Ørsted (previously named DONG Energy) approached the GFDE in 2013 to transplant onto brownfield land in the Fish Dock and construct office facilities to support O&M activities for its Westermost Rough project, as “the Fish Dock infrastructure largely met our needs for our early offshore wind projects” (Senior Advisor interview, Ørsted; Ørsted, 2017). To secure Ørsted’s investment, GFDE constructed a new pontoon and berth for Ørsted’s O&M vessels (Senior Director interview, GFDE). The GFDE and the Fish Dock, as a key infrastructural asset, also attracted RES and CWind who operate as smaller O&M service providers and who invested in 2013 (with CWind later expanding in 2018), thus adding to the PoG’s O&M activities and supporting the regional offshore wind path (OffshoreWIND, 2013a; Humber Business, 2018a).

As such, the diversification and conversion of port infrastructure at the Fish Dock was enabled by the GFDE’s proactive investment strategy to provide suitable port infrastructure, centred upon meeting the port demands of developers and having “the ability to get European and central government funding through the [North East Lincolnshire] council” (Senior Director interview, GFDE; Monios & Wilmsmeier, 2016; Boas, 2007). This was shaped by GFDE’s governance and ownership model as “a type of cooperative business and operating like a consortium effectively” (officially a Private limited Company), who have received around £2.2 million in grants from the EU and UK government and have spent approximately £3 million on infrastructure supporting O&M activities (Senior Director interview, GFDE; GFDE, 1991a; 1991b). Essentially the range and growth of O&M activities at the Fish Dock was shaped by investments from the GFDE and firms, which created a considerable demonstration effect and led to ABP later realising that O&M was an important port market in supporting offshore wind activity.

6.4 Path realisation: 2013 onwards

The final episode marks a distinctive period of change from the previous episode of uncertainty and delay constraining the Humber Ports’ adaptation and diversification and hindered the development of a regional offshore wind path (Notteboom, 2016; Jacobs & Notteboom, 2011; Martin, 2010; Figure 2.4). This episode is organised into two elements. The first element is around the transplantation of Siemens into the Port of Hull (PoH) to conduct manufacturing and installation activities, and the second element is the continued expansion and private investment from Ørsted into the Royal Dock at the Port of Grimsby (PoG) to conduct further O&M activities. Although Siemens and Ørsted were involved in different offshore wind activities at different ports on the Humber, they both made strategic transplantations and ongoing investments to drive forward the construction of infrastructural assets and superstructure upon brownfield land (BBC News, 2013; 2014; Maskell & Malmberg, 1999). These flagship investments enabled the Humber Ports to diversify on a greater scale in terms of port assets and firm activities supporting the offshore wind sector, which fully established a new regional path around offshore wind (Humber Business, 2018b; 2018c; Notteboom, 2016; Martin, 2010; Boas, 2007; Figure 2.4).

6.4.1 Flagship investments into manufacturing activity: 2013 onwards

This element of the episode is around Siemens' and ABP's FID (Final Investment Decision) to legally commit to investing in a joint venture (BBC News, 2014). These investments enabled the PoH (Port of Hull) to become a manufacturing and installation base for offshore wind through constructing port assets at the Alexandra Dock and the Paull site on the North bank of the River Humber (University of Hull, 2018; Maskell & Malmberg, 1999). The legal commitments of Siemens and ABP to their joint venture enabled the transplantation of Siemens into the PoH and ABP's provision of investment to construct port infrastructure, which catalysed a new regional path around the offshore wind industry (BBC News, 2014; Martin, 2010; Boas, 2007). Siemens' Final Investment Decision (FID) to provide £160M for its joint venture with ABP was largely underpinned by the UK government's decision for the first FIDeR round in 2014 which supported five offshore wind projects and provided a new market for Siemens (NAO, 2014; Martin, 2010; DECC, 2014b):

> "DECC gave a high amount of the manufacturing capacity for turbines which was supported in the first FIDeR process to Siemens…so Siemens had a solid pipeline which meant that they were able to invest into their facilities at Hull" Former Commercial Officer, former ABP.

This meant Siemens were the main supplier of turbine components for developers constructing the East Anglia ONE and Neart na Gaoithe offshore wind projects, who were the awarded contracts in the first CfD round in 2015 (DECC, 2014b).

A key example of important operational work which facilitated the Siemens investment, was when HCC and SCG worked closely with Siemens to drive forward the approval of Siemens' new planning application for turbine manufacturing and installation facilities at the Alexandra Dock by September 2014 (Hull City Council, 2014; University of Hull, 2018). This allowed Siemens and ABP to commence the tightly scheduled construction activities corresponding to demands of developers (Executive Director interview, Humber LEP).

ABP's FID to provide £150M for its joint venture was influenced by ABP gaining renewed confidence in Siemens' investment interest in the PoH (Former Managing Director, former ABP; BBC News, 2014). ABP's decision was directly shaped by Siemens becoming newly confident of demand from developers, who had received CfDs within the first FIDeR round (NAO, 2014; DBIS, 2014b; BBC News, 2014):

> "The developers gained confidence because of the government's actions and signed with Siemens to buy their components…then Siemens thought 'we better find a suitable port' and they had a deal with ABP waiting" Former Managing Director, former ABP.

To enable ABP's FID, senior executives within ABP presented a business case to shareholders as a reaction to Siemens' renewed interest, as the FID needed to be commercially viable and based upon the medium to long-term activity of Siemens at the Port of Hull (PoH) (Commercial Manager interview ABP; Monios & Wilmsmeier, 2016; Verhoeven, 2010; Brooks, 2004). ABP's FID to invest £150M marked a distinctive turning point in ABP's corporate decision-making approach as a private port authority, as they made a strategic investment guaranteed to make long-term and steady returns and was directly shaped by Siemens' project-based activity within the UK offshore wind industry (Former Commercial Officer interview, former ABP; BBC News, 2014; Verhoeven, 2010). The FIDs by ABP and Siemens enabled the Humber Ports' adaptation and diversification by prompting Siemens' transplantation and the construction of infrastructure and superstructure at the PoH to support offshore wind activities, thus supporting the regional path around the offshore wind industry (BBC News, 2014; Martin, 2010; Boas, 2007; Figure 2.4).

ABP began constructing infrastructure at the Alexandra Dock in November 2014 to enable Siemens' transplantation of its nacelle manufacturing and assembly operations (BBC News, 2014). However, in the same month Siemens decided against its strategy of manufacturing nacelles at the Alexandra Dock and turbine blades at the Paull site, shifting its transplantation and investment strategy to manufacture blades at the Alexandra Dock and moving the manufacturing and assembly of nacelles to the Port of Cuxhaven (University of Hull, 2018; ; Siemens, 2016b). Siemens decided to shift their production of nacelles to the Port of Cuxhaven because they could access and build a co-located supply chain on a large quayside area whilst having area for expansion (Commercial Manager interview, ABP; Siemens Gamesa, 2017; Humber Business 2018c):

> "In order to make a project operate successfully for offshore wind you need to be able to be quayside based for almost all of your activity to reduce land and marine logistics costs" Project Manager, former ABP.

Siemens' motive to change its UK investment strategy corresponded to their inability to co-locate suppliers on the Alexandra Dock or Paull site and their inability to move large turbine blades between the Paull site and the Alexandra Dock due to unsuitable road infrastructure (Former Commercial Officer, former ABP; University of Hull, 2018; BVG Associates, 2017). Both ABP and Siemens were reluctant to invest an extra £20M to plan, consent and construct new road and port infrastructure to connect the Alexandra Dock to the Paull site, leading to questions over who would pay for the extra costs (University of Hull, 2018; BVG Associates, 2017).

Substantial efforts were again spearheaded by Hull City Council (HCC) to adjust planning consent for Siemens' new blade manufacturing and pre-assembly facility at the Alexandra Dock, as a result of Siemens' altering their manufacturing and investment strategy to construct their planned nacelle manufacturing facility to the Port of Cuxhaven (Senior Director interview, HCC; Hull City Council, 2015; Siemens, 2016a; 2016b; Siemens Gamesa, 2017):

> "From November 2014 to June 2015 there was no planning consent when the Siemens factory was under construction. Some local authorities might have said 'we need to stop until we get permission'. That flexible can-do approach was important" Senior Director, HCC.

Key individuals and highly skilled project managers at ABP in Hull responded to Siemens' new port demands by designating a new operational layout to increase blade production from 450 to 600 per year, whilst managing a strict completion deadline of January 2017 (Project Manager interview, former ABP; Siemens, 2016a). These efforts on the operational scale by HCC and ABP, as part of a broader coalition of firm and non-firm actors, lubricated and facilitated the construction of port infrastructure and superstructure at the Alexandra Dock for Siemens' blade manufacturing and pre-assembly facility (Notteboom, 2016; Cox, 1998; Wood, 1999).

Following the relocation of existing customers and an extensive series of construction activities, Siemens' blade manufacturing and pre-assembly facility in the PoH began operations in September 2016 and the production of blades began December 2016, with the first installation vessels departing in early January 2017 (Project Manager interview, former ABP; Siemens, 2016a; University of Hull, 2018). Siemens' transplantation into the PoH and ABP's investment underpinned the diversification and conversion of the PoH's infrastructural and material assets on brownfield port land, thus catalysing the Humber Ports' adaptation and diversification into offshore wind and greatly enhanced the regional path around the offshore wind industry (Notteboom, 2016; Jacobs & Notteboom, 2011; Maskell & Malmberg, 1999; Boas, 2007; Martin, 2010; Figure 2.4). Siemens created a manufacturing plant for producing lower value blades with fewer supply chain linkages but with a greater labour intensity in the Humber, instead of producing higher value and specialised nacelles with high-skilled engineers (Siemens Gamesa, 2017; Dawley et al, 2019). This meant that the Humber's industrial path was less advanced in terms of manufacturing activities in comparison to the path revealed in the PoC case, which ultimately downgraded the PoH within Siemens' global production network (Siemens Gamesa, 2017; Coe & Yeung, 2015; Dawley et al, 2019; Martin, 2010).

6.4.2 Ongoing Ørsted investment and expansion: 2013 onwards

The second element of the final episode is around Ørsted's investments from 2013 onwards to expand its operations within the Port of Grimsby (PoG) and construct infrastructure at the Royal Dock to support new O&M activities, which enabled the Humber Ports' diversification and further developed the regional path around the offshore wind industry (Ørsted, 2017; Martin, 2010). The UK government created an attractive market environment for Ørsted and stimulated their investment into originally deciding to develop their 'Westmost Rough' offshore wind project (Martin, 2010; Ørsted, 2017). This was done through the UK government awarding Ørsted financial support through a ROC and the Crown Estate awarding Ørsted consent to develop the Westermost Rough site in November 2011 (Senior Advisor interview, Ørsted; Martin, 2010; Ofgem, 2016; Ørsted, 2017).

Ørsted's £11.5M investment to construct infrastructure and superstructure on brownfield land at the Royal Dock was influenced by its necessity to support the long-term O&M of its Westermost Rough project, which was planned to be fully commissioned and operational by 2015 (Senior Advisor interview, Ørsted; Ørsted, 2017):

> "The key driver for DONG [Ørsted] investing and moving into the Royal Dock was its existing infrastructure and they also needed a bigger lock for any bigger vessels in the future" Senior Officer, NELC.

Ørsted's investment was supported by a £1.1M grant from the UK government's 'Growing the Humber' Regional Growth Fund (RGF), administered by the Humber Local Enterprise Partnership (LEP) and NELC (OffshoreWIND, 2013b; Ørsted, 2017). Although this engagement and close coordination between these local, regional and national government actors supported Ørsted's investment through awarding the RGF grant, Ørsted's decision to invest was primarily driven by the pre-existing infrastructural and material assets at the Royal Dock (Executive Director interview, Humber LEP; Maskell & Malmberg, 1999; Ørsted, 2017). These assets included assessible quayside infrastructure, a larger lock than the Fish Dock's lock to handle SOVs (Service Offshore Vessels) in the future, availability of quayside space for expansion and close proximity to the 'Westermost Rough' offshore wind project to enable short steaming time (Executive Director interview, Humber LEP; Senior Advisor interview, Ørsted; Ørsted, 2017).

Offshore wind developers such as Ørsted have greater power than component manufacturers to demand port sites such as the PoG, as developers control how, where and when the installation, operation and maintenance of their offshore wind projects from a particular port location (Senior Advisor interview, Ørsted). This provided ABP in Grimsby and the North East Lincolnshire Council (NELC) with greater leverage than Hull City Council (HCC) and East Riding of Yorkshire Council to secure new and renewed inward investment for O&M, as project developers favoured the PoG over the PoH for conducting O&M activities because of the appropriate infrastructural asset base and had previously demonstrated the suitability of the PoG for supporting O&M (Senior Officer, NELC; Maskell & Malmberg, 1999). The different levels of power and influence of local authorities in the Humber shaped their ability to capture inward investment, whilst operating within a broader coalition of actors concerned with the development and diversification of the Humber Ports into offshore wind (Cox, 1998; Wood, 1999; Notteboom, 2016).

Ørsted's investment was supported by ABP providing a £5M investment to convert lock gates at the Royal Dock, thus enabling Ørsted's O&M vessels to assess the lock for almost 24 hours rather than being tidally restricted (ABP, 2014; Boas, 2007):

> "ABP are a very commercial and profit orientated organisation…they wouldn't have minded investing in the new lock gates if they knew they were getting future business from us [Ørsted] as a result" Senior Advisor, Ørsted.

ABP's investment into the lock gate infrastructure was also catalysed by ABP observing GFDE's (Grimsby Fish Dock Enterprises) business activity of receiving long-term rent contracts and reliable dues from O&M operators in the Fish Dock, which prompted ABP to react and capitalise upon Ørsted's interest to expand (Senior Director interview, GFDE; ABP, 2014; Monios & Wilmsmeier, 2016). Ørsted's O&M activities provide a steadily growing and reliable source of income for ABP, who identified O&M as a long-term port activity and therefore viewed their relatively minor £5M investment as commercially viable and very low risk (Policy Advisor 3 interview, DfT; ABP, 2014; Verhoeven, 2010; Suykens & van de Voorde, 1998).

Ørsted's longstanding future commitments to the UK offshore wind industry was shaped by the DECC's FIDeR round in 2014, which awarded Ørsted a CfD for its 'Hornsea Project One' offshore wind farm (DECC, 2014a; Ørsted Hornsea Project One, 2018). In addition, the DECC's FIDeR first CfD allocation round awarded Ørsted a CfD for its 'Hornsea Project Two' offshore wind farm (BEIS, 2017b). The allocation of CfD subsidies to two of Ørsted's major offshore wind projects catalysed Ørsted's investments to create a larger O&M 'Hub' to support its UK offshore wind project from 2016 onwards (Senior Advisor interview, Ørsted; DECC, 2013; 2014a; DBEIS, 2017c; Humber Business, 2016):

> "I don't think DONG (now Ørsted) would have come to the Humber without the CfDs. It wasn't commercially viable without them and it still isn't" Technical Director, WSP.

Ørsted's O&M Hub required the construction of infrastructure and superstructure at the Royal Dock, including the removal of a coal jetty to enable the installation of larger pontoons, refurbishment of an existing warehouse and construction of additional office buildings and crew facilities (Senior Advisor interview, Ørsted; Humber Business, 2018b). These construction activities were vital for Ørsted's future expansion in the UK offshore wind industry and the operation and maintenance of its Race Bank, Hornsea Project One and Hornsea Project Two offshore wind farms using larger SOVs (Service Offshore Vessels) (Senior Advisor interview, Ørsted).

Ørsted's grander investment commitment and construction activities was also enabled by ABP leasing additional quayside space to Ørsted and ABP's previous investment to construct lock gates for Ørsted (ABP, 2014; Humber Business, 2017b):

> "DONG (Ørsted) went to various port authorities and said 'if you make an investment and changed the infrastructure for us we would certainly consider making a firm arrangement'…rather than just ABP speculatively making a decision and hoping they win an O&M contract" Regional Manager, A2SEA.

These decisions and investments reflect ABP's profit-oriented motive of leasing quayside land on a long-term basis to secure returns for its shareholders via O&M activities (Verhoeven, 2010; Baird & Valentine, 2007). O&M activities provided a dependable source of revenue for ABP, as the lifetime of a current wind turbine is around 25 years (Regional Manager interview, A2SEA). Investments made by Ørsted and ABP enabled the Humber Ports to adapt and diversify into offshore wind through supporting new O&M activities at the Port of Grimsby (PoG), further developing the regional path around offshore wind through new job creation and stimulating regional supply chain growth (Notteboom, 2016; Martin, 2010).

6.5 Conclusion

This empirical chapter discussed the different phases of the Humber Ports' adaptation and diversification into offshore wind through three distinctive episodes. The episodes highlight two tracks of the Humber region's offshore wind path trajectory and reflect two different forms of port adaptation and diversification into offshore wind: offshore wind manufacturing and installation activities at the Port of Hull (PoH) and offshore wind O&M activities at the Port of Grimsby (PoG). This chapter can form some important conclusions explaining the Humber Ports' adaptation and diversification in relation to the thesis' research questions regarding the diversification of port assets, dynamics of port governance and ownership, and enabling and/or constraining multiscalar institutional environments.

