CREATING REGIONAL INDUSTRIES:

PATH CREATION AND OFFSHORE WIND IN THE U.K.

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Thesis submitted for the degree of Doctor of Philosophy

February 2019

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(88,754 words)

Abstract

This thesis contributes to evolutionary economic geography theory relating to the process of regional industrial path creation. The research provides an important point of departure within the literature by exposing and explaining how institutional environments enable or constrain path creating agency. In particular, the enquiry focuses on the role of multi-scalar institutions in mediating the interplay of actors, assets and mechanisms to create new regional industrial paths relating to socio-technical transition, specifically offshore wind, in Glasgow and Humberside. The research analyses how regional and extra-regional institutional environments shape the timing, scale and nature of this causal interplay and subsequent industrial path outcomes. By adopting this approach, a more comprehensive account of regional industrial path creation and its effect on regional development is generated which gives due cognisance to both endogenous and exogenous causal factors. Although the research focuses on lagging regions, the findings have relevance across regional types. Finally, the multi-scalar and multi-actor perspective exposes and explains the role of differing state actors and state institutions in facilitating regional path creation.

Dedication

To my beloved muse, Judith,

my kith and kin,

and the two exceptional places which shaped my research,

Glasgow and Humberside.

Lose ourselves in the history
of mine and steel and ships,
the glorious empire somewhat shaming,
trade and tobacco lording
over golden and red sandstone
where the tree newer grew,
the bird never flew,
the fish never swam,
the bell never rang.

Among stones balanced on stones
for height, splendour and fame
ancestors linger, edge us on to chase
dreams defying stresses and strains,
to build stronger and grander and higher,
resenting that the tree never grew,
the bird never flew,
the fish never swam,
the bell never rang.

Conversing with past we build our future,
limits expand with the universe.
Ideas from afar ebb and flow
through windows, doors open
for the drift into spaces between
where trees can grow,
birds can fly and sing,
fish can swim,
bells can ring,
and the ring binds us all together.

IEE Lees, The Tree that Never Grew

Isolate city spread alongside water,
Posted with white towers, she keeps her face
Half turned to Europe, lonely northern daughter,
Holding through centuries her separate place.

Behind her domes and cranes enormous skies
Of gold and shadows build; a filigree
Of wharves and wires, ricks and refineries,
Her working skyline wanders to the sea.

And now this stride into our solitude,
A swallow-fall and rise of one plain line,
A giant step for ever to include
All our dear landscape in a new design.

The winds play on it like a harp; the song,
Sharp from the east, sun-throated from the west,
Will never to one separate shire belong,
But north and south make union manifest.

Lost centuries of local lives that rose
And flowered to fall short where they began
Seem now to reassemble and unclose,
All resurrected in this single span,

Reaching for the world, as our lives do,
As all lives do, reaching that we may give
The best of what we are and hold as true:
Always it is by bridges that we live.

Philip Larkin, Bridge for the Living

Acknowledgements

I would like to thank my supervisors, Professor Danny MacKinnon and Doctor Stuart Dawley of CURDS, for all their unstinting support over the last four years. Danny and Stuart were the finest of guides and interpreters through the inspiring but hazardous terrain and unfamiliar culture of my PhD. Their constructive challenge and unwavering support ensured that my thinking and drafting remained focused, despite the gravitational pull of many alluring but extraneous texts and ideas. The views, insights and assistance they offered, for which I am immensely grateful, will always be remembered.

I would also like to recognise the generosity of Doctor Ben Fisher and Doctor Emil Evenhuis who recently completed their doctorates at CURDS. Their reflections on their own journeys and research were greatly valued.

In undertaking this research I was struck by the generosity of many persons both within Newcastle University and beyond. In particular, I am immensely grateful to all my interviewees for their kindness in time, thought and candour, and the team at Offshore Renewable Energy Catapult in the first year of my research.

I would also like to express gratitude to all the bearers of friendship, wise words and support throughout my professional and academic careers. In particular, I'd like to thank Professor Alan McGregor of the University of Glasgow who has always been generous in his scholarly and practical advice over the last two decades and also suggested CURDS for my PhD research.

Finally, I would like to acknowledge and thank my family and friends for all the love and support they so generously give.

It is by the light of others that we navigate our own lives.

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Chapter 1: Introduction

"What's past is prologue."

Act II, Scene I: The Tempest, William Shakespeare

1.1 Industrial Renewal and Path Creation: Bridging Theory and Policy

In 2017, the UK Government launched a new industrial strategy (BEIS, November 2017) which noted that "grand challenges" such as clean growth offer significant opportunities for regional reindustrialisation. However, the document was not accompanied by detail on how these opportunities could be realised. Additionally, although the strategy recognised the importance of "place" there was limited attention given to how regional heterogeneity could facilitate new regional industries and contribute to national industrial ambitions. This paucity is surprising given the UK's increasingly quasi-federal disposition, ad hoc devolution of powers and place based approach to transferring national funding for economic development. Moreover, given that the strategy identified potential radical new opportunities for regional industrial renewal, such as energy transition, a lack of corresponding radicalism in re-imagining the role of the state in regional industrial renewal was notable.

Tellingly, the UK Government could learn from preceding efforts to create new regional industries. In particular, lessons could be learnt from attempts to engender and harness industrial opportunities associated with socio-technical transition; the shift from the production, diffusion and application of one technology to another to fulfil a critical societal need (Geels, 2004; Markard and Truffer; 2008; Truffer and Coenen, 2012). For more than a decade, varying levels of government in the UK have prioritised energy transition, especially in regard to offshore wind, as a catalyst for regional industrial renewal. However the results, despite significant policy and resource commitments, have been mixed. Earlier projections of national and regional employment creation in relation to offshore wind have only been met in small measure[1]. Therefore, there are evidently key lessons to be learnt from this disconnect between expectation and outcome regarding the creation of new regional industries relating to socio-technical transition such as energy transition.

[1] ORE Catapult, 2014; Cambridge Econometrics, 2017

Simultaneously, as the offshore wind industry was evolving, a significant and compelling body of research in evolutionary economic geography was being developed in relation to the creation of new regional industrial paths. This research has provided valuable insight on how regions can utilise their heterogeneous assets and experiences inherited from previous economic structures and conditions to create new industrial paths. Such research has evident utility to regions faced with the challenge of finding a means to achieve industrial renewal and reorient their economic trajectories. Moreover, this body of work has increasingly considered the role of social agency in path creation. Even so, there is a paucity of research on how such agency is enabled or constrained by its institutional context.

Therefore, this research assesses how regional path creation and associated social agency are facilitated or impeded by the institutional environment in which they are set. In doing so, it will utilise the experience of path creation in two regions which was engendered by socio-technical transition relating to decarbonisation of the energy system, specifically offshore wind, as its lens of analytical enquiry. The two selected regions are Glasgow and Humberside. Although both regions can be broadly characterised as lagging, there is marked variation which will facilitate comparison of the influence of regional heterogeneity, including assets, institutions and research capacity, on path creation. Moreover, while there are similarities in their broader institutional environments, the Glasgow case is also set within the devolved policy context of the Scottish Government, thereby facilitating insight into the role of differing extra-regional environments in mediating agency and path creation.

Significantly, in 2014, Michael Fallon, a UK Government Minister, stated that the establishment of a technology and innovation body in Glasgow, Offshore Renewable Energy Catapult, and a Siemens manufacturing facility on Humberside represented key milestones for government policy in relation to the development of the offshore wind industry[2]. Therefore, both regions offer relevant entry points for understanding the role of UK policy on creating regional industrial paths.

In terms of the characterisation of both regions as lagging, it is appropriate to offer clarification of the denotation applied in this study. Regional taxonomies such as lagging (Pike et al, 2007; Crescenzi and Rodriguez-Pose, 2011), under-performing (Pike et al. 2007), old industrial (Pike et al, 2010; Trippl et al, 2017) and peripheral

[2] REALPOWER: News from the wind and marine energy industries, Issue 36, Spring 2014

(Dawley, 2007; Hudson, 2007; Trippl et al, 2017) can be relatively fluid and overlapping, often obscuring observable heterogeneity between regions (and within them). It is a variety akin to Tolstoy's (1999) observation that: "Happy families are all alike; every unhappy family is unhappy in its own way" (p 1). Therefore, in this study, the characterisation of lagging is used in a broad sense, denoting regions that can be portrayed, both quantitatively and qualitatively, as socio-economically disadvantaged in their national context. This weakness is reflected in socio-economic indicators such as higher levels of unemployment and economic inactivity and low household incomes. Additionally, longstanding consequences of adverse structural change have led to an over-dependence on the public sector and lower value employment and a deficit of knowledge intensive, higher productivity firms.

Finally, by fusing this enquiry with my experience of developing and implementing economic and regional development strategies, the research aims to strengthen the bridge between the worlds of evolutionary economic geography and policy. It is an endeavour that will hopefully contribute to lessening the gap in "understanding how regions diversify into new growth paths and to what extent public policy may affect this process" (Asheim et al, 2011a, p 894). Although the research was undertaken to provide insight on how lagging regions could create new industrial paths and address a research bias towards examining regional "success stories" (Pike et al, 2007, p 1260), lessons will have a relevance across regional types.

1.2 Agency and Enabling and Constraining Environments: A Missing Link

As noted, evolutionary economic geography has made notable progress in refining path theory and concepts over the last decade. In particular, Martin's model of local industrial evolution (2010) represents a key contribution in conceptualising path creation and development as a dynamic and open process. In turn, the model has encouraged greater analysis of the role of social agency in path creation (Dawley, 2013; Steen, 2016; Evenhuis, 2017). Such research represents a welcome departure from more deterministic accounts of regional industrial change (Stam and Garnsey, 2009). In addition, subsequent enquiry has offered greater specificity of path evolutionary processes; for instance in regard to the nature of related actors, assets and mechanisms and their interplay (Asheim, 2011a; Kasabov and Sundaram, 2016; MacKinnon et al, 2018).

Martin's (2010) contention that industrial change is caused by gradual, endogenous firm-led agency is a position advanced in subsequent research (Neffke et al, 2011; Martin and Sunley, 2014a). However, this contention limits its applicability and utility to the circumstances often found in lagging regions. Moreover, although Martin alludes to the notion that some environments are more conducive to path creation than others, limited detail is offered. Strikingly, it is a gap that has largely endured in the literature, despite some notable exceptions (Dawley, 2013; MacKinnon et al, 2018).

Therefore, my research addresses these theoretical shortcomings by analysing the process of path creation and related agency in lagging regions, whilst recognising its pertinence to other regional types. In particular, the research investigates the nature of enabling and constraining environments for path creating agency. Moreover, given the prominence accorded to institutions for incentivising and dis-incentivising actors, a central aspect of this analysis pertains to the role of institutions in promoting and mediating the agency of path actors over time. In addition, the research responds to calls for greater cognisance of the interplay of exogenous and endogenous forces on path creation (Boschma et al, 2017; Pike et al, 2017) and the role of non-firm actors, especially the state, (Dawley et al, 2015) by adopting a multi-scalar and multi-actor perspective. By giving greater regard to the state in path creation, recent calls for reconsidering the role of policy and state actors in regional industrial renewal can be addressed (Martin et al, 2015; Pike et al, 2016a).

Furthermore, the research considers how the institutional mediation of path creating agency regulates the scale, character and timing of regional path creation. Therefore, the avenue of investigation accommodates consideration of how new industrial paths can counter long standing regional weaknesses and contribute to wider regional development.

1.3 Aims and Research Questions

The research has three central aims of enquiry, framed by a desire to enhance understanding of how socio-technical transition, in this case relating to offshore wind, can engender regional industrial path creation and regional renewal. These are to:

- Further unpack the open and conditional nature of path creation and the associated causal interplay between actors, mechanisms and regional assets;

- Assess how institutional environments enable and constrain actor agency and its interplay with mechanisms and assets to shape the timing, scale and nature of path creation and outcomes; and
- Illuminate the role of the state in path creation and generate theoretical insights which can inform regional and industrial policy.

In order to both focus and drive the enquiry, three research questions are posed:

- *What are the key forms of agency that shape regional path creation?*
- *How do multi-scalar institutional environments enable or constrain this process?*
- *What is the scale and character of the resulting path and its effect on regional development?*

1.4 Thesis Structure

The thesis follows a sequential structure of enquiry. It is one that reflects Coffey and Atkinson's observation that "research problems, research design, data collection methods and analytic approaches should all be part of an overall methodological approach and should imply one another" (1996, p11).

Thus, the subsequent second chapter provides a review of literature pertaining to evolutionary economic geography and path theory before undertaking a review of literature relating to the nature and role of institutions in facilitating regional economic and industrial change. Having framed my enquiry within the pertinent literature relating to regional industrial path creation, the chapter subsequently presents the analytical framework for guiding my empirical enquiry.

The third chapter details the research methodology. In doing so, the chapter explains the bespoke case study approach and the selection of the cases of regional industrial path creation (offshore wind paths in Glasgow and Humberside). The chapter then turns to detailing the mixed methods deployed, including an account of the empirical research process, before explaining the post field work analysis.

The fourth chapter has two purposes. Firstly, it provides a contextual account of the wider offshore wind sector in which the Glasgow and Humberside regional industrial path cases are embedded. Secondly, it provides accounts of Glasgow and Humberside's pre-formation regional environments, thereby temporally framing both

regional cases within their unique regional contexts. This dualistic conceptualisation of context permits illumination of exogenous and endogenous factors, such as sectoral and technological path dependences and historic regional path dependences, thus framing and informing both cases (Martin and Sunley, 2006; MacKinnon et al, 2009; Coenen et al, 2015; Binz et al, 2016; Boschma et al, 2017).

The fifth and sixth chapters are case studies which explore the process of offshore wind path creation in Glasgow and on Humberside. Each of these chapters examines three sequential causal episodes of industrial path creation in the respective regions. By following and investigating the unfolding path creation process through space and time (Pike et al, 2016b), the shifting interplay of multi-actor agency and mechanisms in valorising regional assets can be deconstructed and the mediating role of multi-scalar institutional environments exposed.

The penultimate seventh chapter compares the empirical evidence across the two cases, framed and informed by the analytical framework. Case heterogeneity in terms of path assets, actors and mechanisms and their causal interplay are contrasted, whilst the role of multi-scalar institutional environments in enabling or constraining related actor agency and path outcomes are compared.

The eighth and final chapter presents the conclusions of the research. Firstly, the empirical findings of the investigation are synthesised and framed within the context of the research questions. Secondly, key contributions to path theory are offered. Thirdly, implications for policy and practice in regard to regional industrial development are identified. Finally, promising lines for future evolutionary economic geography path research are identified.

Chapter 2: Economic Change, Path Creation and Institutions

2.1 Introduction

This chapter has two purposes. Firstly, it reviews literature relating to regional industrial change and continuity, particularly pertaining to path creation theory. In doing so, the review recognises recent progress in evolutionary economic geography literature in positioning path creation as an open and dynamic process shaped by strategic social agency (Martin, 2010; Dawley, 2013; MacKinnon et al, 2018). However, a current imprecision on how institutional environments enable or constrain this process is identified (Dawley et al, 2015). Consequently, the review considers a range of literatures that can inform my research on how path creation is shaped by its institutional context. Secondly, based on this assessment, the chapter establishes the analytical framework that focuses and drives the enquiry on the nature of enabling and constraining institutional environments for path creation.

The chapter is structured into three sections. The first reviews evolutionary economic geography literature, particularly pertaining to path theory, including the role of social agency in influencing path evolution (Garud and Karnoe, 2003; Steen, 2016). In particular, Martin's model of local industrial evolution (2010) and path branching theory (Boschma and Frenken, 2011) provide insights into the path creation process and the associated interplay of actors, assets and mechanisms (MacKinnon et al, 2018). In response to this broad review, the second section focuses on a related theoretical missing link (Dawley et al, 2015) concerning how institutional environments enable or constrain path creating agency. Accordingly, there is consideration of literature that can assist in addressing this gap, primarily relating to the influence of institutions and institutional frameworks on industrial and regional change and continuity (Amin and Thrift, 1994b; Christopherson, 2002; Peck and Theodore, 2007; Gertler, 2010). Also given the importance accorded to novel knowledge in engendering economic evolution, theory pertaining to the interplay of institutions and innovation is considered (Asheim et al, 2011b; Cooke et al, 2004; Trippl et al, 2017). Additionally, in response to the literature's predisposition to privilege the regional level (Lovering, 1999; Pike et al, 2017b), the review also seeks out multi-scalar, relational perspectives. The third and final section of the chapter,

presents the analytical framework based on the insights generated by the review of the literature.

2.2 Evolutionary Economic Geography and Path Theory

Although economic change is one of capitalism's constants, traditional economics has often paid limited attention to the dynamics of change, preferring to adopt an equilibrist paradigm (Scott, 2000a; Boschma and Martin, 2007). However, in recent decades an evolutionary economic perspective has emerged that attempts to understand how the actual economy evolves over time. Witt (1997, 2006) observes that evolutionary economics explicitly addresses two aspects of economic change. Firstly, it identifies the dynamical trajectories of change over time and rejects notions of inevitable equilibrium, thereby recognising that economies can embark on virtuous upward or malignant downward spirals (Myrdal, 1957). Secondly, it contends that novelty is the driver of self-transformation from within. The notion of dynamic change over time is not a new one nor is the notion of novelty creating economic change. Smith (1776) referred to historic stages of development and Marx and Engels (1848) contended that ongoing destruction (Vernichtung) was inherent to capitalism in order to create wealth. This latter notion of intrinsic volatility was revisited nearly a century later by Schumpeter (1942) who observed that the "creative destruction" of innovation drives economic transformation; and that innovation is generated within firms. This firm-led perspective represents a common viewpoint in evolutionary literature, thereby marginalising the role of multi-actor, political-economic processes of change, such as the global shift to renewable energy (Truffer, 2014; Essletzbichler, 2012; Pike et al, 2017b).

However, what differentiates evolutionary economics from other explanations of temporal economic change is its application of explicit evolutionary concepts. One approach within the school has applied the concepts of Generalised Darwinism - such as variety, selection and adaptation - to economic change (Witt, 2003). A second has adopted Complexity Theory by applying concepts such as emergence, self-organisation and hysteresis to micro-economic dynamics (Potts, 2000). Finally, a third approach has utilised the theory of Path Dependence, the concept that historical contingency and self-reinforcing dynamics determine evolutionary economic outcomes (David, 1985, 1988; Arthur 1987, 1994). Although this literature represents a notable endeavour to understand how economies change over time, the

preponderance of economic theory to treat economies “as a wonderland of no spatial dimensions” (Isard, 1956, p 25) persists. In response, economic geographers have applied “the insights of evolutionary economics to create a distinct body of theory and empirical research within economic geography” (Coe, 2010, p 2). The goal of this “evolutionary turn” (Boschma and Martin, 2007) is twofold: firstly, to apply concepts and ideas from evolutionary economics and evolutionary thinking to assist explanation of how the economic landscape changes over historical time; and, secondly, to demonstrate how applying a geographical lens facilitates understanding of the processes that drive economic evolution and how geography determines the nature and trajectory of an economy’s evolution (Boschma and Martin, 2010). As with evolutionary economics and its antecedents, this disciplinary turn has placed theoretical and conceptual emphasis on the micro-behaviour of firms, thereby maintaining a clear link with the Schumpeterian contention that firms and entrepreneurs are the central agents of change (Boschma and Frenken, 2006, 2011; Martin 2010; Boschma and Martin, 2007, 2010). However, it is a focus that has been at the expense of understanding the role of other actors, such as the state (Pike et al, 2009; Gertler, 2010; Dawley et al, 2015).

Of the three noted schools of evolution, economic geographers have been the most receptive to path dependence; the notion that processes and systems are constrained by their history and that path outcomes are shaped by such history (Martin and Sunley, 2006). The adoption of this theory can be attributed to its ready applicability to a fundamental concern of economic geography, the issue of geographically uneven development (Martin and Sunley, 2013). Path dependence has emerged as an important framework, certainly the most important of evolutionary economic geography, for conceptualising and debating inertia, continuity and change within regional economies. Despite a lack of precision surrounding the application of this “irredeemably metaphorical idea” (Martin and Sunley, 2006, p 428), path conceptualisations are commonly adopted for theorising on the evolution of delineated regional industries and regional economies (Martin and Sunley, 2006, 2014a; Boschma and Martin, 2007, 2010; Martin, 2010). Moreover, it has been observed that there remains limited understanding of how the latter influences the former, and vice versa (Grabher, 1993; Henning et al, 2013; Evenhuis, 2017). Similarly there remains partial comprehension of the influence of wider sectoral and technological path dependences on region-level path evolution given that the

interaction of scales remains a relatively unexplored topic (Martin and Sunley, 2006, 2014a; Boschma et al 2017). For example, there is limited consideration of how the temporality and form of regional industrial path creation is shaped by the wider industrial system in question i.e. the underlying universal industrial form and logic that regulates the process of change (Van de Ven and Poole, 1995; Martin and Sunley, 2006).

Despite this shortcoming, integrating path research objects (e.g. regions, industries), subjects (e.g. path dependence, path creation) and levels (regional, extra-regional) into a holistic and integrated framework has remained embryonic and problematic (Martin and Sunley, 2006, 2013). The implications of this observation for my research design and methods will be considered in due course. Prior to this, several key theories relating to path dependence and path creation which underpin the research merit further attention.

2.2.1 Path dependence: structure before agency

As noted, path dependence relates to how previous events within a system increase the probable occurrence of future events. Three principal strands of path dependency theory can be identified. The concept is often associated with David's (1985, 1988) assertion that technological fields become locked-in to a trajectory even when other technologies are available[3]. Alternatively, Arthur (1987, 1994) identifies dynamic increasing returns as a source of path dependence, whereby externalities and learning mechanisms produce positive feed-back mechanisms that reinforce existing development trajectories. Finally, North (1990) and Setterfield (1997) recognise that institutional and social arrangements co-evolve and become self-reinforcing, thereby creating institutional hysteresis.

Building on these theories of path dependence, Martin and Sunley (2006) observe that institutions and technology embody the two main "carriers of history" within an economy. It is an observation endorsed by Gertler's (2010) contention that economies "evolve along distinctive paths that are shaped by their own particular constellations of institutional structures" (p 3). In addition, Archer's (1996) assertion that "the future is forged in the present, hammered out of the past inheritance by current innovation" (pxxvi) foregrounds the power of innovation in reshaping technological legacy and its relationship with regional change and continuity. Thus,

[3] To evidence this point, David highlighted the diffusion and retention of the QWERTY key board

institutions and innovation are positioned within the path dependence canon as primary factors of evolution.

Tellingly, North (1990) identifies the potential for practical application of path dependence theory to understand the scope for change in an economy. He asserts that the path sets the possibilities and represents "a way to narrow conceptually the choice set and link decision-making through time" (p 258) and that path dependence "is not a story of inevitability in which the past neatly predicts the future" (p 259). North's position infers that path trajectories are not pre-destined by inherited structures and, importantly for my research, opens the door to the possibilities of strategic social agency (Martin, 2010; Dawley, 2013; MacKinnon et al, 2018). However, there are shortcomings in the path dependency canon that diminishes its value for understanding regional economic change and the role of agency.

Firstly, "lock-in", a concept synonymous with path dependence, implies a more deterministic and constraining actuality than the possibilities for purposive agency that North infers (Martin and Sunley, 2006). Lock-in relates to a situation where "historical contingency and the emergence of self-reinforcing effects steer a technology, industry, or regional economy along one path rather than another" (Martin, 2010, p 3). There is indeed compelling empirical evidence of the lock-in phenomenon in recent economic history[4]. Even so, from a theoretical perspective Martin (2010) notes that lock-in sits uneasily with evolutionary economics contention that change is irreversible and equilibrium unachievable (Witt, 1997, 2006).

A second related shortcoming is the contention that there is "positive path dependency" and "negative path dependency" (Stam and Garnsey, 2009). In the former, regional assets are readily combined with firm-led agency to create new industrial trajectories but in the latter, limited regional assets and firm-led agency constrain deviation from existing trajectories (Boschma, 2007). However, this contention produces a binary and static understanding of regional path dependence, which underplays the complex economic heterogeneity, including that of actors, and conditionality of circumstance across regions (MacKinnon et al, 2002, 2009; Pike et al, 2006, 2007; Dawley, 2013; McCann and Ortega-Argiles, 2013; Coenen et al, 2015). Moreover, the positon does little to assist understanding of how to address

[4] For example, Scotland's "Silicon Glen" was locked-in to lower value routinized foreign-owned IT manufacturing processes. Such lock-in ensured that the industry within Scotland never entered a period of cumulative reinforcement and qualitative re-orientation. An exogenous shock caused by the emergence of new manufacturing routines located in Central Europe and China rapidly reduced the industry in Scotland

uneven spatial development, “the fundamental concern of our discipline of evolutionary economic geography” (Martin and Sunley, 2013, p 32) and a key motivation of this research.

A third shortcoming of path dependence relates to its theoretical contention that de-locking is caused by an unpredictable spasmodic exogenous shock (Arthur, 1987, 1994; David 1985, 1988, 2005; Martin and Sunley, 2006); a perspective rooted in the notion of cycles or waves of disruptive innovation for explaining economic change (Kondratiev, 1935; Schumpeter, 1942). Despite the potential validity of this position, there remains a paucity of research regarding the relationship between exogenous stimuli and regional industrial de-locking and change, notwithstanding some notable departures (Essletzbichler; 2012; Fornahl et al, 2012; MacKinnon et al, 2018). It is a deficiency at odds with a growing literature on the opportunities for disruptive socio-technical transition to engender new industries (Markard and Truffer, 2008; Essletzbichler, 2012; Coenen et al, 2015). Therefore, there is a requirement for further research relating to how regional path dependence can be effected by the exogenous stimulus of transition. As regards my own research, this requirement will be addressed in the analytical context of the offshore wind sector.

In summary, path dependence’s inherent inclination towards retrospection and continuity makes it better placed to act as a framework for contextual comprehension rather than one for exploring and identifying the dynamics and options for regional economic change. Moreover, although spasmodic exogenous shock which stimulates innovation is cited as a cause of path de-locking, limited theoretical attention has been paid to the relationship between extra-regional stimuli and regional path evolution. Thus, in separation from wider notions of path creation and evolution (Martin 2010), the value of path dependence for understanding regional industrial change is circumscribed. Finally, the prominence accorded to innovation for initiating and influencing industrial change is significant (Morgan, 2004; Howells, 2005). For example, all of Martin and Sunley’s (2006) “escape routes from regional lock-in” (p 424) are dependent on the utilisation of innovation[5]. Therefore, it is apposite to provide further theoretical precision regarding the nature of innovation and its relationship with change, before moving on to more open and dynamic accounts of path evolution.

[5] These will be discussed further in section 2.2.4

2.2.2 Innovation and industrial change

In evolutionary economic geography, innovation is commonly perceived as a future-oriented process whereby novel knowledge is applied in a specific spatial context to enable the creation of new commercial products, processes and services (Asheim, 1996; Cooke, 2002; Cooke et al, 2004; Morgan, 2007). Therefore, innovation is the means by which the future is enabled through reconfiguration of legacies in the present (Archer, 1996), thereby allowing regions to de-lock from their past. Or to put it another way, innovation is a source of openness and change in regions and associated industries. Accounts of how regions source such knowledge mirrors the tension between exogenous and endogenous accounts of regional development (Pike et al, 2017b).

The source of novel knowledge for innovation is often presented as endogenous, emerging from micro-economic feedback processes (Howells, 2005; Karnoe and Garud, 2012; Cooke, 2013). This conceptualisation fits with the contention that the innovation on which regional path change is reliant is a "highly localised phenomenon dependent on place specific factors" (Martin, 2010, p 20). Alternately, the source of novel knowledge for innovation is conceived as exogenous, often relating to disruptive knowledge (Solow, 1956; Howells, 2005; Boschma, 2009; Cooke, 2013). This perspective aligns with the contention that regional path de-locking is caused by exogenous radical knowledge punctuating the prevailing technological equilibrium (Arthur, 1987; David 2005; Coenen et al, 2015; Boschma et al, 2017).

However, a prevalence in the literature "for ignoring exogenous stimuli" (Trippl et al, 2017, p 2) and privileging endogenous sources of innovation (Isaksen, 2014) has generated two orthodox assumptions that should be highlighted for my enquiry. Firstly, it is assumed that a primary barrier to regional industrial change is inadequate regional-level innovation capacity (Morgan and Nauwelars, 1999; Cooke et al, 2004). Secondly, that the promotion of such capacity should be a primary focus of public policy (Morgan, 2003; Cooke, et al, 2004; Asheim et al, 2011b). This theoretical perspective has had a profound influence on policy making despite the application of related regional development models, such as clusters, regional innovation systems, learning regions and university commercialisation (Porter, 1990; Cooke et al, 2004; Morgan 2007, 2013b; Goddard et al, 2012, 2013), having questionable success in changing the industrial fortunes of lagging regions. More recently, this endogenous emphasis has coupled with cognisance of regional heterogeneity to engender Smart

Specialisation as a dominant policy framework in the UK and EU (Hausman and Roderik 2003; Foray et al, 2011; McCann and Ortega-Argiles, 2013).

Therefore, to summarise, innovation is recognised in the literature as a catalyst of economic change, connecting an economy's past with its future in the present. However, there remains an ongoing theoretical debate on the source of novel knowledge and its application to engender innovation and regional industrial change. It is to further understanding the dynamic and conditional nature of regional path evolution that the chapter now turns.

2.2.3 Path creation and agency

Path creation accentuates the possibility of change in an economy and readily integrates conditionality and social agency, thereby tempering notions of determinism and binary scenarios of regional dynamism or inertia (Stam and Garnsey, 2009). The notion of path creation facilitates the concept of path as process (Martin, 2010)*;* an ongoing evolutionary interplay of path creation, path dependence and path destruction. It is a concept that accommodates mindful deviation (Garud and Karnoe, 2003, 2012) and purposive agency (Martin, 2010) of actors in effecting path outcomes, including scale, nature and timing. Given its emphasis on economic and industrial change, it is surprising that not more consideration is given to path creation in research and policy pertaining to regional industrial development (Neffke et al, 2011), as compared with concepts such as clusters (Porter, 1990; Maskell, 2001). Hence, path creation is placed centre stage in my enquiry on the role of social agency in creating regional industries.

Three explanations are commonly cited for the creation of new paths: creation occurs by "random chance", such as the formation of a firm in a certain location (Krugman 1991); creation occurs as a response to a "window of locational opportunity" – based on the notion that new industries have few established inputs and therefore their location is serendipitous (Storper, 1995); or creation occurs as a result of strategic purpose and deliberate action (Garud and Karnoe, 2003; Martin, 2010). There is a curious contradiction inherent in the first two explanations when set against the broader church of evolutionary economic geography theory, given its contention that the future is contingent on a place's past. This seems marginalised by the notions of "random chance" and "windows of locational opportunity"; explanations that "conflate ex-ante unpredictability with ex-post inexplicability" (Martin and Sunley, 2006, p 426).

Although the first two explanations align with a notion of unforeseen events being the catalyst for path de-locking (Arthur, 1987, 1994; David 1985, 1988; Martin and Sunley, 2006), they sit uneasily with empirical evidence that indicates that strategic purpose and deliberate action (Garud and Karnoe, 2003; Martin, 2010) have created new “socio-economic-technological structures, socio-economic practices and development paths” (Martin and Sunley, 2006, p 408). In response, research has identified the importance of mindful deviation and purposive experimentation of actors for creating new path trajectories. Path creation theory has also slowly introduced to the analytical stage a broader set of actors. Path related concepts such as bricolage (Garud and Karnoe, 2003) and heterogeneous actor alignment (Binz et al, 2016) recognise the role of co-ordinated agency of multiple actors (although micro-economic and firm-centric accounts of change still predominate e.g. Boschma and Martin, 2010; Martin and Sunley, 2014a).

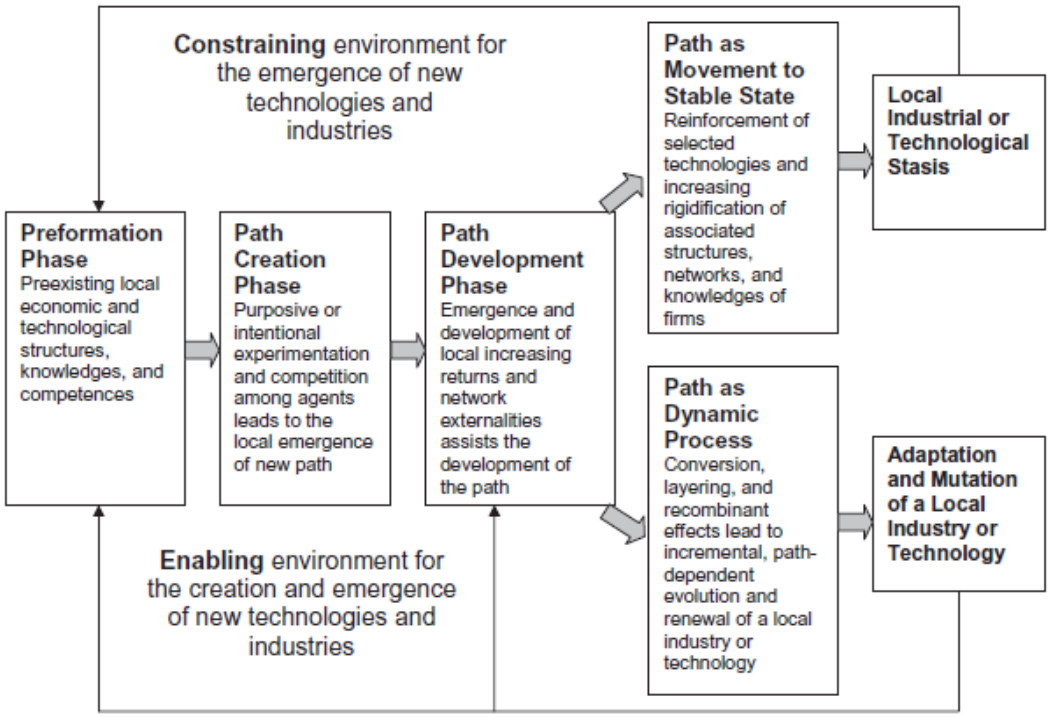
Critically, however, there is still inadequate research pertaining to why path actors deviate from the past, strategize and experiment in the present and reimagine the future. Steen (2016) rightly contends that in order “to understand why particular paths emerge instead of others there requires more attention to agency and how actors respond to changes in the contexts in which they operate” (p 1608) and how expectations of outcomes shape collective and individual action. This mirrors the contention that economic actors have differing motivations for action shaped by institutions and institutional frameworks that manage expectations and uncertainties and co-ordinate interaction (Boschma and Frenken, 2006; MacKinnon et al, 2009; Bathelt and Gluckler, 2014; Evenhuis, 2017).

It is posited that to understand why actors deviate “the agentic dimension of social action [needs to be] analytically situated within the flow of time…. Since social actors are embedded within many temporalities at once, they can be said to be oriented towards the past, the future, and the present at any given moment, although they may be more oriented toward one or another within anyone emergent situation…. manoeuvrability, inventiveness and reflective choice of social actions [is] in relation to the constraining and enabling contexts of action” (Emirbayer and Mische, 1998, p 963). In effect, actors choose in the present whether to break from their past by their expectations regarding the future: expectations shaped by the institutional environment in which their actions are set (Emirbayer and Mische, 1998; Bakker, 2014; Steen, 2016). Moreover, given that path creation has been evidenced as a

product of distributed agency, the institutional generation of collective expectations and co-ordination assumes importance (Garud and Karnoe, 2003; Bathelt and Gluckler, 2014; Binz et al, 2016). Furthermore, theoretical attention to institutional entrepreneurs - actors who mobilise resources, competences and power to create or transform existing institutions - indicates that individual agency should not be discounted (DiMaggio, 1988; Battilana et al, 2009; Boschma et al, 2017).

This elasticity of agency (Peck and Theodore, 2007) has two significant implications for this research. Firstly, changes to the institutional environment in which agency is set may mean that actors or actor coalitions have more favoured or prominent causal roles in the process of path creation at different periods of time. Secondly, such changing actor roles and power may influence the dynamic of regional industrial path evolution and quantitative and qualitative outcomes over time (MacKinnon et al, 2009; Gertler, 2010; Dawley, 2013; MacKinnon et al, 2018).

Significantly in the literature, the notion of path creation as part of a temporal conjunctive process shaped by social agency has been integrated into Martin's (2010) influential model of local industrial evolution (fig. 2.1) The model places emphasis on the "locally contingent nature of self-reinforcing economic development, particularly the quasi-fixity of technological change… and institutional forms" (Martin and Sunley, 2006, p 398), conceptualising change as primarily a region-specific, gradual process.



Source: Martin, 2010, p 21

Figure 2.1: Model of local industrial evolution

Martin's model helpfully identifies a number of sequential phases which "evolve gradually by a changing mix of and orientation… of firms and their activities (p 14)". By recognising this sequential process as open to social agency - albeit agency that is enabled or constrained by the institutional environment in which it is set - the model accommodates the contention that "at every step along the way there are choices" (North 1990, p 258) in regard to the path's future. This indicates that ongoing opportunities exist for social agents to influence path scale and character (e.g. its place in the wider sector's division of labour), thereby eschewing the determinism of path dependence.

Martin's path phases are: preformation; path creation; and path development. The model indicates that the path will either lead to eventual stasis (essentially lock-in) or ongoing adaptation. This process of change is facilitated by mechanisms "that operate at the micro-level to impart slow change" (Martin, 2010, p 14). In terms of this research, the focus of enquiry explicitly pertains to the path creation phase "whereby purposive or intentional experimentation and competition among agents leads to the local emergence of the new path" (p21). More recently, MacKinnon et al (2018) define path creation as the emergence of new development trajectories in a region

based upon the growth of new industrial sectors or new products, techniques and organisational forms.

Although Martin's model is a useful conceptual construct for understanding path change, it has three shortcomings that will be addressed in the context of this research. Firstly, it marginalises the potential role of exogenously sourced knowledge for regional path creation. Secondly, although not precluding non-firm actors, such as the state, it is experimentation within and between firms that is the model's principal focus of enquiry. Thirdly, and crucially for this research, although Martin contends that "some localities seem more enabling of this process than others do…. [and] in other places the local environment may be less conducive, perhaps even constraining" (p 20), Martin provides little specificity, especially in regard to associated institutional contexts and settings. By way of insight, Martin parallels his notion of enabling and constraining environments with the somewhat static notion of regional positive and negative path dependency which was critiqued earlier (Stam and Garnsey, 2009). It is a perspective that limits understanding of how constraining environments could become enabling and vice versa. Dawley (2013) identifies that a "challenge still remains to specify further the contexts of enabling and constraining environments…. that explain the creation and geographic diversity of new paths" (p 2). In the intervening years evolutionary economic geography literature has continued to identify a lack of specificity on how not only regional institutional environments but also extra-regional institutional environments and their interaction foster path creation (Dawley et al, 2015; Steen 2016; Evenhuis; 2017; MacKinnon et al, 2018). However, to comprehend what would represent an enabling or constraining institutional environment, there is firstly a need to delineate the path creating process that such environments mediate.