Firstly, the role of the government has been significant in shaping the national offshore wind market environment for ABP, the GFDE and firms to make investments into infrastructural and material assets to support manufacturing, installation and O&M activities (GWEC, 2016; Maskell & Malmberg, 1999). These investments shaped the shifts between the key episodes of the Humber Ports' adaptation and diversification into offshore wind (Notteboom, 2016). By providing a renewable energy market support initially through ROCs and later CfDs, the UK government provided a level of investment certainty which catalysed interest from offshore wind developers (Centrica, E.ON, Ørsted) to invest into the UK offshore wind market and subsequently transplant operations into the PoG to conduct O&M activities (DECC, 2014; 2015b). Equally, the UK government drove a period of uncertainty through introducing the EMR, which reduced the installation capacity estimates from 33GW by 2020 to 8-16GW by 2020 and created a lack of clarity regarding levels of market support via CfDs beyond 2020 for offshore wind (DECC, 2011; 2012). The decisions and policies of the government created a constraining institutional environment for project developers, manufacturers and port authorities who were seeking to invest into offshore wind, which disrupted the diversification of the Humber Ports into offshore wind (Martin, 2010; Dawley et al, 2015). Fortunately for developers, component manufacturers and the Humber Ports, the UK government created a renewed sense of market clarity through the first FIDeR (Final Investment Decision Enabling Renewables) round for CfD support in 2014 (DECC, 2014; 2015b). This influenced and catalysed the ABP and Siemens joint venture investment which enabled the conversion of the Alexandra Dock at the PoH and stimulated continued investment from Ørsted into the Royal Dock at the PoG (Siemens, 2016a; Dawley et al, 2019; Humber Business, 2016). These larger investments greatly enhanced and embedded the offshore wind path in the Humber by financing the large scale construction of the Humber Ports' asset base, whilst creating new employment and regional supply chain opportunities.

Secondly, there was a distinctive lack of a strategic port 'Master Plan' and long-term vision from ABP, regional government agencies and local authorities for the Humber Ports' long-term development. This meant that ABP weren't enabled by a port 'Master Plan', allowing it to become more 'reactive' and responsive to emerging market opportunities and make 'opportunistic' investments, as opposed to operating as a more 'proactive' and strategic port authority through planning to support offshore wind in the long-term future (Monios & Wilmsmeier, 2016). Senior executives and officers at ABP in Hull had sought to strategically shift ABP's investment approach to diversify the PoH's market portfolio and asset base to capture opportunities in offshore wind (University of Hull, 2018). This was originally stimulated by HCC's drive for creating new economic opportunities for Hull and Siemens' search for a UK port base. Furthermore, the decline of fishing activities at the PoG and an investment approach made by Centrica, prompted the GFDE (Grimsby Fish Dock Enterprises) to diversify the PoG's market portfolio and asset base into supporting small-scale O&M activities (BBC News, 2007; 2013). A coalition of firm and non-firm actors, often with overlapping responsibilities, worked together temporarily to successfully capture investments from Siemens and Ørsted, whilst addressing various operational, strategic and policy issues (Dawley et al, 2019; Phelps and Wood, 2006; Cox, 1998; Wood, 1999).

However, the lack of a port 'Master Plan' and strategic long-term vision meant the Humber Ports took a 'reactive' investment approach and responded to opportunities emerging in the offshore wind market (Monios & Wilmsmeier, 2016; Notteboom, 2016). This allowed the Humber Ports to be opportunistic, flexible and swift to respond to emerging investment opportunities in the UK offshore wind market, despite having a lack of vision, a fragmentation of port sites and little up-front financial commitments to attract investment from offshore wind firms (Monios & Wilmsmeier, 2016; Dawley et al, 2019). Essentially the port adaptation and process in the Humber Ports case was firm-led, in comparison to a more port-led adaptation and diversification process in the PoC case, meaning the 'reactive' approach was most suitable for the Humber Ports to capture inward investment and enabling these evolutionary processes (Monios & Wilmsmeier, 2016; Notteboom, 2016).

Thirdly, Siemens and Ørsted were the two main offshore wind firms catalysing the Humber Ports' adaptation and diversification and shaping the region's offshore wind path trajectory (Siemens, 2016; Humber Business, 2016). In essence, Siemens and Ørsted invested into the Humber Ports because of their geographical position to support Siemens and Ørsted within their North Sea offshore wind production networks, whilst being in close proximity to planned offshore wind projects in the North Sea with short steaming times for installation and service vessels.

The government was the source of investment uncertainty when it introduced the EMR (Electricity Market Reform) framework, which underpinned Siemens' uncertainty and catalysed investment delays from Siemens and subsequently ABP (DECC, 2011; 2012; Financial Times, 2014). Despite the initial drive from Siemens to transplant into the PoH, Siemens' lack of certainty over supporting offshore wind activities disrupted ABP's interest and commitment to investing into the PoH following the MoU (Financial Times, 2014). Moreover, this lack of certainty from ABP was influenced by their investment policy of confirming a legal FID (Final Investment Decision) through a joint venture with an investor before making a large-scale investment for the conversion of port infrastructure, in order to forecast potential returns for its shareholders. However, ABP provided investment for converting lock gates at the PoG and catalysed Ørsted's investment into the Royal Dock without a FID from Ørsted, although this was a considerably less sum and was an important addition to ABP's infrastructural asset base anyway (ABP, 2014). Therefore, this investment posed less risk to ABP's shareholders compared to ABP's larger investment for its joint venture with Siemens.

Chapter 7 Comparative analysis of port diversification and path creation: cases of the Humber Ports and Port of Cuxhaven

7.1 Introduction

The preceding empirical analysis chapters discussed how the processes of port adaptation, diversification and path creation unfolded in each case study. This chapter moves things on still further by developing a comparative analysis, cutting across cases and using the analytical framework developed in Chapter 2. The chapter's analytical framework helps draw out the important contrasts between national institutional and market environments, port visions and strategies, infrastructural and material asset bases, port governance models and investment approaches, corporate strategies of offshore wind firms and inward investment, and regional path outcomes.

7.2 National institutional environments

The empirical analysis added a deeper understanding of how the multiscalar institutional environment influences and shapes the adaptation and diversification process, as argued for by Hassink et al (2019), Trippl (2019), Dawley et al (2019), MacKinnon et al (2018), Martin (2010) and others in EEG. As part of which, the empirical analysis uncovered that the levels of "alignment" of strategic ambitions and visions of key actors (port authorities, sub-national government agencies and offshore wind firms) to the national institutional and market environments were crucial for enabling the port adaptation process (MacKinnon et al, 2018, pp27; Martin, 2010; Notteboom, 2016; Figure 2.4).

The evolution of the UK and German market subsidy regimes for offshore wind was an important factor in enabling *and* constraining the path creation process within both port cases, as the shifting institutional environment and market subsidy regimes influenced how, why and when the Port of Cuxhaven (PoC) and the Humber Ports diversified into offshore wind (Notteboom, 2016; Martin, 2010; Wind Europe, 2017a; 2017b). The most important changes in the national institutional environments for market creation and industrial development are outlined in Table 7.1:

	2000	2002	2009	2011	2014
UK	• Crown Estate Round 1 Projects	• ROCs (Renewable Obligation Certificates)	• Release of ‘banding’ (greater financial support) • Crown Estate Round 3 Projects.	• EMR (Electricity Market Reform) • CfDs (Contracts for Difference)	• FIDeR Round • Offshore Wind Industrial Strategy (OWIS) (2013)
Germany	• RESA 2000: Renewable Energy Sources Act (Erneuerbar e-Energien-Gesetz). • Alpha Ventus Research Programme (Began 2001).	• Federal Offshore Wind Strategy.	• RESA 2009: Higher feed-in-tariffs and capacity targets • Alpha Ventus test site (Opened 2010)	• Continuation of RESA policy and subsidy regime.	• RESA 2014: Reduction of installed capacity targets.

Table 7.1: Main institutional environment changes
Source: Author’s own research

Germany experienced a more progressive and stable institutional and market environment for offshore wind in comparison to the UK, which endured more significant political change and greater fluctuation in market regimes, despite the UK developing offshore wind projects at a much earlier stage in the early 2000s (BMWi, 2015; GWEC, 2016; IRENA, 2012). Due to a stronger alignment between offshore wind industrial and market policy in Germany in comparison to the UK, Germany’s Federal government could better enable port adaptation by creating a stable environment for sub-national government agencies, port authorities and firms to provide investment and capitalise upon market opportunities (BMWi, 2015; IRENA, 2012; MacKinnon et al, 2018).

Overall, the contrasting national market and industrial policy environments both enabled and constrained the port adaptation process and the path trajectories of the Humber Ports and the PoC, by enabling and constraining investment from project developers, manufacturers and port authorities (Notteboom, 2016; Jacobs & Notteboom, 2011; Martin, 2010). The evidence highlighted that changes in the UK and German institutional environments and offshore wind markets drove disinvestment and operational uncertainty, as they became misaligned to the future industry expectations of project developers and manufacturers, which constrained the path creation process in similar ways across the port cases (MacKinnon et al, 2018; Notteboom, 2016; Martin, 2010; Dawley et al, 2015). Similar episodes of investment uncertainty were evident in each case for key actors (port authorities, sub-national government agencies and firms), as the German and UK governments shifted the institutional environment by altering the market subsidy regimes and industrial policies for offshore wind (DECC, 2011; 2012; BMWi, 2015; Martin, 2010; Figure 2.4).

When the UK market environment changed in the early 2010s there were only small-scale O&M activities occurring at the Port of Grimsby (PoG), supporting the long-term operation of UK offshore wind projects (BBC News, 2007; 2013; OffshoreWIND, 2012a; 2013a). In contrast, there was already largescale manufacturing and O&M support presence in the PoC, which created more exposure to market uncertainty, given the sensitivity of manufacturing activities to sustained flow of orders, investment and contracts from project developers (Cuxhavener Nachrichten, 2007; 2009b; Wind Power Monthly, 2011). Three firms consequently disinvested from the PoC as a result of changes in the institutional and market environment (AfW Cuxhaven, 2017). Therefore, as the PoC had a larger scale of existing manufacturing activities than the Humber Ports, a greater number of high value manufacturing activities, high skilled engineering jobs, potential future reinvestment prospects and supply chain opportunities were lost in the PoC case in comparison to the Humber Ports case (AfW Cuxhaven, 2017; 2018c; Financial Times, 2014). As a result of its existing manufacturing function at this point in time, the path creation process in the PoC case was more vulnerable to changes in the institutional environment in comparison to the Humber Ports case, whilst only planned investments were disrupted within the Humber Ports case (Notteboom, 2016; Martin, 2010; Financial Times, 2014).

Similar episodes of path revival and realisation emerged from the episodes of uncertainty within both port cases, as port authorities, sub-national government agencies, external offshore wind firms and national governments realigned to support the port adaptation process (MacKinnon et al, 2018; Martin, 2010; Gertler, 2010). However, the diversification and path creation processes were renewed in a similar way from 2014 onwards through large scale investment, as enabling institutional environments consisting of more stable market subsidy regimes, ambitious installed capacity targets and planned offshore wind projects became strongly related to firm demand and the diversification strategies of port authorities and sub-national government agencies (Martin, 2010; Notteboom, 2016; BMWi, 2014; DECC, 2014a; 2014b). This shaped the regional path outcomes in comparable ways, as both port cases experienced increased levels of overall employment within offshore wind activities, new firm transplantations and future investment commitments from existing firms (AfW Cuxhaven, 2017; University of Hull, 2018; Siemens, 2016a; 2016b; Siemens Gamesa, 2017). Therefore, the port adaptation process is highly mediated by how firms, port authorities and sub-national government agencies manage existing investment plans in response to shifting national institutional and market environments for offshore wind (MacKinnon et al, 2018; Notteboom, 2016; Martin, 2010).

By taking a long-term research horizon, the comparative analysis has revealed the evolution of multiscalar institutional environments. Hassink et al (2019, pp5) argue that scholars in EEG should aim for a better understanding of how key firm and non-firm actors navigate fluctuating multiscalar institutional environments “to create favourable conditions for new growth paths” (Trippl, 2019; MacKinnon et al, 2018; Dawley et al, 2019). The research contributes towards this by demonstrating that multiscalar institutional environments and arrangements best enable port diversification and positive path outcomes around offshore wind when they are stable and provide long-term confidence for key port actors (Martin, 2010; Hassink et al, 2019; Wind Europe. 2017a). This enables key port actors (port authorities, sub-national agencies and firms) to strategically plan and make proactive investments based upon future market opportunities, supported by clearly defined national policy frameworks and subsidy regimes (Figure 2.4; Dawley et al, 2019).

In relation to the national institutional environment, the changes in port governance arrangements and investment were differentiated by contrasting ‘varieties of capitalism’ in the UK and Germany, as outlined by Hall and Soskice (2001) (Debrie et al, 2013; Notteboom et al, 2013). The UK operates as a LME (Liberal Market Economy) as a distinctive form of capitalism, with policies often made in a top-down manner from centralised government bodies and features investment from privately owned port authorities (Hall & Soskice, 2001; Monios, 2017; Notteboom, 2016). On the other hand, there is a more decentralised form of economic governance in Germany with a bottom-up policy making approach and functions as a CME (Coordinated Market Economy), meaning it has financial, institutional and policy support for publically-owned port authorities and government agencies on regional and local scales (Hall & Soskice, 2001; Monios, 2017; Notteboom, 2016). However, this dualistic framework of CMEs and LMEs has been critiqued by Ćetković et al (2016, pp4) who draw on the work by Vivian Schmidt (2005, 2012), wherein they argue that the institutional arrangements of CMEs and LMEs can be further conceptualised as being 'simple', when the "state structure is centralized and governing is concentrated in a single authority", or 'compound', when states "feature multiple authorities." Ćetković et al (2016, pp5) conceptualise that Germany is a 'compound CME', operating as a state with high coordination and relations between "state-industry-labour-science", supported by multiple levels of government (Schmidt, 2005; 2012; Hall & Soskice, 2001). The port adaptation process in the PoC case was different to the Humber Ports case as Germany functions as a compound CME, therefore it has higher levels of strategic coordination between sub-national levels of government and publically owned ports such as the PoC, alongside a greater decentralisation of power and resources to sub-national government agencies (Ćetković et al, 2016; BMVI, 2016; Hall & Soskice, 2001; Notteboom, 2016; Martin, 2010). By drawing upon work by Rodriguez – Pose and Gill (2003, pp335) we can clearly understand that the PoC case had a greater "decentralisation of resources, authority and responsibility" to make key investment decisions and control the port diversification process, alongside a stronger "legitimacy" of sub-national government agencies to provide large grants and support port diversification, in comparison to the Humber Ports case (AfW Cuxhaven, 2017; 2018c; Martin, 2010).

The governance arrangements of ports strongly influenced the investment strategies adopted by port authorities and sub-national government agencies (Monios & Wilmsmeier, 2016; Verhoeven, 2010). The empirical analysis uncovered the investment strategies of port authorities and sub-national government agencies was a key differentiating factor, in which ‘proactive’ investments were made in the PoC case, in contrast to ‘reactive’ investments made in the Humber Ports case (Monios, 2017; Monios & Wilmsmeier, 2016). These investment strategies were influenced by contrasting varieties of capitalism in the UK and Germany and their distinctive institutional environments (Hall & Soskice, 2001; Martin, 2010; Figure 2.4). For example, the reactive investment strategy adopted by ABP in the Humber Ports case reflects typical corporate investment in the UK as a simple LME and the Anglo-Saxon port governance model, as privately-owned ports characteristically invest to make returns for shareholders in a flexible and opportunistic manner (Monios, 2017; Verhoeven, 2010; Hall & Soskice, 2001; Ćetković et a, 2016). This investment strategy enabled ABP to react efficiently to the interest shown by Siemens and Ørsted in the Humber Ports as part of a growing UK offshore wind market, which catalysed the port adaptation process (Notteboom, 2016; Monios & Wilmsmeier, 2016). By contrast, the proactive investment strategy adopted by Niedersachsen Ports in the PoC case reflects the typical investment priorities of publically-owned bodies in Germany as a CME, whereby return on investment is not a priority and can make riskier investments to support new industrial growth and create new employment opportunities (Hall & Soskice, 2001; Monios & Wilmsmeier, 2016; Verhoeven, 2010). However, this proactive investment strategy meant the PoC was more exposed to changes in the institutional environment for offshore wind in 2013, which resulted in a more constrained port adaptation process in this period in comparison to the Humber Ports (Monios & Wilmsmeier, 2016; Notteboom, 2016; BMWi, 2015).

As such, Germany’s national variety of capitalism as a compound CME reflects and is reflected by the characteristics of the Hanseatic governance model in the PoC case (Ćetković et al, 2016; Suykens & Van de Voorde, 1998; Verhoeven, 2010). This is evident in the decision of sub-national state actors to not prioritise returns on infrastructure investment, who worked in close coordination with Niedersachsen Ports to ultimately create new jobs, attract inward investment and grow the offshore wind supply chain (AfW Cuxhaven, 2017).On the other hand, the UK’s national variety of capitalism as a simple LME reflects and is reflected by the typical features of an Anglo-Saxon governance model in the Humber Ports case (Ćetković et al, 2016; Suykens & Van de Voorde, 1998; Verhoeven, 2010). This was underlined by ABP’s uncertainty around making large scale infrastructure investments which required shareholder approval, highlighting the demand for private port authorities to ensure returns on investment (Monios, 2017; Verhoeven, 2010). Based upon the comparative analysis and national institutional contexts, Table 7.2 includes the ideal characteristics of Anglo-Saxon and Hanseatic port governance models:

Anglo-Saxon governance model	Hanseatic governance model
Operating within simple LMEs	Operating within compound CMEs
Private port ownership and governance	Public port ownership and governance
Reactive infrastructure investments	Proactive infrastructure investments
Opportunistic and flexible investment strategies	Long-term and strategic port visions
Prioritising shareholder returns	Prioritising local stakeholder benefits and job creation
Conservative investment risk-taking	Progressive investment risk-taking
Project-based engagement with sub-national actors	Continuous partnership building with sub-national actors

Table 7.2 Characteristics of Anglo-Saxon and Hanseatic port governance models

National offshore wind markets and certainty around market subsidies mediate the port adaptation, diversification and path creation processes, by directly influencing periods of inward investment and investment disruption (Notteboom, 2016; Martin, 2010; Figure 2.4). Monios and Wilmsmeier (2017) and Notteboom (2016) suggest that strategic plans and investment for port diversification are heavily shaped and constrained by fluctuating national and international market environments (Jacobs & Lagendijk, 2014; Martin, 2010). The comparative analysis directly reflects these arguments, as strategic plans and investments in both cases were enabled and constrained by broader institutional environments and signals in the UK and German offshore wind markets (Martin, 2010; Dawley et al, 2015).

7.3 Port governance models: proactive versus reactive investment strategies

Port ownership and governance structures shape how and why port authorities and/or sub-national government agencies invest to diversify port infrastructure and market portfolios (Notteboom, 2016; Monios, 2017; Monios & Wilmsmeier, 2016; Figure 2.4). The PoC’s diversification into offshore wind was largely enabled by ‘proactive’ investments into port infrastructure, which were strategically coordinated by sub-national public actors, in order to catalyse future inward investments (Martin, 2010; Steen & Hansen, 2018; Monios & Wilmsmeier, 2016). Essentially, as the PoC adopts a Hanseatic port governance model of public ownership and operation, the port authority and sub-national government agencies prioritised creating a new long-term future for the PoC and catalyse new employment and supply chain opportunities, by making 'proactive' infrastructure investments using public resources (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Niedersachsen, 2003; Monios & Wilmsmeier, 2016). This aim reflects how some publically owned port authorities can invest into port infrastructure to generate "catalytic effects, such as attracting businesses, creating jobs and income within the area of the port", as argued by Musso et al (2006, pp172). In contrast, the Humber Ports adopt an Anglo-Saxon port governance model and are privately owned, operated and controlled by ABP (Associated British Ports), which organises its economic activities and corporate strategies in response to fluctuating port markets, as it operates within the UK's LME (Liberal Market Economy) (Verhoeven, 2010; Suykens & Van de Voorde, 1998; ABP, 2016; 2017a; 2017b; Hall & Soskice, 2001). This meant that the Humber Ports only invested into supporting new offshore activities if they could generate short-term returns for shareholders, reflecting the private port ownership arrangement of ABP (Brooks & Cullinane, 2007b; Verhoeven, 2010). Key individuals at ABP reacted to emerging offshore wind market prospects in an opportunistic manner and waited for legal investment commitments from external firms before investing into relevant port infrastructure (Monios & Wilmsmeier, 2016; Verhoeven, 2010; Brooks & Cullinane, 2007b). This kind of reactive and opportunistic investment approach by ABP reflects the competitive nature and profit-driven characteristics of the UK's private port sector and LME, which strongly influences ABP's investment approach of monitoring and seeking new opportunities in approaches made by external firms in the port marketplace (Hall & Soskice, 2001; Monios, 2017). The reactive investment approach meant the Humber Ports diversification and offshore wind path was constrained due to ABP's dependency upon opportunities in the offshore wind market being available (Monios & Wilmsmeier, 2016; Notteboom, 2016; Martin, 2010).

In contrast to the UK's highly centralised system of port policy, the decentralisation of decision-making power, financial resources and responsibilities for port policy to the state level in Germany's federal governance system, enabled Niedersachsen Ports to adopt a Hanseatic port governance model of public ownership and operation and make proactive investments into infrastructure using public resources (Brooks & Cullinane, 2007b; Hall & Soskice, 2001; Monios & Wilmsmeier, 2016). The devolution of power and resources has enabled sub-national actors to collectively mobilise to subsequently catalyse port diversification (Martin, 2010; Pike & Tomaney, 2009; Simmie, 2012). The port governance context and multiscalar institutional environment meant the PoC's adaptation and diversification process was continually supported over time through a series of proactive and planned infrastructure investments, which ultimately captured more inward investments in comparison to the Humber Ports (Martin, 2010; Notteboom, 2016; Monios & Wilmsmeier, 2016). The provision of infrastructure before or in parallel with firms actively seeking port bases can stimulate multiple inward investments over time, as revealed in the PoC case (Wind Europe. 2017a; AfW Cuxhaven, 2017). This investment approach is most associated with the Hanseatic governance model and public ownership by a sub-national government body, whereby ports can better access public financing and support (Suykens & Van de Voorde, 1998; Verhoeven, 2010; Brooks & Cullinane, 2007b).

In contrast, the Humber Ports' reactive investment strategy to diversify is more risk averse because ABP only invests into new market activities if it can predict short-term returns (Notteboom, 2016; Monios & Wilmsmeier, 2016; Martin, 2010). This finding reflects Talley (2007, pp502) who argues that "if the port is privately owned" its economic objective is to "maximise profits to a minimum profit constraint". By contrast, the sub-national, non-firm (public) actors in the PoC case viewed investment into port infrastructure as necessary for generating new regional economic growth, job creation and supply chain opportunities (AfW Cuxhaven, 2017; Suykens & Van de Voorde, 1998; Verhoeven, 2010). This finding is supported by the OECD (2009, pp114) who highlighted that publically owned port authorities "do not aim for profit maximisation but have other objectives, such as contributing to overall economic development", an argument which is strongly supported by Brooks and Cullinane (2007b). As such, the proactive investments by sub-national government agencies and the port authority enabled a greater number of firm transplantations, higher levels of state-led and inward investment, a larger physical expansion of port infrastructure and a higher number of offshore wind jobs in the PoC compared to the Humber Ports (Monios & Wilmsmeier, 2016; AfW Cuxhaven, 2017; 2018c; ABP, 2019a; 2019b). Therefore, as a result of the proactive investments into port infrastructure the adaptation and diversification processes were better enabled in the PoC case compared to the Humber Ports case (Monios & Wilmsmeier, 2016; Notteboom, 2016). Nevertheless, the investment approach adopted by ABP in the Humber Ports case allowed the Humber Ports to react quickly in response to interest shown by offshore wind firms and project developers, which did enable port adaptation and diversification into offshore wind (Monios & Wilmsmeier, 2016; Monios, 2017; Notteboom, 2016).

To enable the more effective path creation process and more developed offshore wind path in comparison to the Humber Ports case, the PoC altered its governance structure in 2005 and brought in experts from engineering and energy backgrounds to focus upon proactively investing and constructing new infrastructure to attract firms, which enabled its strategic diversification (Monios & Wilmsmeier, 2016; Debrie et al, 2013; Maskell & Malmberg, 1999; Niedersachsen Ports, 2009). The empirical analysis revealed that new individuals from the ports and offshore energy sector were given executive power by Niedersachsen Ports for making "long-term decisions" to enable the long-term diversification of the PoC into offshore wind, ultimately enabling them to strategically plan, govern quayside land, invest and design new port infrastructure projects to capture offshore wind firms (Debrie et al, 2013, pp61). Without this shift and reform in governance, the PoC may not have diversified into offshore wind at this moment in time to establish a new regional offshore wind path (Debrie et al, 2013; Niedersachsen Ports, 2009; Martin, 2010).

By contrast, the Humber Ports managed to capture firm investments into manufacturing and O&M activities without ABP changing its governance arrangements in the Humber (Notteboom, 2016; Martin, 2010; Dawley et al, 2019; BBC News, 2013). The Humber Ports' diversification into offshore wind was primarily influenced by key executives at ABP and the GFDE (Grimsby Fish Dock Enterprises) as part of a 'reactive' investment to support offshore wind activities (Monios & Wilmsmeier, 2016; University of Hull, 2018; BBC News, 2007; 2013). Despite these contrasting ownership and governance settings, the key actors in both cases managed to diversify into offshore wind and create new offshore wind paths (Debrie et al, 2013; Notteboom, et al, 2013; Martin, 2010; Figure 2.4). However, the diversification and path creation process occurred through contrasting approaches, with a more effective proactive and strategic investment approach in the PoC case in comparison to the reactive and opportunistic investment approach in the Humber Ports case (Notteboom, 2016; Monios & Wilmsmeier, 2016). The empirical analysis highlighted that for ports to successfully diversify and enable a more developed path beyond the path creation phase, port authorities and sub-national government agencies can continuously seek to proactively and strategically invest into infrastructure to attract future firm investment, or if possible, reform their governance arrangements to do so, as highlighted by ABP (Martin, 2010; Monios & Wilmsmeier, 2016; Monios, 2017; Debrie et al, 2013; Figure 2.4).

For the PoC and Humber Ports to diversify and unlock new regional paths around offshore wind, several important elements had to combine and successfully align (MacKinnon et al, 2018; Dawley et al, 2019). The creation of a national offshore wind market catalysed port authorities and sub-regional government agencies to identify new economic opportunities for their ports (Notteboom, 2016; Debrie et al, 2013; Figure 2.4). Next, the port governance actors made investment decisions which reflected Anglo-Saxon (private) or Hanseatic (public) governance arrangements, in order to enable inward investment from offshore wind firms (Verhoeven, 2010; Musso et al, 2006; Brooks & Cullinane, 2007b; Figure 2.4). The port's infrastructural and material base, alongside the port governance arrangements and investment approaches, mediated how the port governance actors diversified their existing asset base (Maskell & Malmberg, 1999; Figure 2.4).

7.4 Port visions and strategies

The chapter will now move onto analyse the port visions and investment strategies, which have proven to be important mediators of the scale and scope of port adaptation processes. The thesis has revealed that once the national offshore wind market has been created and for the port adaptation process to occur, key actors concerned with a port identify new economic opportunities and change its investment approach to capitalise upon potential opportunities within the offshore wind industry (Notteboom, 2016; Martin, 2010; Figure 2.4). This factor identified in the empirical analysis contributes to a better understanding of how the creation of joint visions for the future by sub-national actors are crucial for enabling the port adaptation process (Trippl, 2019; Hassink et al, 2019). As suggested by Steen and Hansen (2018), a dynamic 'collective agency' is required between firm and non-firm actors to identify a strategic vision and newly identified economic opportunities for path creation, which can be manifested through a port 'Master Plan' or a new investment approach to diversify a port's market portfolio and asset base (Notteboom, 2016; Jacobs & Notteboom, 2011; Maskell & Malmberg, 1999; Figure 2.4). Firstly, the thesis highlighted that a 'collective agency' between the port authority and sub-national government agencies found expression through a new strategic port vision in the PoC case, which aimed to catalyse the long-term growth in a new market (Steen & Hansen, 2018; Niedersachsen, 2003). This demonstrated 'place leadership' as a distinctive type of collective agency, whereby the Niedersachsen Ports and sub-national government agencies worked across multiple "institutional and organisational divides, in order to build a collective vision for a new offshore wind path for the PoC and broader regional economy" (Grillitsch and Sotarauta, 2018, pp14; MacKinnon et al, 2019). Secondly, the research uncovered how a 'collective agency' between senior executives at ABP established a new opportunistic investment approach in the Humber Ports case (Steen & Hansen, 2018; Grillitsch and Sotarauta, 2018). This highlights the role of 'institutional entrepreneurship' as a type of collective agency, as institutional entrepreneurs at ABP in the Humber challenged existing investment norms and practices of ABP as an organisation, which typically focused upon conservative investments into reliable markets, in order to harness and valorise port assets for offshore wind and diversify into a newly emerging market (Grillitsch and Sotarauta, 2018; MacKinnon et al, 2019). These key findings support Notteboom's position, as he argues that to enable port diversification a strategic vision or new investment approach from a port authority is required, in combination with collective action from local actors (Notteboom, 2016; Maskell & Malmberg, 1999). In addition, the alignment of a new port vision or investment approach to broader institutional and market settings is crucial for enabling processes of port diversification and new path creation (MacKinnon et al, 2018; Notteboom, 2016; Martin, 2010; Figure 2.4).

A clear contrast between the port cases is the opportunistic diversification strategy of ABP at the Humber Ports, which differs from a more long-term port vision formed by key actors to enable the PoC's diversification (Notteboom, 2016; Monios & Wilmsmeier, 2016, Monios, 2017). An 'Offshore Master Plan' (OMP) was designed and released in 2003 to propose how the PoC could capitalise upon emerging opportunities in the embryonic German offshore wind industry (Niedersachsen, 2003; Wüstenhagen & Bilharz, 2006). The OMP demonstrated the strategic vision of key local and state level actors concerned with the PoC's long-term adaptation and success, aiming to create a regional path (Niedersachsen, 2003; Martin, 2010). The decentralisation of decision-making power and resources to the state level for ports enabled key sub-national government agencies to create this new long-term vision, reflecting the distinctive CME of Germany with strong state and local actors driving path creation and development processes from the bottom-up (Hall & Soskice, 2001; Martin, 2010; Niedersachsen, 2003).

In contrast to the PoC, firm and non-firm actors concerned with the Humber Ports' diversification, did not create a long-term vision through a port 'Master Plan' or strategy to build future infrastructure and subsequently capture new market opportunities (Notteboom, 2016; Martin, 2010; Parola et al, 2018). However, key actors at the Humber Ports successfully identified and capitalised upon emerging opportunities in O&M (Operations and Maintenance) and manufacturing activities, after they reacted to interest from developers and component manufacturers seeking suitable UK port sites (BBC News, 2007; 2014; Financial Times, 2011; Monios & Wilmsmeier, 2016; Wind Europe. 2017a). The Humber Ports adopted a more opportunistic and short-term vision in comparison to the PoC, which nonetheless still enabled the Humber Ports to adapt and diversify into offshore wind (Monios & Wilmsmeier, 2016; Parola et al, 2018; Notteboom, 2016; Martin, 2010).

Essentially, the contrasting port visions and strategies meant that the diversification of PoC was focused upon the long-term adaptation and diversification of the PoC, whereas the new investment strategy underpinning the Humber Ports' diversification was driven by capitalising upon new market opportunities to generate profits for ABP (Notteboom, 2016; Pike et al, 2010; Martin, 2010). However, Hull City Council, North East Lincolnshire Council and the Humber LEP were following a similar strategy to actors in the PoC, aiming to create a new offshore wind path for the Humber region (Humber LEP, 2016). Both strategies work for enabling port adaptation and diversification into offshore wind. However, in comparison to the Humber Ports, the long-term vision of key actors at the PoC to consistently seek to attract offshore wind firms and build port infrastructure accordingly, enabled the attraction of a greater number of offshore wind firms and higher level of financial investment to create a more developed regional path around offshore wind.

Another distinctive contrast is how and why different forms of actor coalitions formed and worked to enable different port adaptation processes and path outcomes (Notteboom, 2016; Phelps & Wood, 2006; Cox, 1998; Martin, 2010). The formation of a coalition of public actors on the state and local level within the PoC case was critical in enabling the PoC to capitalise upon opportunities in offshore wind (Phelps & Wood, 2006; MacKinnon et al, 2018; Cox, 1999; Notteboom, 2016). Key local and state actors demonstrated 'place leadership' to create a new port vision for the PoC and worked collectively across organisational divides to enable inward investments, whilst continually focusing upon capturing manufacturing, installation and O&M activities over a long-term period (Grillitsch & Sotarauta, 2018; Steen & Hansen, 2018; Cox, 1998; Wood, 1999; AfW Cuxhaven, 2017). In addition, the institutional arrangement of non-firm (public) actors involved in establishing this coalition did not change since its formation, meaning there was a continuous strategic focus and collective agency involved in capturing investment into offshore wind activities at the PoC and creating a new regional path (Martin, 2000; 2010; Steen & Hansen, 2018). On the other hand, the actor coalition in the Humber Ports case consisted of both firm (private) and non-firm (public) actors, which continuously changed because actors conducted work in a 'temporary' manner to capture certain inward investments at different points in time, reflecting the opportunistic approach of these key actors (Dawley et al, 2019; Phelps and Wood, 2006; University of Hull, 2018). For example, at the PoH (Port of Hull) the Single Conversation Group (SCG) and Joint Project Team (JPT) included firm and non-firm actors with overlapping responsibilities and remits, who acted at different times in response to solve various strategic, technical and planning issues to attract and manage a key inward investment (University of Hull, 2018; Figure 2.4). Nevertheless, the contrasting actor coalitions managed to identify and capture a range of offshore wind activities to ultimately enable processes of port diversification and regional path creation around the offshore wind industry (Notteboom, 2016; Martin, 2010; Figure 2.4).

The empirical analysis revealed different forms and arrangements of actor coalitions within the port cases, which worked over contrasting timescales and worked together in contrasting ways (Phelps & Wood, 2006; Dawley et al, 2019; Cox, 1998). As a result of these contrasting actor coalitions, the port diversification process and the regional offshore wind paths were ultimately different in terms of their development and evolution (Notteboom, 2016; Martin, 2010). The longevity of an essentially unchanged coalition of firm and non-firm actors in the PoC case, who had a strategic vision, continual focus and collective agency around expanding infrastructure for offshore wind activities, enabled the PoC to capture numerous inward investments over time and create a more developed offshore wind path than identified in the Humber Ports case (AfW Cuxhaven, 2017; Dawley et al, 2019; Steen &

Hansen, 2018; Martin, 2010; Figure 2.4). A central reason why the regional path in the PoC is more developed in comparison to the Humber's regional path is because a more strategic coalition of actors worked together continuously over a longer timescale, overcame a greater period of uncertainty with more firms disinvesting, and subsequently attracted more firms and investment within a period of expansion (Notteboom, 2016; Cox, 1999; Wood, 1998; AfW Cuxhaven, 2017).