2.2.4 Assets, actors and mechanisms of path creation

Although Martin's model (2010) has valuably illuminated the possible temporal stages of path evolution, of which path creation is one, it provides less insight into the dynamic, contingent process of path creation itself. Path creation can be conceptualised as the agentic interplay (Emirbayer and Mische, 1998) of three commonly cited components: assets; actors; and mechanisms (Martin and Sunley; 2006; Dawley, 2013; MacKinnon, et al 2018). In effect the process relates to pre-existing regional assets being identified, harnessed and valorised by economic and organisational actors and the associated operation of path creating mechanisms

(MacKinnon et al 2018). It is to delineating these three path creating elements that this section turns.

Regional assets encompass the knowledge, skills, competences, experiences and infrastructure inherited from previous paths and patterns of economic development (Martin and Sunley, 2006). However, they can also be less historically dependent and relate to the availability of land and proximity to natural resources (Martin and Sunley, 2006; Fornahl, 2012). Recognising such heterogeneity, regional assets can be conveniently grouped within five broad domains: natural assets; infrastructural and material assets; industrial assets; human assets; and institutional assets (Maskell and Malmberg, 1999; MacKinnon et al, 2018). Moreover, the utility of these assets vis-à-vis a region's actual or potential economic competitiveness is likely to demonstrate a high level of correlation with their combined "value and rareness" (Maskell and Malmberg, 1999).

The reconfiguration and valorisation of such assets is dependent on the strategic agency and mindful deviation of actors to realise expected outcomes. As previously noted, a number of accounts relating to path creation emphasise the collective and distributed nature of actor agency (Garud and Karnoe, 2003; Binz et al, 2015). Even so, path theory has a tendency to stress the agency of firms and entrepreneurs, reflecting a micro-economic orientation of enquiry (Boschma and Frenken, 2006, 2011; Boschma and Martin, 2007, 2010; Martin, 2010). Nevertheless, this focus has been broadened out by the discipline's interest in the role of innovation in path creation which has encouraged the study of universities and research bodies in path evolution (Klepper, 2007; Simmie et al, 2008; Goddard et al, 2012, 2013). Tellingly, despite some notable exceptions (Dawley, 2013; Dawley et al, 2015; MacKinnon et al, 2018), there remains insufficient analysis of the role of the state in this agentic path creating interplay.

Finally, the transformation of assets to enable actor expectations is commonly attributed to mechanisms associated with two types of path creating process: path de-locking (Martin and Sunley, 2006) and path branching (Boschma and Frenken, 2009). Implicit within both conceptualisations is the notion of mechanisms being the means of facilitating innovation in regional economies by applying novel knowledge to inherited regional assets. Martin and Sunley (2006) identify five mechanisms that facilitate de-locking from historic industrial trajectories and engender new path trajectories (table 2.1).

Although all five mechanisms do not preclude the agency of a wider set of actors in engendering their operation (such as universities or the state), they more readily accord with the Schumpeterian notion of firm-led innovation. Furthermore, whilst the inclusion of transplantation accommodates exogenous sources of novel knowledge for path creation, the other mechanisms more readily accord with an endogenous perspective on path creation; reflecting the common emphasis on endogenous led analysis and prescription (Pike et al, 2017b; Trippl et al, 2017).

Sources of New Path	Associated Characteristics
Indigenous Creation	Emergence of new technologies and industries from within the region that have no immediate predecessors or antecedents
Heterogeneity and Variety	Diversity of local industries, technologies and organisations promotes constant innovation and reconfiguration, thereby escaping 'lock-in'
Transplantation from elsewhere	Importation of a new industry or technology from outwith region, which forms the basis of a new pathway of regional growth
Diversification into (technologically) related industries	An existing industry goes into decline but its core technologies are redeployed to provide the basis of related new industries in the region
Upgrading of existing industries	Revitalisation and enhancement of region's industrial base via infusion of new technologies or introduction of new products and services

Based on Martin & Sunley, 2006

Table 2.1: Sources of new path creation

Significantly, the mechanism of diversification (Martin and Sunley, 2006) aligns with a body of work in evolutionary economic geography regarding related variety and path branching (Boschma and Frenken 2009; Neffke et al, 2011; Cooke, 2012). Its theoretical contribution is based on the premise that regional industries can more readily evolve by branching into new industries that utilise related knowledge and technology; and extra-regional industries are more prone to enter and stay in a region if they are related to industries within it (Neffke et al, 2011). In short, existing regional industries and related technologies and knowledge "will affect the ways regions create new variety over time and transform and restructure their economies" (Neffke et al, 2011, p 261). Four branching sub-mechanisms have been identified that facilitate related industrial variety (Boschma and Frenken, 2009):

- Firm diversification through new products, acquisitions and mergers;
- Entrepreneurship facilitating spin-offs and start-ups;

- Labour mobility between firms and sectors;
- Social networking.

These four branching sub-mechanisms provide further insight into the notion of diversification as proposed by Martin and Sunley (2006) by placing more emphasis on the ownership dynamics of firms, such as acquisitions and mergers, and wider institutional forms, such as networks. Furthermore, although labour market dynamics are arguably implicit in the delocking mechanisms (2006), path branching recognises them as an explicit mechanism, building on Boschma's (2005) observation that the capacity to innovate is embodied in workforce skills and routines. This acknowledgement of regional labour market dynamics accords with Kasabov and Sundaram's (2016) assertion that local economies can "reinvent and regenerate…. repeatedly over time" (p 1530) by re-orienting path-dependent regional pools of skills to new value creating opportunities.

Finally, it has been observed that the concept of mechanisms is often reductionist and narrow, with limited attention given to their relational and interactive properties (Jessop, 1997; Dawley, 2013). Recent research has also noted that the process of path creation does not privilege one type of mechanism but can occur through inward investment, sectoral diversification or the creation of firms (MacKinnon et al, 2018). Furthermore, consideration of mechanisms apropos non-firm actors such as the state seems marginalised (McKinnon et al, 2018). Finally, mechanisms need not operate like "clockwork" nor operate in an aligned or co-ordinated fashion (Dawley, 2013). Critically, they are contingent, their operation intimately bound with institutions (Daly, 1991, Jessop, 1997; Dawley, 2013; Steen, 2016). Therefore, the next section of this chapter will consider how the institutional environment can enable or constrain the operation of mechanisms and their causal interplay with actors and assets.

2.2.5 Path theory: summary

Having considered pertinent literature relating to path theory, a number of promising lines of enquiry for the research have been identified. Although path dependence when coupled with path creation represents a powerful theoretical framework for understanding continuity and change in regional economies, there is limited analysis of how differing path dependences - sectoral, technological and regional – mutually shape regional industrial path creation (Boschma et al, 2017). Whilst Martin (2010) establishes path creation as part of a sequenced evolutionary process, his model

remains relatively deterministic and the possibilities and choices of social agents to shape path outcomes are somewhat opaque. Moreover, although path creation can be conceptualised as a causal interplay of actors, mechanisms and assets, orthodoxy privileges analysis of firms in this process at the expense of other actors.

Crucially for this research, while it is theoretically advanced that some institutional environments are more amenable to path creation than others there is limited specificity on what represents an enabling or constraining institutional environment (Dawley, 2013; Dawley et al 2015; Evenhuis, 2017). Moreover, although Martin indicates that some local institutional contexts and settings are conducive to path creation, recent literature has indicated that for meaningful insight to be generated a multi-scalar institutional perspective needs to be adopted (MacKinnon et al, 2018). Furthermore, notwithstanding the identified potential role of exogenous stimuli in path creation there is, despite some notable exceptions (Essletzbichler, 2012; Coenen et al, 2015), limited attention given to how multi-scalar institutions mediate the fusion of such path creating stimuli with a regional economy. Accordingly, to further position and assist my research regarding the theoretical gap apropos enabling and constraining institutional environments (Dawley et al, 2015), the chapter now turns to consideration of pertinent institutional literature.

2.3 Institutions and Path Creation

In order to address the theoretical missing link of how institutions enable or constrain path creating agency, this section reviews institutional literatures that may provide insights in to what ways such agency is activated, mediated and bounded. In doing so, the role and powers of institutions in facilitating economic and industrial change will be explored. Also, to respond to the privilege commonly accorded to regional and local level institutions in the literature (Lovering, 1990), the chapter seeks out multi-scalar and broader relational perspectives. Thus before examining regional level institutions, there is consideration of the role of extra-regional institutions, especially the state, in shaping regional economic evolution (Christopherson, 2002; Peck and Theodore, 2007; Gertler, 2010). Subsequently, attention is given to economic geography's institutional turn and its privilege of the regional scale in understanding change and continuity (Amin and Thrift, 1994b; Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Amin, 1999; Rodriguez-Pose, 2013). By reviewing such literature, associated theory relating to institutions and the promotion of innovation is

consequently considered (Moulaert and Sekia, 2003). In this regard, regional innovation systems are used as a theoretical entry point (Cooke et al, 2004; Trippl et al, 2017). However, extra-regional and relational accounts of innovation which connect with broader technological and industrial dynamics are also assessed for insights regarding enabling and constraining institutional environments for path creation (Bathelt et al, 2004; Geels, 2004; Boschma, 2005; Asheim; Truffer and Coenen, 2012; Trippl et al, 2017).

2.3.1 Institutions: pervasive but slippery

Institutions wield a pervasive influence over the fortunes of economies (Peck, 1999; Martin, 2000; Amin, 1999; Christopherson, 2002; MacKinnon et al, 2009; Gertler 2010). As previously noted, they incentivise and motivate actors to break with the past by facilitating future expectations and reducing uncertainty (Emirbayer and Mische, 1998; Steen, 2016); in effect regulating the tension between past, present and future for agents of change. Importantly, institutions not only enable or constrain action, they also provide stability (North, 1991; Geels, 2004), indicating that they are sources of both path dependence and creation. Moreover, their organisational qualities make the mutual alignment of collective and individual social agency possible (Evenhuis, 2017).

Given that institutions regulate expectation, uncertainty and co-ordination amongst heterogeneous actors, they will critically have a bearing on actor deviation from past practice to attain future industrial outcomes and the subsequent degree to which mechanisms are operationalised and regional assets utilised to achieve these outcomes. Thus institutions have a significant bearing on the timing, scale and nature of path creation. However, the role of institutions has often been relegated in economic geography, a research predilection fostered by the ambiguity surrounding the term (Peck, 1999; MacKinnon, et al, 2009; Pike et al, 2016b).

Although the term institution is widespread there is no definitional unanimity (Hodgson, 2006). However, they can be very broadly delineated as “systems of established and prevalent social rules that structure social interaction” (Hodgson, 2006, p 3). These rules include formal regulations, legislation, policies, customs and norms that regulate the behaviours of economic actors (North, 1990; Gertler, 2010; Rodriguez-Pose, 2013). Moreover, institutions interact and evolve to create dynamic institutional frameworks that empower and privilege different agents through time and space (Emirbayer and Mische, 1998; Geels, 2004; MacKinnon et al, 2009). An

expedient utilitarian analogy is that the institutions represent the “rules of the game” (North, 1990; Peck, 1999; Geels, 2004; Gertler, 2010). These rules determine the “interaction between institutions and organisations that shapes the evolution of an economy. If institutions are the rules of the game, organisations and their entrepreneurs are the players” (North, 1990, p361). In other words, Smith’s (1776) agentic “invisible hand” is guided through time and space by its institutional environment.

Martin (2000) helpfully identifies the co-existence of both an institutional environment (comprising formal and informal conventions) and institutional arrangements, whilst recognising a close symbiotic relationship between them. This taxonomy is summarised below.

Institutional Regime Type	Nature of the Systems	Institutional Expressions
Institutional Environment	Formal Conventions	Structures of rules and regulations, mostly legally enforced
	Informal Conventions	Customs, norms, cognitive paradigms and social routines
Institutional Arrangements	Organisational Forms	Firms, government bodies, higher education, research bodies, unions etc

Based on Martin, 2000

Table 2.2: Institutional conceptualisation

Although, the causal properties of differing institutional frameworks have been evidenced, there has been a preponderance to focus on how institutional configurations at a specific spatial scale inform the elasticity of agency (Peck and Theodore, 2007), thereby promoting useful but somewhat partial accounts of the relationship between institutions and economic change. For example, research has illustrated how variegated national models of capitalism, such as national industrial investment, regulation and research, engender economies to evolve along distinctive paths at the national and sub-national levels (Reich, 1992; Christopherson, 2002; Peck and Theodore, 2007; Gertler, 2010). Contrastingly, much research has focused on regional level institutions and their influence on social agency and economic outcomes (Amin and Thrift, 1994b; Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Martin, 2010; Rodriguez-Pose, 2013). Tellingly, Schroder and Voelzkow (2016) have illustrated that regional industrial trajectories are conditioned by the interplay of national and regional institutions and that their mutual efficiency is

contingent on their level of complementarity. Even so, little research has been undertaken on the interplay of extra-regional and regional institutions on path creating agency and path outcomes (Dawley et al, 2015; Trippl et al, 2017). Therefore, my research regarding enabling or constraining environments should recognise this inter-scalar institutional interplay and the significance of their alignment.

Furthermore, it is observed that institutions exhibit inertia and continue when they are no longer fit for purpose - thereby constraining social agency - and are inclined only to evolve by major episodic reconfigurations. Therefore, institutions can be carriers of history and are subject to path dependence (Martin and Sunley, 2006; Martin, 2000). Thus, an important role for actors is to induce change in institutions to facilitate agency; a contention associated with the notion of the institutional entrepreneur (DiMaggio, 1988; Battilana et al, 2009; Boschma et al, 2017). Therefore, for this research, the causal relationship of the interplay of actors, mechanisms and assets with institutional continuity and change will give insight on enabling and constraining path creating environments. In addition, the latitude of actors to reconfigure institutions should be considered as part of such environments.

2.3.2 The state: the omnipresent architect

Although it has been observed that regional industrial development is mediated through multi-layered institutions of governance and government (Pike et al, 2007; Schroder and Voelzkow, 2016), the manner in which they interact to incentivise or disincentivise strategic social agency relating to path creation has received limited attention (MacLeod, 2001; Gertler, 2010; Dawley et al, 2015; Trippl et al, 2017; MacKinnon et al, 2018). However, understanding and exploring the nexus between the nation state and the region is critical for generating insights into institutional environments which enable or constrain path creation. In particular, appropriate consideration needs to be given to the role of the nation state in this interaction, despite its seeming relegation in much of the regional development literature (Lovering, 1999).

This seeming marginalisation of the nation state and its interaction with the regional scale is arguably due to a misperceived diminution of its power (O'Neill, 2008); a perspective promoted in popular literature such as the "The End of the Nation State: The Rise of the Regional Economies" (Ohmae, 1995) and "World class: Thriving Locally in the Global Economy" (Kanter, 1995). However, in terms of this research,

the motives for the nation state's apparent marginalisation are significantly less important than the reasons for according the nation state due regard in comprehending an enabling or constraining environment for regional path creation.

Notably, the nation state can play a crucial role in the construction, operation and regulation of markets and industries to achieve broader socio-political goals. It does so by prioritising, rationalising and regulating the conduct and power of actors (Jessop, 1990; Foucault, 1991; O'Neill, 2008). Thus by having the ability to design and apply rules that create the national institutional environment (Peck, 1999; Martin 2000), the state is a key architect of a significant component of the wider socio-economic "rules of the game", those pertaining to market and industrial change at the national and sub-national levels (North, 1991). To further utilise this analogy, the nation state has significant influence in determining: who plays in this aspect of the game; when they play; the rewards received for playing; the power of players; and how the game is adjudicated.

Therefore, nation state "rules" can influence the temporal activation of individual and collective agency through generating actor expectations, co-ordinating their responses and managing uncertainty (Geels, 2004). For example, Essletzbichler (2012) and Coenen et al (2012) evidenced how aligned state policy (e.g. relating to R&D) and regulation (e.g. subsidy) incentivised, co-ordinated and de-risked distributed agency to create new renewable energy markets and related industries. Therefore, a nation state can align its horizontal policies, such as energy policy, vertical industrial policies and territorial development policies to enhance actor deviation from past practice (Chang, 2014). Conversely, it is contended that the UK gives limited cognisance to the spatial consequences of non-spatial state policies and the economic and spatial efficiency of policy interaction (Barca et al, 2012; Martin and Sunley, 2015). Therefore, critically for this research, examination of nation state policy design and co-ordination should provide insights into the extra-regional institutional conditionality of the interplay of actors, mechanisms and assets in fostering new regional paths (Peck 1999).

Notably, this potentially enabling and constraining institutional environment is dynamic. Episodic recalibrations of the "moral and philosophical" rationales for economic and industrial intervention by the state, such as the pursuit of growth,

development, efficiency and equity[6], can be observed (Pike et al, 2007)[7] . Consequently, differing governments adapt state "rules" (policies, regulations, norms and practices) to pursue their ideological predisposition pertaining to national and sub-national development (Pike et al, 2007). Currently, the UK state pursues its primary rationale for intervention, economic growth, through supply-side measures supporting labour market flexibility, enterprise and innovation (MacKinnon, 2012; Pike et al, 2016a). Therefore, to understand the construct of enabling or constraining environments for regional path creation, there is a need to connect such environments with fluid extra-regional political ambitions and institutional dynamics (MacKinnon et al, 2009; Pike et al, 2007, 2017).

In addition, the nation state defines the parameters and power of regional economic development actors. For example, it is the primary arbitrator of "major episodic reconfigurations" of such actors (Martin, 2010), as evidenced by the abolition of the English RDAs and the Scottish Development Agency. Therefore, the nation state has a major bearing on whether a region is just a passive receptacle for economic activity or an empowered policy space (Scott, 1998; Pike et al, 2007; Hudson, 2007). Moreover, given the observed causal powers of the nation state to evoke "growth impulses" via horizontal and vertical policies (Trippl et al, 2017), it has been proposed that there is a need to critically reassess the relative role and power of regional state actors and institutions in facilitating economic change (Rodriguez-Pose, 2013; Pike et al, 2017a). In support, Dawley et al (2015) observe that a crucial research gap relates to "how capacities of local policy makers are conditioned by national state strategies and wider political economic contexts"[8]. Therefore, for this research there is a need to understand the influence of the nation state on regional level powers and policies in shaping regional path creation.

This requirement further foregrounds the need to explore multi-scalar institutional alignment and policy efficiency in economic geography. Gertler (2010) in his comparative analysis of the evolution of industries in the federal systems of Canada and the United States illustrated that multiple levels of government can interact

[6] Seemingly simple terms but ones whose meaning is contingent on ideological perspective and purpose

[7] Adam Smith, Chair of Moral Philosophy at Glasgow University, would have recognised such moral contingency. He viewed the market as a form of social order to create "real improvements, through which mankind are benefited and human nature ennobled" (1776, p 229)

[8] Thus arguably questioning the limits of contextual, bottom-up policy tools and initiatives (Rodriguez-Pose, 2013; Dawley et al, 2015; Pike et al, 2017b), such as Constructing Regional Advantage and Smart Specialisation (Hausman and Roderik 2003; Foray et al, 2011; McCann and Ortega-Argiles, 2013)

benignly to facilitate positive industrial change at the local level. This notion of institutional alignment supports Schroder and Voelzkow's (2016) observation that regional industrial trajectories are conditioned by the degree of inter-scalar institutional complementarity. Furthermore, Rezvani (2016) identified that highly autonomous regions are more inclined to have higher levels of economic wealth creation than regions in highly centralised nation state structures. These are important findings for my research in regard to enabling and constraining institutional architectures, especially in the context of a UK unitary state pursuing asymmetric decentralisation of power from London to home nations and regions. Thus, there is a clear need for this research to "unpack the state and how its multi-dimensional and multi-scalar manifestation of its regulatory nature privileges some places over others" (MacLeod, 2001, p 1154) in relation to the path creating interplay of actors, mechanisms and assets.

2.3.3 Institutions and new regionalism

Reflecting the relationship between institutions and economic change, a new regionalist disposition gathered momentum in academic literature through the 1990s (Amin and Thrift, 1994b; Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Amin, 1999). Advocates of new regionalism accord institutional primacy at the regional level and contend that a region's institutional environment can best mediate regional economic change and enable a more qualitative process of economic development (Morgan, 2013b). The theoretical currency of new regionalism is also premised on the notion that the "national scale can be too distant, remote and detached" (Rodriguez-Pose, 2013, p 1037)[9]. Critically for my research, this theoretical disposition promotes regions as heterogeneous, empowered and dynamic places rather than passive, homogenous arenas reshaped by international and national capital flows (MacKinnon et al, 2002, 2009). Therefore, new regionalism implies that it is at the regional level that policies are best designed to engender actor deviation and the operationalisation of mechanisms to utilise regional assets to create new regional industrial paths.

Central to new regionalism is the role and power of heterogeneous regional institutional networks in shaping and regulating agency (MacLeod, 1997). Moreover,

[9] This is not a new sentiment. Jean-Jacques Rousseau noted: "The general objectives of all institutions must be adapted to meet local conditions" (1762, p 97)

new regionalism privileges the study of informal institutions over more formal ones, such as policy and regulation (Hudson, 1994; MacLeod, 2001; MacKinnon et al, 2009; Rodrigeuz-Pose, 2013). This focus on place-specific institutional networks and their relationship with actor agency has facilitated concepts such as regional institutional thickness (Amin and Thrift, 1994, Amin 1999) and related innovation models (Storper and Scott, 1988; Porter, 1990; Camagni, 1991; Saxenian, 1994; Henry et al, 1996; Goddard et al, 2012, 2003) for understanding institutional mediation of social agency to engender regional economic outcomes. In tandem, the institutional turn has facilitated analysis of region-specific institutional barriers to economic change (Martin, 2010; Rodriguez Pose, 2013), such as rent seeking behaviour and institutional lock-in.

Specifically in relation to regional institutional thickness, Amin and Thrift (1994b, 1995) identify four key characteristics of such thickness: a concentration of diverse institutional arrangements (e.g. firms, research and training organisations, government agencies, trade and representative bodies); interactive networks that promote informal conventions; structures of domination and association that promote collective expectation; and mutual awareness of common purpose. Such characteristics indicate that a profusion of institutions is an insufficient measure of thickness and that dynamism and disposition are also of importance. Tellingly, Martin (2000) and Rodriguez-Pose (2013) observed that there are regional economies with limited institutional thickness that have created highly successful paths, such as in China (increasing its national share of global manufacturing from c. 3% to c. 25% within a generation[10]) and, conversely, there are regions with high institutional density that are synonymous with path dependency and lock-in, such as the Mezzogiorno. Therefore, in terms of this research, there is a need to critically appraise regional institutional thickness as a component of an institutional environment predisposed to enable or constrain path creating agency.

More broadly, such empirical contradictions have led some researchers to question the validity of primarily focusing on regional institutional conditions to explain regional change, continuity and competitiveness. Critiques note a tendency for new regionalism to be based on: empirics relating to successful regions; the relegation of exogenous political-economic forces and inter-scalar power asymmetries; and an emphasis on informal institutions (Lovering, 1999; MacLeod, 2001; MacKinnon et al,

[10] The Economist, 14/3/15

2009; Pike et al, 2017). MacLeod (2001) articulates a common sentiment regarding new regionalism: “It is surely not enough to map the institutional architectures of particular regions without also examining the forces that reshape their economic evolution, whether they relate to firm behaviour, the role of the state at various scales, global money markets…. [whilst proponents] over emphasise the role of soft regional institutions” (p 1156).

Even so, new regionalism responds to Todtling and Trippl’s (2005) concern that the specific strengths and weaknesses of regions concerning their industries, institutions and innovation capability are often ignored. By exposing the interplay of regional heterogeneity and strategic social agency, a new regionalist perspective highlights the deficiencies of “one size fits all” policies (Cooke and Ehret, 2010; Farole, 2011; Rodriguez-Pose, 2013). Subsequently this theoretical viewpoint has led to more contextually sensitive tools of regional analysis, such as Constructing Regional Advantage (Cooke and Ehret, 2010; Pike et al, 2017b).

As regards my own research, new regionalism foregrounds the need for understanding how heterogeneous regional institutions and institutional networks mediate the interplay of actors, assets and mechanisms and subsequent path outcomes. Moreover, given the significance accorded to innovation for linking a region’s past to its future (North 1990), new regionalism has also engendered a notable research tradition regarding how regional institutional networks promote the exploitation of novel knowledge that is also germane to my research.

2.3.4 Institutions, innovation and regional industrial change

As previously noted, innovation, the process of applying novel knowledge to create new products, processes and services, is cited as a key influence on regional industrial change (Archer, 1996; Asheim, 1996; Cooke, 2002; Morgan 2007). Furthermore, it has been observed that regions have differing innovation capabilities and such variety is a determinant of regional economic performance[11] (Nelson and Winter, 1982; Crescenzi and Rodriguez Pose, 2011). Given its importance, it is unsurprising that there is a significant body of theory relating to how institutions and institutional networks mediate and support innovation (Beccatini, 1987; Lundvall,

[11] Boschma (2009) observes that knowledge creation, generation of innovation and their application need not be spatially contiguous. Many EU regions excel in knowledge creation (Morgan, 1994; Fagerberg, 1996; Crescenzi and Rodriguez Pose, 2011) as evidenced by patent registrations, research spending, publications etc. However, the related application may happen in other regions, nations or continents

1994; Storper; 1995; Cooke et al, 2004; Morgan, 2007; Asheim et al, 2011). However, critically for this research, there remains a paucity of theory and empirics regarding how these enable or constrain the path creating interplay of actors, mechanisms and assets, and shape path outcomes. Moreover, in terms of socio-technical transition there is only partial comprehension of how regional institutions facilitate utilisation of related exogenous knowledge or intercede to influence its development. Even so, current theory provides critical insights for shaping this enquiry. As an entry point to this literature, this section will first consider regional innovation systems (Cooke et al, 2004; Trippl et al, 2017). However, in response to an inherent bias towards the regional scale, it will subsequently consider more spatially open and relational interpretations of the institutional conditionality of innovation (Geels, 2004; Boschma et al, 2005; Truffer and Coenen, 2012). Thus framing the research in a multi-scalar context, one cognisant of extra-regional industrial and technological dynamics.

In recent decades, the regional innovation system (RIS) concept has acted as a common focusing device for analysing how differing institutional set-ups promote innovation (Asheim et al, 2011b; Cooke et al, 2004; Grillitsch, 2015). Building on this, Evenhuis (2017) observes that the RIS concept promotes comprehension of how "the processes which underlie innovation (the generation, diffusion, application and exploitation of novel knowledge) are conditioned, facilitated or hindered by institutions at the regional level" (p 509). Although the literature recognises that institutionally centred innovation systems can operate at different spatial levels - global, national and regional - with overlapping, fuzzy borders, the dominant research focus has privileged the region (Nelson, 1996; Cooke et al, 2004; Asheim et al, 2011b).

In terms of antecedence, the RIS concept owes a debt of gratitude to Marshall's theory of local industrial agglomeration (1890) given a common emphasis on place and relational determinants beyond the firm effecting industrial change (Lundvall, 1992; Cooke and Morgan, 1998). Although a number of differing but associated regional innovation models exist, the RIS concept has assumed a degree of analytical dominance (Moulaert and Sekia 2003; Cooke et al, 2004; Trippl et al, 2017). A RIS can be summarised as an instituted framework in which collective learning and innovation activities are shaped by close inter-actor relations, support infrastructure and socio-cultural and institutional configurations (Asheim and Isaksen,

2002; Cooke, 2002; Todtling and Trippl, 2005). Moreover, RIS actors are often categorised within “three institutional spheres” of government, industry and universities, commonly known as the Triple Helix (Etzkowitz and Leydesdorff, 2000; McAdam and Debackere 2017)[12]. Given the above, it could be presumed that a RIS would be a component of an enabling institutional environment for regional path creation given that they support heterogeneous actors apply novel knowledge which will utilise and valorise regional assets. Such capability would facilitate deviation from past economic practice by supporting future-oriented experimentation.

Even so, a number of shortcomings have been identified in regard to RIS concepts, which given their theoretical association with new regionalism also mirror its deficiencies. Firstly, the RIS concept is largely predicated on empirics relating to successful regions (MacKinnon, 2009). Secondly, the emphasis on soft institutions makes observation and measurement challenging (Moulaert and Sekia, 2003). Thirdly, RIS theory reflects the enduring tension between endogenous and exogenous accounts of development (Pike et al, 2017b) privileging endogenous stimuli over exogenous ones (Trippl et al, 2017). Even so, recent research has engaged with these shortcomings. Trippl et al (2017) identifies a trio of RIS typologies that accommodate the existence of differing kinds of regions and adopts the utilitarian proxy of organisational density as a measure of system capacity. These three types are noted below:

(i) Organisationally thick and diversified RIS in metropolitan and advanced technology regions (such regions are well endowed with a variety of different dynamic industries, strong research organisations and support infrastructure which are deeply rooted in external knowledge exchange);

(ii) Organisationally thick and specialised RIS in old industrial regions (such regions are characterised by strong specialisation in established, often outdated, industries and inward-looking networks that limit interaction with extra regional knowledge);

(iii) Organisationally thin RIS in peripheral regions (such regions are dependent on investments relating to natural resources, cheap labour and

[12] The recent inclusion of society as a fourth institutional sphere represents the Quadruple Helix (Kim et al, 2012; Leydesdorff, 2013)

land which require limited embedding in thin local knowledge networks and related exogenous and endogenous relationships are highly asymmetrical).

In recognising such variation Trippl et al (2017) contend that it is in the second and third RIS types that the need for exogenous knowledge to facilitate innovation is the most pressing; mirroring recent findings that path renewal in old industrial regions requires access to such knowledge (Isaksen, 2014; Coenen et al, 2015). However, Trippl et al (2017) also identify a pressing need for research regarding how the path creating causal power of regional innovation systems are mediated and bounded by the extra-regional institutional frameworks in which they are set, particularly those of the nation state. Therefore, to enable my research on how institutional systems promote innovation and path creating agency, especially in challenged regions, there is a need for the research to augment these regional perspectives with wider relational viewpoints.

To this end, it is important to also consider literature that recognises regional innovation as being embedded in and circumscribed by multiple, complex inter-dependencies straddling a variety of scales (Oinas and Malecki, 2002; Pinch et al, 2003; Morgan, 2014; Binz et al, 2016; Boschma et al 2017). Such literature is premised on the “de-territorialisation of closeness” (Howells, 2002); the decoupling of geography and proximity. Five proximities that enable regional innovation have been by identified by Boschma (2005), as summarised below (table 2.3).

Type of Proximity	Contribution to the innovation process
Cognitive	For innovation to be identified and exploited there is a minimum level of knowledge required between differing actors.
Organisational	Organisational arrangements facilitate the transfer of novel knowledge between actors. A continuum exists from no formal ties between actors to integrated supply chains.
Social	Social relations between actors at a micro level engender trust based on personal relations, culture and common experience, thereby encouraging knowledge sharing.
Institutional	Formal institutions, such as regulations, and informal ones, such as values, govern dynamics of inter-organisational relations. As such, institutional arrangements can enable or constrain knowledge transfer and innovation.
Geographic	Short distances bring people together, promoting exchange of tacit knowledge. Even so, it must be combined with cognitive proximity. Also, other forms of proximity can substitute for geographic proximity.

Based on Boschma, 2005

Table 2.3: Types of proximity

This conceptualisation of differing proximities aligns with literature on the "globalising of regional development" (Coe et al, 2008), in which inter-scalar networks can be conceptualised as "global pipelines" (Bathelt et al, 2004) through which transactions and partnerships connect local actors, often in routinized nodes, with extra-regional novel knowledge that facilitates innovation. Thus paralleling the contention that path creation is an "alignment process where heterogeneous actor networks mobilise knowledge and financial investment, market access and technology legitimacy" played out on a broad global scale (Binz et al, 2016 p 174). In such a networked environment, the role of foreign owned firms in mediating regional access to novel knowledge assumes prominence (MacKinnon et al, 2002; Coe, et al, 2008; Dawley 2010; Elola et al, 2013; Dicken, 2015). In short, the region is only one geographic scale that facilitates knowledge sourcing and utilisation, thereby positing questions for my research relating to: firstly, the causal power and primacy of regional institutions and frameworks in promoting innovation to enable path creating agency; and secondly, extra-regional and regional institutional configurations best suited for harnessing novel knowledge for regional path creation.

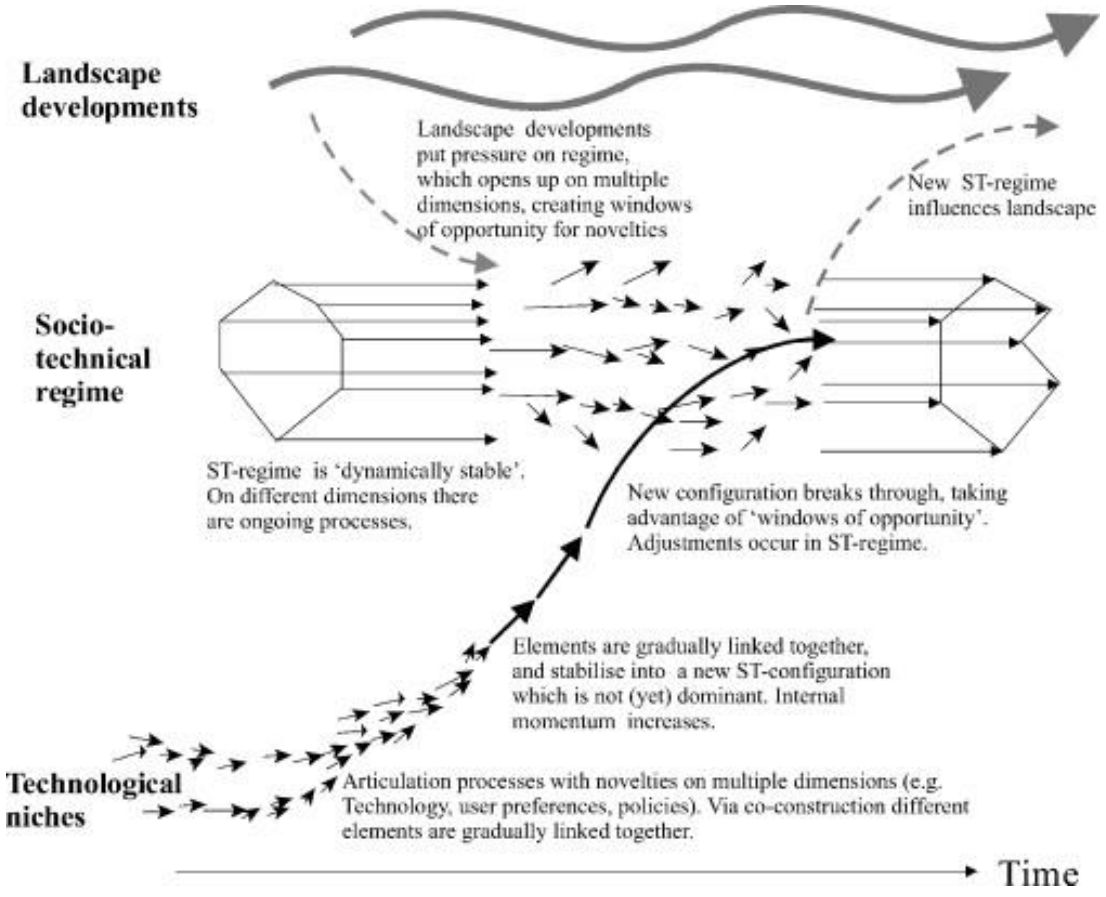
2.3.5 Institutions, socio-technical transitions and industrial change

By accepting the utility of broader relational concepts for this research, theory pertaining to socio-technical transitions is also brought in to view (Geels, 2004; Markard and Truffer, 2008). These literatures relate to the occurrence of profound change to the prevailing socio-technical paradigm, such as decarbonisation of the energy system or artificial intelligence, echoing theoretical precursors such as disruptive storms of innovation and technological waves (Kondratiev, 1935; Schumpeter, 1942). Tellingly for this enquiry, its two core concepts, the Multi-Level Perspective (MLP) and Technological Innovation Systems (TIS), foreground such transition as an instituted process with no set priori territorial boundaries (Truffer, 2014).

Central to MLP is its conceptualisation of three levels of transition (see fig. 2.2). Firstly, a Socio-Technical Landscape represents the macro manifestation of the socio-technical system in society (e.g. the built environment) and is highly path dependent (Geels, 2004). Secondly, a Socio-Technical Regime (Geels, 2004) is a meso level construct composed of the rules (institutions) of differing interacting sub-regimes (e.g. government, technology, industries, markets) that is also inclined to path dependence. Finally, a niche represents a space with least path dependence where transition can engender new technological paths (Geels, 2004; Geels and Schot, 2007b; Boschma et al, 2017).

Niches represent protected environments where institutional “shielding, nurturing and empowerment” from powerful incumbent forces allows actors to deviate and experiment (Smith and Raven, 2012). Moreover, it is proposed that such protected institutional environments can be created by “strategic niche management” (Schot and Geels, 2007), a process dependent on “system builders” (Hughes, 1987; Geels, 2004). System builders connect the domains of economics, technology, research and politics, co-ordinating these spheres into a functioning techno-industrial system by working with and adapting existing rules, regimes and institutions which provide constraining and enabling contexts for actors (Geels, 2004). Therefore, these agents of change facilitate institutional reconfiguration of the prevailing rules (e.g. policies, regulations, norms) in order to allow actors to deviate and utilise novel knowledge that creates new technological paths. Although the predominantly non-territorial notions of a niche and system builders are problematic for regional research, they represent useful concepts for further exploring the institutional conditionality and

relational contexts of new industrial paths, particularly those relating to transition (Coenen et al, 2012; Essletzbichler, 2012; De Laurentis, 2013).