7.5 Infrastructural asset base: greenfield versus brownfield

The physical nature and form of a port's infrastructural and material asset base is shaped by previous industrial activities occurring within the port, which consequently shapes the future diversification and path creation processes (Maskell & Malmberg, 1999; Notteboom, 2016; Martin, 2010). The conversion and expansion of a port's infrastructural and material asset base occurs on either greenfield or brownfield land, which has been identified by the port authority, sub-national government agencies and firms to have the potential to support the offshore wind industry (Notteboom, 2016; Maskell & Malmberg, 1999; Figure 2.4). To enable the diversification of assets, port authorities and/or sub-national government agencies identify how underutilised port assets can be valorised and reoriented, in order to capitalise upon a new market and support an emerging sector within a region (Notteboom, 2016; Maskell & Malmberg, 1999; Dawley et al, 2019). The diversification of the infrastructural and material asset base is shaped by the alignment between the national market environment, the new strategic port vision and demand from offshore wind firms (Notteboom, 2016; Maskell & Malmberg, 1999; MacKinnon et al, 2018; Figure 2.4). Whilst Maskell & Malmberg (1999) highlight five different types of assets which can be identified and harnessed by actors to enable processes of diversification and path creation, this section focuses upon the availability and deliverability of land as the key element in providing appropriate infrastructural and material assets at ports (Maskell & Malmberg, 1999; MacKinnon et al, 2018; Figure 2.4). Moreover, this section also emphasises the importance of proximity of ports to particular offshore wind projects, which is a key natural asset for enabling port diversification and new path creation around offshore wind (Maskell & Malmberg, 1999; Wind Europe. 2017a).

The availability and deliverability of greenfield or brownfield land is an important factor differentiating the diversification and path creation processes within the port cases (Notteboom, 2016; Martin, 2010). Before the PoC's diversification into offshore wind, it had large areas of greenfield land available to be converted for offshore wind purposes (AfW Cuxhaven, 2017; Boas, 2007; Figure 2.4). The PoC's pre-existing asset base, with extensive areas of greenfield land, allowed key non-firm actors to plan and construct high-quality port infrastructure for offshore wind firms and trigger processes of port diversification and path creation (AfW Cuxhaven, 2017; Notteboom, 2016; Martin, 2010). As there was large-scale availability of greenfield land, firms could request specialised infrastructure to be constructed to serve their needs, which stimulated investment interest from manufacturing firms seeking to capitalise upon an emerging national offshore wind market (AfW Cuxhaven, 2017; BMWi, 2015). This meant that a greater number of firm transplantations were facilitated more affectively over time in comparison to the Humber Ports case, as there was an existing or planned availability of infrastructure for firms to access and harness for their specialised offshore wind activities (AfW Cuxhaven, 2017; Martin, 2010; Figure 2.4).

By contrast, the Humber Ports had declining and underutilised infrastructural and material assets upon brownfield land with very limited area for expansion before its diversification into offshore wind (Notteboom, 2016; Martin, 2010; Maskell & Malmberg, 1999; Figure 2.4). Despite this constraining factor, key firm and non-firm actors have successfully diversified and converted the Humber Ports' infrastructural asset base to support offshore wind (Notteboom, 2016; Maskell & Malmberg, 1999). However, the diversification and conversion processes in the Humber Ports case were constrained by the historical nature and the range of technical, planning and environmental challenges associated with adapting an infrastructural asset base upon brownfield land (Notteboom, 2016; Maskell & Malmberg, 1999; University of Hull, 2018; Figure 2.4). The complex infrastructure related issues were created by the Alexandra Dock at the Port of Hull being an old and declining infrastructural asset base on brownfield land, which was shaped by historical industrial activities (Maskell & Malmberg, 1999; University of Hull, 2018). This meant the Humber Ports' diversification process was disrupted until the technical, planning and environmental problems were resolved by key actors, thus constraining the growth of a new regional offshore wind path (Notteboom, 2016; Martin, 2010; University of Hull, 2018).

However, in parallel with the conversion of the Alexandra Dock at the PoH, the rival AMEP (Able Marine Energy Park) on the south bank of the Humber Estuary had greenfield land with potential to support offshore wind activities, which stimulated the interest of Siemens as they could request specialised port infrastructure (Financial Times, 2014; Able UK, 2017). Unfortunately for Able UK, its greenfield AMEP could not be delivered on time for Siemens or other offshore wind firms at the time, such as Ørsted (Able UK, 2017). This was driven by an overall lack of demand for the AMEP, which was underpinned by the associated "£450 million of capital investment and lengthy statutory planning required" to construct the AMEP, meaning the site became too risky for Siemens to pursue (Dawley et al, 2019, pp9). Furthermore, Able UK required compulsory acquisition from the UK government for land owned by ABP, which led to multiple planning objections by ABP and a "High Court review process that increased the risks associated with the rival AMEP" (Dawley et al, 2019, pp10). Ultimately, the lack of availability and deliverability of the greenfield AMEP and the availability of existing brownfield port land and infrastructure at the Alexandra Dock which met the deliverability needs of Siemens, became a pivotal factor in stimulating diversification and path creation in the Humber Ports case (Notteboom, 2016; Dawley et al, 2019; Martin, 2010; BBC News, 2014).

The empirical analysis revealed that brownfield port land is a key factor shaping the contrasting processes of port diversification and path creation around O&M activities within the comparative cases (Notteboom, 2016; Martin, 2010). The existing infrastructural asset base at the Port of Grimsby (PoG), consisting of the 'Fish Dock' and 'Royal Dock' with brownfield land, was key in attracting investment from developers looking to conduct O&M activities at relatively little continuous cost (BBC News, 2007; 2013; ABP, 2019b). In contrast, the PoC had very little available existing infrastructure available for O&M activities with suitable brownfield port land, as it was already being utilised for other port-related activities such as general cargo, automobiles or container handling at the 'Cuxport' terminal (AfW Cuxhaven, 2017; Cuxport, 2017a; 2017b). Furthermore, key port actors responsible for the future diversification of the PoC, decided against investing into and constructing specialised port infrastructure to exclusively support O&M activities because of the PoC's lack of proximity to planned offshore wind projects in the German North Sea (AfW Cuxhaven, 2017; BSH, 2014). Therefore, the geographical projection of future German offshore wind projects did not align to the strategic ambitions of key actors concerned with diversifying the PoC's infrastructural asset base to support O&M activities (MacKinnon et al, 2018; BSH, 2014; Notteboom, 2016; Maskell & Malmberg, 1999).

By contrast, the existence of brownfield land at the PoG was the key factor in catalysing the port diversification and path creation process, as it strongly aligned to the demand of developers seeking to operate and maintain their previously constructed offshore wind projects (Notteboom, 2016; Dawley et al, 2019; Wind Europe. 2017a). On a broader scale, project developers such as Ørsted recognised the Humber Ports as being in close proximity to their current and future UK offshore wind projects, in comparison to ports in Teesside, the Port of Tyne or the Port of Blyth (BVG Associates, 2016). This evidence suggests that existence of brownfield port land is not sufficient enough to attract O&M activities to enable port diversification and new path creation. Brownfield port land, as well as greenfield port land, needs to be in close proximity to future offshore wind developments and the prior construction of offshore wind projects to stimulate processes of port adaptation.

The brownfield port land at Alexandra Dock had a limited expansion area and was smaller in scale compared to the greenfield land at the PoC, which was a key factor in influencing Siemens' decision to shift nacelle manufacturing activities to the PoC (AfW Cuxhaven 2017; ABP, 2019a). Moreover, the co-location of suppliers for manufacturing nacelles was not possible at the PoH due to the limited physical scale of the Alexandra Dock, whereas the PoC could provide large greenfield areas to build specialised port infrastructure for a range of co-located suppliers whilst supporting O&M and installation activities (AfW Cuxhaven 2017; ABP, 2019a). As such, the limited physical scale of the Humber Ports' infrastructural asset base constrained their ability to attract a larger range of firms, co-located suppliers and offshore wind activities, thus hindering the further development of the Humber's regional offshore wind path (Notteboom, 2016; Maskell & Malmberg, 1999; Martin, 2010). Therefore, the PoC case highlighted that ports with large areas of greenfield land to construct new infrastructure have a greater capacity to attract a largescale manufacturer who requires co-located suppliers and quayside access (AfW Cuxhaven, 2017; Siemens Gamesa, 2017).

The empirical analysis suggests that the port adaptation process can be supported by infrastructure on greenfield and brownfield port land (Notteboom, 2016; Maskell &

Malmberg, 1999; Martin, 2010). However, these processes are best stimulated by the extent to which port land and infrastructure can be made available through timely deliverability, alongside the degree to which port land and infrastructure can serve the scale and meet the proximity of demand of current and future offshore wind projects (Dawley et al, 2019; BVG Associates, 2016). This is underpinned by the extent to which the pre-existing land and infrastructure can be converted and expanded on time, and when offshore wind activities can subsequently occur in line with project development timeframes (Maskell & Malmberg, 1999; Dawley et al, 2019; University of Hull, 2018; Figure 2.4).

7.6 Offshore wind firms: corporate strategies and investment

Ports are infrastructural platforms for enabling processes of adaptation and diversification (Notteboom, 2016; Maskell & Malmberg, 1999). However, offshore wind developers and manufacturing firms are catalysts and drivers of port adaptation (Notteboom, 2016; Dawley et al, 2019). Processes of port adaptation, diversification and the realisation of a port vision, are all strongly dependent upon firms providing inward and indigenous investment to diversify existing infrastructural assets and conduct offshore wind activities (Notteboom, 2016; Boas, 2007; Maskell & Malmberg, 1999; Wind Europe. 2017a; Figure 2.4). However, due to the different ownership and governance arrangements of the ports in this thesis, the port authorities had contrasting levels of dependency upon securing investment before making their own investments to diversify into offshore wind, which consequently mediated and differentiated how the diversification and path creation processes occurred (Notteboom, 2016; Debrie et al, 2013; Martin, 2010). This key contrast is informed by Debrie et al (2013, pp61), who argue that investment from privately owned port authorities “happens only when risk is limited in relation to expected profit”, which is in clear contrast to publically-owned port authorities who are typically more concerned with the wider economic development of the region (Verhoeven, 2010; Suykens & Van de Voorde, 1998; OECD, 2009).

The empirical analysis revealed that manufacturing firms and offshore wind developers have distinctive investment characteristics, infrastructure requirements and corporate strategies which influenced and differentiated the port diversification and path creation processes within the port cases (Wind Europe. 2017a; Dawley et al, 2019; MacKinnon et al, 2018;

Afewerki, 2019). Key manufacturing firms in the early German offshore wind industry demanded specialised infrastructure for manufacturing activities and onshore assembly of components. For example, Cuxhaven Steel Construction (CSC), AMBAU and Strabag were early industrial players in the German offshore wind industry and the emerging production network, who were prepared to make large inward investments (AfW Cuxhaven, 2017; Cuxhaven Nachrichten, 2007; 2009b; AMBAU, 2016; 2018; Coe & Yeung, 2015). Their willingness to invest and their demand for pre-existing port infrastructure was heightened by the proactive nature of key actors at the PoC who were at the same time planning to invest and construct port infrastructure to capture offshore wind activities (Monios & Wilmsmeier, 2016; Niedersachsen, 2003). As lead firms within the early offshore wind production network in Germany and Europe, CSC, AMBAU and Strabag adopted similar corporate strategies of taking large investment risks to produce components, in order to cement themselves as the main producers of offshore wind components in the early German offshore wind industry (Cuxhaven Nachrichten, 2007; 2009b; AMBAU, 2016; 2018; STRABAG, 2009). Similarly, the path creation and diversification process in the Humber Ports case was driven by key firms and developers becoming active in the emerging offshore wind market, aiming to undertake manufacturing, installation and O&M activities (Notteboom, 2016; Martin, 2010; Dawley et al, 2019; Afewerki, 2019). However, the growing activity of key firms and developers triggered port actors (port authorities and sub-national government agencies) to react to this market activity and retrospectively invest to secure returns for shareholders, meaning the Humber Ports' diversification into was led by offshore wind firms and the PoC's diversification was led by Niedersachsen Ports (Verhoeven, 2010; Monios, 2017; Dawley et al, 2019).

This reflects the overarching institutional and market context of the UK as a LME (Liberal Market Economy), whereby privately owned port authorities have to prioritise generating revenue and returns on infrastructure investment, in order to operate and grow in a competitive port marketplace (Hall & Soskice, 2001; Brooks & Cullinane, 2007b; Baird & Valentine, 2007). For example, as part of Siemens' corporate strategy to capitalise upon the growth of the UK offshore wind market and become a lead firm in the European offshore wind production network, they began searching for a UK port to conduct manufacturing activities and ABP reacted to this market activity by retrospectively attempting to secure their investment (Notteboom, 2016; Monios & Wilmsmeier, 2016; Financial Times, 2011;

2014; Coe & Yeung, 2015; HM Government, 2014b). The Humber Ports' firm-led diversification was demonstrated by Centrica, E.ON and Ørsted approaching the GFDE (Grimsby Fish Dock Enterprises) and ABP at the PoG (Port of Grimsby) to conduct O&M activities, which stimulated a reaction from the GFDE and ABP who retrospectively made investments into port infrastructure to capture their investment (BBC News, 2007; 2013; OffshoreWIND, 2012a; 2012b, 2013b). Ørsted is the main firm in the Humber Ports case in regard to becoming a lead O&M provider and project developer within the UK offshore wind production network (Ørsted, 2019; Coe & Yeung, 2015). In terms of Ørsted's corporate strategy, its vision and aim shifted in the early 2010s from being a producer of fossil fuels towards becoming a global leader of renewable energy production, and the UK's growing offshore wind market presented a new opportunity to realise that overarching vision (Ørsted, 2019; 2020; DONG Energy, 2013). As such, as the Humber Ports were more dependent and under greater influence of developer and firm investment decisions in comparison to the PoC case, firm-led diversification occurred in the Humber Ports and a port-led diversification processes occurred in the PoC case (Martin, 2010; Isaksen, 2015; Dawley et al, 2015).

The example of Siemens as a key manufacturing firm within both port cases provides an interesting comparison of corporate strategy, investment and new path creation (Dawley et al, 2016; Martin, 2010). As part of Siemens' European corporate strategy to move towards a new port-based manufacturing and logistics approach for producing turbines to reduce costs, Siemens provided inward investments into the PoC and the Port of Hull (PoH) (Siemens Gamesa, 2017; Siemens, 2016a; 2016b). However, as Siemens invested to produce more complex, specialised and higher value nacelles at the PoC and lower value turbine blades at the PoH, this meant that Siemens required suppliers with high level engineering capacity to be co-located to the Siemens factory at the PoC (Siemens Gamesa, 2017; Siemens, 2016a; 2016b). Therefore Siemens' corporate strategy and inward investment into the PoC served as more of a catalyst for attracting additional manufacturing firms in comparison to Siemens' inward investment into the PoH, thus better enabling the processes of port diversification and path creation (Siemens Gamesa, 2017; Siemens, 2016a; AfW Cuxhaven, 2017; Martin, 2010).

The different types of firms and the mode of inward investment they provided to conduct specialised offshore wind activities also differentiated the port adaptation process and path outcomes (Notteboom, 2016; Martin, 2010; Wind Europe, 2017a; 2017b). In the PoC case, several firms provided investment over time to conduct high-end and specialised manufacturing activities, who were prepared to provide largescale investments to expand the port asset base (AfW Cuxhaven, 2017). In contrast, the manufacturing activity at the Humber Ports has been solely centred upon Siemens' willingness to provide inward investment to convert the port asset base and conduct more routine based blade assembly activities (Siemens, 2016a; BBC News, 2014; Boas, 2007; Figure 2.4). However, this mode of investment was heavily dependent upon Hull City Council convincing ABP to enter into competition to capture Siemens' investment (Dawley et al, 2019). Similarly, inward investment provided by offshore wind developers to convert infrastructure and construct O&M bases in the Humber Ports also meant they had to negotiate with and convince ABP to support their activities (Humber Business, 2016). By contrast the PoC case, a range of high-end and specialised manufacturers were reacting positively to the pre-existing and long-term expansion of infrastructure to support offshore wind activities (AfW Cuxhaven, 2017). Furthermore, the inward investments made by firms into the PoC to conduct manufacturing activities and produce more high value and specialised components such as nacelles, foundations and towers, meant it has become a more high-end manufacturing hub in comparison to the Humber Ports case (AfW Cuxhaven, 2017; Wind Europe, 2017a). As a result of the distinctive modes of investment, types of offshore wind activities and the level of dependency of external manufacturing firms upon the port authority to support their inward investment, the adaptation and diversification process in the Humber Ports case was driven by external firms, in comparison to a port-led adaptation and diversification process in the PoC case (Notteboom, 2016; Martin, 2010; Figure 2.4).

7.7 Path outcomes

The contrasting configurations of how pre-existing infrastructural and material assets were diversified by coalitions of key port actors, which were shaped by distinctive port governance contexts and multiscalar institutional environments, differentiated how the port adaptation process unfolded within the comparative case studies (MacKinnon et al, 2018; Notteboom, 2016; Martin, 2010; Figure 2.4). There has been a greater number of manufacturing and O&M firms which invested into the PoC in comparison to the Humber Ports. These inward investments occurred when a national market for offshore wind was established, which catalysed port authorities and sub-national government agencies to convert or expand infrastructural and material asset base, in order to capture inward investment and establish a platform for offshore wind firms (MacKinnon et al, 2018; Martin, 2010; Maskell & Malmberg, 1999; see Figure 2.4). Distinctive path creation processes with contrasting qualitative characteristics emerged as outcomes of the unfolding port adaptation process (Notteboom, 2016; Martin, 2010).