Source: Geels 2004, p 915

Figure 2.2: A dynamic multi-level perspective on system innovation

The associated Technological Innovation Systems (TIS) concept privileges analysis of the interplay of institutions, actors and technology in creating new industrial paths via transition (Truffer and Coenen, 2012; Truffer, 2014). Again the perspective is essentially aspatial, examining how "strategic agency in heterogeneous actor groups jointly act upon locked-in structure and mobilise resources to create a new industry" (Boschma et al, 2017, p 36). The TIS concept contends that obstacles to territorial renewal are not necessarily unique to a region, emphasising that path dependence can apply to both technology and place (Coenen et al, 2015; Boschma et al, 2017). However, proponents of TIS (as with MLP) note that undifferentiated conceptualisations of space and scale and differing levels of government power makes it application to territorial development problematic (Truffer and Coenen, 2012; Truffer, 2014).

Even so, aspects of both MLP and TIS concepts can bring valuable, alternate perspectives regarding the role of disruptive socio-technical transition and associated institutions in engendering regional industrial path creation, and what could constitute an enabling and constraining environment. Such perspectives primarily relate to: the instituted and relational nature of transition; the need for institutional alignment to foster transition and related industrial change; and the role of institutionally protected space to challenge broader technological path dependence.

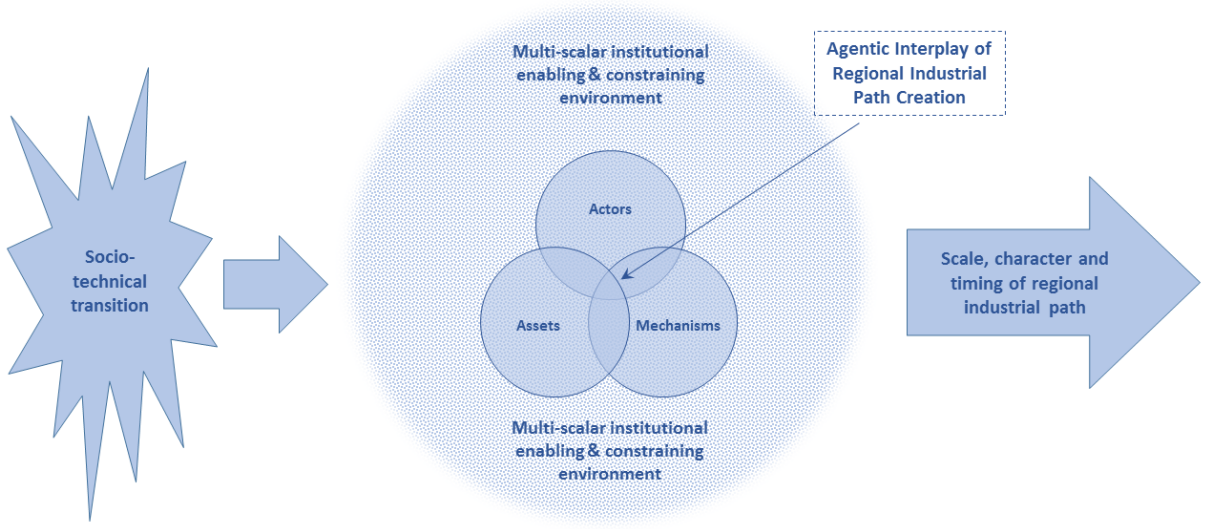
2.3.6 Institutions and regional economic and industrial change: summary

Having considered theory relating to institutions and economic change, a number of key theoretical aspects and gaps indicate key lines of enquiry for the research. As previously noted institutions can incentivise future-oriented actor deviation by shaping expectations, facilitating co-ordination and reducing uncertainty. However, there is a research preponderance to focus on one institutional scale and type (e.g. soft institutions at the regional scale) rather than understanding how the elasticity of path creating agency is shaped by the multi-scalar interplay of institutional types or how wider institutional path dependence shapes regional path creation. This has led to limited consideration of how nation state "rules" interact with the regional level to mediate path creating agency or condition the latitude of regional economic development actors. Moreover, although innovation is recognised as being institutionally contingent, a focus on regional institutional configurations has limited consideration of how the multi-scalar and relational institutional environment regulates the utilisation of novel knowledge at the regional level. However, more open spatial conceptualisations of the interplay of actors, institutions, networks and knowledge, such as niches, promise insight into what constitutes an enabling environment for path creation vis-à-vis socio-technical transition. Finally, a deficiency of analysis regarding multi-scalar institutional interplay has occurred despite empirics indicating that strategic efficiency in achieving industrial change and development is contingent on the degree of institutional complementarity.

2.4 Analytical Framework: Institutional Environments and Path Creation

Having reviewed the literature relating to path creation theory and the relationship between institutions and regional change, the analytical framework can now be presented. The framework is a device for informing and focusing my enquiry into the nature of enabling and constraining institutional environments for regional industrial path creation. It has been shaped by the theoretical and conceptual insights

generated by the literature review. In this section, I will describe the theoretical content and assumed relations within the analytical framework (figure 2.3).



Source: Own elaboration

Figure 2.3: Regional industrial path creation: analytical framework

The analytical framework presupposes the role of innovation in linking a region's past with its future through the application of novel knowledge (Archer, 1996). In doing so, it contends that socio-technical transition (Geels, 2004; Markard and Truffer, 2008), in this case the introduction of offshore wind to the UK's energy system, is a catalyst for the application and utilisation of novel knowledge within a region which triggers the path creation process (Martin and Sunley, 2006; Neffke et al, 2011). Furthermore, the framework has been developed to understand the positive effect that energy transition can have on regional industrial reorientation and not the negative consequences (e.g. the costs of decarbonisation) on broader industrial dynamics and systems.

The framework foregrounds the path creating interplay between actors, mechanisms and regional assets (MacKinnon et al, 2018). The representation assumes that the greater the activation and interaction of these components, the more pronounced are the process and outcomes of path creation. In terms of delineating actors and related agency, the framework, to overcome a seeming bias towards the role of firms in path theory (Boschma and Frenken, 2006, 2011; Martin, 2010), accommodates the role of both firms and non-firm actors, such as the state and universities and research bodies (Goddard et al, 2012; Dawley et al 2015; Pike et al; 2016b; MacKinnon et al, 2018). In addition, consideration of the role of distributed, collective and individual

agency is accommodated (Garud and Karnoe, 2003; Binz et al, 2015). The framework does not privilege one type of mechanism but recognises that differing mechanisms can contribute to path creation e.g. diversification and transplantation (Martin and Sunley, 2006; Boschma and Frenken, 2009). Moreover, it is assumed that actor agency and associated mechanisms enable valorisation and reconfiguration of heterogeneous regional assets relating to: natural assets; infrastructural and material assets; industrial assets; human assets; and institutional assets (Maskell and Malmberg, 1999; MacKinnon et al, 2018).

The path creating interplay of actors, mechanisms and assets is represented as bounded and mediated by the multi-scalar institutional environment (both formal and informal) in which it is set. In presenting this environment as multi-scalar, the interplay of regional and extra-regional forces on path creation is accommodated, thereby mitigating the tension between endogenous and exogenous accounts of regional change (Pike et al, 2017b). Also, it is presumed that extra-regional “rules” (MacLeod, 2001; Geels, 2004; Gertler, 2010), especially in relation to policy and regulation, are not only mediating regional industrial path creation but also the wider process of sectoral and technological development in which the regional industrial path is embedded. Thus, this contention permits exploration of the interaction of extra-regional sectoral and technological path dependences with regional level path dependences (Martin and Sunley, 2006; Boschma et al, 2017). Additionally, at the regional level, institutional thickness and systems relating to industrial change and innovation are accommodated within the framework (Amin and Thrift 1994b, 1995; Asheim et al, 2011; Cooke et al, 2004; Trippl et al, 2017).

It is proposed that this mutable multi-scalar institutional context can represent a changing enabling and constraining environment for path creation, regulating the agency of path actors and their interplay with mechanisms and assets over time. In turn, such institutional conditionality will shape path phasing, through the generation of key causal moments of path creation, thereby illuminating the need to carefully follow the path through time and space (Pike et al, 2016b). Moreover, it is proposed that such institutional interplay will also mediate subsequent path outcomes in terms of path scale and character e.g. in terms of path quality and its position in the wider sector’s division of labour (MacKinnon et al, 2018). Consequently, this will have a bearing on the broader process of regional economic development and regional path dependence.

2.5 Conclusion

By reviewing the literature relating to the process of regional industrial path evolution and the role of institutions in mediating it, the chapter has identified key departure points for the research regarding enabling and constraining environments for path creation. Moreover, the review has led to the development of an analytical framework that integrates path research objects (e.g. regions, industries), subjects (e.g. path creation, socio-technical transition) and scales (e.g. nation states, regions) into a holistic research framework (Martin and Sunley, 2013). By applying this framework to the research, the interplay of exogenous novelty with the institutionally mediated process of path creation (the interaction of actors, mechanisms and assets) can be examined and the influence on path outcomes assessed. In doing so, insights for theory and policy regarding the opportunities and means of creating new regional industrial growth paths will be generated.

Chapter 3: Research Methodology

3.1 Introduction

Having framed my enquiry regarding enabling and constraining environments for regional industrial path creation within the literature and developed the related analytical framework, this chapter details the methodology of research. It reflects Coffey and Atkinson's observation that "research problems, research design, data collection methods and analytic approaches should all be part of an overall methodological approach and should imply one another" (1996, p11). In doing so, the chapter firstly explores the Critical Realist and Geographical Political Economy informed positioning of the research. In turn, there is an explanation for selecting and developing a bespoke case study approach and, subsequently, justification of the cases of regional industrial path creation selected. The chapter then turns to detailing the mixed methods deployed, including an account of the empirical research process and interview programme, before explaining the post field work analysis.

3.2 Philosophy of Enquiry

How a researcher perceives and interprets the world needs to be explicitly noted to allow the audience to position and contextualise the research vis-à-vis its underlying assumptions of reality (Hempel and Oppenheim, 1948; Massey and Meegan, 1985; Yeung, 1997, 2003; Scott, 2000; Pike et al, 2016b). In undertaking this research I have adopted a Critical Realist (Bhaskar, 1975; Sayer, 1992; Yeung, 1997) philosophy of enquiry complemented by the perspective of Geographical Political Economy (Pike et al, 2016b). However, before explaining this selection it is worth exploring why ontological and epistemological demarcation is required.

Grix (2002) identifies that a lack of philosophical transparency has meant that academics are often arguing past each other. For example, methodologies reflecting the equilibrist structural perspective of neo-classical economics will facilitate differing empirical enquiry and interpretation from ones that privilege non-deterministic social perspectives relating to agency and transformation (E.F. Schumacher, 1973; Malecki, 1997; Sheppard, 2011; Chang, 2014). Furthermore, economic geography specifically has not been immune to the contestation of philosophical perspectives and, in turn, methodological choices. As noted by Scott (2000): "Economic geography has behaved quite differently from what might be expected of a rationally ordered discipline pursuing some pre-ordained epistemological mission" (p 484).

Although the positivism (Wittgenstein, 1921) of post-war regional science represented a quantitative research dominance based on “identifying the regularities of the neo-classical space economy” (Scott, 2000, p 486) such hegemony was challenged from the 1960s onwards by diverging philosophical perspectives and turns predicated on social interpretation (Scott, 2000; Barnes et al, 2007; Pike et al, 2016b). Consequently, there is no one size fits all methodology in economic geography, rather the researcher must select a method that is apposite for facilitating their specific enquiry (Peck and Theodore, 2012; Pike et al, 2016b). For this research, as noted previously, a Critical Realist ontological and epistemological position has been selected. A number of inherent presuppositions, elaborated below, makes this choice appropriate.

My research reflects the Critical Realist premise (Bhaskar, 1975; Sayer, 1992; Yeung, 1997) that events are generated through mechanisms embedded in wider social, economic and political structures (Lawson, 1989; Sayer, 1992; Del Casino Jr et al, 2011; Edward et al, 2014). This creative process is understood to be “contingently realised in specific time space contexts” (Hudson 2006; p 377). Therefore, a potential predilection to identify “universal laws” is mitigated by the requirement to understand the unique contexts in which outcomes occur (Sayer, 1982; Edward et al, 2014). Thus, Critical Realism aligns with my research interest in industrial path causality in heterogeneous regions and its relationship with multi-scalar institutions over time. My research also adheres to the philosophy’s recognition of the duality of structure and agency, the dynamic reciprocated relationship of causality (Sayer, 1982; Duncan and Ley, 1982; Giddens, 1984). It is a methodological perspective that facilitates exploration of the relationship between path creating agency and its multi-scalar institutional environment; mitigating the risk of the enquiry being monopolised by determinism or voluntarism (Duncan and Ley, 1982; Giddens, 1984).

In addition, a Critical Realist informed methodology has been complemented by the utilisation of a Geographical Political Economy (GPE) perspective; an analytical outlook that foregrounds the political-economic nexus (MacLeod, 2001; Martin and Sunley, 2006; MacKinnon et al, 2009; Pike et al 2017) in which path creation is embedded. It is an approach which analyses how the spatialities of capitalism co-evolve with economic, political and social processes (Sheppard, 2011). GPE neatly connects empirical enquiry relating to industrial economic evolution to broader

questions of value creation, institutional variance and uneven actor power across spatial scales and time (Pike et al, 2016b). Thus reflecting that “micro-entities are never isolated atoms but are shaped by their meso and macro-environments” (Essletzbichler, 2009, p 162). Additionally, by adopting this analytical paradigm, the enquiry is better attuned to unpack the state and its multi-dimensional and multi-scalar roles (MacLeod, 2001; MacKinnon et al, 2009) in path creation vis-à-vis transition. Finally, by combining a GPE perspective with a Critical Realist methodology, partial and generic accounts of regional change that overplay either exogenous or endogenous interpretation are mitigated (Hudson, 2006; MacKinnon et al, 2009; Pike et al, 2017b).

Before turning to research design, brief consideration of the moral sentiment embedded in methodological choices is appropriate (Hume, 1740; Smith, 1759). Scott (2000) rightly notes “the immensely real substantive issues” (p 496) that are at stake in economic geography and the “extraordinarily rich collection of insights into the spatial and locational foundations of economic life” (p 484) that is generated by the discipline. However, Gregory’s (1994) adjunct that geography should “seek not only to make social life intelligible but also to make it better” (p 10) is important. Research, from my perspective, should be accessible and valuable to policy makers - as well as academics - and should be vested with moral mission. Given that addressing the policy challenges of geographically uneven development (Asheim et al, 2011; Martin and Sunley, 2013) is a central motivation for this research, GPE is well placed to meet the material research needs of the economic development community. GPE engenders methodological engagement with and insight in to a real-world in flux, removing evolutionary theories from a world of abstraction to one of policy and practice (Massey, 1984; Martin and Sunley, 2014). By fusing GPE with Critical Realism, the economic geographer can fulfil their important societal task of making abstract and invisible but vital relationships regarding change and continuity, located within space and time, tangible and visible[13].

3.3 Selecting and Applying a Research Design

Having detailed the ontological and epistemological choices underpinning my research, the selection of research design can now be addressed. In order to understand the institutionally mediated, multi-scalar, multi-actor process of regional

[13] With thanks to Josef Koudelka, Czech landscape photographer, for this insight

industrial path creation, there is a need to “get inside” (Clarke, 1998) and “follow” (Pike et al, 2016b) the unfolding phenomenon. Such a requirement lends itself to a case study approach, facilitating the deep contextualisation required of the methodological combination of Critical Realism and GPE approaches. This section will: firstly, detail the merits of the case study method for the research; secondly, it will explain the design of the case study model; and, finally, establish the rationale for case selection.

Yin (2009) observes that a case study approach should be adopted when the:

a. Focus of study is to answer the questions relating to the “how” (apropos the process of path creation), the “why” (apropos the cause of path creation) and the “who” (apropos the path actors), thereby, facilitating insight into the contingency and causality of path creation;

b. Researcher wants to address contextual conditions because they are relevant to the phenomenon under study, thereby aligning with the enquiry’s interest in spatial and institutional contextual contingency; and

c. Boundaries are unclear between the phenomenon and its context, thereby reflecting the enquiry’s interest in the relationships between regional industrial path creation and its interplay with wider regional and sectoral and technological path dependences.

Complementing these methodological strengths, a case study approach is well suited to the generation of practical, concrete, context-specific knowledge (Flyvbjerg, 2006), a quality that is pertinent given the enquiry’s ambition of generating findings of both theoretical and policy utility. Furthermore, a case reflects a phenomenon occurring in a bounded context (Miles and Huberman, 1994), thereby enabling application of the analytical framework within a specified region within a specified timeframe. Moreover, reflecting Yin’s (2009) observation that a case study is “an empirical inquiry about a contemporary phenomenon set within its real-world context” (p 18), the case approach also accommodates the wider, multi-scalar environment in which it is nested. Finally, although the case is temporally bounded and defined by the phenomenon of path creation, it will be historically contextualised and placed within its preformation state (see Chapter 4).

In order to enable comparative analysis, two cases of regional industrial path creation will be selected. This approach responds to calls from within the discipline for greater

utilisation of comparative analysis to better understand the influence of differentiation, diversity and heterogeneity in the economic landscape on regional economic change. Moreover, such comparison enables empirical and, in turn, deductive and inductive "cross-referencing" over space and time (Boschma and Frenken 2009; Coe, 2010; Gertler, 2010; Pike et al, 2016b).

Two common models of case comparison can be identified in the literature, namely a Single Case with Embedded Units and a Multiple Case approach (Baxter and Jack, 2008); see figures 3.1 and 3.2 below.

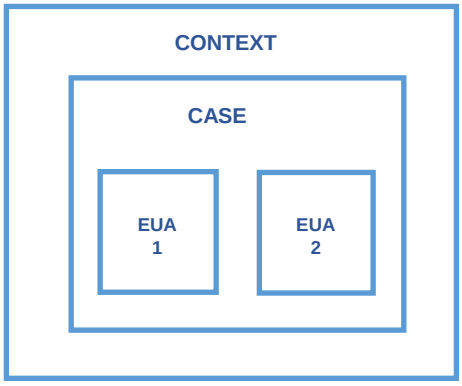


Figure 3.1 Model of single case study with embedded units of analysis (EUA)

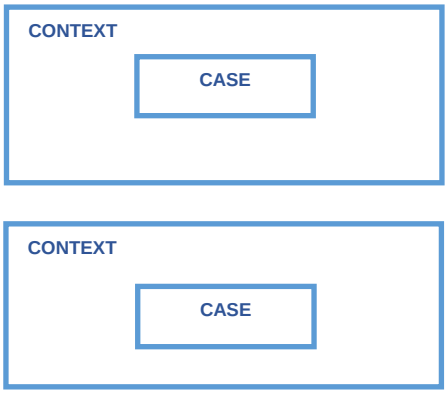


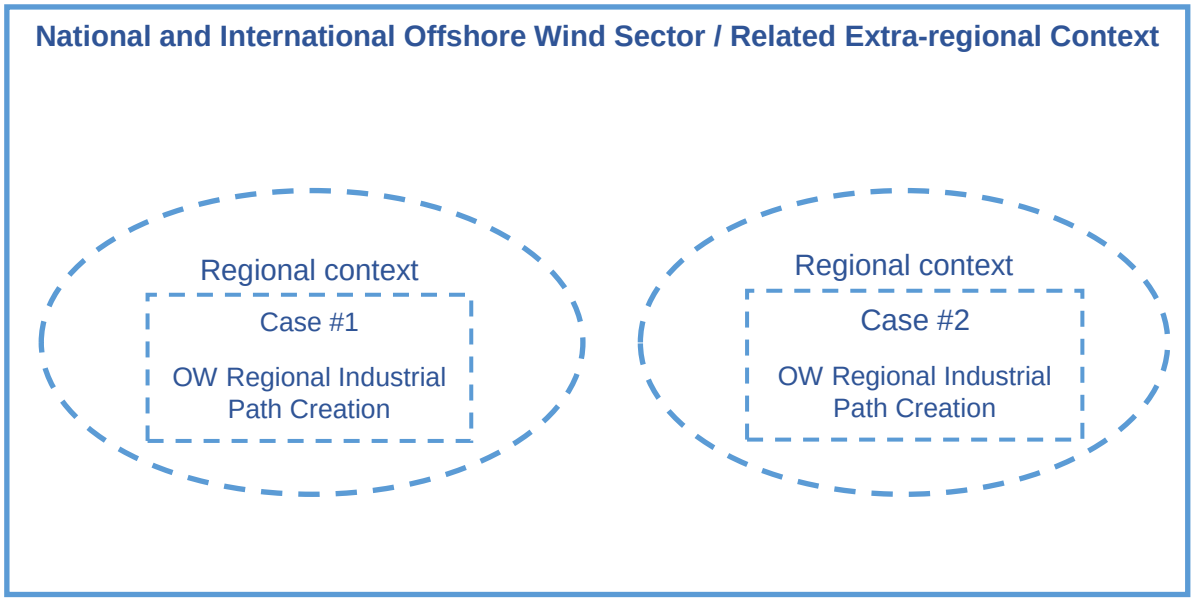
Figure 3.2 Model of multiple case approach

Based on Baxter and Jack (2008)

Both models have merit but also deficiencies. A Single Case with Embedded Units has convenience in that it attempts to group research entities (i.e. regional industrial paths) into a shared case and contextual framework. However, Baxter and Jack (2008) contend that where the context for each case is different, a multiple-case study approach is appropriate. Given that a key aspect of the research relates to how regional heterogeneity (e.g. regional assets, regional institutions) effects regional industrial path creation, contextual variability needs to be accommodated. However, although a multiple case study model can readily reflect differing regional contexts, the regional industrial paths being examined should not be treated as wholly isolated occurrences given the existence of common extra-regional influences (e.g. nation state institutions, wider sectoral dynamics). Therefore, the notion of "incorporated comparison" (McMichael, 1990) is adopted in recognition that the regional industrial path cases are also embedded in relatively similar extra-regional settings (MacKinnon et al, 2009; Pike et al, 2016b). This multi-scalar relational perspective facilitates comprehension of how extra-regional dynamics, such as those relating to socio-technical transition, interact with regional specificities. It also complements the

notion of regions as “zones of policy implementation” (Peck and Theodore, 2012); places where extra-regional policy interacts with regional heterogeneity resulting in differing regional path outcomes. As Massey and Meegan (1985) observe: “A Single national policy, may well produce one effect in one situation and a completely different effect in another” (p 9).

Consequently, the research has adopted a hybrid case study model (figure 3.3) that is sympathetic to distinctive regional contexts whilst explicitly accommodating the multi-scalar relations and dependencies in which both cases are embedded. Thus “following the path” creation process wherever it may lead (Pike et al, 2016b). This Critical Realist and GPE informed case model aims to illuminate the “deep-seated as well as wider relations, positions and contexts of agents and inter-related structures” (Pike et al, 2016b, p 132) that shape path creation, and in doing so generate insight into the nature of enabling and constraining environments for regional path creation.



Source: Own elaboration *(broken lines denote porous nature of relations)*

Figure 3.3: Two cases of regional industrial path creation placed within respective regional contexts nested in their extra-regional context

3.3.1 Selection of two cases

Two cases were selected based on their instrumental value in relation to the analytical framework (Burawoy, 1998; Baxter and Jack, 2008) reflecting Flyvbjerg’s (2006) observation that a small number of varying cases that allow in-depth practicable exploration of the significance of contingent conditions and outcomes

offer greatest insight. However, the level of case variance was tempered by the recognition that the cases had to be sufficiently similar to facilitate credible and relevant comparative analysis in regard to regional industrial path creation linked to transition (George and Bennett, 2005; Gerring, 2007). Moreover, given the desire to adopt incorporated comparison apropos nation state "rules", the two cases required to be embedded in the same nation state context (making international case selection inappropriate).

Furthermore, case selection was also based on the recognition that if a small number of cases are selected judiciously, lessons with broader applicability can be generated through inference (Yeung, 2003; Yin, 2009; Flyvbjerg, 2005; Pike et al, 2016b). Similarly, selection was informed by the desire not to sacrifice empirical insight for empirical breadth, thereby limiting the ability to "follow the path" in required detail (Pike et al, 2016b). The process of case selection was also informed by Peck and Theodore's (2012) observation that by selecting appropriate cases the researcher can seek to create and reconstruct theory, not just test it. Therefore, the cases selected permitted the interplay of deductive and inductive approaches (Teddlie and Tashakkori, 2009; Pike et al, 2016b).

In summary, the selection of two cases was based on information-oriented selection (Flyvbjerg, 2005) with regard to evidence of:

- The emergence of regional industrial paths related to the stimuli of energy transition, namely offshore wind, thereby ensuring instrumental case relevance;
- Regional contextual variance, for example in terms of regional assets and institutions, which are correspondingly interacting with similar extra-regional sectoral dynamics, thereby promoting incorporated comparison;
- The operation of similar nation state "rules" at the regional level (i.e. policy and regulation relating to offshore wind), thus allowing each case region to be treated as a "zone of policy implementation".

3.3.2 Relevance of Glasgow and Humberside cases

In 2014, Michael Fallon[14], a UK Government Minister, stated that the establishment of a new UK Government innovation body in Glasgow, Offshore Renewable Energy Catapult (OREC) and a Siemens manufacturing facility on Humberside represented key milestones for the UK Government's offshore wind strategy and the development of the industry. However, these two regional industrial paths are not only relevant due to shared political and industrial significance and corresponding ability to offer entry points for understanding the role of national policy on creating regional industries, they are also appropriate given their evident case variation.

Both cases allow for insight into the role of regional heterogeneity on the path creation given differing pre-formation contexts (Martin, 2010). Moreover, both cases vary in terms of their respective qualitative positions in the broader national and international offshore wind's division of labour, facilitating insights into how the character of new paths is shaped. Additionally, although the regions are embedded in a similar nation state context they have differing levels of institutional thickness (Amin and Thrift, 1994b, 1995) and forms of regional innovation systems (Trippl et al, 2017), promoting exploration of the importance of regional level institutional frameworks on path creation. Finally, the Glasgow case is set within the devolved Scottish context whilst the Humber case is embedded within a less devolved institutional sub-national context, thereby allowing exploration of how differing multi-scalar institutional architectures influence path creation (Gertler, 2010; Schroder and Voelzkow, 2016). To expand:

- Glasgow and Humberside exhibit differing economic histories and resulting economic structures, assets, competences and practices (Martin and Sunley, 2006) - even so, both regions have experienced economic decline making them relevant for understanding path creation in lagging regions (Pike et al, 2006; Dawley, 2013; McCann and Ortega-Argiles, 2013; Coenen et al, 2015);
- Glasgow's path creation is less dependent on geographic proximity to natural resources (offshore wind farm sites), whereas Humberside is highly dependent on such proximity (Martin and Sunley, 2006; Fornahl et al, 2012);
- Differing divisions of labour in relation to the broader sectoral path are evident (MacKinnon et al, 2018) – routine operational and manufacturing functions are

[14] REALPOWER: News from the wind and marine energy industries, Issue 36, Spring 2014

evident on Humberside, whilst higher value knowledge functions are more evident in Glasgow;

- Contrasting sub state institutional contexts are evident in relation to both paths (Gertler, 2010) e.g. the Glasgow path is also nested within and subject to devolved Scottish Government's institutions and powers;
- Differing forms of UK state activism (Dawley et al, 2015) can be identified - Glasgow hosts the HQ for the UK Government's technology and innovation centre, Offshore Renewable Energy Catapult (OREC), while Humberside is the location of a significant inward investment by Siemens facilitated by the UK state;
- Divergent local innovation capacities pertaining to the industry are evident in both regions – Glasgow exhibits characteristics associated with an organisationally thick and specialised regional innovation system (Trippl et al, 2017), including a university recognised internationally for electrical power engineering research, whereas, Humberside exhibits characteristics of an operationally thin regional innovation system (Trippl et al, 2017).

Corroborating this final point, The Economist (2011)[15] observed that both Glasgow and Humberside were two regions in the UK well placed to benefit from the emergence of the Offshore Wind industry. However, it noted that the two regions' offerings were markedly different; Glasgow's predicated on knowledge and research and Humberside's on proximity to the natural resource and excess port infrastructure. In short, the two cases of regional industrial path creation are pertinent for empirical observation to permit assessment and comparison of the respective multi-scalar processes of path creation in heterogeneous regional contexts. Thus providing fresh insight into what represents enabling and constraining environments (Martin, 2010; Dawley, 2013; MacKinnon et al, 2018) for path creation in relation to socio-technical transition.

The temporal framing of the two cases of regional industrial path creation within the analytical framework relates to an approximate period of ten years between 2006 and late 2015. 2006 was the year in which an electricity utility firm established the first offshore wind team in Glasgow and, in the same year, Grimsby was identified by

[15] The Economist, 17/2/11

offshore wind project developers as an O&M base. In 2015, the end year for both cases, a significant change to the UK subsidy regime for offshore wind energy occurred (see Chapter 4). Although the cases are temporally bounded by these events relating to path creation, each is historically positioned in the following chapter in order to connect the cases to their regional preformation states and illuminate respective regional path dependences, assets and institutions.

3.4 Research Method

The research method implied by the analytical framework favours intensive and qualitative primary case research supported by secondary data analysis (Sayer, 1992; Parsons and Knight, 2005; Peet, 1998; Pike et al, 2016b), enabling exploration of the "complex, fuzzy and difficult to isolate relations between institutionalised processes and economic outcomes" (Rodriguez-Pose, 2013, p 1038). Moreover, the employed research method enables comparative analysis and cross referencing of the empirical evidence across the cases to facilitate theoretical review and development. Secondary data sources are utilised to assist description of the two cases within their contexts, identify and position sources of primary research and augment and corroborate the primary research findings. This approach reflects mixed methods (Yeung, 2003), whereby the researcher uses differing "data collection, analysis and inference techniques, for the purpose of breadth of understanding and corroboration" (Johnson et al 2007, p 123). The approach reflects Yeung's (2003) recommendation that the researcher adopts a methodology that facilitates triangulation; whereby distinct but complementary research methods corroborate research findings. Given the limited availability of longitudinal quantitative data relating to each of the regional industrial paths an emphasis on qualitative enquiry is required.

3.4.1 The Interplay of Primary and Secondary data

Interviewee Identification

In order to explore the path creating causal relations between path actors, assets and mechanisms, mediated by multi-scalar institutions, forty-nine actor interviews were undertaken to garner primary data. This section will firstly explain the interviewee selection process, which was crucially informed by secondary data, and then describe the preparation for and execution of these interviews.

Reflecting the multi-actor perspective (Garud and Karnoe, 2003; Binz et al, 2016; MacKinnon et al 2018) of this research three broad path actor types were identified for interview in relation to each regional industrial case:

- Firm actors (including representative bodies);
- Non-firm actors relating to the state;
- Non-firm actors relating to research.

In addition, to reflect the enquiry's multi-scalar perspective and facilitate a research process that can "follow" the unfolding paths (Pike et al, 2016b), actor selection was not restricted to those whose operational domain was at the regional level[16]. Therefore, to operationalise multi-scalar empirics, actors were also divided into three groupings reflecting their: relevance to one of the two selected industrial path cases (Glasgow or Humberside); or their relevance to the wider sector in which both cases were embedded. However, as inferred by the case study model (figure 3.3), a degree of porosity in regard to these actor groupings was accepted; for example extra-regional sectoral path actors would have germane insights on the regional industrial cases and regional path actors would have germane insights on the broader sector.

Additionally, given a key aspect of the research pertains to understanding strategic agency in the process of path creation, senior executives and policy makers with power to effect change were selected for interview. Furthermore, reflecting the analytical framework, interviewees were also selected according to their knowledge or representation of aspects of the institutional and/or sectoral and technological contexts in which the paths were set.

Interviewees were identified via personal networks and secondary data. In recognition that job titles can misrepresent what a person does and their power within an organisation (Harvey, 2011), in-depth research regarding their relevance was undertaken, especially for potential interviewees outside my own industrial and government networks. This was largely done via utilisation of social media (primarily LinkedIn), organisational websites, published minutes, reviewing media sources, and discussion with my industry and government contacts. In short, in-depth utilisation of secondary data was crucial for identifying appropriate sources of primary data.

[16] London represented a spatial concentration of actors with a bearing on the wider sector's development

This was a time intensive process and researching each potential interviewee could take upwards of half a day. Subsequently a spreadsheet was populated, thereby facilitating consideration of interviewee coverage in terms of the following factors:

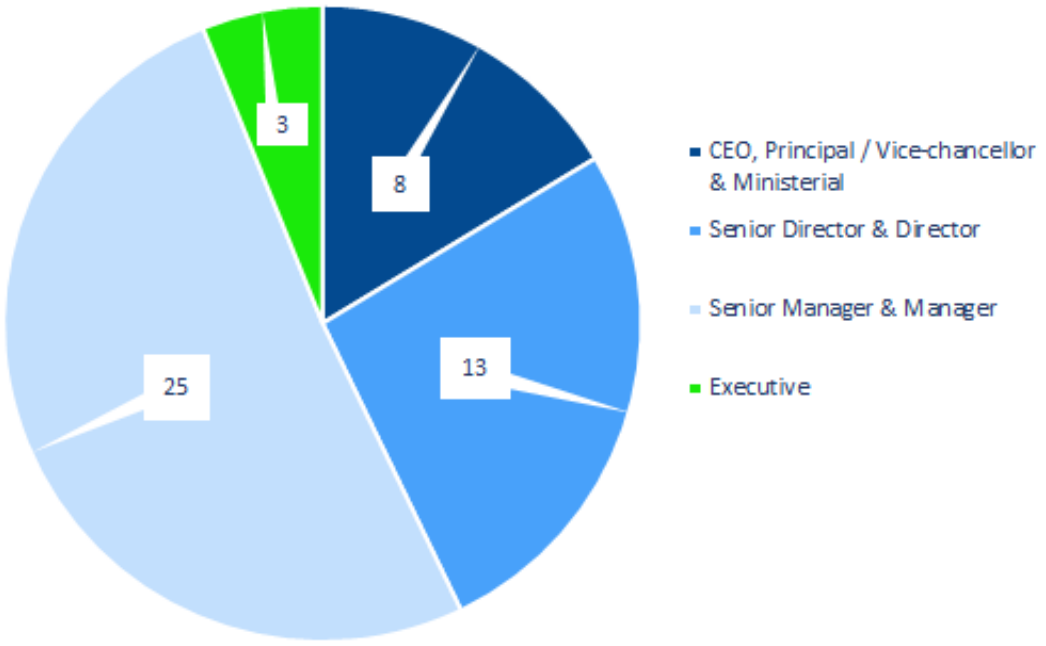
- Actor type (firm, non-firm state, non-firm research);
- Case perspective (regional industrial path or broader sector);
- Professional function and career history;
- Institutional and technological knowledge;
- Participation in industry networks and governance bodies;
- And level of authority / power to effect change.

Fifty interviewees were identified and forty-nine were subsequently interviewed in relation to the Glasgow and Humberside cases and the wider offshore wind sector (the latter largely undertaken in London). Comprehensive coverage in relation to the above noted factors was met.

In particular, the quality of those interviewed was notable in terms of their seniority, knowledge and perspective. Many interviewees were key influencers within their respective actor types and across actor types. Also, many had chaired or participated in UK, Scottish and regional industrial, government and partnership fora:

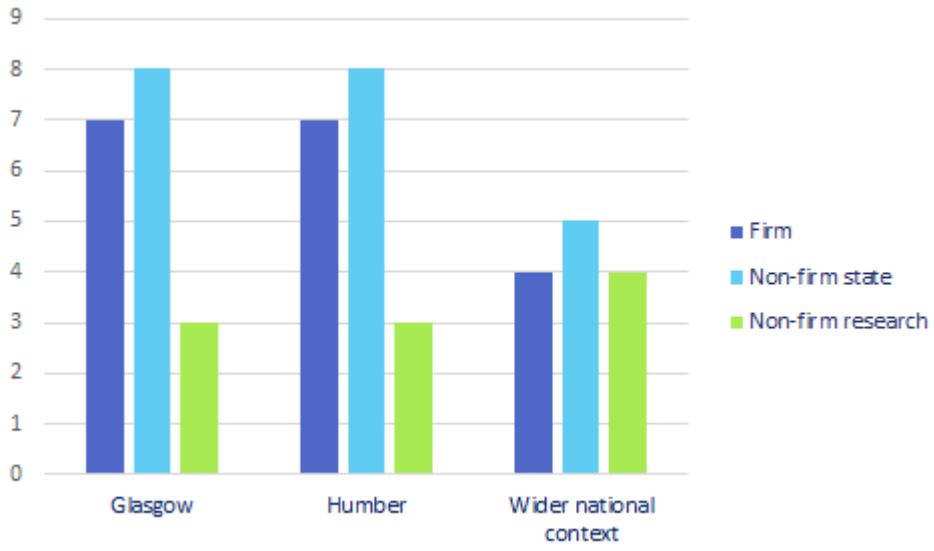
- Eight interviewees were at Principal / Vice Chancellor, Ministerial, CEO levels (the latter in both private and public organisations);
- Thirteen were at senior director and director level in OEMs, utility companies and public bodies, such as Iberdrola, Siemens, Scottish Power, Scottish Enterprise, SSE;
- Twenty-five were at senior manager or manager level in firms and public bodies, such as Associated British Ports, Atkins, BIS, Crown Estate, DECC, Innovate UK, local government, Scottish Government, The Treasury;
- Three were executives in public bodies, such as the Welsh Government and local government.

Figures 3.4 and 3.5 summarise the breakdown of the primary research interviewees.



Source: Own elaboration

Figure 3.4: Interviewees by seniority



Source: Own elaboration

Figure 3.5: Interviewees by geography and actor type

A more detailed summary of the actors that participated in the primary research is detailed in tabular form in the appendices, divided in to the two regional paths and the broader sectoral path and utilising the three path actor classifications (Appendices A, B and C). Anonymity for interviewees was adopted to encourage engagement and candour in interview. Therefore, a code was subsequently given to each interviewee that is utilised in the following case study chapters.

Positionality and Ethics

The cohort of interviewees represented an elite (Zuckerman, 1972; Harvey, 2011) and therefore consideration of research positionality was required. An elite is defined as those who hold “important social network, social capital and strategic positions within social structures and are able to exert influence” (Harvey, 2011, p x) and who have “significant decision-making influence within and outside” organisations (Zuckerman, 1972, p 11). Given such status, there was the potential for those approached to feel suspicious or threatened by a request to be interviewed about matters that could be interpreted as professionally, commercially or politically sensitive. Therefore, I needed to elicit trust from my initial approach and subsequently during the conduct of the actual interview (Valentine, 2013). Elite’s also have a high degree of vested interest in the status quo and therefore questioning needs to explore and challenge such positional perspectives without triggering withdrawal and detachment (Zuckerman, 1972; Clark, 1989; Cochrane, 1998; Harvey, 2011).