The thesis uncovered the contrasting scale and scope of diversification and path outcomes. There were contrasting levels of diversification in regard to the scale and scope of the offshore wind activities created within the case studies in comparison to other market activities within the ports (Notteboom, 2016). The PoC was more diversified into offshore wind as it has received a very high level of public investment, approximately €280m into port infrastructure to support offshore wind in comparison to the Humber Ports which received smaller public investments into planning and project related activities, alongside the £25.7m Green Port Growth Programme (excluding funding for port infrastructure) (University of Hull, 2018; AfW Cuxhaven, 2018c). Moreover, ABP has made a £15m investment into container handling facilities at the PoH in 2018 and has planned a £26m investment into expanding its river terminal to handle a greater number of automobiles (Offshore Energy, 2018; Grimsby Telegraph, 2019a). The contrasting levels of public investments and overall commitments to construct port infrastructure to support offshore wind activities, alongside the recent investments from ABP highlighting how the port owner prioritises investments into other port activities to maximise traffic and revenue, emphasises how the scale and scope of the Humber Ports' diversification into offshore wind is at a lower level than what is revealed within the PoC case (AfW Cuxhaven, 2017; 2018c; ABP, 2019a; 2019b).

Furthermore, a greater number of firms (eight in total) in the PoC case provided a larger scale of inward investment (£350m approx.) in comparison to the Humber Ports case, which had six firms providing inward investment (£200m approx.), including two small-scale O&M support firms (AfW Cuxhaven, 2018c; University of Hull, 2018; Grimsby Telegraph, 2019b; E.ON, 2019; OffshoreWIND, 2012b). This supported the creation of a higher number of jobs, more regional supply chain opportunities and coincided with a larger scale of investment from port actors (port authorities and sub-national government agencies) in Cuxhaven (AfW Cuxhaven, 2017; University of Hull, 2018; ABP 2014; Figure 7.1; Figure 7.2). This led to a more developed regional offshore wind path in the PoC case in comparison to the Humber Ports case (Notteboom, 2016; Martin, 2010). Based upon interview data and news articles, Figures 7.1 and 7.2 highlight the contrasting path trajectories within each port case based upon direct offshore wind employment at manufacturing and O&M firms over time (AfW Cuxhaven, 2017; Cuxhavener Nachrichten, 2007a; 2009b; 2013; OffshoreWIND, 2012a; 2012b; 2013a; 2013b; Siemens, 2016a; 2016b; Siemens Gamesa, 2017; 2019; AMBAU, 2018; University of Hull, 2018). As a result of fluctuating periods of growth and contraction within the adaptation and diversification process, the path trajectory in the PoC case was more unstable and volatile, with a greater scale of contraction between 2011 – 2014 in comparison to the Humber Ports case, despite creating a greater number of jobs (Figure 7.1; 7.2). By contrast, the port adaptation and diversification processes in the Humber Ports case led to a more gradual and slower growth of the offshore wind path in comparison to the PoC case, characterised by the ongoing expansion of O&M and a softer episode of disruption between 2011 – 2013 (Figure 7.1; Figure 7.2).

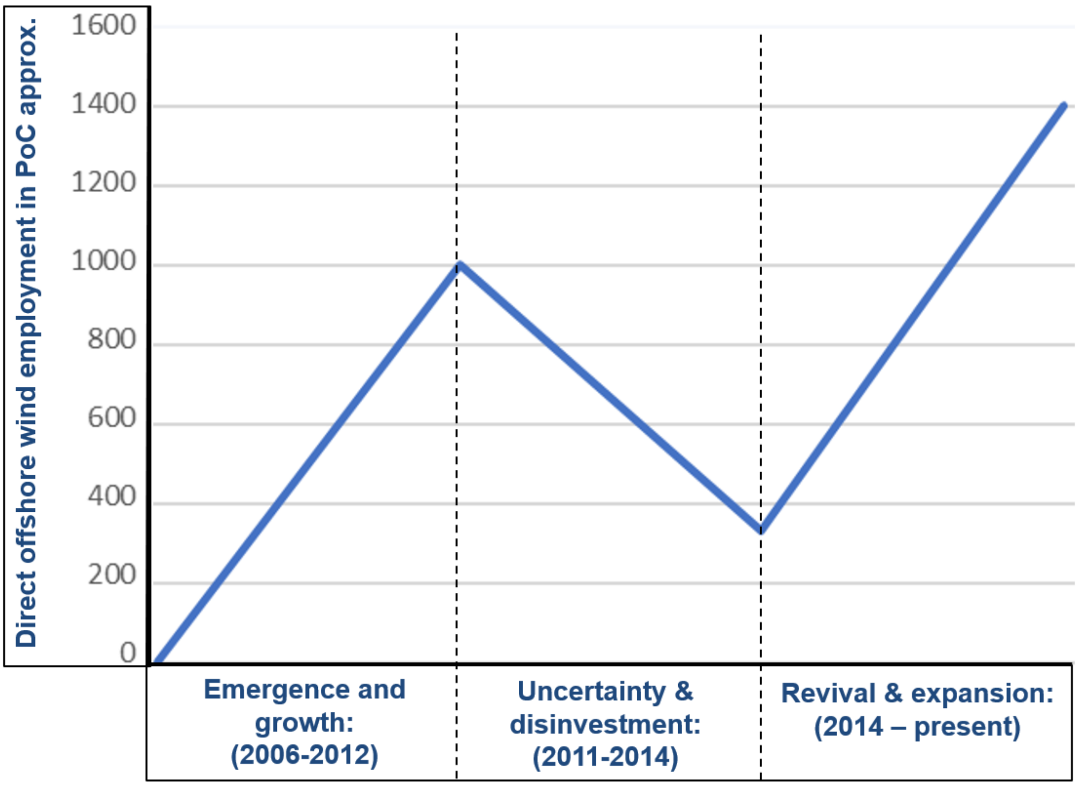


Figure 7.1: Port of Cuxhaven’s adaptation and path creation
Source: Author’s own research

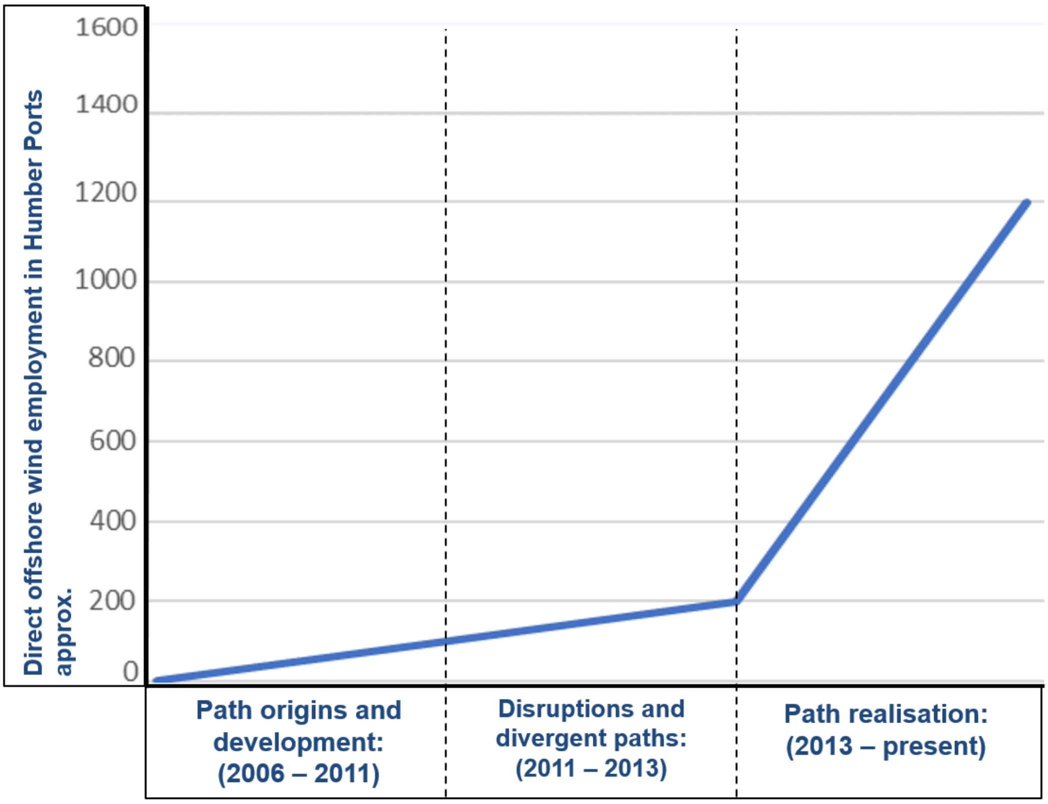


Figure 7.2: Humber Ports' adaptation and path creation
Source: Author's own research

The Humber Ports case has a greater scale of O&M activities and investment from a broader range of industry-leading developers (such as Ørsted) in comparison to the PoC case, alongside a higher number of current and future offshore wind projects supported by the Humber Ports (Ørsted, 2019; Humber Business, 2016; Afewerki, 2019; BSH, 2014; Crown Estate, 2010b). Therefore as O&M activities occur over an approximate 25 year lifecycle of offshore wind projects, the regional offshore wind path in the Humber may be more sustainable and resilient to external shocks such as political or offshore wind market change and development, in comparison to the path in the PoC case (Martin, 2010; Martin, 2012; Martin & Sunley, 2015b). In contrast, the PoC is more focused upon supporting more higher value manufacturing activities in the offshore wind industry and on a larger scale than the Humber Ports, meaning it is highly dependent upon manufacturing firms winning future contracts for offshore wind projects in the North Sea (AfW Cuxhaven, 2017; University of Hull, 2018; Wind Europe. 2017a). Ultimately, this may lead to fluctuating offshore wind port activities, reflecting how inward investment from manufacturing firms and regional path trajectories are strongly influenced by national institutional and market environments (Wind

Europe. 2017a; Martin, 2010; Dawley et al, 2019). The diversification of the Humber Ports and the PoC into offshore wind have created distinctive qualitative characteristics of the regional path outcomes (MacKinnon et al, 2018; Martin, 2010):

Case	Mode of investment	Position in production network	Characteristics of regional path
Humber Ports	• Conversion of assets (brownfield land) • Dependent upon exogenous investment (offshore wind firms).	• Assembly based production • Long-term O&M support	• Embryonic path • Broad offshore wind portfolio
Port of Cuxhaven	• Expansion of assets (greenfield land) • Indigenous and exogenous investment (offshore wind firms)	• Advanced engineering and production • Sporadic O&M support	• Established path • High value, specialised manufacturing

Table 7.3: Composition of path outcomes

Table 7.3 outlines the key differences in the composition of the path outcomes emerging from the port case studies. The diversification of the Humber Ports has created a broad offshore wind portfolio in comparison to the PoC, consisting of assembly based manufacturing and long-term O&M support, which has stimulated an embryonic offshore wind path in the Humber region. The creation and future development of the regional offshore wind path in the Humber remains highly dependent upon engagement and investment provision by exogenous offshore wind firms, with the port authority unlikely to make any future investments to support offshore wind. An established offshore wind path has been created by the PoC's adaptation and diversification, characterised by high value and specialised manufacturing offshore wind activities. The PoC has established itself as a leading port in offshore wind production networks for supporting advanced engineering and production, alongside supporting more sporadic O&M activities. The PoC's diversification was driven by investment from the port authority and sub-national government agencies for the expansion of new assets on greenfield land, which catalysed indigenous and exogenous investment from offshore wind firms. Overall, Table 7.3 highlights that the PoC has stimulated an established and specialised offshore wind path, whilst the Humber Ports has created a broad offshore wind portfolio, with capacity to grow its embryonic offshore wind path through renewing its long-term O&M support.

In addition to the path outcomes outlined in Table 7.3, there were contrasting distributional aspects of the path creation process and outcomes across the two cases (Martin, 2010). In the PoC case, the creation of a new path was for the economic benefit of Cuxhaven itself, establishing a new infrastructural base to generate new job opportunities and a strong localised supply chain within or adjacent to the port (AfW Cuxhaven, 2017; 2018c). In a similar way, the creation of a new path in the Humber Ports case was to create a new economic future for the Humber at a moment of increasing unemployment and uncertainty in the late 2000s (IBM PLI, 2006). However, from the perspective of ABP, the formation of a new path for the wider region also had to generate a successful revenue stream by harnessing and diversifying dormant port infrastructure at the Alexandra Dock (PoH) and Royal Dock (PoG) for new purposes, in order to maintain or increase profits for its external shareholders (University of Hull, 2018; Ørsted, 2016; Humber Business, 2017b).

The success of path creation has been assessed and measured in this research project by comparing levels of investment and commitments from port authority and public bodies to construct port infrastructure for offshore wind, the scale and quality of jobs created, the levels of inward investments from firms, the quantity of new firms and local supply chains within each case, the potential levels of future investment in relation to the offshore wind paths, and the overall composition and qualitative nature of the offshore wind path outcomes (see Figure 7.1; Figure 7.2; Table 7.3). These key path outcomes reflect the nature and success of the offshore wind paths and provides the empirical basis upon which the research is arguing that the path within the PoC case is more developed (Martin, 2010). However, assessing and measuring the success of path creation in a quantitative and qualitative manner is an important area of evolutionary and comparative path creation research which requires deeper theoretical and empirical development (Pike et al, 2016a; MacKinnon et al, 2019; Martin, 2010).

7.8 Conclusion

Both port cases successfully demonstrated diversification into offshore wind and are currently leading port bases in the UK and German offshore wind industries. However, by deploying the analytical framework in a comparative context I have revealed the key factors which differentiated how the port adaptation process occurred, and how regional path outcomes subsequently emerged and developed out of these processes. A key overarching factor was the national institutional environment (Notteboom, 2016; Martin, 2000; 2010; Gertler, 2010; Figure 2.4). The national institutional environments are influenced by the variegated modes of capitalism evident in the UK, encouraging private port governance and the centralisation of resources and decision-making power, and in Germany, supporting public port ownership and governance and the decentralised resources and decision-making power, which are critical in shaping port adaptation (Martin, 2010; Hall & Soskice, 2001; Debrie et al, 2013; Brooks & Cullinane, 2007b).

The national institutional environment for offshore wind, comprising national policy frameworks and market subsidies for offshore wind, was a pivotal factor in creating and subsequently constraining offshore wind markets in the UK and Germany, which shaped the port adaptation process across both cases (GWEC, 2016; IRENA, 2012; Martin, 2010). The variance in national institutional environments shaped the planning and consequent geography of offshore wind project development and the levels of market subsidies for offshore wind, which thus influenced when and where firms, port authorities and sub-national government agencies provided investment (Martin, 2010; Dawley et al, 2019). Comparable changes in the national offshore wind markets at parallel points in time required port actors (port authorities, sub-national government agencies and firms) to strategically respond and plan their future investments accordingly (GWEC, 2016; IRNEA, 2012; Notteboom, 2016). As a result of differing port governance arrangements, investment approaches and responses to changes in the national market and institutional environments from port actors, the port adaptation process was less constrained in the PoC case in comparison to the Humber Ports case (Verhoeven, 2010; Notteboom, 2016; Martin, 2010). Stable national market and institutional environments for offshore wind best support port diversification and path creation processes (Notteboom, 2016; Martin, 2010). There are several key factors differentiating the port adaptation process and path creation outcomes within the comparative port cases, which closely reflect the elements underpinning port adaptation outlined in the analytical framework (Notteboom, 2016; Martin, 2010; see Figure 2.4).

Distinctive port governance models and the decision-making activities of key port actors (port authorities and sub-national government agencies) differentiated the port adaptation processes and path creation outcomes (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Notteboom, 2016). Due to the public governance and ownership of the PoC, these port actors were less concerned with making short-term returns on investment into infrastructure than private sector orientated port actors within the Humber Ports case (Verhoeven, 2010; Suykens & Van de Voorde, 1998). This is reflected in how port actors in the PoC case decided to proactively invest into port infrastructure, enabling them to attract a series of inward investments and create an established offshore wind path, as part of a long-term strategic vision (Monios & Wilmsmeier, 2016; AfW Cuxhaven, 2017; Table 7.3). In contrast, the port actors in the Humber Ports case were reacting to a growing offshore wind market and made investments into port infrastructure following legal investment commitments of firms to ensure future returns (Monios & Wilmsmeier, 2016; Financial Times, 2014). Therefore, the public governance context and proactive investment approach was more effective in enabling a port-led diversification process in comparison to private governance context in the Humber Ports case, enabling a firm-led diversification process and reactive investment approach (Verhoeven, 2010; Monios & Wilmsmeier, 2016).

Following the creation of a national institutional and market environment for offshore wind, the analysis revealed the variance in port visions and investment strategies in shaping the adaptation and diversification processes (Notteboom, 2016; Trippl, 2019; Martin, 2010). The vision for the PoC was based upon a long-term strategy of building an offshore wind port, which enabled the PoC to become a leading port in the European offshore wind industry and enable a new regional offshore wind path to emerge as an outcome of this port diversification processes, characterised by a series of inward investments (Notteboom, 2016; Martin, 2010). In contrast, the strategy for port diversification in the Humber Ports case was based upon a reactive investment approach, to capture short to medium term returns for shareholders, which did enable inward investments despite constraining the decision-making process of certain firms (Monios, 2017; Monios & Wilmsmeier, 2016). Due to its firm-led diversification process, the Humber Ports have been dependent upon offshore wind firms making up-front investment commitments to diversify into offshore wind (AfW Cuxhaven, 2018c; University of Hull, 2018). In contrast, creating a long-term strategic port vision is more effective in enabling port-led diversification, as it allows port authorities and sub-national government agencies to make strategic investment plans for diversification into a new market over a long-term period (Notteboom, 2016; Martin, 2010). To fully realise a new port vision or investment strategy, port authorities and sub-national government agencies may provide substantial investments into infrastructure to enable a demonstration affect, which can act as a catalyst for capturing inward investment (Notteboom, 2016; Maskell & Malmberg, 1999; AfW Cuxhaven, 2017; Figure 2.4).