In regard to my own positionality, I have worked in economic and industrial development at management and director levels for over two decades. I am also the Chair of the Economic Development Association of Scotland (EDAS). This was advantageous as I am familiar with the culture and circumstance of the interviewees and positioned the research to enhance engagement and candour and mitigate their perception of the interviewer as supplicant (Desmond, 2004; Harvey, 2011). However, throughout the research process I had to be conscious of the need to manage the dialectic tension of “involvement and detachment” (Clark, 1998; Cochrane, 1998), which accordingly informed my interview preparation, approach and execution (Valentine, 2013), which is subsequently explained in this chapter. In particular, I managed the tension of occupying a space between being an insider and an outsider by ensuring that each interview followed a standard and structured sequential set of themes and questions derived from my analytical framework based on the literature review (Dwyer and Buckle, 2009).

In addition, given my desire to engage with powerful and insightful actors and generate research findings which could have subsequent bearing and profile within their respective professional communities, my default position was that all interviews were anonymous in order to promote candour. This was explained in the letter of approach and at the start of the interview. If in exceptional circumstances there was

an unforeseen need or preference to name a contributor, I stated that their explicit permission would be sought.

Interview Preparation and Approach

The pre-planned interview discussion themes and questions were semi-structured in nature to enable the research interview to be a conversation with a purpose (Eyles, 2008). The lines of enquiry were informed by the themes of the analytical framework. By utilising a non-rigid interview structure, opening up new lines of related enquiry or giving prominence to rewarding ones during the interview could be accommodated (Clark, 1998; Cochrane, 1998; Eyles, 2008; Valentine, 2013). Also, by deploying more open-ended questions, I was better placed to explore contending accounts of the relationships between causality, contingency and outcome with the interviewee, while still allowing scope for following up with close-ended questions to generate specific data. The discussion themes and questions were tailored to meet the specificities of three interviewee groupings – the Glasgow and Humberside industrial paths and the wider sector - with sufficient commonality retained to allow subsequent comparison (see Appendices D, E and F). A small number of initial pilot interviews were undertaken at the outset of the interview programme in December 2015 and following review the interview questions and process were adjusted to enhance generation of relevant data. This pilot process also tested and duly demonstrated the value of audio recording of the interviews in order to observe and respond to the subject and effectively manage the interview (Aberbach and Rockman, 2002; Harvey, 2011; Valentine, 2013).

Interviewees were approached via an emailed letter sent from my university account that detailed the nature and purpose of the research and emphasised its potential positive societal impact for government, industry and academia. The letter also clearly stated that their knowledge and insights would be beneficial. There was also reference to my own professional background: noting that I had worked in economic and industrial development for over twenty years (including senior positions with Scottish Enterprise and Offshore Renewable Energy Catapult) and that I was the Chair of the Economic Development Association of Scotland. By stating the potential societal impact of the research regarding awareness of the industry's importance to national and regional development and also explaining my background, it mitigated the potential perception of the interviewer as supplicant (Desmond, 2004; Harvey, 2011). Additionally the letter explained that their input would be anonymous. One

hour of time was requested for the interview and, if amenable, it was noted that a convenient date and location would be sought. It was stated that the recipient could withdraw from the process at any stage, in order to lessen any sense of pressure or obligation.

Specific arrangements were either confirmed via email or telephone call, sometimes via their personal assistant. Due to the working practices of the interviewees some meetings were rearranged at short notice and flexibility was required (one interview took place in central London at 08.00hrs and a number of interviews were undertaken after normal working hours) but all took place, bar one. Furthermore, all were undertaken in person with the exception of two interviews that were conducted by telephone after being rescheduled on a number of occasions due to interviewees having to participate in meetings at short notice.

Finally, prior to interview, I returned to secondary data collation, primarily contemporary media reports regarding the interviewee's organisation, to understand current issues relating to their organisation that may influence or prejudice their responses and frame their reference. Such research also allowed me to demonstrate a knowledge and interest in their organisation during the interview. I also ensured that I was attuned to the current issues and sensitivities within the wider industry, such as the longer term prospects of the industry given significant changes to the government subsidy regime in 2015.

Interview Execution

The interviews were primarily undertaken over a six month period from December 2015 to end May 2016, thereby ensuring a similar temporal context. However, there was a degree of phasing in the interview execution to ensure that I concentrated on one geographic focus at a time. This not only allowed me to prepare for and research one cohort of interviews in an efficient and sequential manner, it also ensured that I remained focused on the subsequent generation of and initial reflection on primary data from these specific geographies in a delineated fashion. Broadly speaking, Glasgow interviews were conducted between December 2015 and end January 2016, wider sectoral interviews (primarily in London) were conducted in February 2016 and Humberside interviews were conducted between March and May 2016.

Most interviews took place in the interviewee's place of work. The interview "warm-up" (Valentine, 2013) consisted of providing an account of who I was and why I was

undertaking the research and underscoring its relevance to the development and understanding of the offshore wind industry, and explaining the importance of their input to the research in non-academic language. I then asked the interviewee to sign the consent form that I also counter signed. I then asked if it was acceptable to record the session. No interviewee refused and most quickly lost any inhibition. Only on two occasions did audio recording effect interview dynamics with one interviewee acceding to being recorded but then subsequently acting in a more guarded manner, while another asked me to stop the audio recording in order that they could expand on a sensitive commercial matter. Before commencing the semi-structured interview, I summarised the sequence of the interview themes and noted that the interview should be concluded within the hour.

Having researched personal career backgrounds, professional networks and current organisational issues pertaining to the interviewee, I was able during the course of the interview to demonstrate a knowledge of their professional and corporate positionality that gained me a degree of respect as an informed interlocutor and promoted interviewee candour (Desmond 2004; Harvey, 2011). This allowed for more challenging questions and lines of discussion to be explored in an affable manner. Also, during the interview, I did not lead the interviewee but I did encourage further exploration and validation of the utility of their contribution by using phrases such as “that’s useful” and “that’s interesting”. I also gave a sense of progress by communicating interview milestones (“moving on to the next theme” “we’re now moving on to the latter part of the interview”, “nearly finished”), in order that the interviewee did not become anxious about interview drift and poor time keeping by myself. This also allowed the interviewee to communicate whether they were bounded by the pre-agreed one hour interview timeframe. In reality, most interviews lasted approximately one hour and fifteen minutes with a small number lasting for nearly two hours.

During the interview “warm down” (Valentine, 2013), I informed the interviewee that I had switched off the audio recorder. This period of the interview was the most informal and facilitated discussion pertaining to the interviewee’s often more personal views, as opposed to more corporate ones. It was at this stage, I would also offer some of my own views informed by my research and career, before thanking them for their insights and time. This closing five or ten minutes was important for conveying respect and appreciation for their inputs. Many of the interviewees said the process

had been valuable for them, allowing them to step back and consider the development of the industry from a broader perspective. A small number of interviewees called the process “cathartic”. Most said I could contact them again and asked if the findings could be shared with them. Immediately after the interview, I made a note of the meeting to capture initial post impressions of the interview and transcribe any relevant points that had not been captured by audio recording (Teddlie and Tashakkori, 2009).

3.4.2 Sources and utilisation of secondary data

Secondary data was utilised to situate and describe the Glasgow and Humberside regional industrial path cases in their wider historical, regional and sectoral contexts. As previously noted, this data also informed the research design, such as the interview preparation. Subsequently, secondary data facilitated corroboration of the primary research. Specifically, utilisation of these secondary sources provided:

- Data on the preformation contexts of the two case study regions, including regional assets and previous patterns and paths of economic development, in order to place them in their historical and path dependent contexts;
- Accounts of the development of the offshore wind industry both at the regional and the broader national and international sectoral level;
- Data on the formal institutional environment (e.g. energy, industry and territorial policies and related regulation);
- Information on power and functions of relevant path actors and data on the related informal institutional environment (e.g. networks, conventions);
- Data on technological environment (e.g. offshore wind technologies and related practices);
- A means to identify potential interviewees, shape the research questions and corroborate subsequent empirical findings.

Secondary data was sourced from government at the local/regional, Scottish, UK and EU levels and business, industry and corporate publications, journals and media. Industry and business representative bodies at the regional level (including Chambers of Commerce), the national level (including Renewables UK and Scottish Renewables) and the international level (including the European Wind Energy Association) also represented important sources of data. Public records were also

utilised, such as Parliamentary reports and records[17] and Board papers of economic and industrial development organisations. Also, public data collected while working in the industry and attending UK Government, Scottish Government and European Commission meetings was utilised. However, the interpretation and application of these sources was tempered by Flowerdew and Martin's (2013) recognition of the innate nature of such data: "Secondary data is a cultural artefact, produced for administrators with priorities and ways of seeing the world that may be very different from those underpinning your dissertation" (p 58). Finally, as noted, the ad-hoc nature of statistical evidence and inadequacy of longitudinal data sets, such as Standard Industrial Classification (SIC), relating to the offshore wind industry across spatial levels informed and delimited selection of research techniques (Clark, 2013).

3.5 Data Analysis

In order not to privilege a deductive or inductive approach in regard to the collation of the data from the interviews, thereby prejudicing subsequent analysis, two collation methods of interview data were adopted (Teddlie and Tashakkori, 2009; Crang, 2013; Pike et al, 2016b). These were applied to the Glasgow interview data in the first instance and then Humberside.

Firstly, a list of codes informed by the analytical framework was created to plot pertinent transcribed data for each case study derived from the interviews with the respective case actors and broader sectoral actors. The codes facilitated data collation in relation to: key path actors and types; operation of mechanisms; valorisation and reconfiguration of regional assets; utilisation of novel knowledge relating to the path; related influence of formal and informal institutions; interaction with dynamics of wider sector; key causal moments; and the scale and nature of the emergent regional industrial path and relationship with wider regional economy (see Appendix G). Against each of these primary categories, key outputs from my interviews were plotted and collated. This was done by summarising key data relating to the above categories on post-it notes and grouping recurrences on a wall 4 meters by 1.5 meters.

[17] For example, a record of a debate in the House of Commons on the evening of 9th February, 2016 relating to the development of the UK's offshore wind industry that I attended

In order to utilise a more inductive approach, open coding was also adopted. This allowed for the transcribed data to be collated around emergent themes and meanings, thereby allowing interview data to be utilised in the identification, description and classification of patterns excluded by the former approach (Teddlie and Tashakkori, 2009; Crang, 2013). In this method, post-it notes were grouped into emergent configurations. In turn, this approach generated, for example, fresh insights into the mutability of common purpose (as regional actors often defaulted to perceiving such purpose at a national or a local level, not a regional one), the relationship between strategic social agency and collective path narratives and conceptualisations (the metaphysical connection between words, things and action[18]) and cited counterfactuals of regional industrial path creation outcomes (i.e. interviewee perspectives on what could have been).

In parallel, to these collation processes primary data was considered alongside secondary data for corroboration, context and auxiliary insight (Crang, 2013). Moreover, secondary data was also plotted along a timeline divided into years between 2006 and 2015 (inclusive) to identify temporal dynamics of the path and key instances of actor agency, institutional developments and technological change, and consider these against the primary research evidence (see Appendix H for a Glasgow example).

This synthesis of primary and secondary data was then employed in the conceptual construction of the respective regional industrial path case studies pertaining to Glasgow and Humberside. The Glasgow case study was the first to de developed and drafted. Both case studies were developed to follow the respective journeys of path creation (Pike et al, 2016b), thereby facilitating exploration of the influence of multi-scalar institutions on enabling or constraining path creation. Driving this evolutionary narrative was the path's manifestation delineated through time and space. Key observed episodes of path creation and related key instances of agency, identified through the data collation processes noted above, acted as temporal focusing devices for the application of the analytical framework. By adopting such an approach, empirical data relating to objects, subjects and levels could be identified and grouped within a segmented but integrated temporal framework (Martin and Sunley, 2013) and buried, deep-seated relations, positions and contexts of agents and inter-related structures revealed over time and space (Pike et al, 2016b). In

[18] With thanks to Rene Magritte, "Ceci n'est pas une pipe"

effect, each selected instance of path creating agency acted as a “Petri dish” to allow comparison within and across the respective cases on the influence of institutions on enabling or constraining path creation and the related interplay of differing actors, mechanisms and assets.

In turn, this immersive but structured account of the phenomena (Clark, 1998) facilitated detailed comparative analysis of the two cases and utilisation of both deductive and inductive approaches (Teddlie and Tashakkori, 2009; Pike et al, 2016b). This dualistic interplay of approaches ensured that theory contained in the literature review was confronted, refined and developed and its transfer from a world of abstraction to one of policy and practice facilitated (Martin and Sunley, 2014; Pike et al, 2016b).

3.6 Communication of Findings

Given a key aim of the research is to generate knowledge that is useful to policy (Gregory, 1994, Scott, 2000; Yeung, 2000; Martin and Sunley, 2013; Pike et al, 2016b) and which has societal impact (REF, 2014) there is an intent to disseminate findings beyond academia. A programme for communicating the findings will be developed and progressed. In turn, the findings will be summarised and circulated to interviewees and other relevant stakeholders in the form of a policy briefing. Given that the research has focused on the multi-scalar nature of path creation, the findings will be circulated to relevant policy makers at the UK, Scottish and regional levels. In addition, a policy focused seminar for disseminating the findings will be held under the auspices of the Economic Development Association of Scotland and I will also utilise the findings in the context of my membership of the steering group for the Scottish Government’s Centre for Regional Inclusive Growth. I am also pursuing options in regard to publication and presenting at RSA conferences[19].

3.7 Conclusion

This chapter has explained my ontological and epistemological approach to the research. In adopting a Critical Realist perspective complemented by the analytical position of Geographical Political Economy, my research is well placed to consider the relationships between agency and structure in a manner which links spatial-industrial economic evolution to broader questions of power, value creation and

[19] Initial findings were also shared at a CURDS internal seminar and the AAG Conference in Boston, 2017

uneven development across scales. By developing a hybrid case study model that is sympathetic to distinctive regional contexts whilst explicitly accommodating the broader multi-scalar relations and dependencies in which both cases are embedded, the regional path's evolution and related enabling and constraining institutional environments can be explored through time and space. Moreover, the Glasgow and Humberside cases were selected for their instrumental value regarding the influence of transition on heterogeneous regional contexts, albeit ones effected by the same nation state "rules". It is to understanding the broader sectoral and regional preformation case settings that the study now turns.

Chapter 4: Positioning the Cases within Sectoral and Regional Contexts

4.1 Introduction

This chapter has two purposes. Firstly, it positions both cases in the broader, longitudinal process of socio-technical energy transition, particularly in relation to the development of offshore wind (Geels, 2004; Markard and Truffer, 2008). Secondly, it frames both cases in their respective pre-formation regional contexts (Martin, 2010). This dualistic contextualisation facilitates subsequent case analysis of the interaction of broader sectoral dynamics and regional heterogeneity to engender path creation and the role of institutions in mediating this interaction (Boschma et al, 2017; Trippl et al, 2017; MacKinnon et al, 2018).

The chapter is divided into two main parts. The first delineates and considers the institutions, actors and technologies which mediated energy transition, especially relating to offshore wind. In doing so, it will initially consider the formation of the offshore wind market between 1990 and 2015, a process that was primarily state-led, before turning to the related formation of the industrial value chain, a process that was primarily firm led. The second part of the chapter explores Glasgow and Humberside's unique path pre-formation contexts, including regional assets (Maskell and Malmberg, 1999; Martin and Sunley, 2006), which had the potential to interact with the dynamics of the broader offshore wind sector. Also, regional institutional contexts that shaped continuity and change in both regional economies are explored (MacLean, 2001; MacKinnon et al, 2009; Evenhuis, 2017). Finally, there is a concluding reflection on the importance of sectoral and regional positioning of the cases prior to presentation of the Glasgow and Humberside case studies.

4.2 Development of Offshore Wind Sector Part 1: Formation of the Market

4.2.1 Overview

The offshore wind energy market is a product of the global political drive to reduce greenhouse gas emissions and is a distinct and notable aspect of the broader process of socio-technical energy transition. Since the 1990s an explicit and calibrated relationship between government institutions and the offshore wind market's evolution has been evident, reflecting the contention that energy transition is

an instituted process (Essletzbichler, 2012; Truffer and Coenen, 2012; Coenen et al, 2012). This section will consider the emergence of this market between 1990 and 2015. It will do so by initially exploring how institutions incentivised mindful actor deviation and experimentation to create a terrestrial wind market, the antecedent of offshore wind (Garud and Karnoe, 2003; Martin, 2010: Steen, 2016). It will then consider how changes to these institutions, particularly policy and regulatory "rules" (North, 1990; Peck, 1999; Geels, 2004; Gertler, 2010) produced consequent actor deviation to create an offshore wind market, with particular focus on the UK, including consideration of the devolved Scottish context. Finally, it will identify the resulting scale of the offshore wind market at the UK and EU levels; thereby setting the scene for an account of the development of the related industry value chain.

4.2.2 Multi-scalar institutions and energy transition

The international commitment to reduce greenhouse gas emissions, initiated by the UN Framework Convention on Climate Change (UNFCCC) of 1992, fostered new energy markets and enabling technologies to counter global carbon-based energy path dependence (David, 1988,1994; Arthur; 1987, 1994; Geels, 2002; Martin and Sunley, 2006). In 2007, European Union member states agreed a collective target of reducing greenhouse gases by 20% from the 1990 level by 2020, subsequently revised to a 40% reduction by 2030. This EU level intent was paralleled in individual member states. For example, in the UK, the Climate Change Act of 2008 set an 80% cut in the UK's carbon emissions by 2050; and by doing so, the UK became the first country in the world to introduce long-term legally binding targets.

In order to meet these ambitions, targets relating to the generation of renewable energy were also introduced. The EU's Renewables Energy Directive of 2009 set a legally binding target of 20% of electricity from renewables by 2020; a target revised upwards in 2014 to 27% by 2030. Again these commitments were played out at a sub-EU level. For example, Denmark in 2011 set a target of 100% of electricity from renewable sources by 2035 and, in the same year, the Scottish Government set a target of 100% by 2020. However, the renewable energy technologies on which the attainment of these targets was dependent were commercially uncompetitive at their introduction. Therefore, the process of global energy transition required significant public subsidy and support to engender renewable energy markets. To facilitate this

transition, circa $88bn of public subsidy per annum (EWEA, 2013) was being awarded to the European renewables energy sector by 2011.

One particular disruptive technology, onshore wind, emerged as key to delivering targets cost-effectively. A number of related economic and technological factors - especially investor confidence derived from public support and the scaling up of the generating power of the standard turbine model (the single rotor horizontal axis) - allowed the cost of terrestrial wind power to fall by a factor of three over two decades. By 2015 the cost of generation in the UK was £55 pMWH compared with a wholesale price of £40-£50 (ORE Catapult, 2015). Such encouraging economics allowed the global cumulative capacity of this disruptive technology to rise from 5 gigawatts (GW) in the early 1990s to over 432 GW in 2015 (Global Wind Energy Council, 2016). However, with such scaling up came concerns about the reliability of the onshore wind resource, the finite nature of development sites and environmental impact.

In light of these concerns, the benefits of larger and more consistent offshore wind resources harnessed by adapting an onshore technology that had evidenced impressive cost reduction was compelling. As summarised by Ernst and Young (2015, p 6): “Power fluctuations are small due to the constant and consistent nature of wind offshore. Thanks to its improved predictability and reliability, offshore wind is also better suited than onshore wind to provide operating reserve capacity to the electricity network”. The first offshore wind turbines became operational in Danish waters in 1991, and were introduced to UK waters in 2000, demonstrating the viability of the technology, if not the market.

The emergence of a viable market was both enabled and constrained by changing nation state disposition. Concern regarding the financial burden of subsidies on domestic and industrial consumers has led to fluctuating levels of policy and regulatory support for renewable energy in EU states, especially post 2008. As observed by EWEA (2013, p 9): “Weakened legislative frameworks, economic crises and austerity measures implemented across Europe are hitting the wind industry.” For example, Germany in 2014 addressed the cost of renewable energy subsidies - which had grown to 16bn Euros in 2013 – by revising its Renewable Energy Sources Act to limit renewable energy surcharges. The Journal of Offshore Wind (2014, p 12) noted that Germany’s reform “means a more gradual shift to the adoption of renewable energy such as offshore wind”. In other EU countries with offshore wind

ambitions, such as Denmark and the Netherlands, this measured approach was also evident. Therefore, government prioritisation directly impacted on the size, speed and geographic manifestation of the market. It is to specifically exploring policy in the UK and its impact on market manifestation that the chapter turns.

4.2.3 UK state institutions and energy transition

Since the emergence of the "Big Six"[20] electricity utility firms from the privatisation of state assets in 1990, enabled by the Conservative Government's Electricity Act of 1989, UK energy policy has been premised on market liberalisation and competition. The UK, unlike countries with nationalised utility companies, in essence forfeited the ability to directly manage the electricity market. Therefore, changes to the energy system that were not commercially competitive were incentivised through subsidies for private firms. As part of the Electricity Act of 1989, a Non-Fossil Fuel Obligation (NFFO) was introduced. The NFFO required electricity suppliers to buy electricity from renewable electricity generators and guaranteed purchase at fixed prices for fifteen year contract periods. Even so, suppliers demonstrated high levels of path dependence (David, 1994; Arthur; 1999; Martin and Sunley, 2006; Martin, 2010; Boschma et al, 2017) in relation to the established carbon-based energy regime and by 1999 onshore wind generated only 344 MW of electricity, less than 0.15% of national consumption.

However, by 2014 this terrestrial energy source was generating 12 GW, an increase of over thirty fold on the 1999 figure, contributing almost 9.5 % to national consumption. This step change was contingent on institutional factors incentivising actors to deploy this disruptive energy technology by creating expectations of future reward and minimising future uncertainty (Bathelt and Gluckler, 2014; Steen 2016; Evenhuis, 2017). Notably, these included:

- The UK's UNFCCC and EU obligations and related enabling legislation (Energy White Paper, 2003; Energy Review, 2006; Climate Change Act, 2008; etc.) signalled long-term state commitment to decarbonisation;
- A significant proportion of the UK's carbon and nuclear power generating infrastructure was nearing end of operational life and wind power was seen by

[20] British Gas/Centrica (UK owned), EDF Energy (French owned), E.On (German owned); RWE Npower (German owned), Scottish Power (Spanish owned), SSE (UK owned)

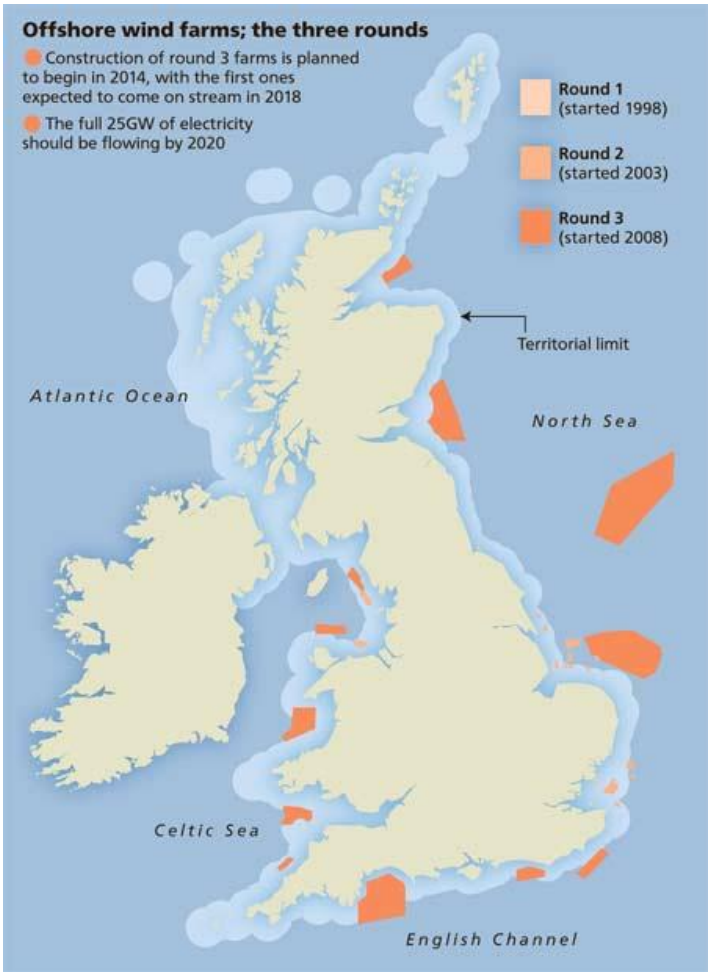
policy makers as a credible, clean and increasingly cost-efficient contributor to securing supply.

However, one institutional factor in particular should be singled out for enhancing expectation of reward and mitigating uncertainty amongst the UK's electricity generators, thereby incentivising adoption of this disruptive technology. In 2002, the Renewables Obligation (RO) subsidy was introduced in the Utilities Act (2000). Through the RO, the UK Government placed an obligation on suppliers to source a proportion of their electricity from renewable energy sources. Electricity suppliers met this obligation by purchasing Renewables Obligation Certificates (ROCs), either from renewable generators or from the ROCs market, the cost of which was borne by consumers[21]. The twenty year support period for the generators within the RO regime compared favourably with the fifteen year period of the NFFO; generating sufficient long-term confidence to encourage purposive agency via experimentation (Martin, 2010) amongst electricity utility firms and their institutional investors. Subsequently, to promote the development of alternate disruptive technologies, differing RO bandings were introduced in 2009 with offshore wind receiving 2 ROCs per MWh compared with 0.9 ROCs per MWh for onshore wind.

Complementing this benign subsidy environment for the UK's Offshore Wind Market was one particularly significant institutional innovation. In 2001, The Crown Estate, the owner and landlord of the UK's seabed, launched its first leasing round for offshore wind farm sites in the knowledge that geographic factors, such as water depths and wind conditions, around much of the UK's coast were conducive to development. Given the infancy of offshore wind technologies, this first leasing round focused on lower risk shallow, near to shore sites that were economic to develop. Crown Estate leases for these sites and the related planning consents, granted by DECC on the recommendation of the UK Planning Inspectorate, were awarded to project developers, usually large electricity utility firms, deviating from their terrestrial business models. In 2003, given the positive response to the first round, a second one was launched by The Crown Estate. Buoyed by the anticipated more generous RO subsidy to be introduced in 2009 and project developer appetite for the previous rounds, The Crown Estate in 2008 launched its final UK round to date. Round 3

[21] Although the cost of this subsidy was paid for by consumers, a period of real term wage increase allowed this consumption levy to be increased with limited consumer anxiety, thus minimising political concern

offered nine large offshore zones for development, some of which gained consents for windfarms in excess of 1 GW (figure 4.1). In short by 2009, the UK state had successfully aligned leasing, consenting and subsidy.



Source: The Times, 2008

Figure 4.1: Location of Crown Estate rounds

Given the interaction of favourable institutional and geographic factors, the purposive agency (Martin, 2010) of all the “Big Six” private electricity utility firms was triggered. These UK project developers were supplemented by European energy companies, such as the state owned firms of Dong (Danish), Statoil (Norway) and Vattenfall (Sweden) and private firms such as Mainstream (Ireland) and EDP (Portugal). In particular, Dong became a dominant developer with an exclusive or shared stake in a third of Round 1 and 2 operational windfarms (Renewables UK, 2013). Moreover, as offshore wind technology matured driven by a growing publicly subsidised market, international institutional investors and lenders became more active in the financing and refinancing of offshore wind farms. However, as noted by European Wind

Energy Association, this led to developers further aligning their interests with those of institutional investors who favoured lower risk projects with higher and faster rates of commercial return premised on the application of tried and tested technologies (EWEA, 2015). The implications of this business model for the technological path dependence of the industry were profound (David, 1994; Arthur; 1999; Martin and Sunley, 2006; Boschma et al, 2017).

4.2.4 Austerity and the UK's offshore wind market

Following the financial crisis of 2008 many EU Governments pursued policies of austerity that adversely effected market development relating to energy transition. Likewise, the UK's Coalition Government formed in 2010 framed its programme for government in the doctrine and convention of austerity (Martin, 2000; Evenhuis, 2017), signalling its intent to reduce the cost of offshore wind by establishing the Offshore Wind Cost Reduction Task Force in 2011. Subsequently, the Energy Act of 2013 reversed the perceived largesse of the ROC regime by introducing a Levy Control Framework (LCF) capping subsidies for renewable technologies. Linked to this, DECC in 2014 introduced a new subsidy regime, Contracts for Difference (CfD) based on an industry Strike-Price model for low carbon generation[22]. The Strike-Price ensured that if the average market price for offshore wind electricity fell below the pre-agreed figure a generator would receive the difference in subsidy during a fifteen year period (rather than the more generous twenty year period offered to developers by ROCs)[23]. Between 2014 and 2017, DECC indicated that the Strike-Price should fall from £155 per MWh to £140 MWh for offshore wind. Moreover, the allocation of the CfD subsidy was based on competitive bidding between developers. This auction saw bids of less than £120 per MWh being accepted by DECC for two offshore wind projects scheduled for commencement in 2017/18. However, these two projects represented only 1.1GW of the 25 GW of offshore wind projects in development. Lawyers, Burness Paull, commented (Ward, 2015, blog): "With offshore developers said to be spending in the region of £15m to £20m on their projects to simply get to the auction stage, a funding pot that does not provide the necessary levels of comfort or certainty is an unattractive and risky proposition". This new phase of state support

[22] A transitional subsidy, Final Investment Decision Enabling for Renewables, FIDER, was introduced in 2013
[23] At times when the market price exceeds the strike price the generator is required to pay back the difference

for market creation led to institutional divergence between leasing and subsidy, thereby creating many doubtful projects in the UK's project pipeline.

In 2015, a Conservative government was elected. Soon after, the Secretary of State for Energy and Climate Change announced[24] that gas, nuclear and offshore wind electricity generation were to be the key components of UK's electricity mix. However, the Minister emphasised that government support for offshore wind was conditional on steep cost reduction and signalled a non-binding commitment to no more than three additional CfD auction rounds by 2020, facilitating a total cumulative capacity of 10 GW. Concerns regarding increasing policy uncertainty became evident in the industry. Niall Stuart, Chief Executive at Scottish Renewables, an industry body, told the Energy and Climate Change Committee at Westminster: "If you're an offshore wind developer, you know there is an intention to have three allocation rounds in this parliament, but we don't know the exact timescales. People are scaling back investment or freezing investment altogether on projects that they don't see a clear market for" (Energy Voice website, 2016). In short, institutional triggers were now insufficient to stimulate market creation on a scale that had been previously anticipated.

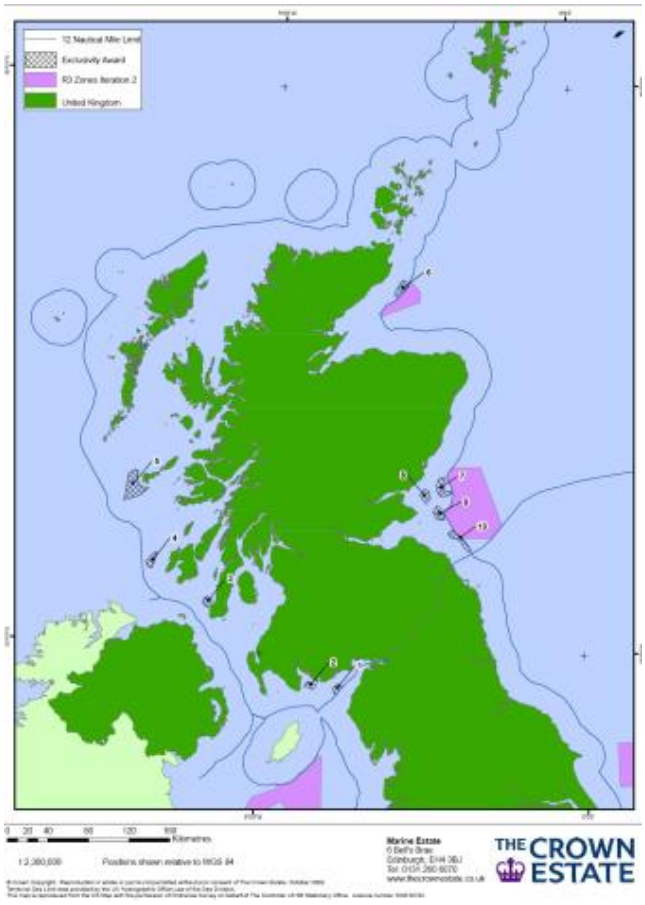
4.2.5 The Scottish institutional context and the offshore wind market

To frame the Glasgow case there is a need to explore the devolved institutional context in which it was also nested. As evidenced by its globally significant renewable energy targets, the Scottish Government aimed to be an international leader in renewable energy generation, including offshore wind. This ambition was matched by the scale of the offshore wind energy resource, estimated at 25% of the European total (Scottish Government, 2013) and the presence of mature offshore engineering capability relating to oil and gas.

Despite the size of resource, political will and relevant know-how, challenging oceanographic conditions, such as water depths, and prejudicial distance from large UK urban markets, a disadvantage compounded by the prohibitive charging model of the National Grid, were impediments to exploitation. Even so, the SNP Government from assuming office in 2007 promoted market development through the institutional means at its disposal, initially relating to spatial consenting and planning. To address the lack of Scottish sites in The Crown Estate's first and second leasing rounds, the

[24] Amber Rudd's "Course Correction" speech of November 2015

Scottish Government worked with The Crown Estate to launch the dedicated Scottish Territorial Waters (STW) Round in 2009, promoting ten development zones with a combined potential generating capacity of over 6 GW (figure 4.2). In the following year, the Scottish Government established a new agency, Marine Scotland, to oversee marine management and planning, including the licencing and consenting of offshore wind farms. In 2011, Marine Scotland published a marine planning framework for offshore wind. The document represented a global first and was commended by the European Commission.



Source: The Crown Estate, 2013

Figure 4.2: Scottish territorial water sites

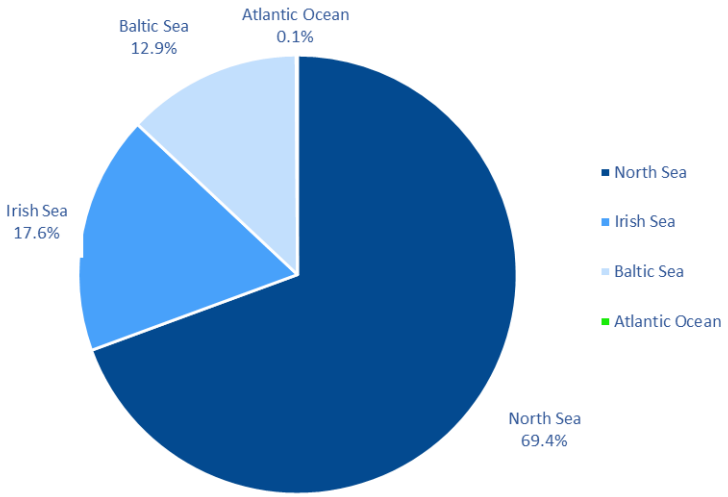
Consequently, in 2013 the Scottish Government utilised its Renewables Obligation Scotland (ROS) powers, which were devolved from the UK ROCs subsidy framework[25]. The Scottish Government incentivised innovative projects by setting a band of 2.5 ROCs for offshore wind test and demonstration sites and a band of 3.5 ROCs for pilot projects relating to floating turbines. These higher rates, as compared

[25] A devolved power that was withdrawn by Westminster in 2017 through the UK Energy Act of 2013

with the rest of the UK, were introduced to encourage turbine innovation and, particularly, floating foundation innovation to negate the need for costly conventional foundations in deeper waters. Given the targeted nature of the SRO, the devolved government was arguably a market adaptor rather than a market creator, creating a protected space from market norms akin to a niche (Smith and Raven, 2012), in which disruptive technologies could be developed and demonstrated.

4.2.6 Scale of the international and UK offshore wind energy market

As noted, fluctuating institutional responses shaped the emergence of the offshore wind energy market. In 2015, the Global Wind Energy Council observed that the creation of the global offshore wind market was a slower, more truncated process than envisaged. By the end of that year, just over 12 GW was installed globally. Of this, over 11GW was located in the waters of eleven European countries with almost 70% being located in the North Sea (fig 4.3).



Based on EWEA, 2016

Figure 4.3: European installed cumulative capacity by sea basin

In 2015, the UK was the world's largest offshore wind market accounting for 5.1 GW of generation with c. 1,500 turbines, representing 46% of the European total, followed by Germany with 3.3 GW with c. 800 turbines, representing 30% of the European total (table 4.1). However, to put the EU's total roll-out of installed capacity of 11 GW in the perspective of earlier expectations, DECC (2013) had anticipated 10 GW solely in UK waters by 2015 and the Crown Estate (2010) had projected 15GW by 2015 as possible, with 30GW by 2020. The anticipated momentum was just not there.

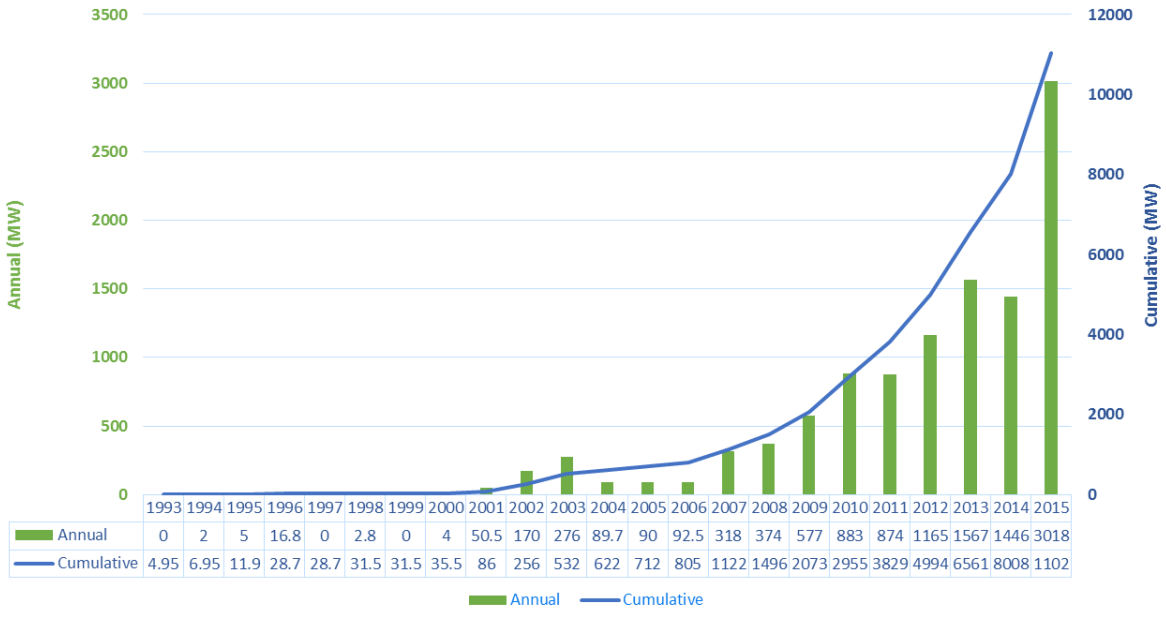
Country	BE	DE	DK	ES	FI	IE	NL	NO	PT	SE	UK	Total
No. of farms	5	18	13	1	2	1	6	1	1	5	27	80
No. of turbines	182	792	513	1	9	7	184	1	1	86	1454	3230
Capacity installed (MW)	712	3295	1271	5	26	25	427	2	2	202	5061	11027

Based on EWEA, 2016

Table 4.1: No. of wind farms and turbines and capacity installed in European waters by end 2015

The UK's leading position was a product of a spurt of installation based on Round 1 (2001) and 2 (2003) projects being progressed in the context of an actuating and aligned leasing, planning and subsidy framework; benign conditions further emphasised by the third Crown Estate leasing round and the increase in state subsidy in 2009 (fig 4.4).