The availability and deliverability of infrastructural and material assets was a key factor influencing the port adaptation process (Maskell & Malmberg, 1999; Notteboom, 2016; Martin, 2010). The greenfield land at the PoC had large potential for expansion and was incrementally delivered through a series of investments from the port authority and sub-national government agencies (AfW Cuxhaven, 2017; Niedersachsen, 2003). This subsequently catalysed several inward investments over time from offshore wind firms, which enabled the PoC to deliver an attractive asset base, diversify into a leading offshore wind port and successfully create a new regional path (AfW Cuxhaven, 2017; Notteboom, 2016; Martin, 2010). In contrast, stagnating and underutilised brownfield land within the Humber Ports case had particular environmental and consenting issues, which caused some barriers to inward investment from key firms (University of Hull, 2018). Nevertheless, the brownfield land at the Humber Ports was available and more deliverable for offshore wind firms than competing port sites, such as the AMEP on the south bank of the River Humber (Dawley et al, 2019). Therefore, the deliverability of the Humber Port's port infrastructure alongside the scale and proximity of demand for the Humber Ports, stimulated the adaptation and diversification processes, which enabled the Humber Ports to establish itself as a leading offshore wind port base and create a new regional path (Dawley et al, 2019; Maskell & Malmberg, 1999; Martin, 2010). Whilst having greater potential, ports endowed with greenfield land are dependent upon a strong configuration and relationship between the national institutional environment, prospective offshore wind firms and the strategic port vision, investment decisions and financial resources of key port actors, who have the power and legitimacy to diversify a port's market portfolio and asset base (Martin, 2010; Notteboom, 2016; Monios & Wilmsmeier, 2016; Rodríguez-Pose & Gill, 2003).

Chapter 8 Conclusion

8.1 Introduction

This thesis has reaffirmed the importance of studying ports as strategic asset bases within regions and uncovered the importance of investigating the port authority as an overlooked actor in shaping processes of adaptation, diversification and regional path creation. By undertaking the international comparative analysis of two case studies, the research has been successful in meeting the overall **aim** of the thesis:

To better understand and assess processes of port adaptation and diversification, based upon the role of local institutions harnessing and valorising inherited and geographically specific port-related assets.

In response the thesis began by assessing key strands of literature within Evolutionary Economic Geography (EEG), the role of institutions in EEG and port governance, ownership and diversification. Based upon this analysis, I designed an analytical framework to explore how port adaptation and diversification shapes the regional path creation process and to compare two empirical cases consisting of the Humber Ports case (Port of Hull and Port of Grimsby), and the Port of Cuxhaven case.

This chapter will discuss the main empirical findings to answer the three research questions explored within the thesis, explain the key theoretical and conceptual contributions, provide recommendations for enabling port diversification and path creation and outline future research directions.

8.2 Main empirical findings

This section will unpack and explain the main empirical findings to provide answers for the three key research questions of the thesis.

What forms of port diversification have been developed by port authorities and associated regional institutions?

The port authorities and associated regional institutions in both cases established two contrasting forms of diversification, which differentiated the adaptation process around offshore wind (Notteboom, 2016; Martin, 2010). First, port-led diversification is when investment is provided by the port authority and sub-national government agencies for new infrastructural assets to be constructed on greenfield land, in order to serve a new purpose and market, such as offshore wind (see Figure 2.4; Notteboom, 2016; Maskell & Malmberg, 1999). Second, firm-led diversification occurs when investment is driven by external (offshore wind) firms and developers and support by investment from port authorities, in order to realign existing infrastructural and material assets on brownfield land and support a new market (see Figure 2.4; Martin, 2010; Boas, 2007; Maskell & Malmberg, 1999). Port-led and firm-led diversification are not binary and are often overlapping in reality, as the diversification process can be led by both port actors (port authorities and sub-national government agencies) and external firms at different times throughout the adaptation, evolution and diversification of a port into new market (Notteboom, 2016; Martin; 2010).

Port-led diversification is more evident in the PoC case, wherein the port authority, state government and local authority expanded new port infrastructure which diversified the PoC's asset base and future market portfolio, enabling the PoC to adapt and diversify into offshore wind (Notteboom, 2016; AfW Cuxhaven, 2017). This form of port-led diversification was based upon the long-term aim of the port authority and sub-national government agencies, which was to capture a series of turbine component manufacturers, installation activities and O&M operators gradually over time (AfW Cuxhaven, 2017; Niedersachsen, 2003). The incremental expansion of ports assets at the PoC through a series of infrastructure construction projects adds new conceptual and empirical evidence to existing understandings of potential diversification mechanisms in EEG, as conceived by Martin and Sunley (2006), highlighting how a distinctive form of diversification can occur (Notteboom, 2016; AfW Cuxhaven, 2017; Niedersachsen, 2003). The gradual expansion of port assets to enable diversification was articulated in the 'Offshore Master Plan', which was created and continually updated by a strategic coalition of actors working on a sub-national scale (Niedersachsen, 2003; AfW Cuxhaven, 2017). The PoC diversified into manufacturing, installation and O&M offshore wind activities because key port actors led the diversification process and proactively planned and constructed infrastructure projects, in order to meet projected demand and capture inward investment (Monios & Wilmsmeier, 2016; Notteboom, 2016).

In contrast, a firm-led diversification was dominant in the Humber Ports case, shaped and driven by the actions of external offshore wind manufacturing firms and developers, who shifted the investment approach of ABP at the Humber Ports. Essentially, the port authority and local government agencies in the Humber Ports case reacted and responded to the interests of leading firms and converted port assets accordingly to capture their investments, which enabled a different port diversification process in comparison to the PoC (Monios & Wilmsmeier, 2016; Boas, 2007; Notteboom, 2016).

The conversion of port assets in the Humber Ports case was constrained at certain points in time as various factors caused barriers for inward investment, which hindered this form of firm-led diversification and differentiated it from the form of port-led diversification found in the PoC case (Boas, 2007; Notteboom, 2016; University of Hull, 2018). As ABP and local government agencies focused upon converting existing port infrastructure in response to interest from external manufacturing firms and developers, the firm-led diversification process was limited to capturing a certain scale of inward investment and offshore wind activities (Boas, 2007; Notteboom, 2016). That said, the deliverability of port infrastructure in the Humber Ports case was pivotal in enabling the firm-led diversification process, as it captured investment ahead of rival port sites such as the AMEP (Siemens, 2016a; BBC News, 2014; Able UK, 2017). Moreover, the conversion of port assets in the Port of Grimsby (PoG) to support extensive O&M activities, as a distinctive form of firm-led diversification, may lead to longer term investments in supporting the long-term port adaptation process in the Humber Ports case (Notteboom, 2016; Martin, 2010; Humber Business, 2016a). This is because current O&M activities at the PoG will occur for the 25 year lifespan of existing offshore wind projects and there is an increasing long-term demand from developers for operating and maintaining offshore wind projects from the PoG (Renewable UK, 2017a; Ørsted, 2019; Ørsted Hornsea Project One, 2018; OffshoreWIND, 2018).

In what ways do port ownership and governance models shape a port's capacity to adapt?

The 'Anglo-Saxon' port governance model is evident in the Humber Ports case, meaning the Humber Ports are owned and governed by an independent private port authority named ABP (Associated British Ports) (see Table 2.1; Suykens & Van de Voorde, 1998; Brooks & Cullinane, 2007b; Verhoeven, 2010). In contrast, the 'Hanseatic' port governance model is evident in the PoC case, meaning the PoC is under public ownership of the state government and operated by a private company under public ownership of the state (Niedersachsen) government, named Niedersachsen Ports (NPorts) (see Table 2.1; Suykens & Van de Voorde, 1998; Verhoeven, 2010; Baird, 2004).

One feature of the Hanseatic port governance model is to enable the long-term diversification of the port into a new market, whilst supporting the broader economic development of the region that the port is situated within (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Notteboom, 2016). The thesis revealed this key characteristic by analysing the role of NPorts, who focused upon the long-term diversification of the PoC by establishing a strategic port vision in 2003 and strengthened the PoC's initial and future capacity to diversify into offshore wind, which catalysed a new regional path (Notteboom, 2016; Trippl, 2019; Hassink et al, 2019). The effect of the Hanseatic governance model upon the PoC's adaptation and diversification is primarily evident in the prolonged efforts of NPorts, the Niedersachsen government and the City of Cuxhaven, who invested and constructed quayside infrastructure in parallel or in advance of emerging market opportunities (AfW Cuxhaven, 2017; Niedersachsen, 2003). This required largescale investment of public resources into a series of port infrastructure projects and thus reflects an important trait of the Hanseatic governance model, which is utilising decentralised decision-making powers and financial resources to enable port adaptation (Verhoeven, 2010; Notteboom, 2016; Rodríguez-Pose & Gill, 2003; AfW Cuxhaven, 2017; 2018c). Furthermore, the building of the PoC's capacity to adapt through a long-term diversification process required the broader consideration and implementation of the strategic ideas generated by key individuals within sub-national government agencies and other associated bodies (Notteboom, 2016; Trippl, 2019; Pike et al, 2010). The Hanseatic governance model enabled the sharing of strategic ideas and long-term investment plans between NPorts, the Niedersachsen government and the City of Cuxhaven (Verhoeven, 2010; Suykens & Van de Voorde, 1998).

A change of port governance structures can subsequently alter the capacity of a port to adapt and diversify into new markets (Debrie et al, 2013; Notteboom, 2016; Monios & Wilmsmeier, 2016). The evidence of port governance change in the PoC case indicates the importance of considering how the governance arrangements of ports strongly influence how ports can diversify into new markets (Debrie et al, 2013; Notteboom, 2016). The introduction of a dedicated port authority at the PoC, which was actively focused upon diversifying its market portfolio over a long-term period, strengthened the PoC's capacity to adapt and diversify into offshore wind (Niedersachsen Ports, 2009; Debrie et al, 2013). However, when senior individuals within a port authority alter how they view new and emerging market opportunities such as offshore wind, due to internal and/or external changes, influences or pressures, this can also transform and heighten a port's capacity to adapt (Pike et al, 2010). For example, key senior executives at the Humber Ports decided to shift towards supporting the offshore wind sector from being solely involved in traditional port activities and markets such as general cargo handling and automobiles, which enabled the Humber Ports capacity to adapt and diversify into offshore wind (Notteboom, 2016). This finding supports a key argument from Monios and Wilmsmeier (2016), who suggest that port adaptation and evolution can change as a result of new strategies from key stakeholders (Notteboom, 2016).

Port governance models influence and shape whether proactive or reactive investments are made by port authorities and/or sub-national government agencies into quayside infrastructure, which may shape a port's capacity to diversify its asset base and adapt over time (Monios & Wilmsmeier, 2016; Notteboom, 2016). The Hanseatic governance model enables proactive investments into infrastructure, as demonstrated by the PoC (Verhoeven, 2010; Suykens & Van de Voorde, 1998). NPorts made largescale investments using public resources before commitments were made by external investors because short-term returns on infrastructure investment are not prioritised in the Hanseatic governance model (Verhoeven 2010; AfW Cuxhaven, 2017). Essentially, these proactive investments heightened the PoC's capacity to adapt and diversify by attracting a series of inward investments from project developers and manufacturing firms, who were actively seeking suitable ports to serve offshore wind projects (Monios & Wilmsmeier, 2016; Pike et al, 2010; Notteboom, 2016).

In contrast, reactive investments are encouraged when ports operate within the Anglo-Saxon port governance model (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Brooks & Cullinane, 2007b). The reactive investments made by ABP in the Humber Ports case were opportunistic in nature and only occurred in direct response to interest shown by an external investor (Monios & Wilmsmeier, 2016). This constrained the Humber Ports' capacity to adapt and diversify because ABP and associated sub-national government agencies were highly dependent upon the interests of external firms to catalyse their own investments into infrastructure (Baltazar & Brooks, 2007; Brooks & Pallis, 2008). However, as the Humber Ports operates within an 'Anglo—Saxon' governance model, they may be more inclined to conduct reactive investments, as they need to generate and predict reliable returns for shareholders, meaning they find it more difficult to proactively invest into port infrastructure before securing a customer as it entails greater financial risk (Monios & Wilmsmeier, 2016; Talley, 2007; Verhoeven, 2010). Monios and Wilmsmeier (2016) argue that making more proactive investments into port infrastructure can heighten the capacity of ports to adapt, evolve and capture new market opportunities (Pike et al, 2010). For the Humber Ports to achieve this, key individuals within ABP may need to shift the perspective of its shareholders and justify how the port will generate suitable returns on an investment with greater risk, whilst considering taking a more long-term investment approach (Monios & Wilmsmeier, 2016; Talley, 2007; Musso et al, 2006).

How do multiscalar institutional environments enable and/or constrain port adaptation?

Empirical research in EEG regularly focuses upon endogenous factors and occasionally overlooks exogenous factors influencing processes of adaptation and diversification, which has led to a growing number of calls to better understand how the multiscalar institutional environment shapes these processes (Martin, 2010; Gertler, 2010; Morgan, 2013; Dawley et al, 2015). To address this issue, this thesis has uncovered how multiscalar institutional environments enabled and constrained port adaptation in different ways within the case studies (Martin, 2010; Notteboom, 2016). The institutional environments consist of the market subsidy regimes for offshore wind, national, regional and local industrial policies and strategies, rules and regulations governing ports and the offshore wind industry, and the institutional arrangements of the port authority and sub-national government agencies (Martin, 2000; 2010; Gertler, 2010; Hassink et al, 2019). The thesis has identified a more strongly enabled port adaptation process occurred in the PoC case in comparison to the Humber Ports case, as a result of multiple factors aligning and combining on multiple scales in a more consistent manner through a series of key causal episodes (MacKinnon et al, 2018; Dawley et al, 2019; Hassink et al, 2019; Martin, 2010).

On the national scale, the UK and German governments developed broader institutional environments that at various times have moved between enabling and constraining conditions for offshore wind, thus shaping a contrasting port adaptation process within the case studies (Martin, 2010; Gertler, 2010; GWEC, 2016). The policy-driven and subsidy-dependent nature of the offshore wind industry meant that the port adaptation processes within the port cases were strongly shaped by market subsidy regimes and industrial policies for offshore wind on the national level (Notteboom, 2016; Martin, 2010; Dawley et al, 2015; GWEC, 2016). The UK government adopted a market-led approach for establishing offshore wind, prioritising the provision of market subsidies to attract investment from project developers and subsequent inward investment from turbine manufacturers (DECC, 2011; Dawley et al, 2015). This meant the port adaptation process in the Humber Ports case was strongly dependent upon financial commitments from large project developers into the UK offshore wind market around the Humber region, as demonstrated by as Ørsted, E.ON and Centrica.

In contrast, from the early 2000s the German government prioritised implementing industrial policies for strengthening manufacturing capacity, in order to capture future opportunities in the manufacturing of offshore wind turbines (Lema et al, 2014; IRENA, 2012; BMWi, 2015). Consequently, the port adaptation process in the PoC case was heavily shaped by the investment commitments and disinvestments of a series of component manufacturing firms (AfW, 2017; Notteboom, 2016). This highlights the specificity of offshore wind as a case of port adaptation and diversification, as port markets such as general cargo handling and automobiles are less dependent upon market subsidies and industrial policy, and would therefore enable a more stable port adaptation process (Notteboom, 2016; BMWi, 2015).

However, the institutional environment on the national scale shifted in 2011 in the UK and 2013 in Germany and as a result, it severely jeopardised market opportunities for ports to capitalise upon and therefore hindered the port adaptation process in both port cases (Martin, 2010; IRENA, 2012; Notteboom, 2016). Therefore, the thesis has uncovered the importance of considering the enabling and constraining nature of the multiscalar institutional environment, as changes on the national scale around a specific port market such as offshore wind, support and hinder the process of port adaptation and diversification on the sub-national scale (Martin, 2010; 2000; Notteboom, 2016).

The sub-national scale is also of critical importance in shaping the port adaptation process (Martin, 2010; Brooks & Pallis, 2008). The port authority and sub-national government agencies in the PoC case provided consistent investment into a series of infrastructure projects, which strongly aligned to the emerging national market environment and the Federal government's ongoing commitments to providing market subsidies and installed capacity targets (AfW Cuxhaven, 2017; MacKinnon et al, 2018; BMWI, 2015). Moreover, the port authority in the Humber Ports case and the associated sub-national government agencies also worked closely together to ensure their investment approaches and policies strongly aligned to the requirements of firms interested in the Humber Ports when necessary (Dawley et al, 2019; University of Hull, 2018). However, as the port authority and government agencies on the sub-national scale in the PoC case decided to actively pursue a long-term and strategic port vision to continually expand port infrastructure despite periods of uncertainty and firm disinvestment, meant that it strongly and more consistently aligned to the national-level market, institutional and policy environment in comparison to the Humber Ports case (Niedersachsen, 2003; Martin, 2010; IRENA, 2012). By drawing upon insights from Rodríguez-Pose and Gill (2003), it becomes clear that the diversification of the PoC and the regional offshore wind path was more strongly enabled by the port authority's ability to access decentralised financial resources in the form of public grants and loans, exercise authority and responsibility for port development, and draw upon the strong legitimacy given to sub-national government agencies for directing infrastructure investment and expansion (AfW Cuxhaven, 2017). This extent of decentralisation and close cooperation between sub-national government agencies and port authorities to support new emerging sectors and regional development reflects the distinctive variety of capitalism of Germany as a 'compound CME' (Ćetković et al, 2016; Martin, 2010; Hall & Soskice, 2001). As such, Germany's federal government has encouraged strong strategic coordination between government institutions and industrial actors such as ports by devolving extensive decision-making and spending powers, legitimate political authority, and substantial financial and human resources to sub-national levels of government (Ćetković et al, 2016; Rodríguez-Pose & Gill, 2003; Hall & Soskice, 2001; BMVI, 2016).

8.3 Theoretical contributions of the thesis

As noted in Chapter 3, comparative studies of port adaptation and diversification mainly focus upon exploring the internal functionality and context of port authorities, only occasionally adopt long-term historical perspectives and are largely based upon analysing trends in quantitative data when investigating empirical cases, meaning they lack a broader qualitative understanding of what causes and shapes port adaptation and require a more conceptually developed comparative focus (Notteboom, 2016; Wang & Ducruet, 2013; Ducruet & Itoh, 2016; Pike et al, 2016a). However, the fields of port studies and transport geography recognise that notions of port adaptation, diversification and port governance are increasingly important in relation to future research (Monios & Wilmsmeier, 2016; Notteboom, 2016). By drawing upon key concepts in EEG and literature on the role of institutions and governance, the conceptual approach taken within the thesis contributes to existing comparative port studies, by investigating and comparing the underlying contexts, influences, actors and mechanisms driving and influencing port adaptation (Pike et al, 2016a; Notteboom, 2016).

The thesis engages with the port and port authority as new analytical sites and actors in the processes shaping adaptation, diversification and path creation, a perspective that has been previously unexplored in EEG. The research is novel in using the port as a new object to study these evolutionary processes, looking beyond industries, sectors and clusters as typical research objects (Pike et al, 2016a; Simmie & Martin, 2010; Martin, 2010). International comparative analysis of case studies is becoming increasingly important because it can provide “deeper insights and challenge the rigor and robustness of conceptual frameworks and theoretical explanations” within the evolutionary approach in economic geography and path creation studies (Pike et al, 2016a, pp135; Boschma & Frenken, 2009). Furthermore, conducting international comparative analysis of case studies to investigate processes of adaptation and diversification enables the strengthening of future empirical studies in EEG, allowing them to become “more comparable, transparent, and cumulative” (Boschma & Frenken, 2009, pp156; Pike et al, 2016a).

As outlined in the Literature Review, the thesis draws upon work of Martin and Sunley (2006), Martin (2010), Pike et al (2010) and MacKinnon et al (2019), by defining port adaptation as the long-term process of change in response to external changes in the institutional environment, and port diversification as the re-orientation of assets to capture new markets and drive port adaptation (Maskell & Malmberg, 1999). Drawing upon the work of Martin and Sunley (2006), my thesis defines port diversification as the re-orientation of port assets to serve a new and different purpose within a new port market (Maskell & Malmberg, 1999). The analytical framework was designed to clarify and better understand the process of port adaptation and allow the international comparative analysis of port cases (see Figure 2.4; Notteboom, 2016; Martin, 2010; Pike et al, 2016a). As such, the analytical framework facilitates a better understanding of the causality, drivers and influences upon port adaptation (Pike et al, 2016a; Notteboom, 2016; Figure 2.4). This allowed us to better understand the operation and connections between “underlying actors, mechanisms and outcomes” of port adaptation (MacKinnon et al, 2018, pp3; Martin, 2010; Dawley, 2014; Notteboom, 2016; Figure 2.4).

The first contribution by the thesis is that the thesis sought to better define, unpack and analyse the diversification process to better grasp how it is operationalised, which is often an abstract process to consider in EEG research (MacKinnon et al, 2018; Martin, 2010). Essentially, the analytical framework (Figure 2.4) and Figure 8.1 address the ‘who’, ‘what’, ‘where’ and ‘why’ questions when ‘doing’ research into evolutionary processes, which existing research on port adaptation and diversification in the areas of port studies and transport geography need to better comprehend and conceptualise (Pike et al, 2016a; Notteboom, 2016; Jacobs & Lagendijk, 2014). Scholars in EEG have recognised the need for exploring specific moments “where conscious and deliberative agency by participant actors and institutions can influence and even shape the quantitative extent and qualitative nature of the emergent paths and their trajectories” (Pike et al, 2016a, pp138). Therefore, the thesis sought to unpack and unravel the port adaptation and diversification processes through key causal episodes, identified and created by the grouping of a series of smaller events by similar time of occurrence and purpose, which ultimately accentuated the important moments of change in the adaptation of the port cases (Pike et al, 2016a). The thesis built upon the analytical framework (see Figure 2.4) and drew upon the "Integrative framework" for path creation constructed by MacKinnon et al (2019, pp121) to create Figure 8.1 which forms part of the first contribution, as it provides a more tangible and empirical understanding of how the port diversification process unfolds, adds to existing literature in EEG on diversification and branching and enables a more advanced international comparative analysis of port diversification (see Martin & Sunley, 2006; Boschma & Frenken, 2006; Boschma & Martin, 2007; Boschma et al, 2016; Cooke, 2012).

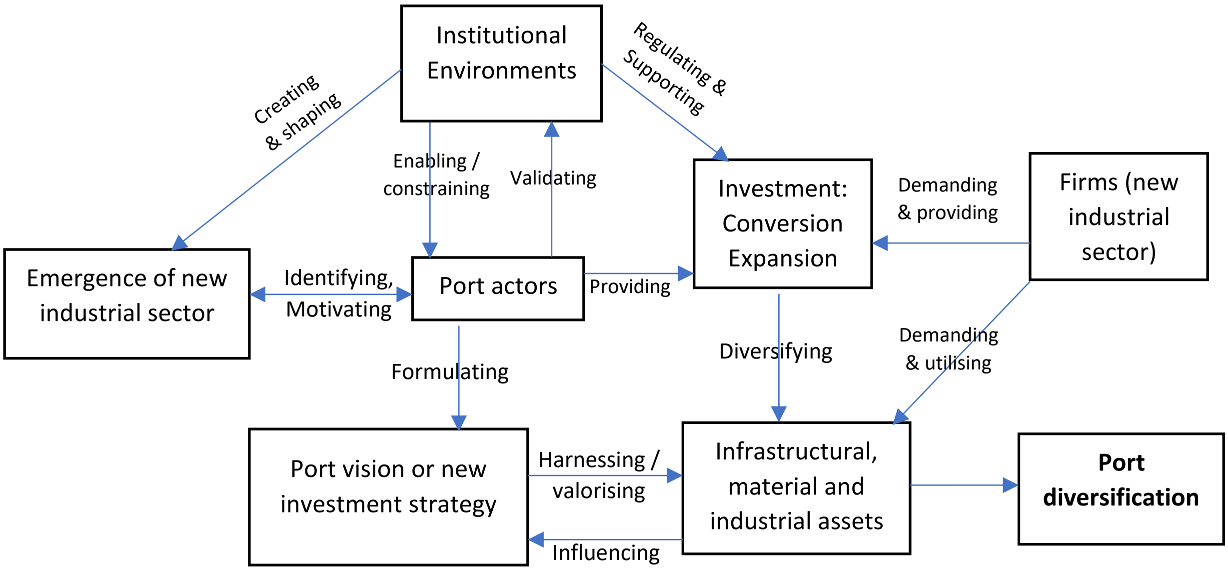


Figure 8.1: The process of port diversification in practice
Source: Author (adapted from MacKinnon et al, 2018).

The elements within Figure 8.1 interact and combine to stimulate port diversification. Port actors (port authorities and sub-national government agencies), operating within particular institutional environments, identify an emerging economic opportunity emerging within their region. The port actors formulate a port vision or new investment strategy to harness and valorise their infrastructural, material and industrial asset base, in order to capitalise upon the newly emerging industrial sector. Port actors (port authorities and sub-national government agencies) provide investment to convert and/or expand the asset base, in order to fully realise the port vision or new investment strategy and meet the demand of firms operating within the emerging industrial sector, which have specific demands for port assets. The investments made by port actors are enabled, constrained and validated by the institutional environments they are operating within. Once the port assets have been converted and/or expanded and firms operating in the new industrial sector provide investment and are utilising the diversified port assets, the port has then successfully diversified to serve a new port market and will subsequently support regional path creation. As previously stated, the first contribution is the unpacking and analysing of the adaptation and diversification process which contributes to a key research gap in EEG, as scholars have called for an improved understanding of the "nature and operation" of these processes (MacKinnon et al, 2018, pp3; Dawley, 2014; Martin, 2010). The thesis has responded to this research gap in EEG by highlighting that the process of diversification in ports is primarily shaped and determined by two modes of investment acting as key causal mechanisms (Notteboom, 2016; Martin, 2010; Figure 8.1; Figure 2.4). The research uncovered how port diversification is operationalised by investment into ports assets through 'conversion' (Notteboom, 2016; Boas, 2007; Streek & Thelen, 2005). The thesis recognises and applies conversion as a mode of investment undertaken to realign port assets for new uses on brownfield land, which acts as a mechanism of port diversification (Martin, 2010; Boas, 2007; Maskell & Malmberg, 1999; Figure 8.1; Figure 2.4). This understanding and application of conversion as a concept moves beyond the traditional application of conversion in EEG and socio-political research, wherein conversion is when existing arrangements, structures, rules and procedures are reoriented, realigned and modified to serve new functions and purposes (Martin, 2010; Boas, 2007; Streek & Thelen, 2005; Thelen, 2003). Although not derived from the existing EEG literature, the thesis identified 'expansion' as a key mode of investment through which port (infrastructural, industrial, material) assets are expanded on greenfield land to serve a new purpose, thus acting as a mechanism for the diversification of ports into the offshore wind market (Maskell & Malmberg, 1999; Figure 8.1; Figure 2.4). This conceptual insight provides a new way of conceptualising and conducting a comparative analysis of how the diversification process unfolds through the expansion of port assets (Notteboom, 2016; MacKinnon et al, 2018; Dawley, 2014; Pike et al, 2016a; Figure 8.1; Figure 2.4).

The thesis made a second key conceptual contribution by exploring external institutional environments, to better understand how the port adaptation process is enabled and constrained over time (Martin, 2010; Gertler, 2010; Trippl, 2019; Hassink et al, 2019). Research in EEG has in the past placed strong emphasis upon endogenous factors such as (knowledge base, skilled labour market, technology base, physical assets) for generating new paths of growth and influencing the diversification process (Neffke et al, 2011; Boschma & Frenken, 2009; Martin, 2010). However, Martin (2010), Morgan (2013) and Dawley et al (2015) have highlighted the growing demand in EEG research to better understand how the external institutional environment influences and shapes adaptation, diversification and path creation processes (Gertler, 2010; Martin, 2000). In response, the thesis makes a key contribution to EEG research on institutions by highlighting how external institutional environments enabled and constrained the processes of port adaptation and diversification in different periods (Martin, 2010; Notteboom, 2016). The external institutional environments of the offshore wind industry in the UK and Germany enabled the decision-making behaviour, investment strategies of port authorities and their distinctive modes of investment, which consequently shaped how port adaptation unfolded (Martin, 2010; Notteboom, 2016). Essentially, the market opportunities in offshore wind for ports strongly depends upon the levels of market subsidies provided by national governments, as highlighted by the similar roles played by the UK and German governments (IRENA, 2012; Dawley et al, 2015).

Moreover, the thesis contributes to and draws together strands within existing literature on institutional approaches and on port governance to conduct the international comparative analysis of the port cases (see Martin, 2010; Gertler, 2010; Verhoeven, 2010; Notteboom, 2016; Pike et al, 2016). Based upon key lines of analysis within 'varieties of capitalism' research, the thesis demonstrated how different national government arrangements reflected distinctive 'Hanseatic' and 'Anglo-Saxon' port governance and ownership models, which consequently shaped contrasting port adaptation processes (Hall & Soskice, 2001; Theodore & Peck, 2007; Martin, 2000). Germany has a decentralised form of government through a federal system with power, resources and responsibility for ports designated to state or local governments, which enables the sub-national governments and publically owned ports to effectively stimulate and support port adaptation (BMVI, 2016; Niedersachsen, 2009; Martin, 2010). Germany's variety of capitalism is indicated by the Hanseatic port governance model which shapes many German ports, whereby the port authority has power, resources and responsibility to invest public money and therefore proactively drive port adaptation (Hall & Soskice, 2001; Theodore & Peck, 2007; Verhoeven, 2010). By contrast, the UK has a highly centralised government and liberal variety of capitalism, meaning power, resources and responsibility for ports lies with private port owners operating within a Anglo-Saxon port governance model, reflected by conservative and risk averse investment strategies (Hall & Soskice, 2001; Peck & Theodore, 2007; Monios, 2017; Verhoeven, 2010). Essentially, port adaptation in the UK is strongly influenced by private port authorities being reactive and opportunistic regarding their investment strategies, basing decisions on the requirements of national or overseas organisations as active shareholders (Notteboom, 2016; Monios & Wilmsmeier, 2016; Baird & Valentine, 2007).

The third key contribution is the identification of how two different port governance and ownership models actively shape and influence processes of port adaptation, diversification and regional path creation (Brooks & Cullinane, 2007b; Notteboom, 2016; Martin, 2010). This contribution aims to complement existing literature on port governance and ownership (Verhoeven, 2010; Suykens & Van de Voorde, 1998; Debrie et al, 2013), by providing a deeper comprehension of how different port governance models can shape contrasting processes of port adaptation through the international comparative analysis of port cases (Notteboom, 2016; Pike et al, 2016a). As evident in the PoC case, the 'Hanseatic' port governance model of public ownership and operation enables ports to make more proactive investment decisions and take greater risks on providing investment for port infrastructure, as making continuous returns is not a main priority for the state government as port owner (Suykens & Van de Voorde, 1998; Verhoeven, 2010; Monios & Wilmsmeier, 2016). This port governance arrangement is best suited for stimulating port adaptation, as it enables the port authority to construct port infrastructure and form an important regional asset base, thus providing an enhanced ability to attract firms and inward investment (Martin, 2010; Maskell & Malmberg, 1999; Dawley et al, 2019). Nevertheless, the 'Anglo-Saxon' port governance model evident in the Humber Ports case supported port adaptation by having the power and freedom as a private port owner to respond quickly to interest from external firms and make more reactive investment decisions (Brooks & Cullinane, 2007b; Monios, 2017; Martin, 2010). However, the nature of private port governance and ownership, orientated around generating returns on infrastructure investment for external shareholders, means that it is difficult for private ports to speculate and proactively construct port infrastructure for port diversification and path creation, without having certainty around its future usage to provide satisfactory returns (Brooks & Cullinane, 2007b; Notteboom, 2016; Monios, 2017; World Bank, 2016).

The thesis makes a final key contribution in terms of recognising the importance of the agency of actors for driving port adaptation, which subsequently stimulates new regional path creation (Notteboom, 2016; Trippl, 2019; Martin, 2010). The international comparative analysis of the port cases uncovered how the agency, motives and actions of the port actors (port authorities, sub-national government agencies and firms) were critical in facilitating new port visions, instances of investment and the diversification of port assets (Figure 8.1; Figure 2.4; Notteboom, 2016; Pike et al, 2016a). Drawing upon the different types of agency outlined by Grillitsch and Sotarauta (2018), the research revealed that port authorities and sub-national government agencies in the PoC case demonstrated evidence of 'institutional entrepreneurship' by modifying existing institutional arrangements, rules and norms to establish a long-term port vision, which enabled the harnessing and valorising of port assets (MacKinnon et al, 2019; Figure 8.1). In the Humber Ports case, key individuals within the port authority and sub-national government agencies acted more as 'innovative entrepreneurs', as they identified and subsequently exploited new economic opportunities in the offshore wind market by formulating a new investment strategy to harness and valorise port assets (Grillitsch and Sotarauta, 2018; MacKinnon et al, 2019; Figure 8.1). The port authorities and sub-national government agencies in the PoC case, which operated as innovative and institutional entrepreneurs, demonstrated the necessary 'place leadership' by advocating their regional offshore wind paths to attract external firms and interests, whilst building a coalition of actors to enable a new regional path around offshore wind (Grillitsch and Sotarauta, 2018; MacKinnon et al, 2019; Bailey et al, 2010; Figure 8.1).

Port visions are a key example of how actors exercise their agency and plan future investment to catalyse the adaptation process, thus providing a better understanding of how port adaptation and diversification are operationalised (MacKinnon et al, 2018, pp3; Dawley, 2014; Trippl, 2019). This contribution complements a growing research agenda in EEG by providing an international comparative analysis of how different actors exercise agency to drive adaptation and new regional path creation (Grillitsch and Sotarauta, 2018; MacKinnon et al, 2019; Steen, 2016; Pike et al, 2016a). There are two clear types of port visions and approaches created by port actors (port authorities and sub-national government agencies), which highlights the necessary agency required to drive port adaptation and path creation (Notteboom, 2016; MacKinnon et al, 2018). On the one hand, there can be more strategic and long-term port visions aiming to construct large-scale port infrastructure in order to attract a series of inward investments and firms, as demonstrated in the PoC case (AfW Cuxhaven, 2017; Niedersachsen, 2003). On the other hand, there can be more opportunistic and shorter-term investment approaches, which aim to capitalise upon specific inward investment opportunities at certain moments in time, as highlighted in the Humber Ports case. In order for ports to successfully realise their port visions and validate their new investment approaches, coalitions of key actors (port authorities, sub-national government agencies, quasi government bodies) need to work in close coordination to build place leadership capacity, attract investment and manage new firm transplantations (Dawley et al, 2019; Cox, 1998; University of Hull, 2018). The empirical analysis illustrated that a coalition of actors with continuous activity and cooperation managing a series of inward investors are best suited to enable the realisation of a strategic and long-term port vision and port diversification, as highlighted in the PoC case (AfW Cuxhaven, 2019). The empirical analysis also highlighted that opportunistic investment approaches can enable port diversification and are realised by temporary coalitions managing specific inward investments at certain points in time, as evident in the Humber Ports case (Dawley et al, 2019; MacKinnon et al, 2018).