However, the degree of UK industrial benefit associated with offshore wind was not commensurate with the UK's leading market position. It is to understanding this relationship the chapter turns.



Based on EWEA, 2016

Figure 4.4 Cumulative and annual European offshore wind installations (MW)

4.3 Development of Offshore Wind Sector Part 2: The Industrial Value Chain

4.3.1 Overview

The second part of this section considers the institutions, actors and technologies that shaped the scale, nature and timing of the offshore wind's industrial value chain with a particular focus on the UK. At the outset, there is consideration of the factors that facilitated and delimited industrial diversification from onshore wind to offshore wind technologies. Consequently, the section considers the role of industry policy with particular foci on the UK nation state and Scottish devolved government contexts. Finally, it concludes by presenting the resulting shape and scale of the industrial supply chain and economic benefit.

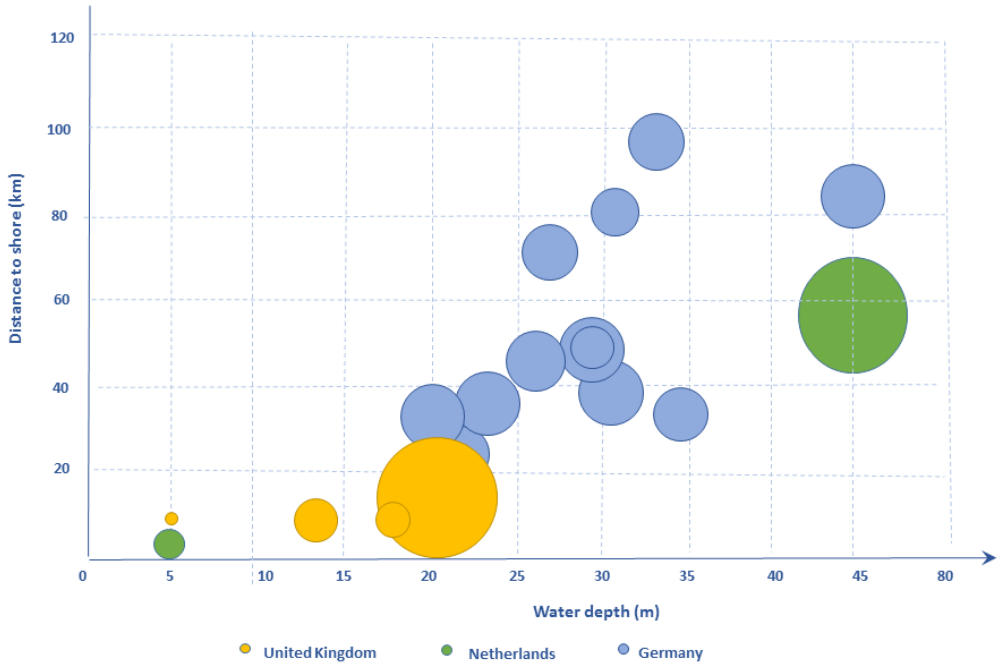
4.3.2 Institutions, technological selection and diversification

As noted, onshore wind experienced a significant cost reduction trajectory achieved by the scaling up of the principal wind turbine design (the single rotor horizontal axis turbine). Although alternates designs were deployed, rapid adoption and subsequent economies of scale ensured it became the incumbent technology for onshore wind; with the average onshore wind turbine size growing from 0.5MW in 1990 to 3 MW by 2012 (EWEA, 2015). This disruptive terrestrial technology and its rapidly maturing research and supply chain relationships were to have a significant influence on the nature of the offshore wind industry.

The first offshore wind farm was constructed in Danish waters in 1991. Although the challenge of designing, installing and maintaining such a facility in a maritime environment should not be under-estimated, this technological first was predicated on diversification of a terrestrial incumbent technology (the single rotor horizontal axis turbine) to a marine environment. Offshore wind did not represent a wholly distinct new technology but rather the diversification of a terrestrial one. Moreover, in Europe this technology was dominated by a few OEMs with mature supply chains with industrial concentrations in Denmark, Germany and Spain (Garud and Karnoe, 2003, 2012; Forhahl et al, 2012; Elola et al, 2013). Critically, a number of cost-related factors promoted technological path dependence in the emerging offshore wind industry:

- Shallow, near to shore waters were preferred by developers due to such conditions readily favouring economic and lower risk diversification of terrestrial technology; subsequently, shallow water technologies dominated

(e.g. mono-pile foundations accounted for 80% of substructures by the end of 2015, as compared with deeper water floating substructures which accounted for only 0.1%). This predisposition to deploy in shallow waters remained dominant in the UK (fig 4.5).

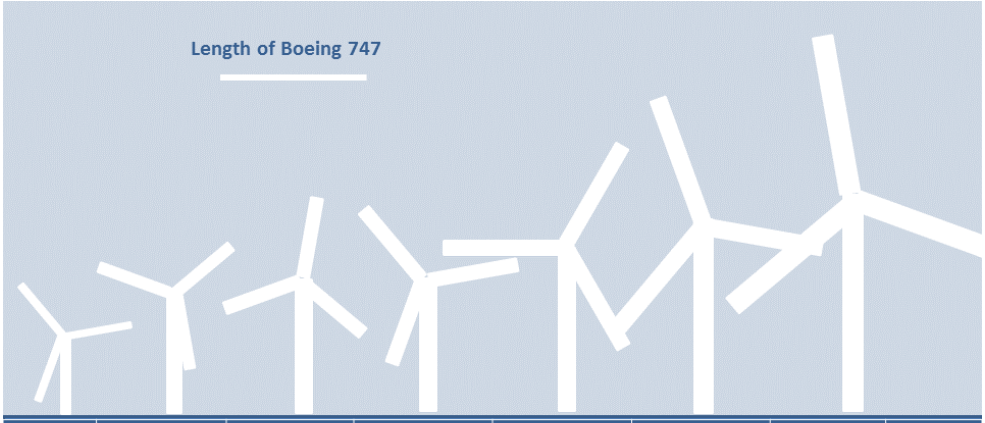


Based on EWEA, 2016

Figure 4.5: Water depth, distance to shore and size of wind farms in construction in 2015

- Given terrestrial incumbent technology was commercially proven, institutional investors favoured diversification and scaling of the generating capacity of this technology rather than the introduction of radical new technology (in 1991 offshore wind turbines were less than 0.5 MW in capacity but by 2015 the largest had a capacity of 8MW – fig 4.6).

- Government priorities emphasised affordability, energy security and decarbonisation ensuring subsidy regimes privileged rapid incremental scaling of proven technology, thereby dis-incentivising longer term non-commercialised radical technologies.



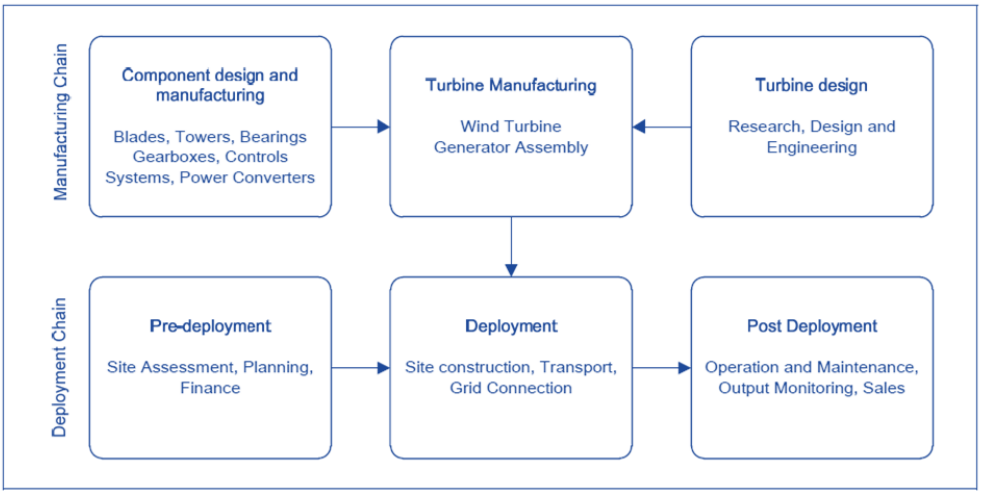
Vindeby	Middelgrund	Nysted	Horns Rev 2	Anholt	Westermost Rough	Burbobank extension	
1991	2000	2003	2009	2012	2014	2016	YEAR
35m	76m	82.4m	93m	120m	154m	164m	Diameter
35m	64m	69m	68m	82m	102m	113m	Tower
0.45MW	2MW	2.3MW	2.3MW	3.6MW	6MW	8MW	Capacity

Based on Dong Energy, 2016

Figure 4.6: Increasing size of offshore wind turbines (from 0.45MW to 8MW)

4.3.3 The industrial value chain

This section will consider how firm-led agency, mediated by state institutions, shaped the development of the industry's value chain. It was one that largely mirrored its terrestrial antecedent, composed of a deployment chain and a manufacturing chain running in parallel with multiple points of interaction. Not only was the structure of the value chain similar, so too were many of the key actors within it. The diagram below is a representation of the value chain (fig 4.7).



Sources: Drawing on Frost and Sullivan (2010); EWEA (2007); EAI (n.d.); CCB International (2011). Arrows indicate flows of goods and services between functions in the chain.

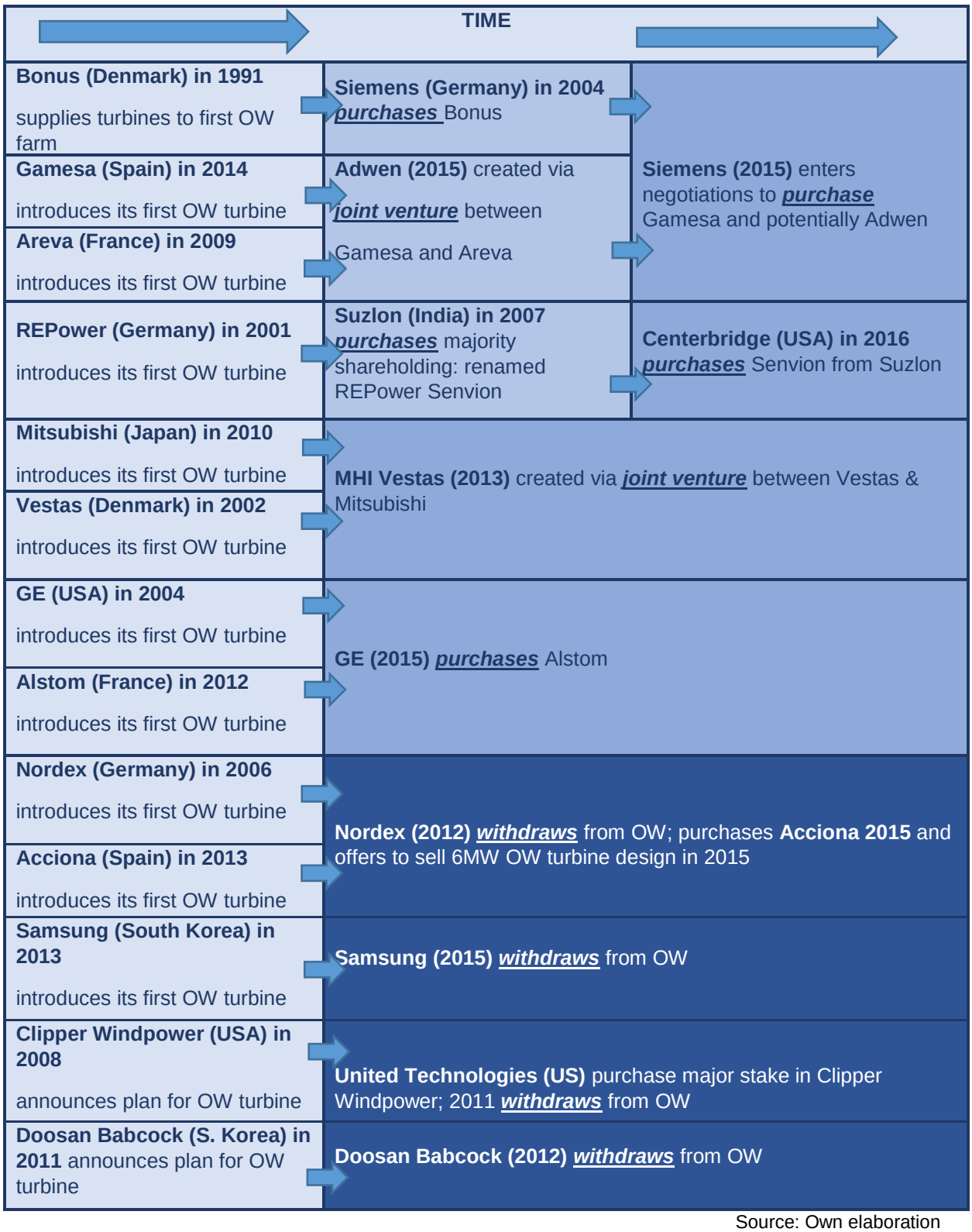
Source: Lema et al 2011, p 10

Figure 4.7: The industry value chain

In Europe, due to high entry costs, the deployment chain was rapidly dominated by incumbent terrestrial actors, typically energy utility companies. By 2014 DONG, Vattenfall, E.On and RWE generated over 50% of European offshore wind electricity (EWEA, 2015). In the UK, the “Big Six” were early actors, augmented by European energy companies, such as the state owned Danish firm, Dong.

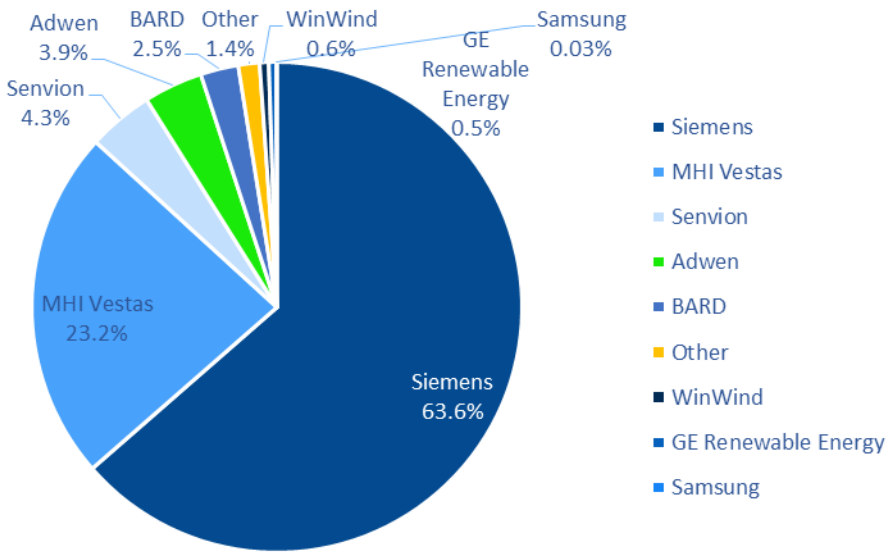
These energy companies in the role as offshore wind project developers maintained relationships with their terrestrial suppliers. Subsequently, the parallel manufacturing chain became dominated by two prominent onshore wind OEM actors: the German firm Siemens, which was awarded all UK offshore turbine orders in 2011 (Renewables UK, 2013); and the Danish firm Vestas. The absence of competition was largely a result of changing state energy policies leading to a smaller offshore wind market than projected (e.g. UK market projections fell from 30GW to 10 GW for 2020 between 2011 and 2014). Thus, state derived future expectations of reward (Steen, 2016) amongst potential rival OEMS and new entrants were insufficient to encourage or sustain their deviation to develop new offshore wind turbines (Garud and Karnoe, 2003).

In turn, uncertain market size and political pressure to achieve cost reductions led to the few OEMs active in the market pursuing economies of scale via consolidation. The table below (table 4.2) details key instances of OEM amalgamation in Europe that led to Siemens and MHI Vestas having nearly 90% market share by 2015 (figure 4.8). Thus, the resulting industrial value chain could be characterised as oligopolistic in nature and predisposed to technological path dependence and spatial concentration in existing manufacturing and research hubs, especially in Denmark and Germany (Martin and Sunley, 2006; Binz et al, 2016; Boschma et al, 2017).



Source: Own elaboration

Figure 4.8: Consolidation of wind turbine firms in Europe



Based on EWEA, 2016

Figure 4.9: OEM share of cumulative number of turbines connected to the grid by end 2015

Reflecting the underlying logic of the industrial system (Van de Ven and Poole, 1995; Martin and Sunley, 2006), the parallel value chain comprised not only the energy utility firms and OEMs but also firms relating to pre-deployment functions (including assessment, planning and design), construction functions (including production and installation of foundations, towers, cabling and electrics) and finally operations and maintenance. These varied functions exhibited differing levels of spatial mobility. Construction and assembly functions required to be as close to an offshore wind farm site as possible, whilst higher value pre-deployment, manufacturing and research functions, were often concentrated in a small number of locations embedded in extra-regional and regional knowledge networks (Garud and Karnoe, 2003; Bathelt et al, 2004; Boschma, 2005; Trippl et al, 2017). Furthermore, given the oligopolistic hue of the industry, offshore wind innovation was increasingly characterised by bounded collaborative incremental innovation as compared with open dispersed radical innovation (Karnoe and Garud, 2012; Elola et al, 2013).

Finally, given that no national markets of the previously anticipated scale were created, firms re-calibrated their plans and focused on supplying the pan-European market rather than just national ones. This led to supply chain investments being concentrated in a small number of European manufacturing and research hubs, such as Bremerhaven, Hamburg and Cuxhaven in Germany, Brande, Aalborg and Engesvang in Denmark and Hull in the UK.

To summarise, the domination of the parallel value chain by a small number of firms whose relationships often pre-dated offshore wind diversification rapidly created technological path dependence (David, 1994; Arthur; 1999; Geels, 2004; Martin and Sunley, 2006; Boschma et al, 2017). This outcome was fostered by austerity-oriented horizontal state energy policies and regulation that stymied projected market growth and placed emphasis on cost reduction. It is to understanding state vertical industrial policies, especially in relation to the UK, that the section turns.

4.3.4 Industry policy and the development of the offshore wind industry

Since the early 1990s renewable energy has been promoted by the state as a means of promoting industrial development, thereby assuaging public concerns over the costs of energy transition. At the European level, the EU's Strategic Energy Technology Plan (EC, 2008) forecasted the creation of 250,000 jobs in onshore and offshore wind industries by 2020, whilst the opportunity of energy transition became central to the spatial development strategies of DG REGIO and DG MARE. Similarly, successive UK Governments and the Scottish Government have been bullish about the potential industrial and economic benefits of offshore wind.

In 2009, the UK Labour Government promoted offshore wind in its document "Building Britain's future – New Industry, New Jobs" (UK Government, 2009) which set out its vision for economic recovery post financial crisis. From 2010 onwards, offshore wind was enfolded within the Coalition Government's policies for industrial development and economic rebalancing. Such prioritisation was founded on studies indicating that the economic benefit from this new transition industry could be substantial. One Government report (ORE Catapult, 2014) estimated that a 15 GW roll-out of offshore generation could create 34,000 direct jobs and an additional £6.7 billion per annum of GVA by 2020. In addition, the report stated that (p 10):

> "The UK will benefit from investment in strategically important technologies and markets, economic diversification, increased international trade and greater economic competitiveness. The UK benefits generated in terms of wealth and employment creation will not be concentrated in one or two regions but will be dispersed across many local economies in the UK."

Yet, despite the UK leading the world in offshore wind electricity generation, it was estimated that only 15% of the related capital expenditure went to UK companies,

compared with 70% for oil and gas (ORE Catapult, 2014). An in-depth survey concluded the UK supply chain was partial and reliant on foreign owned companies (BVG, 2013).

Furthermore, this lack of an indigenous supply chain was reflected in patent activity. Between 1999 and 2008 Germany submitted over 800 related applications to the EPO for wind energy and the UK 127 (OECD, 2013)[26]. Although UK researchers published more papers than those in any other EU member state much of this output related to theoretical blue-sky research (Wieczorek et al, 2013). Given the pressing government priorities of affordability, security of supply and decarbonisation, developers and their tier one OEM suppliers were applying and commercialising research that was closer to market.

To address the limited economic benefit derived from both the UK's leading market and research positions, the Coalition Government in 2013 launched the Offshore Wind Industrial Strategy (OWIS). Given that the first Crown Estate leasing round was launched twelve years before and enhanced subsidies for offshore wind projects introduced four years earlier, the seemingly belated strategy does indicate a tardiness on the part of the UK Government in co-ordinating vertical and horizontal policies (Barca et al, 2012; Dawley et al, 2015). Despite this interval, the first section of the strategy strikingly stresses the significance of regulation and subsidy in creating the conditions for capital investment and enterprise development. Thereby echoing BVG's observation (2012) that supply chain development, market growth and subsidy are inextricably interlinked. There are three other themes relating to investment and enterprise development in the strategy that are worthy of illumination. These are considered in the table below (4.2).

Inward Investment	The OWIS established the Offshore Wind Investment Organisation (OWIO) to promote inward investment. This response reflected the observation by the main industry body that "the UK needs to secure significant inward investment from first tier manufacturers to build upon the limited manufacturing base, in contrast to our competitors who already have supply chains built from onshore wind"[27]. In tandem, six regional Centres of Offshore Renewable Engineering (CORE) were established to attract such investment. The COREs were investment sites to be promoted by partnership between national and local government and LEPs.

26 Data refers to both offshore and onshore patents

[27] Renewables UK, Annual Report, 2013

Supply Chain Development / SME support	Given the low levels of UK content, a central aim of the OWIS was to increase UK sourcing, reflecting a Government ambition of 50% of content to be UK sourced. A UK Government supply chain review in 2013 identified opportunities but also challenges for UK companies to attain such an increase, especially for SMEs, including limited scale, capability and relationships. In 2014, a regulatory means for delivering this ambition was introduced. As part of the new CfD subsidy regime, bidders had to submit a supply chain plan. Government guidance (DECC, 2014) stated that the plans were to encourage an open and competitive UK supply chain and the promotion of innovation to drive down costs. Also due to OWIS, national and regional SME support programmes were introduced.
Innovation	The most evident example of OWIS's commitment to encouraging innovation was the creation of the Offshore Renewable Energy Catapult (ORE Catapult). The technology and innovation centre, headquartered in Glasgow and with test and demonstration facilities in North East England, represented a Government investment of £50m over five years. The centre was tasked with engendering innovation via collaboration between industry, academia and government[28] and aimed to build a bridge between the close to market research needs of industry and the more theoretical focus of universities. ORE Catapult also promoted innovation in specific industry knowledge areas, such as electrical infrastructure, foundations and sub-structures, performance monitoring and O&M.

Source: Own elaboration

Table 4.2: Investment and enterprise themes of OWIS

The informal conventions (Martin, 2000) of the UK Government also influenced policies and practices that shaped the industry's nature, scale and spatial development. The UK pursues a liberal market model of capitalism characterised by a disinclination to industrial planning (Dicken, 2015; Chang, 2014). Although the nation state leased and consented the offshore wind sites and enabled subsidy for generation, the UK Government was cautious about assuming an overtly directive role. In effect, although the state incentivised, reduced uncertainty and co-ordinated "the game", thereby making it the market maker, it sought a role that was more akin to primus inter pares than an industrial champion.

To oversee the OWIS, the Offshore Wind Industry Council (OWIC) was established in 2013. Like the Offshore Cost Reduction Task Force and its successor, the Offshore Wind Programme Board, only a few dominant firms were represented on OWIC alongside government. Sir Jonathon Porritt, a decarbonisation advocate, observed that such oligopolistic-oriented institutional arrangements promoted "locking the

28 The BIS Catapult centres are based on the German Fraunhofer model of bringing together industry, academia and government. They also aspire to similar funding principles of the Fraunhofers: the intention being that they generate one third of their funding from UK Government, one third from competitively won external public source e.g. H2020 and one third from industry contracts

electricity system into a status quo that boosts firm profits" (The Independent, 2015). Moreover, the OWIC was bounded by The Treasury's austerity agenda that dominated Whitehall. In 2015, the Minister of State at DECC stated that: "Further [government] support will be strictly conditional on the cost reductions we have seen already accelerating…. and, if costs, come down, new offshore wind will help us meet the challenge of decarbonisation" (DECC, 2015). Additionally, security of supply also increasingly shaped state thinking. By 2015, private and public under investment had led to the UK's margin of spare electricity capacity falling to nearly 1% (The Financial Times, 2015). As a Treasury interviewee observed (S-UKGov3, author's interview, January 2016): "The bottom line is a government minister can't let the lights go out, they can't risk it…. They'll back the technology that will deliver". Therefore, the incumbent offshore technologies utilised and controlled by a small number of firms were further favoured. In short, government culture and the hard-nosed reality of politics were reinforcing technological path dependence.

Finally, the Government's adherence to a liberal market model and supply side measures marginalised industrial spatial planning and promotion of industrial agglomeration. Illustratively, the Department for Communities and Local Government, the department responsible for local spatial development, had negligible input to the formulation of the OWIS and was not represented on related industry forums. In short, there was limited cognisance of or regard for the spatial consequences of non-spatial state policies (Barca et al, 2012; Martin and Sunley, 2015).

4.3.5 Scotland's industry policy and the emergence of the offshore wind industry

In 2010, Scottish Enterprise, the economic development body for lowland Scotland, published research indicating that offshore wind could create additional GVA of £7.1bn and 28,300 jobs in Scotland within a decade (IPA Economics, 2010). To realise this opportunity the Scottish Government utilised its powers to develop an interventionist programme of industrial support that was distinct from London.

Following the creation of a Scottish Government offshore wind team in Glasgow in 2009, the same year as the Crown Estate's Scottish Territorial Waters leasing round, the devolved administration launched an industrial development route map and national infrastructure plan for offshore wind in 2010. In turn, Scotland's inward investment agency, Scottish Development International, pursued investments from

OEMs that could act as foci in the creation of a new national industry. However, despite five memorandums of understanding being concluded with OEMs between 2010 and 2013 uncertainty caused by changing UK policies negated these proposals, as summarised below:

i. Doosan Babcock shelved plans for an R&D and manufacturing facility near Glasgow;

ii. Areva halted plans for a manufacturing facility in Scotland;

iii. Gamesa moth-balled its R&D operation, near Glasgow, within two years of locating and did not progress plans for a manufacturing facility in Leith;

iv. Mitsubishi dropped proposals for a centre of industrial excellence in Glasgow;

v. Samsung disposed of its 7 MW test turbine off the Fife coast.

Simultaneously, the Scottish Government attempted to shield, nurture and empower firms from dominant institutional and technological forces in order to stimulate innovation and counter sectoral technological path dependence (Smith and Raven, 2012; Boschma et al, 2017). For example, it made £50 million of funding available to encourage firms to deviate and experiment (Garud and Karnoe, 2003; Martin, 2010) in regard to innovative floating and turbine technologies. Moreover, these innovation funds were aligned with the devolved administration's subsidy (ROS) powers to incentivise the adoption of these technologies by firms. Such institutional innovation led to novel projects including:

- Three world-leading floating wind projects;
- Terrestrial offshore turbine test facilities at Hunterston;
- Offshore test facilities for new turbine technologies adjacent to Fife and Aberdeenshire;
- New deeper water foundations, including "jacket" sub-structures.

Finally, from 2010 onwards, given the formation of the UK's Coalition Government, the Scottish Government's overarching policy rationale increasingly diverged from the rest of the UK. A case in point was Scotland's Economic Strategy (Scottish Government, 2007, 2012, 2015), a document premised on the inter-related objectives

of sustainable economic growth and equity. It was a development orientated paradigm that did not mirror Whitehall's increasing focus on austerity.

4.3.6 Scale and manifestation of the international and UK industry

By 2015, 91% of all offshore wind farms were located in EU waters, thereby concentrating the industrial value chain in Europe. Between 2009 and 2014 European employment in offshore wind trebled to 75,000 FTEs (Ernst and Young, 2015). During the same period, investment in the European industry averaged 6bn Euros per year, peaking at 13bn Euros in 2015 (EWEA, 2016). Of the installed capacity the UK had the largest share with 46% and Germany the second largest share with 30%. Over the period 2010 to 2015 both countries saw nearly 20bn Euros of investment in new offshore wind farms (EWEA, 2016). However, this didn't generate corresponding economic impact. By 2015, the UK's offshore wind industry had created 13,000 UK jobs, (BVG, 2015), compared with 20,000 in Germany, two years earlier (BWE, 2015). This mismatch between installation and economic benefit was reflective of the industry life cycle. At the final Operations and Maintenance stage, the UK secured over 70% of purchases and in the initial development and planning stages it secured nearly 60% (BVG, 2015). However, in the manufacturing and deployment phase, the stage of greatest capital expenditure, UK content was only 18% (BVG, 2015). The UK was dependent on OEM transplantation to trigger the development of an indigenous industry and secure a greater share of content. ORE Catapult (2014, p 5) calculated that "at 15 GW a tipping point will have been surpassed encouraging a step change in the UK supply chain's development via international and national investment".

Nonetheless, a marked cooling in UK and other European offshore wind markets led to firm consolidation and the development of pan-European supply chains rather than dedicated national ones. For example, Siemens announced plans to invest in a manufacturing facility in Hull in 2010 but delayed construction until 2015 during which time it reduced the plants planned functions to integrate with its Europe-wide supply chain. Table 4.4 below summarises how such factors impacted on OEM investment plans relating to the UK by 2015.

Alstom (France)	• GE purchases Alstom in 2015 after failure of its own technology • Abandons plans for UK facility post purchase
Areva (France)	• Abandons plans for turbine and blade manufacturing in Scotland following creation of Adwen Joint Venture with Gamesa in 2015
Clipper Windpower (USA)	• Abandons plan for turbine manufacturing in NE England in 2011
Doosan Babcock (South Korea)	• Abandons plan for turbine manufacturing near Glasgow in 2012
Gamesa (Spain)	• Abandons plan for blade and electrical component manufacturing at Leith, Scotland in 2015 after JV with Areva (creating Adwen) • R&D centre outside Glasgow moth-balled in 2013
Mitsubishi (Japan)	• Abandons plan for a major research centre in Scotland • Announces UK activity will be conducted through MHI Vestas JV
Samsung (South Korea)	• Abandons plan for research & manufacturing facility in Fife in 2014
Siemens (Germany)	• Rationalises plan for manufacturing facility on Humberside in 2014; redesigns Hull site for blade manufacture and installation • A new facility for turbine manufacturing at Cuxhaven, Germany, is announced in 2015 and additional blade manufacturing capacity is introduced at Aalborg and Engesvang in Denmark
Vestas (Denmark)	• Abandons plan for turbine manufacturing facility at Sheerness, Kent in 2012, consolidating production in Denmark • 2013, announces activity will be conducted through MHI Vestas JV • MHI Vestas announces blade facility on the Isle of Wight in 2014

Source: Own elaboration

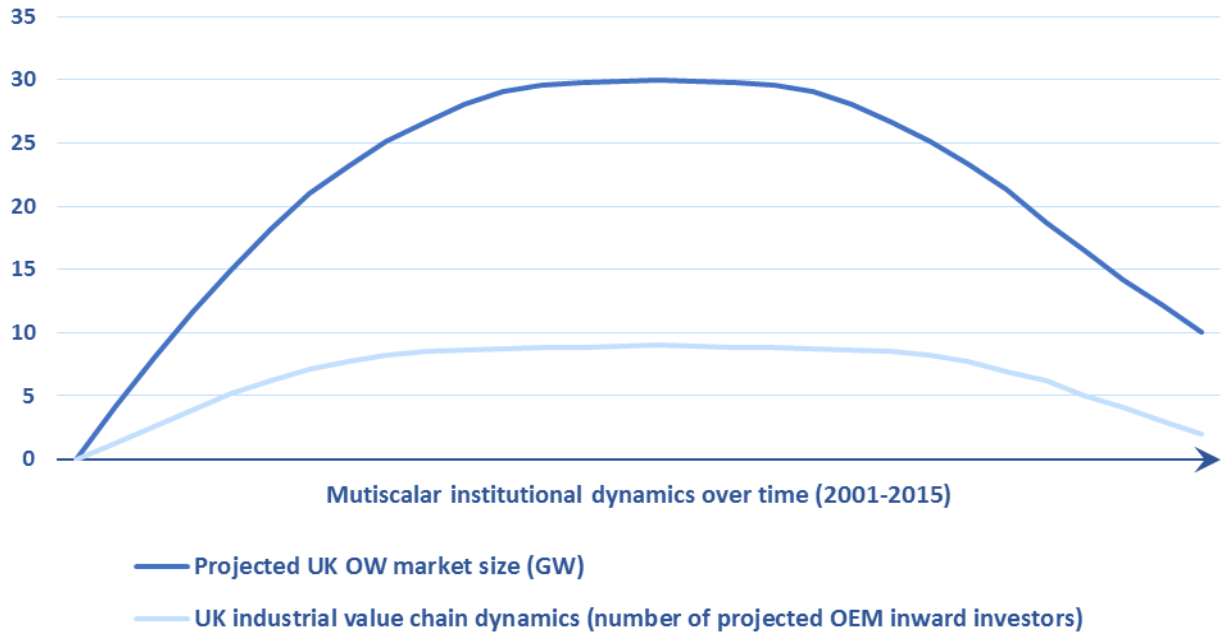
Table 4.3: Abandonment and scaling back of OEM investment plans in the UK

Although by 2015 there were significant supply chain actors in the UK in addition to Siemens and MHI Vestas - such as OSB foundations on Teesside, JDR Cables in Hartlepool, BiFab in Fife - the supply chain that emerged was partial, truncated and precariously linked with future government market support. In turn, there was limited opportunity for clusters of manufacturing activity to emerge that would facilitate cumulative causation and economic impact commensurate with the level of installation.

4.3.7 Summary: formation of the offshore wind sector

Energy transition was and is an instituted process at both the international and national levels. Moreover, the formation and subsequent dynamics of the UK's

offshore wind market and related industrial value chain were mediated by the formal "rules" (policy and regulation) and informal conventions of the state (North, 1990; Peck, 1999; Martin, 2000; Gertler, 2010). This dynamic institutional environment continuously shaped actor expectations and incentivised and co-ordinated firm deviation but often in a seemingly bounded manner, as for example in relation to actor and technological selection, thereby shaping the development of the industrial value chain. Moreover, it also dis-incentivised deviation, for instance a decrease in subsidy led to a contraction in projected market size which, in turn, influenced the potential number of OEM turbine manufacturing inward investors (fig 4.10). Although, opportunities for alignment of horizontal UK energy policy (which largely influenced offshore wind market dynamics) and vertical industry policy (which largely influenced the industrial value chain) were evident, a significant time lag in such co-ordination was apparent, leading to a sector that exhibited oligopolistic characteristics, technological path dependence and a partial supply chain with constrained economic benefit. In addition to nation state institutions, the strategic agency of devolved government and the innovative use of devolved powers was evident, although these powers could be denoted as secondary as compared with those of the nation state in terms of causal orders of importance.



Source: Own elaboration

Figure 4.10 Projected market size and the UK's industrial value chain

4.4 Unpacking Glasgow and Humberside's Preformation Contexts

Having provided an account of the longitudinal process of energy transition and the related development of the offshore wind sector in which both cases are embedded, this section provides descriptions of both regions pre-formation settings. By revealing these distinct regional environments (in relation to economic legacies, assets and institutions) subsequent case analysis can consider their interaction with extra-regional factors to shape regional path creation. Therefore, such comprehension is a pre-requisite for the application of the analytical framework and related case study methodology to facilitate both exogenous and endogenous comprehension of regional industrial path creation (Pike et al, 2017).

The accounts pertaining to Glasgow and Humberside are divided in to three parts. Firstly, for each region there is an historic overview of their economies in order to frame their respective path creation processes within a longitudinal perspective of regional economic change and continuity. Secondly, given that path creation is contingent on valorisation and reconfiguration of legacy assets inherited from previous patterns and paths of economic development, an assessment of these region specific resources is provided (Maskel and Malmberg, 1999; Martin and Sunley, 2006; Fornahl et al, 2012). Thirdly, there is consideration of pre-formation regional economic development institutional arrangements (Martin, 2000; Dawley, 2013; Evenhuis, 2017) which had a bearing on subsequent path creation. In turn, this final section also considers long standing regional institutional path dependences which shaped continuity and change in both regions (Martin and Sunley, 2006). It is to the Glasgow case context that the section first turns.

4.4.1 Glasgow's preformation regional economy: miles better?

In the 1930s the city of Glasgow's population peaked at over 1 million and then went into decline, falling to 580,000 residents by 2006 (National Records of Scotland, 2012) contained within a wider regional population of c. 1.8 million. This demographic contraction is associated with long-term deindustrialisation. The perilousness of the region's overdependence on heavy industry was recognised in numerous reports from the 1930s onwards. However, as noted by Vince Cable in 1975, a future UK Secretary of State for Business and Industry, then a Glasgow City Councillor: "There is now a great deal of documentary evidence available which indicates that despite many years of regional policy, Glasgow's economic problems remain second to none

in Britain" (Brown, 1975). During the 1970s manufacturing employment contracted by over a third and in the following decade manufacturing jobs fell by another two thirds (GCPH, 2006). As a proportion of the city's jobs, manufacturing fell from 22% in 1984 to 6.8% in 2004 (GCPH, 2006). The consequences of the broader city region's lock-in (Martin and Sunley, 2006) to declining industries was bleakly predicted in an SCDI report of 1974: "To lose traditional industries with comparative international advantages is to court a perpetual dynamic of decay" (Harvie, 1997). Moreover, the city of Glasgow did not greatly benefit from Scotland's oil and electronic assembly booms of the mid-1970s onwards due to its position on the opposite coast from the oil reserves[29] and a lack of green field sites for inward investment. Such economic decline combined with deprivation engendered ingrained health problems which became synonymous with the "Glasgow Effect" (the unexplained low life expectancy of Glasgow residents compared to the rest of the United Kingdom and Europe). In 2006 the city had around half of Scotland's most deprived communities and nationally significant levels of unemployment and economic inactivity (Glasgow Economic Forum, 2006).