8.4 Policy implications for port diversification and regional path creation

Based upon the empirical findings and comparative analysis, the thesis suggests that the Port of Cuxhaven (PoC) has been more successful in stimulating new path creation around the offshore wind industry. This overall conclusion can be made because the port diversification process in the PoC case was more strongly enabled by investment from port authorities, sub-national government agencies and firms in the offshore wind industry in comparison to the Humber Ports case. This section will now look at key policy implications and lessons.

The thesis has uncovered that national policy frameworks and institutional arrangements for ports and offshore wind are critical in shaping port diversification and regional path creation (Martin, 2010; 2000). The national framework for ports in Germany underlines the potential benefits for ports to be owned and governed by states and/or local authorities (BMVI, 2016; 2017). The institutional arrangements of publically owned ports, governed and managed by sub-national government agencies in Germany, has helped stimulate and drive new directions for ports and new regional economic development paths, as evident in the PoC case (BMVI, 2016; Niedersachsen Ports, 2009; 2017; AfW Cuxhaven, 2017; Martin, 2010). National ports policy in the UK has enabled a widespread shift of ownership and governance of ports to private port authorities operating on a national scale, often with ties to international bodies as shareholders (Monios, 2017). This national level policy has meant that the creation of new regional paths and the process of port diversification is highly dependent upon decisions of private port authorities aiming to drive profitability and returns for shareholders (Notteboom, 2016; Martin, 2010). For UK privately owned ports to diversify into a new market and stimulate new regional path creation, key individuals within port authorities can decide to strategically change their investment approach and support the growth of a sector emerging with a region, such as offshore wind in the Humber region.

In addition to the importance of national ports policy for shaping port governance and regional economic development, the stability of the national level institutional environment and market regime for offshore wind was pivotal in enabling port diversification into offshore wind and the path creation process (Notteboom, 2016; Martin, 2010; Monios, 2017). The institutional environment and market regimes in the UK and Germany underwent comparable periods of stability and instability (Martin, 2010; MacKinnon et al, 2018). However, the thesis highlighted that on the whole the federal government in Germany provided a more stable policy environment and market regime for offshore wind which was important in providing certainty for port authorities and firms (Martin, 2010; MacKinnon et al, 2018; IRENA, 2012; GWEC, 2016). Therefore, national government institutions should strive to provide a stable policy environment and market regime for offshore wind, as it stimulates investor confidence and assurance that the national government is in full political and financial support of the offshore wind industry (Martin, 2010; MacKinnon et al, 2018).

The research provides some implications for port authorities and sub-national government agencies who are seeking to enable port diversification and regional path creation (Notteboom, 2016; Martin, 2010). The creation of a strategic and long-term port-vision by port authorities as powerful regional economic actors, whilst being opportunistic and flexible to react to emerging market opportunities, is critical for enabling port diversification and regional path creation (Notteboom, 2016; Trippl, 2019; AfW Cuxhaven, 2017). A long-term and strategic port vision allows the port authority to newly focus its human and financial resources upon diversifying to support a new sector over a long-term period, despite future market and investor uncertainty. The port vision can be supported by a sense of direct adaptability and urgency from the port authority to proactively plan, invest and construct port infrastructure, to enable inward investment from external firms and diversify into a new market, such as offshore wind. The formation of port visions can be complemented by conducting horizon scanning research for future market opportunities and carrying out infrastructure planning and investment, which may foster a new and previously unrealised adaptative capacity of port authorities and local institutions and can stimulate wider regional economic development (IPPR North, 2016; Martin, 2010; Pike et al, 2010). The PoC is a leading example of how a port can formulate a strategic and long-term port vision, continuously update it over time and ultimately realise the vision over a decade later (AfW Cuxhaven, 2017; Niedersachsen, 2003). ABP as the port authority of the Humber Ports, other port authorities elsewhere and the project's collaborative partner the Humber LEP (Local Enterprise Partnership), can take key lessons and build on existing strategies from this important governance activity, which emphasises the long-term planning of infrastructure to enable future port diversification and new path creation. However, the private governance model evident in the UK may constrain vision making and proactive investment to a certain extent.

The thesis also revealed that it is critical for sub-national governance agencies, alongside the port authority, to build a strategic coalition of key actors who are jointly concerned with the future diversification of the port and wider regional economic development (Notteboom, 2016; IPPR North, 2016). This involves local, regional and state actors to work closely and in collaboration with port authorities to identify relevant actors who can support the diversification of the port into a new market, such as offshore wind. A coalition of actors is most affective in enabling port diversification and regional path creation when it is continually operating to achieve a common and long-term vision (Notteboom, 2016; Dawley et al, 2019; Trippl, 2019). The changing form and arrangement of the actor coalition can disrupt the progress of successfully achieving port diversification and realising a long-term vision. A successful coalition continuously focuses upon attracting a series of inward investments from external or existing firms actively involved and growing in a new sector such as offshore wind. The decentralisation of decision-making powers, resources and responsibilities for ports to sub-national government agencies is most effective for enabling port diversification and building strategic coalitions of actors (Debrie et al, 2013; Rodríguez-Pose & Gill 2003). However, not all countries are likely to achieve this form of governance in the short to medium term, such as the UK. Therefore, in the context of enabling port diversification and regional path creation in the UK context, it is critical for local councils, Local Enterprise Partnerships (LEPs) and other relevant bodies on the sub-national scale to be open to change, seek future economic development opportunities and continually work in greater collaboration with UK port authorities. A closer relationship can support the building of a strong territorial coalition of actors and the creation of a long-term vision for the region and port(s), centred upon emerging opportunities in a specific sector, such as offshore wind.

As suggested by Evenhuis (2016; 2017), changes in multiscalar institutional arrangements and the environment strongly mediates the process of regional economic change and path creation around new industries (Martin, 2010; 2000). Mirroring the arguments of Evenhuis (2016; 2017), this research has identified how on the local and regional scales in the UK there is greater institutional change and more evidence of "repeated restructuring and refitting of institutional arrangements" known as 'institutional churn', in comparison to Germany (Pike et al, 2015, pp19). This process of institutional churn is exemplified by the shift from Regional Development Agencies (RDAs) to Local Enterprise Partnerships (LEPs) following the election of the UK Coalition Government in 2010 (Pike et al, 2015). Therefore, the institutional environment on the sub-national scale in Germany more strongly enables processes of port diversification and new path creation, as sub-national government agencies have greater longevity and capacity to create and implement long-term port visions (Evenhuis, 2016; 2017; Notteboom, 2016; Martin, 2010). On the basis of this finding, the research can recommend national government institutions should fully consider the consequences of reforming sub-national government, as this may constrain their ability to provide financial support for port authorities and stimulate new regional growth paths.

The thesis can provide some practical lessons for port authorities and sub-national government in the UK, Germany and beyond, and for the Humber LEP as the project's collaborative partner. As previously discussed, the deliverability and availability of port infrastructure for firms in close proximity to offshore wind projects is crucial for supporting port diversification and a regional path around offshore wind. The *Offshore Master Plan* for the PoC set out a long-term port vision and Master Plan, which provided the necessary foresight for expanding and delivering port infrastructure to accommodate for a future offshore wind market (Niedersachsen, 2003; AfW Cuxhaven, 2017). To support a process similar to this, port authorities and sub-national government agencies should try to be open to work collectively and make proactive investments to deliver port infrastructure for firms interested in conducting port-based offshore wind activities (Monios & Wilmsmeier, 2016).

8.5 Future research

The findings and conclusion of the thesis has revealed that there are many directions for future research to further explore and certain issues which can be deepened. There is a clear opportunity for future comparative studies on port diversification into offshore wind using different types of offshore wind ports across different national contexts in Europe, North America and Asia. For example, a future research project could compare an embryonic offshore wind port in the US to a more established port serving North Sea offshore wind projects from Denmark or Germany. This future research would ascertain how relevant and useful the analytical framework developed in this project is for investigating and comparing other ports which have diversified into offshore wind, whilst providing opportunities for changing, deepening and/or extending elements of the analytical framework (Figure 2.4).

The thesis has aimed to strengthen the narrow body of work in EEG and path creation studies which seeks to compare case studies across different international settings (Pike et al, 2016a). The thesis has demonstrated how to go beyond focusing upon single empirical cases in studies of path creation and explore two international comparative cases (Pike et al, 2016a). However, the research faced certain limitations when conducting research on path creation in an international context (Pike et al, 2016a). The research was difficult to operationalise in terms of identifying and accessing the most relevant interviewees involved in influencing the adaptation and diversification process, in order to better understand their particular agency and context (Pike et al, 2016a; Dawley, 2014). This limitation was most apparent because individuals involved in directly shaping the adaptation and diversification of the port cases had either changed organisations or had retired from work, meaning it was hard to actually identify and find these key individuals. The main way of overcoming this limitation was ‘snowballing’ with existing interviewees and using online search tools such as *LinkedIn.* On the whole, the research highlighted the requirement for more multi-site international comparative analysis in EEG and demonstrated some of the challenges found in undertaking ‘deep contextualisation’ of evolutionary and path creation processes across different international settings, which raises questions of how researchers in EEG can conduct and successfully achieve this mode of evolutionary research across different sites (Pike et al, 2016a).

A key limitation in gaining a deep contextualisation of these processes was found in tracing the historical “tracks and routes identified, selected, and explored by actors prior to the emergence” of the offshore wind path in the Humber and Cuxhaven (Pike et al, 2016a, pp132; see Martin, 2010). This difficulty occurred because the research was investigating the role of actors in the past, meaning the interviewees required for the research had moved organisations or had retired from their profession. Another limitation within this project was researching the diversification of the port cases and the path creation process as they evolved in real time as the project progressed (Pike et al, 2016a). This required the consistent researching, updating and cataloguing of the most relevant individuals and organisations the project needed to examine the most important primary and secondary data required to inform the subsequent comparative analysis. Moreover, deciding an endpoint to the empirical research was an additional difficulty and limitation in the project and in researching evolutionary processes over time (Pike et al, 2016). Due to the scope and resources of this project, the endpoint of gathering primary data was at the end of the overseas research in Germany, with greater time and resources the additional primary data may have been collected. Following overseas fieldwork, I gathered secondary data on any relevant developments within the port cases which influenced the adaptation and diversification process, such as the transplantation of Muehlhan into the PoC in 2018 and the expansion of infrastructure at the PoG to support Ørsted’s O&M operations in 2018(Muehlhan, 2018; Humber Business, 2018b)).

Due to the relative success of both port cases in adapting and diversifying into offshore wind, there was a slight limitation in being able to draw strong comparisons and differences, especially in regard to the path creation outcomes of the adaptation process (Notteboom, 2016; Martin, 2010). To address this limitation, future research may consider comparing a port case which has diversified successfully into the offshore wind industry, such as the Port of Esbjerg (Denmark), to a port case which have failed to diversify into offshore wind, such as the Port of Bremerhaven in Germany. This future research may provide theoretical and empirical contributions to research on evolutionary paths, by deepening our understanding of how attempted port diversification has influenced the failure of path creation, or the emergence of different types of regional paths, such as path extension, path exhaustion or path renewal (Isaksen, 2015; Martin, 2010).

Clearly there are opportunities for applying, clarifying and deepening concepts and ideas around how the internal dynamics of port governance can enrich our understanding of how port adaptation and diversification leads to new regional path creation (Notteboom, 2016; Martin, 2010). These concepts and ideas include different types of port governance models, port vision-making and master planning activities, and proactive versus reactive investment decisions and approaches (Verhoeven, 2010; Notteboom, 2016; Brooks & Cullinane, 2017b; Monios & Wilmsmeier, 2016). This may forge greater linkages between concepts and ideas in EEG and ports as key sites of adaptation and change, whilst contributing to existing literature on port governance and diversification (Martin, 2010; Pike et al, 2010; Notteboom, 2016; Monios & Wilmsmeier, 2016).

The offshore wind industry is a unique case of port adaptation and diversification, as it is materially tied to certain offshore locations and therefore requires certain ports in particular localities to support the development of projects. However, there may be other industrial sectors ports can support by diversifying their market portfolio and asset base, in order support new regional path creation around a specific industrial sector (Notteboom, 2016; Martin, 2010). These sectors may include automobiles, subsea oil and gas, or biomass, as they are dependent upon ports as being infrastructural platforms and dynamic conduits to support the growth of particular sectors in certain localities or regions (IPPR North, 2016; Maskell & Malmberg, 1999). Exploring a different sector may clarify and deepen the analytical framework for investigating port adaptation adopted in this thesis, and possibly add valuable theoretical and empirical contributions to key theoretical ideas and concepts in EEG including adaptation, diversification and path creation.

Appendix: List of Interviewees

Humber Ports case

International, National and Sub-national bodies	Nature of organisation: firm or non-firm.	Organisation (state bodies, firms or trade associations)	Position of interviewee(s)	Interview date
International	Firm	Ørsted	Senior Advisor	13/12/2017
International	Firm	A2SEA	Regional Manager	05/12/2017
International	Firm	WSP	Technical Director	09/01/2018
National	Firm	ABLE UK	Senior Director	11/05/2017
National	Firm	ABP	Commercial Manager	07/11/2017
National	Firm	Former ABP	Former Managing Director	30/10/2017
National	Firm	Former ABP	Former Commercial Officer	15/12/2017
National	Firm	Former ABP	Project Manager	30/11/2017
National	Non-firm	HM Government: Department for Transport (DfT)	Policy Advisor 1, DfT	22/01/2018
			Policy Advisor 2, DfT	22/01/2018
			Policy Advisor 3, DfT	22/01/2018

National	Non-firm	Former HM Government: Department for International Trade	Deputy Head	28/11/2017
National	Non-firm	HM Government: Department for Business, Energy and Industrial Strategy.	Assistant Director	20/12/2017
National	Non-firm	Offshore Renewable Energy (ORE) Catapult	Senior Manager	24/11/2017
Sub-national	Firm	Grimsby Fish Dock Enterprises	Senior Director	01/06/2017
Sub-national	Non-firm	Humber Local Enterprise Partnership	Executive Director	15/11/2017
Sub-national	Non-firm	Green Port Hull	Senior Advisor	20/11/2017
Sub-national	Non-firm	Hull City Council	Senior Director	30/11/2017
Sub-national	Non-firm	North East Lincolnshire Council	Senior Officer	19/10/2017
Sub-national	Non-firm	Team Humber Marine Alliance (THMA)	Senior Executive	01/02/2018
Sub-national	Non-firm	Former Yorkshire Forward	Former Executive Officer	14/12/2017

Port of Cuxhaven case

International, National, Lander and sub-state (sub-Lander) bodies	Nature of organisation: firm or non-firm.	Organisation (state bodies, firms or trade association)	Position of interviewee(s)	Interview date
International	Firm	Rhenus Cuxport GmbH	Senior Executive	04/04/2018
			Senior Director	24/04/2018
International	Firm	Nordmark (Denmark)	Senior Director	26/04/2018
International	Firm	Offshore Marine Management GmbH	Senior Director	13/03/2018
International	Non-firm	Offshore Wind Industry Council (OWIC)	Senior Executive	07/05/2018
National	Firm	8.2 Consulting AG	Senior Consultant	23/04/2018
National	Firm	PNE Wind	Senior Project Engineer	25/04/2018
			Executive Assistant	25/04/2018
National	Non-firm	Federal Ministry for Transport and Digital Infrastructure (BMVI)	Senior Academic Advisor	16/04/2018
			Senior Policy Officer	27/04/2018
National	Non-firm	Germany Trade and Invest (GTAi)	Senior Director	10/04/2018
National	Non-firm	ZDS (Federation of German Seaports)	Senior Director	06/04/2018

National	Non-firm	Fraunhofer Centre for Maritime Logistics and Services	Senior Project Lead	11/04/2018
National	Non-firm	Fraunhofer Institute for Wind Energy and Energy Systems Engineering (IWES)	Group Manager	19/04/2018
National	Non-firm	Former Offshore Wind Industry Alliance (OWIA)	Former Manager	03/04/2018
Lander (Lower Saxony)	Non-firm	Ministry for the Economy, Labour and Transport of Lower Saxony	Senior Officer	09/05/2018
Lander (Lower Saxony)	Non-firm	NBank (Niedersachsen Bank)	Senior Financial Officer	18/04/2018
Sub-state (sub-Lander)	Non-firm	Economic Development Agency of Cuxhaven (AfW)	Former Senior Director	09/04/2018
			Senior Advisor	09/04/2018
Sub-state (sub-Lander)	Non-firm	Niedersachsen Ports GmbH & Co. KG (Port of Cuxhaven Office)	Manager	05/04/2018

Sub-state (sub-Lander)	Non-firm	BIS Bremerhaven	Senior Manager	12/04/2018
			Project Manager	12/04/2018
Sub-state (sub-Lander)	Non-firm	University of Bremen	Senior Researcher	07/03/2018
Sub-state (sub-Lander)	Non-firm	Technical University of Hamburg [TUHH], Institute of Maritime Logistics.	Researcher	23/04/2018

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