Even so, there were indicators that contradicted the prediction of a "perpetual dynamic of decay". In the decade before 2006, over 60,000 additional jobs were created and Gross Value Added (GVA) growth averaged 3%-4% per annum, well above the Scottish average (Glasgow Economic Forum, 2006). However, a marked expansion of public sector employment provided Glasgow with the moniker of "Public Sector City" (Tomlinson, 2018). In terms of GDP per capita, Glasgow in 2004 stood at £33,000 compared with a figure of £43,000 for Edinburgh (Glasgow Economic Forum, 2006). An economic assessment (Glasgow Economic Forum, 2006, p 15) observed that Glasgow had: "a lack of knowledge-intensive, highly productive firms able to compete outside their local area [and that] growth in service-sector jobs has been disproportionately large in personal services and sales occupations, rather than in managerial and professional posts. There has been progress on development of the knowledge economy in Glasgow, although this relies heavily on public sector employment." In short, Glasgow required new industries, such as offshore wind, to

[29] Although the British National Oil Corporation was briefly headquartered in the city from 1975 until its privatisation

create knowledge intensive, private sector employment that would drive regional development.

Specifically, in terms of the electrical power generation and distribution industry, Glasgow has maintained discernible regional strengths for over a century. In the late nineteenth century in response to demand for electricity from a rapidly expanding industry and population, Glasgow developed a municipal power generation and distribution industry. The industry was restructured under the Electricity Reorganisation Act (Scotland) in 1954, leading to the establishment of the South of Scotland Electricity Board (SSEB), headquartered in Glasgow. SSEB generated, transmitted and distributed electricity throughout the south of Scotland and northern England. The other organisation created by the Act was the North of Scotland Hydro Electric Board. Through privatisation in 1990, the former became Scottish Power and, the latter, became Scottish and Southern Energy, based in Perth. Given Glasgow's nationally significant role in electrical engineering training and research, many of SSE's managers and engineers had close links with Glasgow.

Furthermore, notable innovations pertaining to renewable energy and electricity power generation and distribution occurred in the city. For example, the inventor of the wind turbine, Professor James Blyth, was an academic at Anderson College (Strathclyde University's precursor) in the late 19th century and the first turbine was built by a Glasgow engineering firm based on his designs. Moreover, in the 1930s, Glasgow industrialists, engineers and politicians played pre-eminent roles in creating the UK's hydro-electricity industry and national grid system. Whilst in the 1980s, a Glasgow based firm, Howden, designed, manufactured and supplied the first large scale wind turbines to the UK electricity industry and was the first European company to export turbines to California, the earliest large-scale market in the world[30]. Finally, by 2006, two of the largest planned European onshore windfarms were adjacent to Glasgow[31].

Preformation regional asset base

As will be explored in the case study, the emergence of the offshore wind path was predicated on the valorisation of three distinct regional assets of value and rareness

[30] Due to a lack of UK regulatory support, Howden withdrew from the wind turbine industry
[31] Scottish Power's Whitelee and SSE's Clyde Valley projects

(Maskell and Malmberg, 1999): labour market and skills; research and training; and embedded, networked organisations with power. Firstly, in 2006 Glasgow had c. 10,000 engineers (Glasgow Chamber of Commerce, 2010) working in utilities, engineering services, manufacturing and defence in the city region. This skills base underpinned the city's capacity to supply the workforce for a large locally based national electricity utility firm and a network of related auxiliary firms. Furthermore, the scale of this regional resource provided local firms with the flexibility to readily respond to new market opportunities, such as onshore renewable wind energy stimulated by the ROCs subsidy of 2002. A director in an electricity utility firm observed (G-Dev 1, author's interview, January 2016): "Glasgow is an assemblage of capabilities and know-how which evolve based on changing energy markets [and] there are very few cities in the UK where you can have a long-term career path in utilities…. and a breadth of career options". In short, by 2006 the regional labour market in regard to electrical generation and distribution was a unique asset of scale.

Another notable legacy asset of Glasgow's industrial past was the presence of a higher education and research sector that was recognised nationally and internationally for engineering excellence, including electrical engineering. Given this history, local universities housed significant research assets relevant to wind power generation and distribution, both terrestrial and marine, such as a power distribution test facilities and oceanographic lab tanks. In 2006, the University of Strathclyde was ranked as one of the best UK universities for research and training in electrical engineering (Universities Scotland, 2008). Furthermore, the long-standing educational and research relationships that the university had with the local electricity industry led to the university being perceived as "a neutral space for collaboration" (cited by G-Dev 1, January 2016). These close links informed the university's educational and research offering, shaping the skills pipeline for local industry. Moreover, an innovation manager within a utility firm (G-Dev 2, author's interview, January 2016) observed that the relationship between Strathclyde University and local electricity utility firms had allowed the university exceptional access to private sector data and infrastructure for its researchers. Given these features, an innovation system had emerged by 2006 that can be described as a localised phenomenon, dependent on region specific institutional arrangements and actor collaboration which promotes knowledge transfer and application (Asheim and Isaksen, 2002; Moulaert and Sekia, 2003; Todtling and Trippl, 2005; Martin, 2010). Thus, in many respects,

Glasgow reflected an organisationally thick and specialised regional innovation system in an old industrial region (Trippl et al, 2017).

Thirdly and finally, the presence of Scottish Power and Strathclyde University, embedded networked organisations of scale vested with power to respond to opportunity, was another critical legacy asset by 2006 for the emergence of the offshore wind path. Additionally, these powerful actors were augmented by local auxiliary firms and government (the Scottish Government's industry department and principal development agency were located in Glasgow). A Director in a utility firm (S-Dev1, author's interview, February, 2016) observed that such a phenomenon, indicative of institutional thickness (Amin and Thrift, 1995), fostered "a rooted, close knit community that rubs off each other…. retaining technical and project know-how…. [which] provides national reach".

Economic development and institutions: exceptionalism seeking coherence

By 2006, the roots of contemporary active government intervention in the local economy could be traced back three decades. In 1976, the recently formed Scottish Development Agency (SDA) established the Glasgow Eastern Area Renewal (GEAR) initiative, an area based response to counter the socio-economic effects of de-industrialisation. In many respects, GEAR was a precursor to the urban development corporation model (Maclennan, Waite and Muscatelli, 2018). Subsequently, to mitigate the city's negative external image, the City Council launched the Glasgow's Miles Better brand in 1983. The campaign acted as a catalyst for reassessing Glasgow's economic future and a focus for a new development narrative (Keeting, 1988). Such repositioning led to the city hosting the Glasgow Garden Festival in 1988 and European City of Culture in 1990, events that encouraged leisure and commercial investment.

Glasgow's subsequent emergence as a centre for service industries enabled new private public partnerships to be forged that side stepped a legacy of political radicalism rooted in its manufacturing past. In 1991 with the formation of Scottish Enterprise, the city gained its own Local Enterprise Company, the Glasgow Development Agency (GDA). It was an organisation predicated on public and private partnership, shifting the SDA's focus from spatial regeneration to business support (Maclennan, Waite and Muscatelli, 2018). Although Scottish Enterprise's national

HQ was co-located with the national inward investment agency and the Scottish Office's[32] industry department in Glasgow, there remained a perceived policy deficit regarding the region's development. In 2006, an earlier observation that "Scotland is a divided land and the Clyde Valley (the Glasgow region) is Scotland's greatest weakness" (The Economist, 1973) arguably retained currency. Therefore, it is appropriate to consider the region's long standing institutional path dependence in order to frame the subsequent regional industrial path creation case in the context of the broader preformation regional development challenge.

Glasgow's enduring socio-economic narrative is one of dissonant disruption, unlike nearby Edinburgh where the enduring functions of government, banking and law have provided greater continuity. Metamorphosing from its longstanding medieval ecclesiastical and academic roles, Glasgow became a global centre of industrialisation, innovation and commerce. In little over a century, the city conceived two epoch defining energy technologies - steam and wind power - and the philosophy of modern capitalism. Frenetic transformation was accompanied by rapid demographic expansion and the presence of the worst slums in Western Europe. Glasgow's regional economic path narrative can be characterised as one of spasms of disruptive change accompanied by socio-economic disjunction. Diverse labels such as The Dear Green Place, Second City of the Empire, No Mean City, Red Clydeside and European City of Culture infer such complexity and the limits to glib generalisation.

Moreover, economic and industrial change was habitually met with inadequate institutional rejoinders. While the decline in Glasgow's industrial base from the Great Depression onwards made the city an exceptional problem for successive UK Governments, there is ample evidence of inapt institutional responses. For example, although the Scottish Development Council that was established in 1931 to chart a new economic direction for Scotland was headquartered in Glasgow, its focus was more national than regional (a paradox mirrored in the contemporary concentration of outward facing national development organisations in Glasgow). Also, when in 1934 four Scottish "Special Areas" were identified by the UK Government for state intervention, the city of Glasgow was specifically excluded, although it represented the largest concentration of unemployment in Scotland (Slaven, 1975). The historian

[32] The Scottish Office was the UK Government Department charged with Scottish matters prior to devolution

Christopher Harvie ruefully observed that: “To declare the Second City a distressed area was too much [for politicians and policy makers]” (Harvie, 1998, p 50). Moreover, for three decades after the Second World War incoherent policies between differing levels of government were promoted. The UK government pursued a shrink Glasgow, shrink the problem philosophy, as embodied in the creation of three west of Scotland new towns (products of the state sponsored Abercrombie Clyde Valley Regional Plan of 1946), whilst city government simultaneously pursued radical regeneration predicated on comprehensive neighbourhood demolition and development of peripheral estates and motorways (products of the city government’s sponsored Bruce Plan of 1945). Subsequently, uncoordinated state policies curtailed the development of new industrial opportunities; for example, in the 1980s the Conservative Government’s energy policies led to the closure of the headquarters of the national oil corporation in the city and the withdrawal of one of the region’s last major indigenous engineering firms from wind turbine manufacturing. In the absence of the required coordinated multi-scalar institutional intervention, the City Council, given limited development levers, embarked on successful but disputably transitory place making strategies and events, such as European City of Culture in 1990, salving Glasgow’s painful transition to its supply-side post-industrial reality. A pressing question in 2006 was could multi-scalar government institutions provide the coherence to harness Glasgow’s exceptional assets for a new regional industrial path that could create the sought after quality, private sector jobs?

4.4.2 Humberside’s preformation economy: lonely northern daughter

The Humber estuary has two principal settlements, Hull and Grimsby; the former being significantly larger throughout their histories. The words by the poet Philip Larkin referring to Hull as England’s “lonely northern daughter” could arguably be applied to either settlement, as both have been relatively isolated throughout their histories, looking outwards to distant ports and fisheries. Herbert Morrison the former Cabinet Minister who was appointed High Steward of Hull in 1956 observed: “Hull is part of the county of York but it seems to be sort of a Kingdom of its own. It is a remarkable place with an individual character” (Hull City Council, 2013). In terms of population sizes, Hull and Grimsby’s populations peaked at c. 310,000 and 92,000 residents, respectively, at the outset of the great depression in 1931. In line with its economic fortunes, Hull’s population had fallen to 266,000 by the 1990s, contained within a wider Humberside County population of 858,000 (ONS, 1993). Moreover,

contrasts between the four local authorities which constitute Humberside were and are significant. For example, whilst the East Riding has the largest land area of any unitary authority, neighbouring Hull on the north bank is one of the most densely populated English local authority areas with limited possibilities for green field site development.

Prior to the financial crash in 2008, the Humber was already experiencing employment decline, with a net loss of 4% (14,000 jobs) in Hull in the preceding five years while employment nationally continued to rise (Centre for Cities, 2009). In the decade between 1998 and 2008 the public sector drove employment expansion with public jobs growing by 27%, while the private sector declined by 4% (Humber LEP, 2014). Moreover, given its ready access to natural resources accessed via its ports, such as fish and timber, and from its rural hinterland, the region retained a notable concentration of low value manufacturing jobs, such as food processing and caravan manufacture. This disposition was reflected in the region having about half the UK average for private sector knowledge intensive jobs in 2006 (Humber LEP, 2014). Mirroring a low skill, low wage regional economy, the Humber had significantly less residents with degree-level qualifications and many with no formal qualifications. For example, 17% of the working age total who lived within 18 kilometres of Hull in the first decade of the new millennium held a degree, the 8th lowest level of 63 British cities (Centre for Cities, 2009). Moreover, preceding 2006, Hull, like North East Lincolnshire (Grimsby's local authority area), had a high proportion of people of working age who were unemployed, ranking 354th out of 376 local and unitary authorities within England and Wales (ONS, 1993).

Specifically, in terms in terms of maritime related industries and logistics, the Humber had and has maintained discernible regional strengths. For many centuries, the Humber has acted as a major portal for the transshipment of goods, resources and people based on trade with the Low Countries and the Baltic, and by the outbreak of the First World War Hull was the third port in the UK in value of trade (Hull City Council, 2013). Additionally, in the decades leading up to 1914, Hull played a major role in the transmigration of European emigrants travelling to North America. In unison, Wilson Line of Hull became the largest privately owned shipping company in the world. On the opposite southern bank of the estuary, Grimsby was reputed to be the largest fishing port in the world by the 1950s. However, changing transport

patterns and rapidly decreasing fisheries put paid to these respective global accolades. Even so, in 2006, the combined Humber ports was the largest seaport complex in the UK and fourth largest in Europe (Humber LEP, 2013).

By 2006, much of the Humber ports' activity was predicated on the carbon economy through the import of coal, oil refining and the transshipment of cars. In the first decade of the millennium, Humber ports imported over a third of the UK's coal and exported a quarter of the UK's refined oil (Bondholders, 2011), thereby providing the region with its Energy Estuary marque. Such a history bequeathed Humberside a unique concentration of maritime related infrastructure, as evocatively described in a poem by Philip Larkin: "A filigree of wharves and wires, ricks and refineries, her working skyline wanders to the sea".

Preformation regional asset base

As will be explored in the case study, the emergence of the offshore wind path was primarily predicated on the valorisation of three distinct regional assets of value and rareness (Maskell and Malmberg, 1999): adjacency to natural assets favourable to the offshore wind industry; relevant infrastructure; and labour market and skills. Firstly, due to favourable oceanographic and wind conditions in the North Sea, the Humber's estuary is in close proximity to one of the largest global concentrations of economically exploitable offshore wind energy resource. Moreover, it is estimated that over half of the entire European offshore wind energy resource is within twelve hours sailing of the sheltered mouth of the Humber. Reflecting on its proximity to this resource, a Crown Estate interviewee (G-CE, author's interview, December 2015) referred to the region as the "lucky Humber", observing that the adjacent "nearshore, shallow waters, good geologic conditions for [turbine tower] foundations and reliable wind speeds were the low hanging resource for the new industry…. [one] close to big power hungry urban markets". In terms of future wind farm development and servicing, a former local O&M manager (H-O&M2, author's interview, May 2016) recalled that an early exploratory study in the 1990s that "looked at every inlet and port from the Norfolk coast up to Bridlington in East Yorkshire, placed Grimsby almost midway between the Northern and Southern limits of their search".

Combined with this proximity to resource, the Humber in 2006 had the UK's largest ports complex. The water depths, quayside lengths and shore-side infrastructure

offered across the principal ports of Grimsby, Hull and Immingham could accommodate a wide spectrum of vessel types, including all vessels associated with the emerging offshore wind sector. Moreover, it was an underutilised asset. Excess capacity had been created by decreasing levels of coal imports due to Government energy policy from the 1990s and the decline of the fishing industry from the 1970s. Such spare capacity ensured that diversification was already being sought by ABP (Associated British Ports), the monopoly port operator, which in 2005 progressed plans for a container facility and a cruise terminal. As observed by a LEP manager (H-RDA, author's interview, February 2016): "ABP was a looking for a new industry…. Immingham was a coal port…. [they wanted] a means by which to future proof their business". A similar process was underway in Grimsby, a director of a local council (H-LA3, author's interview, May 2016) recalled: "The town had a rundown port estate that was looking for a role beyond vehicles, storage and timber…. and the fish quay that had received investment was under-utilised". Furthermore, a waterfront green field development site of circa 1,000 acres, eight miles up the south bank from Grimsby, earmarked for coal fired power station lay unused due to changing energy policy.

The industrial legacy of the Humber also led to the region maintaining a nationally significant concentration of maritime and logistics skills with nearly 15,000 employees in the transhipment sector, accounting for 5% of regional employment in the first decade of the new millennium (Centre for Cities, 2009). In addition given the availability of inputs from its ports and rural hinterland, manufacturing employment was more than double the national average and the Humber had the largest concentration of food processing and caravan construction in the UK. In the first decade of the new millennium, the combined regional employment of these two manufacturing industries was in excess of 70,000 people (Centre for Cities, 2009; LMI Humber, 2017). These nationally significant concentrations of economic activity offered potential investors a ready variety of relatively cheap skills for routinized manufacturing, transshipment and extractive-related type functions.

Finally, it is worth noting that the structure and history of the regional economy – as a low skill extractive, processing and transhipment economy – led to weak institutional relationships between Hull University and industry and government to promote knowledge transfer and application (IBM-PLI, 2006). Thus, the region exhibited

pronounced characteristics of an organisationally thin regional innovation system in a peripheral region, dependent on investments associated with natural resources, inexpensive labour and land, with limited requirements for local knowledge networks (Trippl et al, 2017).

Economic development and institutions: bisected portal seeking institutional coherence

In 1999 the four Humberside local authorities created by the dissolution of Humberside County Council[33] were included within the geographic locus of the newly created Regional Development Agency, Yorkshire Forward. The pan-Yorkshire development body was augmented at the Humber level by the Hull and Humber Chamber of Commerce and Team Humber Marine Alliance (established in 1995 to promote marine related enterprises). However, conspicuously the most powerful de facto Humber-wide development body was Associated British Ports (ABP), the estuary's monopoly port operator, authority and developer, privatised by the Conservative Government in 1981.

Of the four local authorities, Hull had the most noteworthy history of development and regeneration. For example, in 1945, Hull Corporation commissioned Patrick Abercrombie to redesign Hull, although the subsequent proposals were deemed both too costly and radical and shelved. More recently, in the new millennium, the City Council partnered with Yorkshire Forward to create an Urban Development Company (Hull Citybuild), an institutional arrangement which generated local contention given the organisation's emphasis on the development of retail, leisure and services in a city with a non-populous hinterland and a low wage economy (cited by H-LA1, author's interview, July 2016). This in turn led to the City Council commissioning IBM Global Business Consultancy to review the city's economic development in 2006. The resulting action plan noted that "the creation of quality jobs should be at the forefront of every economic development activity in Hull and the sub region…. Hull should follow a more regionally integrated approach and certainly market itself as a region, north and south of the Humber" (IEDC, 2007, p 4). Therefore, it is appropriate to consider the region's long standing institutional path dependence in relation to regional disunion in order to frame the subsequent regional industrial path creation case in the context of the historic regional development challenge.

[33] East Riding, Hull, North Lincolnshire and North East Lincolnshire. The County Council was disbanded in 1996

Strikingly, although Humberside's regional economic function is a product of it being a major portal for goods, resources and people, the geography of the estuary has also bisected the region. This division has led to institutional distinctiveness between the estuary's two main communities, Hull and Grimsby. Reflecting on their separate histories and institutional identities (Hull is in Yorkshire and Grimsby in Lincolnshire) and the implications for the utilisation of regional assets for collective regional benefit, an industrial representative in Grimsby noted (H-O&M2, May 2016) that perceived socio-cultural differences and local allegiances made region wide strategies and promotion highly problematic. A former UK civil servant (H-UKGov1, March 2016) also noted of the regional institutional environment and its limited regional institutional thickness (Amin and Thrift, 1995): "There are limitations to leadership across the Humber given the number of relatively small inward looking single authorities". To try and overcome such fragmentation and promote pan-Humber spatial development Humberside County Council was established in 1974. However, local antipathy to this ahistorical construct led to its abolition in 1996[34]. A telling metaphor for the new County Council was the Humber Bridge which opened in 1981; a bold means of unifying the Humber but one with tolled barriers. Although Yorkshire Forward was intended to bring strategic coordination across the area, Humberside's local authorities remained sceptical of its commitment to their individual needs.

Significantly, it was a privatised monopoly actor, ABP, which was vested with foremost power and means in the form of its waterfront assets to determine the development of the estuary. However, since its privatisation in 1981, ABP had been through the hands of various consortiums of extra-regional owners[35], including Goldman Sachs and the Singapore Investment Corporation, whose priority was profit maximisation rather than regional industrial development. A pressing question in 2006 was could state institutions provide the coherence to harness the bisected region's assets to create a new industrial path and the sought after quality jobs?

4.4.3 Summary: regional preformation contexts

Although both Glasgow and Humberside can be broadly classified as lagging regions (Pike et al, 2006; Dawley, 2013; Coenen et al, 2015) they exhibit contrasting

[34] Local antipathy to coordinating institutions was witnessed twenty years later when all four local authority areas voted for Brexit, even though the estuary's fortunes are linked with Europe

[35] In contrast to the stable public ownership model of Rotterdam, Europe's busiest port on the opposite side of the North Sea

economic structures, competences and practices inherited from previous paths and patterns of economic development (Martin and Sunley, 2006). Such divergence is evident in the assets possessed by both regions. For example, Glasgow retains high value skills and research networks in relation to electrical engineering linked to exceptional higher education assets, such as those in the University of Strathclyde, whilst Humberside has lower value skills and limited research networks reflecting an extractive, processing and transhipment orientated economy. Accordingly, Glasgow exhibits characteristics of an organisationally thick and specialised regional innovation system and Humberside exhibits characteristics of an organisationally thin regional innovation system (Trippl et al, 2017). Finally, both regions have been subject to state policies to counter historic industrial decline. Recently such policies have been aimed at creating higher value private sector jobs, thereby reorienting the qualitative character of both economies and reducing their dependence on public sector employment. However, in the past their respective institutional circumstances have hindered regional economic development.

4.5 The Importance of Context: Summary

This chapter has framed the Glasgow and Humberside cases of regional industrial path creation within their sectoral and regional preformation settings. By adopting this approach, analysis of the interplay of the stimuli of energy transition, relating to offshore wind, with regional heterogeneity in the subsequent cases is facilitated. Thus endogenous and exogenous understanding of regional industrial path creation will be promoted. Moreover, by accommodating and delineating broader sectoral and regional settings, a more comprehensive relational understanding of enabling and constraining institutional environments for regional industrial path creation can be constructed, one that acknowledges the interplay of extra-regional sectoral, technological and institutional path dependences (Martin and Sunley, 2006; Boschma et al, 2017) and regional path dependences (Stam and Garnsey, 2008; Martin, 2010). Having established the respective case settings, it is to case enquiry that the research turns.

Chapter 5: Glasgow Case Study - From Imagined "Global Hub" to Ancillary Knowledge Node

5.1 Introduction

This chapter examines three episodes of regional industrial path creation pertaining to offshore wind in Glasgow from 2006 to end 2015. By exploring these delineated stages of path creation, the causal interplay of path actors, assets and mechanisms is considered, whilst the role of multi-scalar institutions in enabling or constraining path creating agency is illuminated. In addition, the case study facilitates exploration of the related conditionality of the resulting path's scale and character. By following the path, the "deep-seated [and] wider relations, positions and contexts of actors in inter-related structures unfolding over space and time" (Pike et al, 2016b, p 132) are exposed, providing insight on the interplay of exogenous and endogenous forces.

For each of the three episodes, a short description of the path's evolution and identification of associated key foci of enquiry sets the scene for my analysis. In turn, for each of the related analytical foci there is exploration of the mindful deviation (Garud and Karnoe, 2003) and experimentation (Martin, 2010) of path actors and their utilisation of mechanisms to reconfigure and valorise regional assets (MacKinnon et al, 2018). In addition, there is consideration of the causal relationship of this interplay with the institutional context in which it is set. The chapter concludes with a description of the scale and character of the resulting path and its effect on regional development and regional path dependence.

There are three temporal episodes germane to the application and illumination of the analytical framework. During the first, 2006 to 2009, an embryonic regional offshore wind path premised on the diversification of electricity utility firms emerged. By the end of the first episode, Glasgow contained an internationally significant concentration of approximately 150 skilled jobs relating to offshore wind project development and research. In the second period, 2009 to 2013, bullish sectoral projections encouraged more pronounced interplay between assets, actors and mechanisms, involving a wider set of actors, linked to diversification and inward investment. Although the levels of job creation remained relatively modest at about 300 direct jobs, the qualitative nature of the new path was sufficient for international publications to comment on Glasgow's "burgeoning offshore renewable industry" (The Economist, 2011). In the third and final phase, 2013 to 2015, more muted firm-

led path creation was evident. However, private sector attenuation was mitigated by a significant UK state investment in the region, the Offshore Renewable Energy Catapult.

5.2 Episode 1: Path Emergence, 2006 – 2009

In this first episode the regional offshore wind path emerged from Glasgow's mature electrical power generation and distribution industry. As will be demonstrated, its emergence was predicated on the interplay of the exogenous stimulus of energy transition with pre-existing regional assets relating to regional skills, research and training, and embedded networked organisations. During this initial period, the process of path creation was led by a relatively narrow set of firms, supported by higher education and state actors (see fig. 5.1), utilising mechanisms associated with diversification to valorise the aforementioned assets (Martin and Sunley, 2006; Boschma and Frenken, 2009).

In this initial episode of emergence, there is limited evidence of meditated strategic co-ordination to create a new regional industrial path (Garud and Karnoe, 2003; Martin, 2010). Rather, actor experimentation and strategizing for future reward (Steen, 2016) was primarily framed within national and international sectoral contexts. Reflecting the regional path's positioning within a wider extra-regional process of socio-technical transition (Geels 2004; Truffer and Coenen, 2008) there was no common regional narrative amongst actors regarding the emergent path, despite an internationally significant concentration of approximately 150 high value jobs in the region by 2009[36]. This broader framing of actors and assets may account for interviewees describing the regional path's emergence as "hidden", "organic" and "serendipitous". (respectively: G-RDA1, December, 2015; S-R1, December, 2015; G-Rep2, January, 2016).

There are three key foci of enquiry for this episode of emergence. Firstly, the diversification by electricity utility firms to create offshore wind project development teams in Glasgow will be explored. Secondly, there will be consideration of the related diversification (Martin, 2010) of the regional research base and related actors to support this process of firm branching (Neffke et al, 2011). Finally, the

[36] Based on figures provided by interviewees

establishment of the Scottish Government's offshore wind team in Glasgow will be assessed in terms of its effect on the regional path.

Figure 5.1: Key path actors in Glasgow city centre 2006-09

5.2.1 Utility firms' diversification initiates path

This analytical focus relates to the creation of offshore wind project development teams in Glasgow, representing the first notable instances of path creation in the region. The creation of these teams was the product of electricity utility firms mindfully deviating from terrestrial to offshore wind power generation, premised on the exogenous stimulus of new offshore markets and technologies. During this episode, these core path actors primarily employed sub-mechanisms associated with path branching (Boschma and Frenken, 2009), including corporate diversification and acquisition, which facilitated valorisation and reconfiguration of pre-existing regional assets.

A primary path actor at the outset of this episode was Scottish Power, one of the UK's "Big Six". In 2006 it created a dedicated offshore wind team in its Glasgow HQ. A former manager in a utility firm (G-Con1, author's interview January 2016) recounted that the team chiefly "grew out of the existing onshore team that was leading on a range of [onshore] wind farm projects…. allowing the new team to link in

to existing corporate services, such as legal, finance and strategy." Moreover, given the pre-existing skills and functions of the Glasgow HQ office, the new team focused on project deployment: appraisal; design; funding; planning; and proj*ec*t management. Such activities were associated with the higher value functions of the new sector's national and international division of labour[37].

Scottish Power's mindful deviation (Garud and Karnoe, 2003) from terrestrial activity and accompanying experimentation and strategization was incentivised by an increasingly benign UK energy policy and regulatory environment that enhanced expectation of commercial reward (e.g. the Utilities Act, 2000; Energy White Paper, 2003; Energy Review, 2006). A former manager within an offshore wind team (G-Con1, December 2015) recounted that in 2006 "the UK was recognised as the most joined up country in the world for offshore wind…. for leasing, consenting and subsidy". In addition, a Director in a utility firm (S-Dev1, author's interview, February 2016) reflected on the correlation between firm deviation from past practice and institutionally created expectation: "Onshore renewables [firms] did not want to miss out on this new massive opportunity…. a new growing market with government support". Moreover, such incentivised diversification was dependent on institutional entrepreneurship (DiMaggio, 1988; Battilana et al, 2009), as evidenced by the Crown Estate's packaging and promotion of seabed sites via three UK leasing rounds in 2001, 2003 and 2008. A manager within an electrical power firm (G-Dev2, January, 2016) contended that these leasing rounds triggered and structured the activation of firm agency by "setting the tempo, the agenda, providing finite timeframes for us [electrical power firms]". Nevertheless, a quote by a Crown Estate manager (S-CE, author's interview, February 2016) indicates the co-dependent interplay between firm and state agency:

> "Developers said where they wanted to go [in terms of offshore development sites], nobody understood the market. We [The Crown Estate] had no experience of releasing the seabed, so went with developers views…. The developers went where they wanted, primarily near shore. We then came up with the concept of identifying zones in order to allow the developers to assess larger areas and pick out the sweet spots."

[37] The team led on the early West of Duddon Sands project in the Irish Sea

These perspectives indicate that firm-led agency was triggered by interaction between government and firms creating a temporal-spatial framework that incentivised and co-ordinated firm diversification in specific heterogeneous regional settings, in this case Glasgow. Tellingly, a range of interviewees recounted the importance of The Crown Estate maps which plotted the potential offshore development sites. These institutionalised spatial representations of opportunity were a key device for engendering firms and government actors with a visceral sense of opportunity and expectation.

Conspicuously, although Scottish Power's initial diversification from terrestrial wind was incentivised by the institutional environment, it was further enabled by its takeover by a large Spanish utility firm, Iberdrola. Notably, it was a purchase that had been encouraged by the Spanish state's Renewable Energy Plan of 2005 which provided Iberdrola with sufficient domestic expectation and certainty of future reward to mitigate the uncertainty of international expansion. Therefore, the interaction of UK and Spanish institutional environments incentivised the creation of Europe's third largest electricity utility firm and, importantly for the Glasgow path, increased Scottish Power's access to international capital and networks (Bathelt et al, 2004; Coe et al, 2008; Binz et al, 2016) with which it would further reconfigure and valorise regional assets. An innovation manager in a Glasgow based utility (G-Dev2, January 2016) recalled:

> "The tie up with Iberdrola increased Scottish Power's scale of ambition with the company moving from 50 to 100 MW projects to 1 to 2 GW projects…. and increasing its offshore ambitions…. and team. The financial engineering aspects, the complex funding packages of equity, debt, partnership, investment banking became so much easier with a parent company with a massive balance sheet."

In 2007, the UK nation state's policy and regulatory environment which had incentivised Scottish Power's diversification encouraged another utility firm to transplant key functions to Glasgow. Airtricity, an Irish firm that was soon to commence construction of the Greater Gabbard project off the Suffolk coast located its UK HQ in Glasgow. A previous Airtricity employee (G-Dev3, author's interview, August 2016) observed that the Irish firm's investment decision was conditioned by the interplay of regional assets, relating to skills and perceived regional institutional

thickness (see Fig 5.5), with an extra-regional institutional environment that was enabling market creation:

> "They [Airtricity] recognised Glasgow as a centre of capability in the rapidly moving renewables market, including offshore…. and key players in the company were from the west of Scotland and knew many of the players…. [they were] familiar with the area's benefits…. and close networks".

Airtricty's investment decision further valorised the skills within the regional labour market by recruiting 60 staff, half of which would work on offshore projects; thereby contributing to the reconfiguration of the region's path dependent pool of skills and knowledge (Kasabov and Sudaram, 2016). However, just as Iberdrola had been incentivised to reimagine its future, so too had another large utility firm. Encouraged by the institutional environment, Perth-based Scottish and Southern Energy (SSE) acquired Airtricity in 2008. It was a decision according to a director of an electricity power firm (S-Dev1, February 2016) that was based on the need to "further develop SSE's capability in regard to renewables [and] access the city's skills and know-how and address lack of a serious design engineering presence of Perth".

With Glasgow now being the home to two offshore wind development teams, embedded in well-resourced utility firms with evident ambitions for the future, expectations of future reward amongst associated regional energy and engineering consultancies, such as Atkins and Sgurr Energy, encouraged their diversification via intra-firm micro-evolution (Martin, 2010). A manager in a consultancy (G-Con2, author's interview, July 2016) reflected that this adaptation occurred in a "cautious, calibrated manner" shaped by their utility firm clients' expansion plans. Moreover, the same interviewee also tellingly illuminated the importance of local assets in facilitating firm diversification: "Practically all the graduates in our [offshore wind] team are Strathclyde [University] graduates."

In summary, mindful deviation by firms from past practice created the emergent elements of an embryonic, high value industrial path. Moreover, this process was stimulated by the institutional environment in which it was set. Conspicuously, path emergence was primarily predicated on firm-led diversification, linking the exogenous stimulus of energy transition with regional assets recognised as being of value and rareness both nationally and internationally (Maskell and Malmberg, 1999).

5.2.2 University supports firm-led diversification

Another notable analytical focus in relation to the path's emergence relates to the role of the University of Strathclyde. During this episode, increasing collaboration between the university, firms and government to utilise novel knowledge relating to offshore wind signified adaptation of the regional innovation system (Cooke et al, 2004; Asheim et al, 2011b). In this episode, the university played an important role in testing and modifying the disruptive technology on which regional firm diversification was premised. However, despite having a growing reputation for blue sky research[38], it was not itself a source of radical research and knowledge for regional path firms. This was largely due to the evolving RIS, in which the university was embedded, being largely circumscribed by extra-regional technological dynamics and networks.

The diversification of the University of Strathclyde's terrestrial wind research and training capability towards offshore wind was enabled by the ESPRC's[39] SuperGen Wind research programme in 2006. This UK Government funded initiative was described by an energy advisor to the Welsh Government (S-R1, author's interview, December 2015) as "a research-led response to the UK's position in offshore wind…. [one to] capitalise on Strathclyde's and the UK's leading blue sky wind research". In turn, during this episode, the university also established a Centre of Doctoral Training in Wind Energy Systems. An innovation manager (G-Dev2, January 2016) in a local utility firm explained the importance of the university in this episode for the embryonic regional path:

> "In offshore wind the driver is so innovation focused that it is a necessity and not a nice to have to be able to test the technology. Anybody [the project developer] who has the money needs to be in charge. With onshore wind, it's off the shelf. It's hard to go in to Siemens or Vestas and ask them to design a better onshore turbine but you have to have these discussions with offshore. We go to Siemens and Vestas with our ideas about installation, sub-contractures, manufacturing, materials and research. Academia is part of the supply chain for offshore wind, hence we work with the university…. Strathclyde University is a good source of high calibre expertise [for offshore wind] and we get them into the company to work on issues or shape research

[38] The university was in the top three universities in the UK for wind citations and research
[39] Engineering and Physical Sciences Research Council

> programmes…. or secondments. In this space it could be like a Siemens providing a turbine to do the research, Scottish Power providing user requirements and the university say providing high end data analytics…. The university has strong industrial academic ties… it's almost like an excellent consultancy; good rates, responsive, insightful and easy to contract with".

In summary the university was a central actor within an evolving innovation system that exhibited pronounced regional innovation system (RIS) characteristics, including: an operating Triple Helix model (Etzkowitz and Leydesdorff, 2000); organisational thickness (Trippl et al, 2017); and informal conventions and networks (Cooke et al, 2004).

However, the primary causal power of the university and the RIS apropos path emergence cannot be evidenced. The same utility innovation manager (G-Dev2, January 2016) reflected on the role of the university and localised innovation capacity in path emergence:

> "You struggle to make a direct link, it [Strathclyde University] added to the jigsaw but was less influential [than the electricity utility firms]. These industrial research relationships can be geographically split, technologically split and business unit split. It's not so fundamental that you cluster around it. This was about lots of incremental problem solving and feedback loops [for offshore wind]. It's about seeing academia as part of the supply chain, you go where the knowledge is…. although it's handier when it's in your own city."

In short, the presence of the university within the city supported firm diversification by promoting technological legitimisation and adaptation of extra-regional technologies on which firm deviation from past practice was predicated (Binz et al, 2016). However, despite strengths in blue sky research, the university's primary role in testing and validating technology purchased by regionally based electricity utility firms reflected a position that was bounded by extra-regional networks and knowledge flows (Bathelt et al, 2004; Boschma, 2005; Coe et al, 2008; Truffer and Coenen, 2012). It appeared that the university and the RIS in which it was a principal actor could not challenge the emerging technological path dependence of the broader offshore wind sector (Boschma et al, 2017).

5.2.3 Devolved government supports firm-led diversification

In 2009, the Scottish Government established a national offshore wind team in Glasgow. Given its late appearance in this first episode, the team cannot be accorded causal primacy regarding the path's emergence. However, its presence in Glasgow alongside other government economic development organisations[40] merits attention. This concentration of devolved government functions promoted co-ordination and reduction of uncertainty amongst the city's electricity utility firms which in turn further promoted their diversification. However, as will be demonstrated, the Scottish Government was focused on the creation of a new national industry rather than a regional one, thus inhibiting common conceptualisation and recognition of the emergence of the regional industrial path and its related assets.

The national offshore wind team was a product of the new SNP Government's[41] devolved policies regarding climate change (e.g. the Climate Change Scotland Act, 2009) and pursuit of related economic opportunities (e.g. the Government Economic Strategy, 2007). The government's intent was also driven from the top by the First Minister, Alex Salmond, a former energy economist, who was personally committed to reorienting the Scottish economy around renewable energy. A manager in an RDA (G-RDA2, December 2015) recalled:

> "It was the first time I had seen such shared vision between Scottish Government and SE and SDI. The energy teams [in SE and SDI] flipped from oil and gas to offshore wind. This was driven by politics and ambition and a desire to make things happen…. Alex Salmond stayed close to the agencies on this one."

Such action was also incentivised by the broader, benign UK institutional environment in which it was embedded, including the UK wide consumer levy that subsidised offshore wind projects. Additionally, there was a willingness by state actors on both sides of the border to embrace institutional entrepreneurship. A former inward investment manager (G-FDI, December, 2015) recalled that the Scottish Territorial Waters Leasing Round was "just cooked-up and launched" by the Scottish Government and The Crown Estate in 2009 to encourage Scottish projects and

[40] Scottish Enterprise (SE), the economic development agency of Lowland Scotland, and Scottish Development International (SDI), the national inward investment and trade development body
[41] Elected in 2007

incentivise transplantation of firms and technologies. Furthermore, a manager within an electricity utility firm (G-Dev2, January 2016) also identified Scottish Government behaviours that incentivised firm deviation from the past, experimentation in the present and future-oriented strategizing (Steen, 2016):

> "For anybody who has an offshore wind project in Scottish Waters, I have no doubt that they feel reasonably confident that they can go to the [Scottish] Minister with anything to try and accelerate to a solution one way or another. The industry is a relatively small network, you can go to the Minister and resolve things. It's tangible in terms of project confidence, project development, you know you can influence things. I have no doubt that institutional moves that Scotland has made in the past made Scotland an attractive place to do stuff, not because of numbers written down on a sheet somewhere but because at the working level there is an addressability of issues you simply do not have with DECC…. a lot of them [policy makers in DECC] don't even know each other."

However, although the formation of the Scottish Government's offshore wind team evidently augmented Glasgow's institutional environment (see Fig 5.5), the devolved government's positioning of offshore wind as a national and not a regional opportunity did not promote regional level strategizing or co-ordination. In effect, there was a reluctance to recognise and promote Glasgow's unique assets in isolation from the national economy and Aberdeen, Scotland's presumed energy capital. A former Scottish Government Minister (G-SGov2, author's interview, January 2016) recalled that the scale of Glasgow's capability and opportunity was only recognised in Ministerial circles as the government prepared in 2009 for a visit by the Chinese Vice-Premier:

> "I think it was when the Chinese came and visited us and there was a desire to do a kind of retrospective asset register to identify all we had in regard to key players, assets on the ground, capabilities…. although before that Alex Salmond had the twinkle in his eye and knew what was possible, understood policy and its direction [for offshore wind]. You had evolution going on in a range of entities when you started pulling it together, the companies, universities, assets. We did recognise something emerging in Glasgow but what complicates it further is Scotland is a small country…. Aberdeen and

> Dundee were also coming together and promoting their assets. What was deeply bothersome was the fact that this could be a competing axis when it should be conjoining with Glasgow."

This perspective was confirmed a by a former inward investment manager (G-FDI, December 2015) who noted that the Scottish Government "had no view in making Glasgow a capital [for offshore wind] like Aberdeen [for oil and gas]". Strikingly, however, this absence of strategic co-ordination and intent by the Scottish Government to engender a distinct regional path was also mirrored at the city level. The head of a business representative body (G-Rep1, January 2016) recounted: "Glasgow was slow to understand the economic value to the city of the utilities". This disposition was underscored by the near absence of offshore wind in the strategies of local economic development actors and the absence of a co-ordinating regional forum for the industry.

To summarise, although devolved government only appears as a key actor late in this episode, the utilisation of its devolved powers and its conventions complemented institutional change at the UK level, further encouraging firm deviation and experimentation within the region. However, the framing of Glasgow's assets within a national (Scottish) policy agenda and narrative led to path emergence being largely veiled. This led to minimal strategic co-ordination and awareness amongst multi-scalar policy makers regarding the embryonic regional path's potential. Thus, targeted state polices, incentives and initiatives to encourage the path creating causal interplay of actors, assets and mechanisms at the regional level are largely indiscernible in this episode.

5.3 Episode 2: Path Development, 2009-2013

This episode of path development reflects a phase of more pronounced path creating interplay between actors, assets and mechanisms. It is a period characterised by upbeat projections for the offshore wind path in Glasgow and the associated activation of a wider set of path actors related to both project deployment and manufacturing functions, including inward investors (see figs 5.2 and 5.3). Although firm-led agency remained central to path creation, university and devolved government actors also played notable roles in attempting to drive the path's development, particularly through the creation of regional innovation infrastructure

that augmented the RIS. Also, significantly, oil and gas firms were sufficiently incentivised to break with their past and connect the path with novel networks and knowledge. During this episode of path development, a regional path narrative emerged that was recognised both nationally and internationally. Although the level of job creation remained relatively modest, the approximate 300 direct path jobs[42] were well-paid and knowledge-intensive, many vested with high levels of authority.

There are three key foci of enquiry for the path's development during this episode. Firstly, there will be consideration of the increasing mindful deviation of Glasgow's power generation and distribution firms which was allied to benign extra-regional institutional developments, including the release of multiple Scottish offshore wind development sites by The Crown Estate in 2009. The second foci is the creation of the International Technology and Renewables Energy Zone (ITREZ) in 2011 by higher education and devolved government actors to "create a global research and development hub [for] the offshore renewable sector" (Board Approval Paper, Scottish Enterprise, December 2011). Finally, there is exploration of the incentivisation and diversification of oil and gas firms from carbon-based path dependence into Glasgow's offshore wind path during this episode.

Figure 5.2: Key path actors in Glasgow city centre 2009-13

[42] Based on figures provided by interviewees

Figure 5.3: Key path actors in wider region 2009-13

5.3.1 Utility firms accelerate diversification

In this episode, Glasgow based electricity utility firms expanded their offshore wind teams in line with their growing national and international ambitions and sought co-location of parts of their manufacturing supply chain to the region. This enhanced strategization and experimentation by these path actors was accompanied by the operationalisation of a range of path creating mechanisms, including transplantation, which suggested a step change in regional asset valorisation was at hand. Such marked firm deviation from past practice at the regional level was linked to developments pertaining to the nation state's institutional environment for the broader offshore wind sector.

In 2009 institutional developments, including the EU's binding targets for greenhouse gas reduction, Westminster's Low Carbon Transition Plan and Holyrood's Climate Change Act, provided Glasgow's power firms with confidence on the multi-scalar direction of energy transition. These broad benign policies were also complemented by institutional developments more specific to the firms' offshore wind ambitions and expectations. Firstly, in April 2009, the UK Government announced a doubling of the subsidy for offshore wind farms compared with onshore. Secondly, in early 2009, The Crown Estate announced ten exclusivity agreements for offshore wind development sites in Scottish Waters. Thirdly, in summer 2009, the Scottish Government created a

marine planning agency, Marine Scotland, to expedite offshore wind planning applications. An offshore wind team manager in Glasgow (G-Dev3, August 2016) recounted of the significance of such state incentivisation for Glasgow's path development:

> "It was a case of subsidy combining with co-ordinated leasing and streamlined planning; and then BOOM…. People came flocking. If Scotland had been independent, all the indices would have shown it to be the best place in the world to locate [for offshore wind] …. Glasgow was like a boom town"[43].

For Scottish Power, gaining exclusivity from The Crown Estate in 2009 for the Argyll Array site off the Scottish west coast represented a key trigger for a step change in the firm's level of experimentation. The site, which could accommodate 300 turbines and had a development cost of £5.4billion, represented the largest and most ambitious planned offshore wind project in the world. In response, Iberdrola, Scottish Power's parent company was incentivised to further valorise the Glasgow assets of its Scottish subsidiary. In recognition of its unique skills and knowledge, which were embedded in a wider regional capability, Scottish Power's Glasgow HQ became Iberdrola's head office for its global offshore renewables business. Rapidly, the offshore team in Glasgow grew to over 60 staff, with new team members mostly recruited from the regional labour market[44]. Concurrently, Iberdrola, encouraged by wider EU energy transition policies, including the EC's Strategic Energy Plan for Wind (2010), progressed projects in the German Baltic Sea and French Atlantic. These projects and the related international partners provided Scottish Power with access to new international markets, funding and knowledge that could further valorise regional labour and research assets (Bathelt et al, 2004; Coe et al, 2008; Binz et al, 2016).

Significantly, Iberdrola also saw the opportunity with Gamesa, a Spanish OEM of which it was a partial owner, to transplant new turbine technologies to the region, which could then be tested and legitimised in the UK's expanding state subsidised market. It was a proposal that was welcomed by the Scottish Government in the form of a Memorandum of Understanding and support from its inward investment agency, SDI. With the opening of Gamesa's turbine design office in the region in 2011, a

[43] Revealing the importance of Glasgow and Scotland to the UK's overall ambitions in terms of offshore wind
[44] Based on author's interviews

director in a regional innovation centre (G-RHE2, author's interview, December 2015) recalled: "Scotland and the UK became a massive test site for Iberdrola's global ambitions…. Glasgow became its offshore centre".

In 2009, Scottish Power's rival, SSE also pursued more pronounced diversification and experimentation, incentivised by greater certainty of reward. Having secured development rights for a number of UK offshore wind sites, including the 690MW Islay Array and the 670MW Beatrice Array off the Scottish coast, the firm embarked on a programme of investment in Glasgow's assets in order to develop these sites. In doing so, SSE also linked these regional assets to extra-regional networks, knowledge and funding (Bathelt, 2004; Coe, 2008; Binz et al, 2016) via a range of mechanisms. For example:

- In October 2009, only eight months after the Scottish Territorial Waters Leasing Round and six months after the increase in state subsidy, the firm announced that it was creating a £20million Centre of Engineering Excellence for Renewable Energy (CEERE) in Glasgow to harness the region's unique skills and research assets for the design and delivery of its renewable projects (a move that was projected to augment its 70 staff in Glasgow by 300).
- In 2010, SSE agreed a strategic alliance with Mitsubishi Power Systems (facilitated by SDI) to jointly fund and design offshore wind projects which would utilise the region's skills and research assets. In particular, Mitsubishi's development of a hydraulic drive train was seen as a disruptive alternative to the dominant gear-driven turbines of Siemens and Vestas. Subsequently in 2011, SSE opened its offshore wind turbine test centre at Hunterston near Glasgow, with SE support, to test Mitsubishi's prototype turbine.
- In the same year, SSE purchased along with a Hong Kong private equity firm (Marsh Global Holdings) an onshore wind tower manufacturer in Kintyre (a former Vestas inward investment with circa 100 employees), with support from Highland and Islands Enterprise and local government, in order to facilitate diversification into offshore wind towers.
- In 2012, SSE established offshore wind procurement alliances with supply chain firms such as Atkins, Bifab, Mitsubishi, Siemens, Technip and the Wood

> Group by which to “share development costs and create product and process innovation space” (G-Con2, July 2016).

Finally, in 2010, a new entrant Mainstream Renewable Power, an Irish firm, having gained exclusivity for the Neart na Gaoithe wind farm off Scotland’s east coast in 2009, established a project office in Glasgow. A manager in the firm (G-Dev3, August 2016) observed that executives selected Glasgow as the location for their inward investment based on the region’s skills, research and training assets and “networked players”.

In summary, mindful deviation by project developers from past practice in this period indicates significant temporal alignment with and contingency on extra-regional institutional developments. Moreover, while corporate acquisition was the primary path creating mechanism associated with firm diversification in the episode of path emergence, a more diverse range of branching and transplantation mechanisms which valorised regional assets, linking them to international networks, is evident in this period of path development.

5.3.2 University supports firm-led diversification and transplantation

> “Why the rush to a post-industrial city on the other side from the renewable action on the [UK] east coast? Scottish Power and SSE have helped, by cultivating skills in the sector and drawing in contractors, such as Gamesa. The biggest asset, however, is the University of Strathclyde. The university's electrical-engineering department is probably Britain's best.”

The above quote from The Economist (2011) entitled “Green Rush: The Renewable Energy Industry is Heading to Glasgow” provides a degree of insight to the increasing significance of institutional thickness (Amin and Thrift, 1994b) and the region’s research assets, especially the University of Strathclyde, in regard to the path’s creation. Accordingly, it is appropriate to explore the role of the regional innovation system in influencing the causal interplay of actors, assets and mechanisms and the qualitative nature of the path during this episode.

In 2011, the University of Strathclyde, under the leadership of its Principal, Professor Sir Jim McDonald,[45] and Scottish Enterprise announced a £100m public investment to stimulate a research driven offshore wind cluster[46] predicated on regional firm diversification and OEM related inward investment. Both public actors anticipated that the International Technology and Renewables Energy Zone (ITREZ) would "create a global research and development hub [for] the development of offshore renewable sectors, stimulating co-location, investment and job creation" (Board Approval Paper, Scottish Enterprise, December 2011). ITREZ was to be the physical embodiment of the offshore wind RIS: an innovation quarter, adjacent to the University of Strathclyde, which would enable existing and new entrant firms to deviate and experiment (Martin, 2010) by utilising the region's research assets.

In 2012, ITREZ signed joint research agreements with a number of international supply chain actors, including Gamesa and Technip, and also Scottish Power and SSE in order to exploit the region's research capability, both close to market and blue sky. However, a former ITREZ manager recounted (G-RHE2, December 2015) that the initiative was fundamentally dependent "on a large international OEM, probably a new entrant to offshore wind, locating nearby" to link the RIS and local research capacity to extra-regional knowledge flows, funding and markets, thereby facilitating the "development of alternative technologies". Therefore, in some respects, ITREZ could be characterised as an attempt by public and private actors to create something approaching a niche (Geels, 2004): a protected, shielded and empowered space (Smith and Raven, 2012) in which the technological path dependence of the wider sector could be countered (Markard and Truffer, 2012; Boschma et al, 2017).

However, changing extra-regional institutional dynamics were to constrain the path creating powers of ITREZ and the RIS in which it was set. Critically, the UK Coalition Government's austerity programme from 2010 onwards ensured that the cost reduction became central to UK Government offshore wind policy, further displacing a seemingly secondary regard for industrial development. This increased emphasis on cost reduction incentivised developers and their investors to seek projects in lower

[45] Professor Sir Jim McDonald, (appointed Principal in 2009) is a central actor in building relationships between the university and industry and government. He was instrumental in the creation of ITREZ. He is an electrical engineer, who has worked in academia and industry (including Scottish Power) and was energy advisor to the First Minister, Alex Salmond. In 2014, the university awarded the Chair and Chief Executive of Iberdrola, Jose Ignacio Sanchez Galan, an honorary professorship, soon after launching the Iberdrola Energy MBA

[46] SE marketing material and website

risk shallow waters near large urban centres. Therefore, during this episode, the offshore wind projects that were advanced were in English coastal waters that readily favoured the deployment of technology evolved from a dominant terrestrial antecedent. The main beneficiary of this technological preference was Siemens, which in 2011 won 100% of UK offshore wind turbine orders. Critically for ITREZ, Siemens already had its own mature research networks and in-house research capability and infrastructure that had evolved from its terrestrial technologies.

Even so, Glasgow path actors pursued and developed relationships with OEMs that could utilise ITREZ. For example, as noted, the Spanish OEM, Gamesa, which was part owned by Iberdrola, opened a turbine design office in the region in 2011 and signed a joint research agreement with ITREZ to develop new turbine technologies. Whilst in the same year, Doosan Babcock, a South Korean engineering firm with a pre-existing facility in the region signalled in a Memorandum of Understanding with the Scottish Government that it would manufacture turbines in the region. However, ongoing UK state emphasis on cost reduction, as reflected in the UK's Offshore Wind Cost Reduction Task Force (2011) and Programme Board (2012), consolidated the technological dominance of an effective duopoly (Siemens and Vestas) and prompted Gamesa and Doosan Babcock to abandon their transplantation plans in 2012. In short, uncertainties about the development of the offshore wind market and rapid technological path dependence was dis-incentivising the agency of non-incumbent offshore wind OEMs required for the utilisation of ITREZ.

However, it was not only extra-regional policy and regulation which constrained valorisation of regional research assets, diverging informal government conventions also played a part. In 2010 the UK Government established the Offshore Wind Developers Forum, a partnership described by one electricity utility firm manager (G-Con1, December 2015) as focused on "developing a holistic UK support for project development but not the supply chain…. [the forum was] mistaking a utilities cost reduction strategy with an industrial one". In contrast, in the same year, Scottish Enterprise commissioned and publicised research that framed offshore wind as primarily an industrial opportunity[47]. Such diverging perspectives informed the actions of both governments. For example, it was not until 2013 that the UK Government

[47] The study estimated that offshore wind would contribute an additional GVA of £7bn and 28,000 jobs to Scottish economy within a decade

published an offshore wind industrial strategy, three years after the Scottish Government launched its industrial development route map. Therefore, the institutional complementarity (Schroder and Voelzkow, 2016) between London and Edinburgh that had seemed evident in the initial period of path emergence was less pronounced in this period. An RDA manager (G-RDA1, December 2015) noted of the period: “There were no real intensive dialogue or strategic touch points between them [the two governments]”.

In summary, the path creating agency of university and devolved government actors was circumscribed by the extra-regional political-economic framework in which it was set. The failure to notably enhance the power of the RIS via the £100m public investment in ITREZ meant that the region did not become “a centre for generating patents…. or the radical stuff…. the big firms owned the technology” (G-Rep1, January 2016). In effect, extra-regional forces circumscribed the power of the RIS to activate actor experimentation and deviation from past practice or mediate the scale and character of the evolving regional path.

5.3.3 Oil and gas firms pursue diversification and transplantation

In this episode of path development, the mindful deviation of extra-regional oil and gas firms into the Glasgow path is notable. In particular, reference illuminates the conditional and open nature of path creation. Moreover, such diversification and transplantation is all the more noteworthy given the limited historic interface between Scotland’s two mature energy industries: oil and gas centred in Aberdeen; and electrical power generation and distribution centred in Glasgow.

The entry of oil and gas firms into the path was predicated on “the pull” of the growing scale of offshore wind market and related supply chain and “the push” of a sharp fall in the oil price in 2009 (cited by former head of SDI Energy Team, author’s interview, G-FDI, December, 2015). These dynamics heightened expectations of reward (Steen, 2016) amongst the oil and gas sector and encouraged experimentation by actors that had previously “seen the new low risk, low cost and heavily regulated [offshore wind] industry as kindergarten stuff” (G-FDI, December, 2015). Consequently, in 2010, the Wood Group, a global oil and gas firm based in Aberdeen, pursued diversification by acquiring a majority stake in the Glasgow based renewables consultancy Sgurr Energy (the consultancy had been established by former Scottish Power managers). Soon after, Xodus, another Aberdeen based firm

with significant global networks, transplanted its embryonic offshore wind expertise to the city in order to capitalise on the region's skills, knowledge and networks. Such intercity investments were also augmented by international investments, including DNV, a Norwegian oil and marine services firm, which according to its press statements was also drawn by regional assets that were distinct at the international level.

Thus, this episode of path creation demonstrates that the dynamic institutional environment was generating expectations of sufficient scale to incentivise oil and gas firms to deviate from their deep-rooted carbon-based path dependence and diversify towards low carbon power generation. Although not significant in scale, such firm-led diversification and transplantation gave Glasgow's path actors access to the skills, knowledge, technology and networks (Binz et al, 2015) of the established and internationalised offshore oil and gas sector.

5.4 Episode 3: Path Realisation, 2013-2015

During this third and final episode, the industrial path that was realised still exhibited growth characteristics but these were more constrained than had been anticipated during the previous episode. By the end of 2015 approximately 350 direct offshore wind jobs[48] were in the region. However, this was not of the volume foreseen and many were dependent on public funding. Moreover, in this episode, the strategic autonomy of local actors, such as Scottish Power and the University of Strathclyde, which had been evident in previous episodes was reduced. In this period of path realisation, the role of electricity utility firms in regional asset valorisation was muted, whilst the direct role of the UK state became significant, with the establishment of Offshore Renewable Energy Catapult (ORE Catapult). This high-profile decision to locate the UK funded innovation body and the related 100 jobs in Glasgow somewhat masked the changing nature of the path's evolution in terms of the attenuation of firm-led agency and the implications that this would have on the path creating interplay of actors, assets and mechanisms and subsequent path outcomes.

A common view amongst interviewees was that the path that had been realised was "stuttering its way forward" (G-RDA1, December 2015). Just as many interviewees had said that the path had emerged by institutionally inspired happenstance, a similar

[48] Based on figures provided by interviewees

sentiment regarding path evolution in this episode was also evident. Tellingly, a manager within a regional development agency (G-RDA3) revealed: “We had anticipated new turbines and supply chains due to the seeming growth in the market but nobody considered the subsidy regime drying up…. I don’t think it was group think, we just didn’t see it coming”. To interpret, the opportunity to create a new regional industrial path of size and quality was closing and its closure was veiled from economic development policy makers, suggesting a lack of institutional prescience one would associate with policy makers acting as institutional entrepreneurs (DiMaggio, 1988; Battilana et al, 2009) and system builders (Geels, 2004; Boschma et al, 2017).

There are two key foci for understanding the path’s realisation during this period. Firstly, there is consideration of the rapid attenuation of firm-led agency, particularly relating to Scottish Power and SSE. Whilst the second relates to the location of the UK state’s Technology and Innovation Centre (ORE Catapult) in the region and its effect on the nature of regional path creation.

Figure 5.4: Key path actors Glasgow city centre 2013-15

5.4.1 Circumscribed firm-led diversification and transplantation

This analytical focus considers the attenuation of firm-led agency and its effect on the size and character of the regional industrial path. In doing so, it will explore how this outcome was contingent on UK state policy and regulatory changes that made many projects in Scottish waters commercially unviable. Although Scottish Government subsidies incentivised firms to adopt new technologies that could more economically exploit Scotland's offshore wind resources these only partially mitigated the overall impact of UK state changes on the Glasgow path. Moreover, the close temporal co-relation between alterations to the nation state's "rules" (North, 1990) and firm attenuation in the regional path, reveals the relative causal power of the two scales of government.

In 2013, the UK Energy Act, introduced a new subsidy regime for offshore wind projects, Contracts for Difference (CfD). Award of subsidy to project developers was now based on an auction system which supported the lowest cost bids, thereby driving cost reduction via project developer competition. The system privileged projects in shallow and sheltered waters and their associated prevailing technologies. To smooth transition to the new CfD subsidy regime that was scheduled to make its first call for bids in 2014, the UK Government introduced a temporary subsidy regime, the Final Investment Decision Enabling for Renewables (FIDER). Concurrently, in 2013, the devolved Scottish Government introduced enhanced subsidies (Scottish Renewable Obligation Contracts) for supporting innovative projects that demonstrated technologies more suited to Scotland's deeper and dynamic waters, such as floating wind. However, despite such institutional entrepreneurship, the Scottish subsidy could only incentivise projects of a small scale, exposing the devolved government as a market adaptor, not a market maker. Moreover, through its Energy Act (2013), the UK Government consolidated control over the institutional levers of energy policy by scheduling the withdrawal of Scotland's subsidy powers for 2017. The sovereign UK state was exercising its exclusive right to determine devolved powers.

The effect of these institutional dynamics in shaping the expectations of electricity utility firms (Steen, 2016) was significant and tellingly rapid. Increasing institutional uncertainty disincentivised these firms from mindful deviation (Garud and Karnoe, 2003) from past practice and future facing strategizing and experimentation. In the

same month that new UK Energy Act received Royal Assent (December, 2013) Scottish Power withdrew from the globally significant 1.8GW Argyll Array, meaning the firm would have no offshore wind projects in Scottish waters. The firm's geographic project focus was now in English, German and French waters. Illustrating the impact of the changing institutional environment, a director within Scottish Power (BBC interview, December 2013) observed of the firm's abandonment of the project:

> "We believe it is possible to develop the Argyll Array site, it has the some of the best wind conditions of any offshore zone in the UK. However, it is our view that the Argyll Array project is not financially viable in the short term. As cost reductions continue to filter through the offshore wind industry, and as construction techniques and turbine technology continues to improve, we believe that the Argyll Array could become a viable project in the long term. [However] the rate of progress in development of [deep water] foundation and installation technology has been slower than anticipated. The current outlook for offshore wind deployment in the UK suggests this will not significantly improve in the short term."

The implication of the decision was not lost on Scottish Power management in Glasgow. An innovation manager in an electricity utility firm (G-Dev2) recalled: "A huge nearby radical anchor project would have been a focus for local expertise and innovation…. But why should companies bear massive financial uncertainty between auctions… why risk radical innovation". In addition, the subsequent geographic concentration of the sector south of the border had consequences for the place of the Glasgow office within the Iberdrola hierarchy. Although Glasgow remained formally the corporate lead office for offshore wind activities and the related team remained stable in employee numbers (c. 65 staff), the centre of power moved to London, whilst project functions were increasingly dispersed across the EU, close to projects. By 2015, London accounted for 50% of all Iberdrola offshore staff and was the location of the Director of Offshore Renewables[49]. A director in an electricity utility firm (S-Dev2, February 2016) highlighted that "London's now the centre of the offshore [wind] world due to the consenting bodies, the [UK] government, consultees, the contractors, and financiers being in one place….and government industry fora

[49] A graduate of the University of Strathclyde

being here, rotating meetings round respective stakeholder offices…. [Also] London is well placed for connectivity, saving a lot of [international] travel time compared with Glasgow". In short, the impact of regulatory change was combining with the centralised nature of the UK state to diminish the power of the Glasgow office in the Iberdrola hierarchy and, in turn, its autonomy and authority to determine the future of the regional path and related utilisation of regional assets.

Only four months after Scottish Power's Argyll Array decision, SSE announced it was abandoning plans for its largest Scottish project, the Islay Array (690MW), and that it would be minimising corporate exposure in other UK projects. However, unlike Scottish Power, SSE retained a major project in Scottish waters, the Beatrice project (670MW). A director in a utility firm (S-Dev1, February 2016) observed that the project only survived because it had confirmed subsidy under the temporary FIDER arrangements. Tellingly, the director also revealed that the broader uncertainty of the regulatory environment made SSE rethink its approach to jointly developing non-incumbent alternate technologies and to favour the purchase of Siemens technology:

> "Assurity, cost and durability… and existing long term known [terrestrial] relations with Siemens were attractive. It's now about incremental innovation that leads to cost savings of existing suppliers…. operational efficiency, predicting wind speeds, access and maintenance…. these are priorities."

Therefore, SSE abandoned the innovative supply chain experimentation evident in the previous episode and purchased incumbent "off the shelf" technologies. Thereby, leading to reduced valorisation of regional knowledge, research and skills. For example, SSE quietly retreated from plans to create a centre of renewable energy engineering expertise in the city that was projected to create 300 jobs. Another director in the same firm (G-Dev1, January 2016) ruminating on the brittle dependence of corporate forward planning on UK state policy noted: "SSE has developed a unique world class capability in Glasgow and now [UK] government policy has changed….the UK Government has a history of losing focus on industry development".

Moreover, the correlation between the regulatory environment and local corporate strategy had consequences for the future of ITREZ and the RIS in which it was embedded. A senior executive in a university (G-RHE1, author's interview, February

2016) reflected on the institutionally contingent changing focus of ITREZ and the University of Strathclyde:

> "[ITREZ and the university now] promote other low carbon technologies…. nuclear, gas, hydrogen, repowering and efficient electricity distribution, to migrate our talent and research capability to innovation focal points in line with movements in government policy….and income potential…. to meet the commercial needs of the big corporates and their order books."

Conspicuously, the attenuation of firm-led path agency was heightened by policy misalignment within and between government levels (Barca et al, 2012; Martin and Sunley, 2015). For example, the UK Government's CfD auction process of 2014 incentivised a culture of closed industrial price competition, promoting lower risk incumbent technologies; whilst ORE Catapult, launched almost simultaneously by the UK Government, sought to encourage collaborative innovation within the industry. In regard to the UK / Scottish policy nexus, a manager within a regional development agency (G-RDA2, December, 2015) recounted that the UK state's introduction of CfD was "the red light that halted [Scottish] plans…. CfD is slamming the door in Scotland's face…. The industry needed a measured approach to its development, not classic stop start". Moreover, Scottish civil servants observed that UK industry government fora increasingly seemed focused on English waters, a bias they felt was amplified in the run up to the Scottish Independence Referendum of 2014. One remarked (G-SGov1, Dec 2015) that the UK's Offshore Wind Programme Board was "driven by the UK Government with a Saint George's flag".

However, notably in this episode regional consultancy firms recognising the diminished expectations of the path's two anchor firms, Scottish Power and SSE, sought out new market opportunities in English and international markets with support from SE and SDI. Also noteworthy was the mindful deviation of three Glasgow-based consultancies to provide advice and support to floating wind projects that were part funded by the Scottish Government's enhanced subsidy; signalling the potential for a national level technological niche in which Glasgow path actors could play a part.

Finally, a holistic view of state economic development policies relating to the region reveals an absence of coordination between energy, industrial and regional policies.

Illustrative of this strategic deficiency was agreement of a £1.1 billion City Deal in 2014, the same year that changes to UK energy policy had an adverse effect on the regional offshore wind path. All three levels of government (UK, devolved and local) agreed a City Deal comprising supply side investments with limited attention given to regional industrial development, despite the offshore wind path potentially offering the increased GVA, productivity and quality jobs sought by the City Deal partners.

To summarise, given diminished expectations amongst the region's electricity utility firms induced by UK regulatory and policy changes, the interplay of firms, assets and mechanisms was muted in this episode. Although, there is evidence of ongoing experimentation amongst auxiliary firm actors, this was not on a scale that could compensate for the attenuation of the two critical firm actors of the path, Scottish Power and SSE. Moreover, the changing disposition of these dominant local actors in terms of technological selection and investment forced ITREZ and the University of Strathclyde to move away from a primary focus on offshore wind and further reduced the causal influence of local knowledge and research capacity on path creation.

5.4.2 UK state flagship investment augments path

The final analytical focus relates to how direct nation state investment in the regional path shaped the nature of the path's realisation. Specifically, it explores how the UK's new Catapult technology and innovation centre engaged with both regional and extra-regional actors, networks and knowledge flows. This investigative lens also gives insight in to the direct role of the nation state in valorising regional skills and research assets. Furthermore, this analytical focus illuminates the changing orientation of the path's ownership, from private towards public, and the relative importance of public and private investment in the path's evolution.

The UK Government's £50million investment to create the Offshore Renewable Energy Catapult (OREC) in Glasgow and the related recruitment of c. 100 staff over the course of 2013 and 2014 represented a significant endorsement by the nation state of Glasgow's skills and labour market assets. A UK civil servant (S-R3, author's interview, January 2016) recounted that the selection of Glasgow was based on a number of regional attributes:

> "[It] was an open bid process with no spatial prioritisation but there was a need for a pool of potential staff and there was a big vision for ITREZ and a

renewable energy cluster imagined…. and the Catapult could be part of a functioning [Glasgow] network."

Notably, devolved government played a critical role in securing this nation state "inward investment". A regional development manager (G-RDA1, December 2015) recalled that the Scottish Government "aggressively lobbied the UK Government" in order to "locate a new major player in Glasgow's industrial community" (see figure 5.5).

In 2014, OREC entered its new HQ located in the ITREZ and, in the same year, took ownership of significant offshore wind test and demonstration infrastructure at Blyth in North East England (formerly NAREC[50]). Interviewees recalled a sense of heightened expectation regarding how the TIC would support their activities and ambitions. However, the operation of OREC was prescribed by the institutional priorities of the UK state and not the regional industrial community. OREC was tasked with engendering innovation in order to reduce the cost of offshore wind via collaboration between industry, academia and government. It was not about challenging the technological path dependence of the sector to create new industrial development opportunities, but rather it focused on reducing the cost of largely incumbent technologies through innovation. This goal was reflected in the management and governance structure of the new organisation. OREC's Chief Executive had been Chair of the UK's Cost Reduction Task Force and its Industry Advisory Group was largely comprised of incumbent project developers and related suppliers. Significantly, the need for OREC to source a third of its funding[51] from the private sector incentivised the development of relations with established industrial actors who would have better access to funding than new entrants.

In its first two years of operation, OREC did not utilise the region's research assets to the anticipated degree or readily integrate with the RIS. A university technology manager (G-RHE2, December 2015) reflected that "Catapult is poorly networked in Glasgow…. it was like space ship landing…. remaining relatively unintegrated into Glasgow". This view was further evidenced by a director in an electricity utility firm (S-Dev1, February 2016) who suggested confusion regarding the respective roles of ITREZ, a product of Scottish Government policy, and the UK Government's ORE

[50] National Renewable Energy Centre

[51] The other two thirds were to be sourced from UK Government funding and other research funds e.g. EU

Catapult. Moreover, the same interviewee indicated a lack of co-ordination and joined up government strategy in this regard: “There has to be more awareness of Glasgow’s offer and conscious decision making by government and others…. we need to join up a bit better.”

However, it can be contended that ORE Catapult and ITREZ were not competing initiatives but rather differing ones. ITREZ was largely premised on diffusing and applying the region’s knowledge and commercialising the university’s research, both radical and incremental; whilst OREC pursued a UK cost cutting agenda via the application of new knowledge with no spatial preference for its sourcing. Key OREC initiatives and services were not dependent on the regional innovation system e.g. analysing and sharing technical performance data of national and international developers and providing test and demonstration services to OEMs at Blyth. For OREC, the path in which it acted was primarily that of the wider sector and not the regional one. The consequences of this seeming lack of alignment were illuminated by an energy advisor to the Welsh Government (S-R1, December, 2015):

> “Many feel that OREC is not so well networked in Glasgow…. and its university connections are stronger with Newcastle University and Durham because of the location of its test infrastructure [in Blyth, North East England]. Strathclyde [University] thought OREC would commission research and top-up its EPSRC funding but they’ve not been shown the money. There was just not the demand for radical research. If there is a regional innovation system operating, OREC is not really a part of it. It connects with the local economy through recruitment and its Board…. Blyth and the need to get income to cover the costs of its big test infrastructure - that’s good for its thirds model - has shaped its strategic direction and partnerships.”

In summary, ORE Catapult was a much anticipated UK state investment in Glasgow’s offshore wind industrial community that promoted the profile of the regional path both nationally and internationally. Moreover, such state transplantation further valorised the region’s skills and labour market assets. However, it did not have the impact on the valorisation of the region’s research assets or strengthening its RIS that was anticipated, primarily due to its institutionally derived emphasis on sectoral cost cutting privileging established technologies and extra-regional relations. Moreover, it was a predisposition that did not readily engender regional firm

diversification or inward investment and therefore its presence did not have the anticipated effect on private sector job creation. The seeming dislocation between OREC and the regional economy is evidence that geographic proximity does not ensure ready assimilation of a new actor in to a pre-existing regional innovation system, other proximities, including institutional ones, are requisite (Boschma, 2005).

5.5 Character of the Path and Effect on Regional Development

By the end of the final episode approximately 350 high skill, knowledge intensive jobs were associated with the Glasgow path, the largest concentration of such offshore wind jobs in the UK outside London. In the industry's international spatial division of labour, the regional path represented a geographic concentration of specialised skills and knowledge relating to project development and delivery, research and support services. However, given that the path's fortunes had been regulated by a changing and uncertain nation state policy and regulatory environment there was a sense of both unfulfilled potential, especially in regard to private sector investment and job creation, and caution about its prospects.

Despite the agency of multiple path actors, the ambition of harnessing energy transition to create a regional cluster of integrated deployment and manufacturing functions went unachieved, as did the aim of creating a regional industrial community exhibiting characteristics of a technological niche i.e. one that could counter technological path dependence of dominant players. The observations that Glasgow is "a low carbon capability that responds to government and market signals" (G-Rep1, January 2016) expose the causal significance of extra-regional institutional forces in determining the scale and nature of path creating agency. Therefore, despite evident exceptional regional assets that could have allowed it to become an international "global hub"[52], Glasgow became an ancillary knowledge node within an increasingly technologically path dependent sector.

Moreover, by the end 2015, the power of key local path actors, such as Scottish Power, SSE and the University of Strathclyde, which had been influential in the earlier episodes of path creation had been constrained by extra-regional "rules" (North, 1990; Geels, 2004). Despite institutional thickness apparently remaining a notable feature of Glasgow's offshore wind community (see fig 5.5), the community

[52] Scottish Enterprise Board Approval Paper for ITREZ, December 2011

was not vested with sufficient power to influence and mediate extra-regional institutional forces, especially at the level of the nation state, to create a regional path of greater scale and function. Therefore, although Glasgow was more than just a receptacle for economic activity (Scott, 1998; Pike et al, 2007; Hudson, 2007) or a passive arena reshaped by national and international capital flows (MacKinnon, 2014), the region did not possess sufficient power, even when working in partnership with devolved government, to create a globally significant agglomeration of offshore wind firms that could challenge place and technological path dependence (Boschma, 2017 et al).

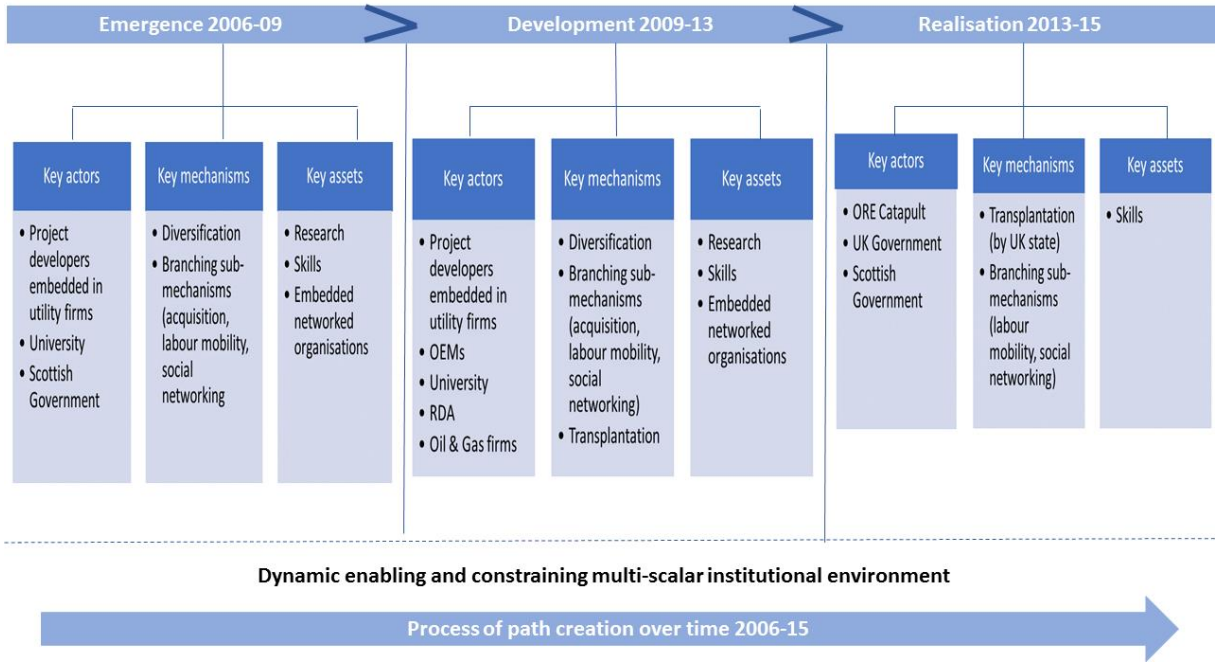
Despite the significant nation state investment in relation to ORE Catapult, this direct intervention by the UK Government did not outweigh the economic impact of the attenuation of private sector investment. This attenuation denied the regional economy the additional private sector, competitive, knowledge intensive jobs and firms that the Glasgow Economic Forum had identified a pressing need for in 2006. Moreover, it is telling that the most significant concentration of offshore wind employment in the city by the end of this account related to ORE Catapult. It was an outcome that further emphasised the regional economy's public sector path dependence, reflecting Glasgow's moniker of "Public Sector City" (Tomlinson, 2018).

This seeming missed opportunity for the region's development caused by changes in state energy policy revealingly mimics previously squandered opportunities in recent decades. In the 1980s skilled jobs relating to the design and manufacture of wind turbines and the location of the British National Oil Corporation's HQ were lost as a consequence of UK state energy policy. Finally, this lack of sensitivity regarding the interplay of multi-scalar state institutions is also redolent of an enduring deficit of coherent inter-scalar government policy in regard to the region's development.

5.6 Summary

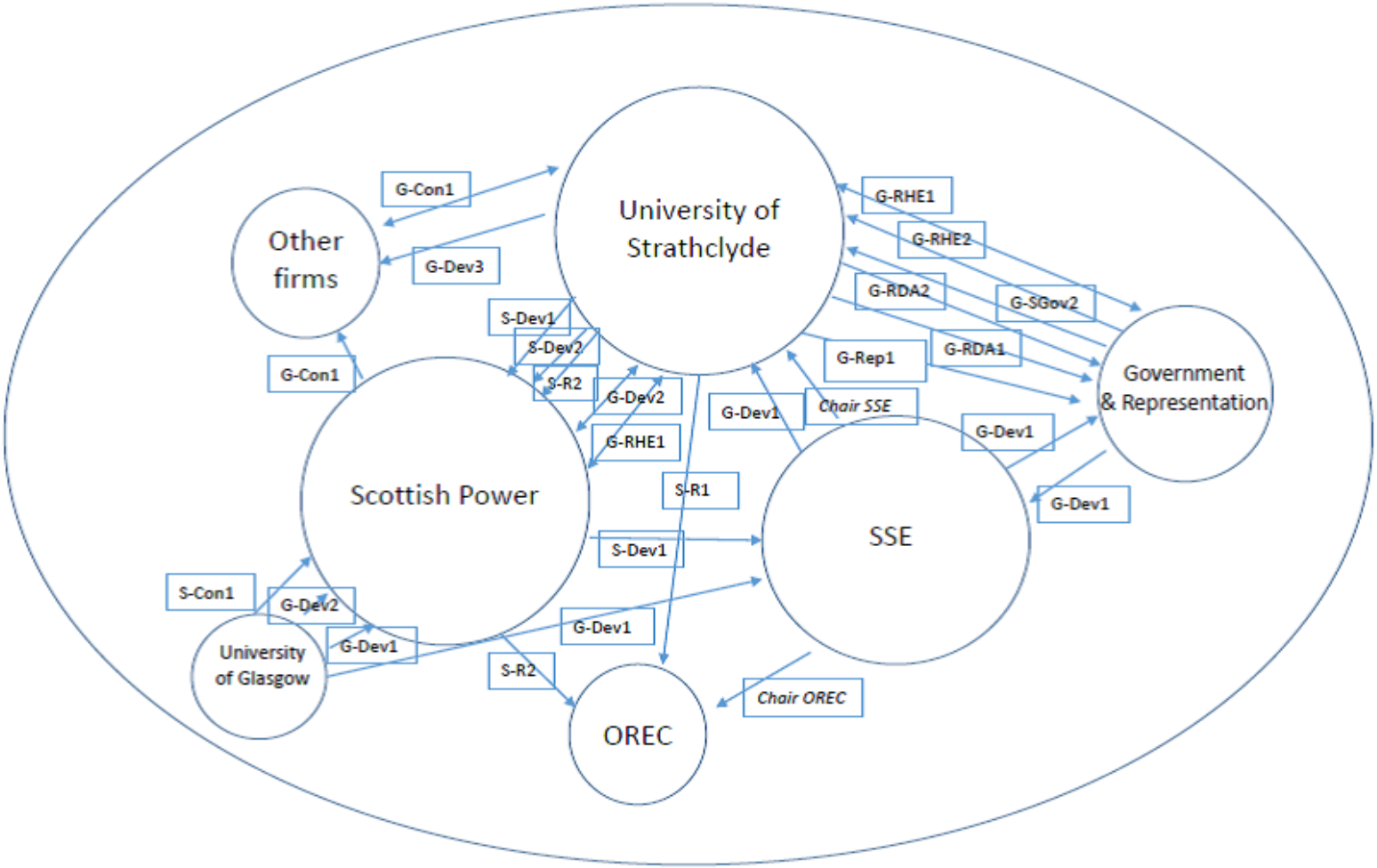
The creation of the Glasgow offshore wind path was the product of the novel knowledge of energy transition fusing with unique regional assets. The degree of fusion was contingent on the interplay of mutable aggregations of actors, mechanisms and regional assets, which was pointedly mediated by the multi-scalar institutional environment. These shifting aggregations and their interplay, occurring in unique temporal and spatial contexts, led to three discernible episodes of path

creation over a decade – path emergence, development and realisation (fig 5.5). At the outset, path emergence was primarily shaped by UK Government policies and regulation which were engendering the development of the wider offshore wind sector. The path was framed within the context of this largely extra-regional development process, leading to limited path awareness at the regional level. Subsequently, the alignment of benign policies and regulation at both the UK Government and Scottish Government levels incentivised increased and distributed firm agency and enhanced interaction of mechanisms and assets. Moreover, the role of regional institutional thickness in both encouraging common purpose and private and public agency became more pronounced, as demonstrated by the creation of ITREZ. However, key changes in the UK institutional framework relating to subsidy led to rapid dis-incentivisation of firm agency and common purpose, despite the continuation of benign devolved policies and regulation. Furthermore, the negative consequences of this outcome were only partially mitigated by the transplantation of a major UK Government flagship investment, ORE Catapult.



Source: Own elaboration

Figure 5.5: Glasgow's timeline of episodes of path creation



Size of spheres represent author's estimate of relative importance of regional path actors

Source: Own elaboration

Figure 5.6: Career dynamics as an expression of institutional thickness 2006-15

Chapter 6: Humberside Case Study - From Imagined "Super Cluster" to Dispersed Supply Chain Nodes

6.1 Introduction

This chapter examines three episodes of regional industrial path creation pertaining to offshore wind on Humberside from 2006 to end 2015. By exploring these changing episodes of path creation, the shifting causal interplay of path actors and mechanisms in utilising regional assets can be deconstructed and institutional influences revealed. As before, the case study facilitates exploration of the related conditionality of the resulting path's scale and character. By following the path, the "deep-seated [and] wider relations, positions and contexts of actors in inter-related structures unfolding over space and time" (Pike et al, 2016b, p 132) are exposed, providing insight on the interplay of exogenous and endogenous forces.

For each of the three episodes, a short description of the path's evolution and identification of related key foci of enquiry set the scene within which the mindful deviation of path actors (Garud and Karnoe, 2003) are examined within a multi-scalar institutional environment. As before, there is consideration of how these mobilised actors utilised path creating mechanisms to convey the exogenous stimulus of energy transition to reconfigure and valorise regional assets in relation to each of these foci (MacKinnon et al, 2018). The chapter concludes with a description of the scale and character of the resulting path and its effect on regional development and regional path dependence.

There are three temporal episodes that will drive the case study's investigation of path creation. During the first period, 2006 to 2011, a nascent offshore wind path emerged, and by the end of the episode c. 100 O&M jobs were located in Grimsby and a significant Siemens' inward investment, the UK's first turbine manufacturing facility, was anticipated for Hull. In the second episode, 2011 to 2014, the anticipated pace of path development slowed, although a pan-Humber marketing brand and Enterprise Zone were created. By the end of 2013 there were approximately 200 jobs and increasing transplantation activity related to O&M in Grimsby but the scale and quality of such path activity was circumscribed. On the estuary's northern bank, a hiatus relating to the Siemens investment meant few jobs had materialised. In the phase of path realisation, between 2014 and end 2015, path resurgence was evident.

Siemens' commenced construction of its facility, albeit it on a reduced scale, that would create 1,000 jobs. There were also significant announcements regarding O&M investment and related job creation in Grimsby. Although the path's scale and quality was less than previously anticipated, the realised regional offshore wind path represented a notable component of the industry's UK and international division of labour.

6.2 Episode 1: Path Emergence, 2006 -2011

During this first episode, an embryonic regional offshore wind path emerged on Humberside focused on three principal sites located at Grimsby, Hull and beside Immingham (see figures 6.1 and 6.2). By the end of this episode of emergence, the south bank was synonymous with project deployment, especially O&M at Grimsby, and the north bank with the proposed Siemens's turbine manufacturing facility. The process of path emergence was primarily dependent on the interplay of firm-led transplantation with the Humber's nearby offshore wind resources, excess port infrastructure and inexpensive maritime and industrial processing skills.

During this initial episode, the path was increasingly recognised as a significant regional opportunity and strategic social agency played a noteworthy role in facilitating the initial causal interplay of assets, actors and mechanisms. A regional industrial representative (H-Rep 2, author's interview, March 2016) recalled:

> "Round 3 [launched by the Crown Estate in 2008] changed perceptions. Offshore wind had previously had something of a sandals perception [amongst local actors] but the scale of offshore wind meant it could touch everyone in the local industrial base; painters, fabricators, lawyers, Tata [the steel works at Scunthorpe]. The Humber had missed out on oil and gas and didn't want to miss out this time… this was the religious phase….. it could be a second industrial revolution for Humberside".

Government actors also increasingly saw the opportunity for a new development path for the region. A former UK Government regional official (H-UkGov1, author's interview, March 2016) recounted the creation of a regional vision in which "decarbonisation provided a meta-narrative for the Northern Powerhouse on Humberside…. providing a rallying call for industrial intervention that was almost evangelic".

There are three key foci of enquiry for the path's emergence. Firstly, the transplantation of an O&M function to Grimsby in 2008 represented a notable early instance of path emergence. By the end of the episode, c.100 jobs[53] were located in the port town, representing the earliest significant concentration of regional path related employment. A second notable occurrence was the purchase by Able UK, a disruptive new entrant to the regional economy, in 2008 of a large green field site with waterfront access on the Humber's south bank and the site's subsequent promotion to offshore wind inward investors, especially turbine manufacturers. Finally, the announcement in 2011 of a Memorandum of Understanding between Siemens and ABP to create a £310 million turbine manufacturing facility, centred on Hull's Alexandra Dock, represented the third and final notable act of path emergence.

Figure 6.1: Principal path creation locations and regional actors on Humberside 2006-11

[53] Based on figures provided by interviewees

Figure 6.2: Images of principal Humber locations of path creation

6.2.1 Utility firm's transplantation initiates path

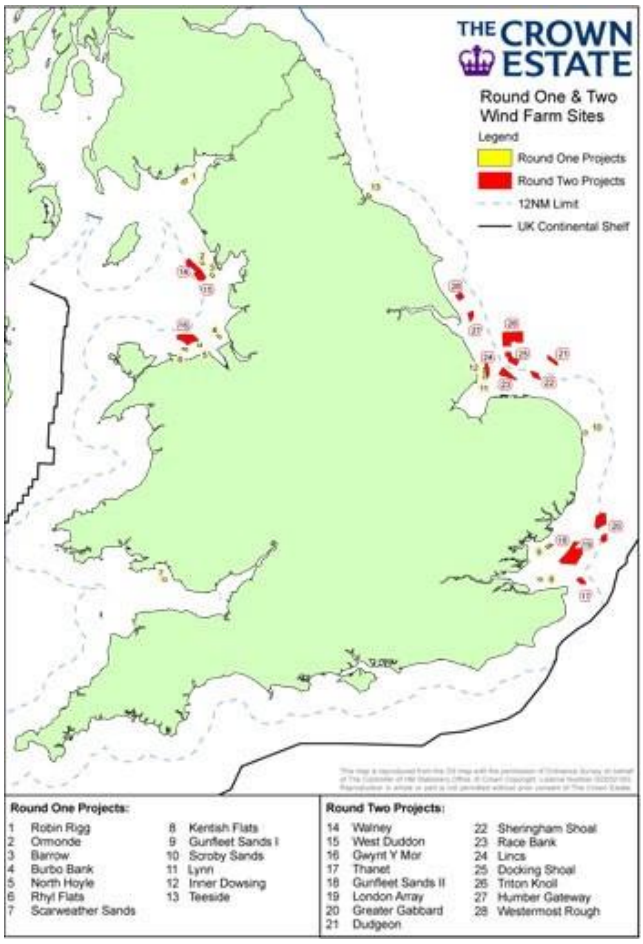
This analytical focus relates to the transplantation of an O&M base at Grimsby Fish Dock in 2008 by the electricity utility firm Centrica, representing the first notable instance of regional path creation. As will be demonstrated, this new investment on Humberside was dependent on changes in the broader UK institutional context that encouraged the terrestrial onshore wind developer to mindfully deviate into offshore wind[54]. However, the selection of the location was influenced by geographical assets and the strategic social agency of local actors, namely Grimsby Fish Dock Enterprises and North East Lincolnshire Council.

In 2006, the Humber estuary was in proximity to six designated offshore wind sites consented to project developers by the UK state, totalling c. 2.3GW (fig 6.3). These assets represented the largest global concentration of readily exploitable offshore wind resource, in terms of wind and maritime conditions and proximity to the national grid and urban markets. Reflecting on these spatial advantages, a former UK Government regional official (H-UKGov1, author's interview, March 16) cited the

[54] For example, Energy White Paper, 2003; Energy Review, 2006; Energy White Paper, 2007; Climate Change Act, 2008

“inescapability of geography” in influencing selection of the region for offshore wind investments.

However, the mindful deviation of Centrica, one of the UK’s “Big Six”, from its terrestrial business model was contingent on state leasing, consenting and subsidy making asset exploitation commercially attractive. Moreover, institutional entrepreneurship (Di Maggio, 1988; Battilana et al, 2009) by state actors had ensured strategic co-ordination of these “rules” (North, 1990; Geels, 2004), as demonstrated by the Crown Estate’s Third Leasing Round being launched in the same year as DECC announced enhanced subsidy for offshore wind projects. Consequently, this interplay of nation state institutions and the profit rationale of Centrica, privileged and encouraged the economic exploitation of near to shore, shallow water sites, such as those close to the Humber.



Source: The Crown Estate, 2009

Figure 6.3: Humber estuary’s proximity to designated offshore wind sites

Given this expectation of commercial reward (Steen, 2016), Centrica commenced construction of the relatively small Round 1 Lynn and Inner Dowsing offshore wind farm in 2006, adjacent to the Humber estuary. Significantly for the initial economic impact of the emergent regional path, the construction process was undertaken from Esbjerg, given the Danish port's developing capability for installing offshore projects in the North Sea basin. Concurrently, Centrica and its O&M partner, RES, sought to find a UK location for the transplantation of its O&M function in order to service the wind farm once operational in 2008. A former O&M manager (H-O&M2, May 2016) recalled:

> "Grimsby had acceptable steaming [90 minutes] to Lynn and Inner… and the motorway, rail link and broadband to the portside.... The big support vessels came from Esbjerg…. [Grimsby's] port's repair systems and slipways were not that important.… In 2008, I responded to a job advert [for an O&M Manager] that my wife showed me in the local paper that was like a personal ad…. at that time nobody in Grimsby had heard of offshore wind".

Given the industry's initial modest growth profile, Associated British Ports (ABP), Humberside's monopoly port operator, was insufficiently incentivised to deviate from past practice. A former O&M manager (H-O&M2, May 2016) recalled that ABP was dismissive of the needs of project developers and associated income when approached in 2006:

> "At that time ABP had no idea what offshore wind was going to be.... for ABP it was a new technology…. [Centrica and RES] set up a high level meeting with ABP. It [ABP] worked by charging per tonne of coal or iron ore. These [O&M] vessels are small, carrying twelve people, in the main aluminium and fibreglass. ABP told them to p*ss off and go talk to Roger Smith [the manager at Grimsby Fish Dock Enterprises] at the fish quay".

It was left to the smaller private actor, Grimsby Fish Dock Enterprises (GFDE), which was seeking additional income to mitigate the reducing revenues from the declining fishing industry, to facilitate fusion of the novel new technology of offshore wind with regional assets. A director with a local authority (H-LA3, author's interview, May 2016) revealed:

> "The first O&M enquiry was through GFDE. Centrica had already approached ABP but they didn't see opportunity and so they [GFDE] hosted them at their office at the fish dock. It's been individuals that have made this happen…. getting the enquiry in was the private sector. The RDA would not have influenced it or helped the renewables industry in Grimsby. It's been individuals, the Kurt Christensens of this world[55].

However, the valorisation of the old fish dock was not solely the product of firm agency but also that of the local Council. A quote by a local authority director (H-LA3, May 2016) reveals the importance of local government in utilising its powers to reduce physical barriers to transplantation:

> "It was an opportunity to transform the port estate. It was rundown, dilapidated, there were demolitions. The twenty five year service contracts [for the wind farms] meant we could start thinking long-term…. We recognised that the lock gates were not fit for purpose, they needed upgraded to allow more O&M vessels to use the quay. It was a direct intervention [of £500,000] by the Council to show commitment to the industry. It wasn't funded by the EU but by the Council…. we had to do a lot of work around State Aids to ensure it would help multiple companies".

By the end of this episode, Grimsby's port assets were being transformed by offshore wind investment, a process enabled by the firm-led transplantation of Centrica and diversification by GFDE. Moreover, activation of such firm agency was largely contingent on changes to the wider UK institutional environment, facilitated by state institutional entrepreneurs, primarily the Crown Estate and DECC. However, a local state actor, North East Lincolnshire Council, played an auxiliary but notable role in priming the reconfiguration of local legacy assets for firm-led utilisation.

6.2.2 Disruptor's diversification promotes transplantation

Another notable analytical focus in relation to the path's emergence was the purchase in 2008 of a large green field site adjacent to Immingham by Able UK, a Middlesbrough firm that specialised in ship decommissioning. Able UK's intention was to develop the Able Marine Energy Park (AMEP) on the site to accommodate offshore wind manufacturing, deployment and O&M functions. In doing, so the new

[55] Owner of a local fishing firm who diversified in to offshore wind services, creating the firm Wind Power Support

regional entrant aimed to challenge the monopoly position of ABP. However, the formal and informal institutional environment in which these ambitions were set represented a barrier to their realisation.

The potential of the large 200ha site, which had been originally earmarked for a coal fired power station but had become available due to changing energy policy, was summarised by a firm director (H-PO2, author's interview, June 2016):

> "In a nutshell, we have the best product. It would be a bespoke facility, tailor made to meet the exacting standards of the industry. It ticks all the boxes. We've had the privileged position of talking in detail to virtually everyone who moves in the sector. We know how long the quay should be, what loading requirements should be, the characteristics of land and slope and requirements for cranes."

Able UK's diversification was contingent on the plans of OEMs to transplant their offshore wind turbine technologies to the east coast of England. Given the seeming scale of the nearby offshore wind market (estimated at 7GW within a national market of 35GW by 2020), GE, Siemens and Vestas undertook numerous regional site visits and appraisals between 2008 and 2009. Such OEM strategizing was encouraged by regional state actors. A former regional development manager (S-OEM, author's interview, August 2016) recalled:

> "There was a massive groundswell right across the value chain. You were regularly at the airport meeting up with visiting companies. You turned in to a tour guide showing off the best sites."

Moreover, Yorkshire Forward[56] promoted the AMEP site for co-location. A former senior UK state official (H-UKGov1, March, 2016) revealed:

> "Yorkshire Forward [was] catalyzed by the Crown Estate maps showing the scale of sites just offshore…. [and] pushed the massive opportunity for co-location and clustering that the site offered investors and their supply chain. It had the potential to be a game changer for the Humber and the North…. all the other sites were un-clusterable [due to size constraints]".

[56] A Regional Development Agency (RDA)

However, although state actors promoted the site for inward investment relating to manufacture and installation, these actors did not possess the resources or powers to address the related physical barriers to transplantation. A local economic development manager (H-RDA, March 2016) reflected:

> "The problem with Able is the quay is not there. Who is going to punch through and invest the £450million for the quayside and the basic site infrastructure? There's a need for a big investor that wants to operate from the site and make the huge investment".

Moreover, the rapid evolution of the industry engendered by the institutionally driven priority of cost reduction led to a swift consolidation in the value chain and technological path dependence (Boschma et al, 2017). In particular, Siemens successful rapid scaling up of its turbine models provided the OEM with a dominant market position by 2011. Responding to such sectoral dynamics, GE in 2011 withdrew from alternate gearless turbine technologies and dropped its transplantation plans. Subsequently, in 2012, Vestas abandoned plans for its new larger scale turbines and their manufacture in the UK, choosing to consolidate turbine manufacturing in Denmark. The implications of these OEM dynamics for the AMEP site was evidenced by a director (H-PO2, June 2016):

> "In 2010 we started the quay design and planning consultation and we shook hands with GE, they were coming here. But the gearless technology for their turbines did not work and hit the dust… Vestas also never took forward their plans as their plans for new products changed… but Siemens were pending, all the guys at Brande (Siemens' Danish HQ) were so excited".

However, as will be consequently evidenced, Siemens was also concerned about the related cost barriers to developing the AMEP site.

Nor did all state actors favour the AMEP site for transplantation. Whitehall's culture promoted caution towards prioritising potential inward investment locations. Although a UK inward investment manager (H-UKGov2, February 2016) described the AMEP site as "the dream ticket given its scale…. a blank canvas that would allow clustering…. it was our Bremerhaven option[57]", a senior colleague on the same day, in the same London office, (S-UKGov2, author's interview, February, 2016) offered

[57] North Sea German Port with an offshore wind supply chain cluster

an insight into normative convention that stymied co-location: “Government never fully understands business so often leaves it to the market. We move around a lot and it takes time to develop such knowledge to make that call, therefore, there is often no [spatial] preference.” In effect, despite government leasing, consenting and subsidising the industry, it remained cautious about influencing or directing the locational decision making of the supply chain. Strikingly, at the regional level, competition between local authorities also undermined strategic co-ordination that may have channelled investors to locations that optimised regional economic impact. A local industry representative in Grimsby (H-O&M2, May 2016) observed:

> “People ignore what is happening round the corner. We’ve got Scunthorpe steel works nearby (twenty miles from AMEP) but we don’t give a sh*t, in part because of the rivalry between Hull and Grimsby, that is as much cultural as economic. There’s an aspiration of an integrated offer but it’s an aspiration”.

The aforementioned rapid technological consolidation also circumscribed the agency of government. Although significant UK state resources were deployed in the form of R&D support to facilitate the development of new turbine technologies to encourage transplantation of the related manufacturing activities, a UK civil servant (S-R3, January 2016), revealed:

> “In all the conversations [with foreign investors] innovation never played a major factor. It was enlightening for government that NAREC[58], the UK’s technological crown jewels, was not the case for most OEMs…. nor did R&D support push anyone over the line”.

Although, the UK state was attempting to influence the emergence of alternate technologies in order that more OEMs located their manufacturing and supply chains in the UK, which would have been to the benefit of AMEP, the adopted means to achieve this outcome were ineffectual. A manager within a technological innovation centre (G-RHE3, author’s interview, December 2015) reflected: “What’s even a few million pounds of government support in an industry that thinks in billions of pounds? Confidence in market and line of sight of subsidy encourages new technologies”.

[58] National Renewable Energy Centre, a significant UK state and EC investment in open access test infrastructure for offshore wind firms, based in Blyth in North East England

By the end of this episode, the 200ha AMEP site remained undeveloped. The absence of public funders and the decreasing number of OEMs to invest in the site, especially in relation to the quayside, ensured that the site remained undeveloped and a major barrier to transplantation was still in place at the end of this episode. Furthermore, although many state actors recognised the opportunity for clustering, their ambitions were negated by the laissez faire approach of the UK state and the vested interests of local development actors.

6.2.3 OEM anchor transplantation announced

The final analytical focus of path emergence on Humberside relates to Siemens' announcement in March 2011 that Alexandra Dock in Hull would be the primary location for its £160m turbine manufacturing investment which would create 1,000 jobs. Such mindful deviation by Siemens was predicated on expectations of reward generated by the favourable UK institutional context. In tandem, ABP, the monopoly port owner, committed to investing £150m in the reconfiguration of the derelict dock to facilitate the inward investment. Notably, the strategic agency and planning powers of national and local government were key to incentivising Siemens' selection of the site.

Siemens' decision to locate its investment on the relatively constrained 59ha dock site was according to an OEM manager (S-OEM1) based on "access to large offshore wind farms, availability of land, river access and logistics." Going on, the executive stressed the importance of geography over other factors: "It was the site that was important. Site and location…. [although] a stable regulatory regime is also very important". Tellingly, the interviewee recalled: "Siemens was going to the south bank [to AMEP] but the related capex[59] of £400 million for its development was such a massive cost that Siemens went away and rethought".

However, the role of government planning powers and procedures in influencing Siemens' specific regional investment location is also worthy of note. Significantly, Alexandra Dock was not only perceived as a lower cost option compared with AMEP but also one with more planning certainty. An OEM manager (S-OEM1) noted that ABP's possession of a consented change of use for Alexandra Dock to a container facility, approved by UK's Department of Transport in 2005 and a pre-existing

[59] Capital expenditure

Harbour Revision Order for the related harbour works, approved by the UK Government in 2006 (effectively an Act of Parliament), were recognised as advantageous for the speedy reconfiguration of the site.

As regards ABP's involvement, a manager in a port operator (H-PO1) revealed that the firm's diversification was also incentivised by both broader energy policy and possession of an approved change of use and consent for harbour works at Alexandra Docks:

> "(ABP) asked how long the coal industry will last. The size and location of Round 3 announcement [2008] was a wake-up call for ABP. [ABP] had a consented facility [Alexandra Dock]…. and started working closely with Yorkshire Forward and the Council…. [ABP] was acutely aware that Siemens was the market leader."

The site, although not rivalling the potential development scope of AMEP, was positioned as one that facilitated transplantation by providing an existing asset which was regulatory primed for reconfiguration at a lower cost (with a potential auxiliary site at Paull in nearby East Riding). In order to consolidate this locational advantage, a partnership between Hull City Council and ABP was formed in 2009, Green Port Hull. A director at a local council recounted (H-LA1):

> "We saw our advantage, we had an HRO [for Alexandra Dock], the flexibility to change use; we had a product that nowhere else in the UK could match. We [Hull City Council and ABP] went straight to Siemens [bypassing Yorkshire Forward], their initial response was there's not enough land, so we came back with the Paull site and the link road…. Site and planning considerations were drivers between Siemens and ABP…. and then we sold the other benefits of locating in the city - labour force, supportive organisations, transport….Yorkshire Forward was hell-bent on this [inward investment] going to the south bank to get a few firms on a big site …We pushed for this ourselves".

Soon after the Memorandum of Understanding was signed with Siemens, ABP submitted to Hull City Council planning applications for a facility at Alexandra Dock for the manufacture, assembly, testing and shipment of offshore wind turbines. Within months outline planning consent for the proposed development was granted by the

Council via a Local Development Order (LDO), a streamlined planning process to expedite the project.

Finally, it is worth observing that intra-Humber institutional competition made each local authority promote its own assets in isolation and there was limited joined up thinking on how Siemens' investment could catalyse other regional opportunities. Significantly, in 2010 it was announced that Yorkshire Forward would be abolished, thereby leaving only local authorities with "limited capacity, incentive or inclination for co-ordination" (cited by H-UKGov1, March 2016) and a less powerful Local Enterprise Partnership (LEP) to mediate the path's regional emergence. Such decreasing institutional thickness (Amin and Thrift, 1994b) would adversely influence agglomeration in the coming episode. Even so, at the end of this initial episode, Siemens proposed inward investment pointedly contributed to the emergence of a regional path narrative that was significant at the UK level.

6.3 Episode 2: Path Development, 2011 - 2014

In this second episode, the anticipated pace of path creation slowed and foreseen levels of private sector economic activity were unrealised in response to a changing institutional environment that constrained transplantation. Although by the end of 2013 there were nearly 200 O&M jobs[60] in Grimsby, the scale and quality of path creation was circumscribed, and on the opposite bank, a hiatus relating to the Siemens investment meant Alexandra Dock remained undeveloped (see fig 6.4). Additionally, a planning challenge by ABP ensured AMEP remained unutilised. Even so, such cross estuary competition was partially mitigated by a new pan-Humber renewables brand and the creation of a regional regulatory forum for the estuary, as part of a Humber City Deal. Moreover, the UK's largest Enterprise Zone was established in 2011 to create "a world class offshore wind hub"[61] (supported by Regional Growth Fund and Growth Deal monies).

[60] Based on figures provided by interviewees.
[61] DCLG, HM Government, 2011

Figure 6.4: Principal regional actors on Humberside 2011-14

During this episode, the above mentioned attenuation of firm-led agency was primarily caused by changes to the UK's policy and regulatory environment. A senior academic at Hull University with significant energy industry experience (H-RH1, author's interview, March 2016) observed: "The industry needs government subsidy but if you don't have long term stability in mandates and there's increasing uncertainty on policy, investors drop in and out and it's bad for innovation and the culture of risk…. and longer term investment cycles and planning". Growing uncertainty amongst firms created by changes to the broader state institutional environment, circumscribed their experimentation and strategizing, whilst promoting competition and caution. A local O&M service provider (H-O&M1, author's interview, March 2016) recounted: "It was all about commercial competition leading to friction and uncertainty rather than common good for the local economy. It felt as if things were in limbo".

The three key foci of enquiry for this episode of path development are: Siemens' delay in progressing transplantation in Hull; regulatory obstacles blocking valorisation of the AMEP site through transplantation; and ongoing but circumscribed development of transplanted O&M functions in Grimsby.

6.3.1 OEM postpones anchor transplantation

A three year hiatus following the announcement of Siemens and ABP's MoU is a key analytical focus for understanding path's development dynamics on Humberside. During this period, UK policy and regulatory changes led to the OEM reconsidering its transplantation plans for Humberside and placing them in the context of its wider European offshore wind supply chain. In turn, ABP and Hull City Council's engagement with the OEM became irregular and uncertain and local actors had limited leverage on wider policy and regulatory developments that were influencing industrial dynamics at the regional level.

Within six months of Siemens' investment announcement in 2011, the UK Government signalled a fundamental review of the costs of offshore wind by establishing the Offshore Wind Cost Reduction Task Force. A Treasury official recalled (S-Uk Gov3, author's interview, February 2016): "There was a sense that things were spinning out of control and [subsidy] commitments were going to splurge over…. The Treasury became more involved". Subsequently, in 2012 the UK Government announced that a new Energy Act would be introduced which would curtail subsidies for offshore wind projects. A manager in a port operator recounted (H-PO1, March 2016): "Siemens were seeing where CfD[62] was going…. Siemens wanted to make sure that they were comfortable and that an industry was going to emerge, that they had a market and an industry to serve". Additionally, a director within a local authority (H-LA1, July 2016) noted that an absence of long term regulatory clarity invoked concerns in Siemens about the related costs of developing the combined Alexandra Dock and Paul sites: "They [Siemens] needed assurance on the policy horizon to model their investment returns".

A UK inward investment official (H-UKGov2, February 2016) recounted that not only Siemens but other OEMs, such as Vestas, began to "pursue a pan-European industrial play…. OEMs that had considered building supply chains in each market [recognised it] couldn't be cost effective given the resulting scale of the industry". Specifically in regard to Siemens, another UK civil servant recalled "getting Siemens to Hull went round in circles for years.... going from a position of let's get Siemens and other OEMs and their supply chains to let's get Siemens as that's all there is. The Cost Reduction Task Force and the other changes sent the signal that cost

[62] Contracts for Difference, the proposed new auction based subsidy system

reduction was the imperative, not economic benefit". In short, nation state energy policy was having a detrimental impact on the ambitions of nation state industrial policy and regional policy (as reflected in the creation of the Humber's "Renewable Energy Super Cluster Enterprise Zone" in 2011).

Moreover, the emergence of a European supply chain combined with the need to rapidly scale up turbine sizes to make them more efficient made finalisation of Siemens' plans for Hull problematic. A manager in a port operator (H-PO1, March 2016) observed:

> "[It was] hard to know what Siemens wanted because technology and scale were happening so fast and [there were] different views within Siemens on design and purpose of the plant…. it was hard to get a design freeze for planning. Everything was moving quickly in terms of the technology and the supply chain given the push for larger machines to lower costs".

Recalling the OEM's hesitation in this episode, a director of a local authority (H-LA1, author's interview, July 2016) reflected:

> "After the memorandum of understanding was signed, Siemens went in to review mode…. they locked us out for six months and went in to radio silence…. We worked through the BIS regional office to emphasise to Whitehall how important clarity on [national] policy was".

Although the Council had a key role in the "nitty-gritty" of delivering the project on the ground, especially in regard to planning (cited by H-LA1, July 2016), the latitude of local government to influence the wider policy environment was seemingly limited. However, co-ordinating energy, industry and regional policies within and across Whitehall was also problematic. A Treasury official (S-UK Gov3, February 2016) cited ingrained impediments to achieving aligned policies:

> "One of the things you'll see if you talk to a lot of people in Whitehall, if there is a [policy] problem there will be eleven different groups to solve it and nine different ways…. [For example, in terms of national infrastructure] there's a construction team in BIS, there's a Government construction strategy run out of Cabinet Office and there's the work of Infrastructure UK [The Treasury]. But there is no reason why this shouldn't join up and be co-ordinated but BIS has a different agenda from Cabinet office and to us [The Treasury]."

In summary, attenuation of Siemens' transplantation activity on the Humber's north bank demonstrates the causal power of extra-regional institutions in mediating the activation and deactivation of path creating agency and related mechanisms to valorise assets at the local level. Moreover, it would appear that local actors had limited influence on shaping such institutional change, whilst national state actors were not fully sighted on or cognisant of the spatial consequences of interacting policies.

6.3.2 Utility firms accelerate transplantation

This final analytical focus pertaining to the regional path's realisation relates to the increasing levels of investment by offshore wind project developers. By end of this episode four offshore wind projects close to Humberside were generating electricity - Lincs, Lynn and Inner Dowsing, Humber Gateway and Westermost Rough. Additionally, the Racebank and Triton Knoll projects were progressing towards construction and the massive 5GW Hornsea Zone was leased. Despite an increasingly uncertain UK policy and regulatory environment, this internationally significant project pipeline generated sufficient expectation of reward amongst project developers to incentivise further investment in Grimsby's port assets.

In 2014, Dong invested £11.5million to reconfigure shore side and marine facilities at Grimsby's Royal Dock to support the construction of Westermost Rough wind farm and accommodate the operation of three O&M vessels from the facility. In 2015, the Danish energy company also announced that it would construct the Race Bank windfarm from the Grimsby Fish Dock and that the port would be used as the O&M base for the 5GW Hornsea development as part of a projected £6 billion investment in the region's industry. In addition, E.ON's O&M base for its Humber Gateway project, deploying MHI Vestas turbines, was established at the Fish Dock in 2014, accommodating four O&M vessels. By the end of 2015, such activities supported approximately four hundred local jobs and circa 30 vessels which made 4,000 O&M trips per year[63].

These investments and the related transplanted technologies also facilitated the successful diversification of regional firms. For example, in 2014, Humber based Rix Sea Shuttle had its fleet of new support vessels fully utilised for O&M and

[63] Based on author interviews

construction activities. In the same year, a Grimsby firm, Anglia Engineering Solutions, won a multi-million-pound contract to supply fabricated and machined components for offshore wind cabling. To support such diversification, the Grimsby Renewables Partnership, a local business forum with one hundred members, was officially launched in 2015 to encourage local sourcing.

By the end of the episode, a director of the local Council observed of the transformation of Grimsby port and the role of local state agency in its ongoing reconfiguration:

> "We had an absolutely transformed port estate, no longer run down and dependent on storage, vehicles and timber….(with) a very different offer for developers and [inward] investors…. with food companies that no longer needing quayside being helped to move to other sites to allow O&M. [The Council is] getting Growth Deal monies for managed workspace for local firms. ABP have now taken over contracting and contracts from Grimsby Fish Dock Enterprises and they've done a draft port masterplan…. that they haven't shared with us but they are coming to talk to us".

The above quote alludes to both the causal path creating interplay of actors, assets and mechanisms but also highlights the ongoing power of a monopoly asset owner, ABP, in determining this process.

6.3.3 Disruptor's diversification stalls

In this episode, the absence of private investment at AMEP is a notable analytical focus for understanding the dynamics of path development on Humberside. Although the site represented the only regional location that could accommodate multiple inward investors, extra-regional policy and regulatory dynamics were mitigating its necessity. The fortunes of AMEP in this episode are also worthy of consideration as they illuminate how regional rivalry unchecked by inadequate regional institutional capacity and power constrained regional industrial path evolution.

The causes of path attenuation and related site investment at AMEP were offered by a director of Able UK (H-PO2, June 2016):

> "The developers were scared by the bidding pressures for subsidy and the need for cost cutting to get it…. and supply chain firms from Europe did not want to set up in the UK and take the risk, and there were few British

> companies that wanted to partner them. The cost of energy, the CfD, is based on a project by project basis, so there is no incentive for Vestas to have a nacelle plant, which is really what our site is about and there is no reason for Dong to make a major ten year commitment. The problem is that CfD makes developers and supply chain think on a project by project basis. Bottom line is each project has its own mobilisation costs, set up costs.... discrete costs. They're not part of a framework. Not even Siemens has been given a proper framework contract that gives certainty and transparency. Everything is bespoke and in isolation. What's the return for the UK?"

This changing institutional environment and related market uncertainty caused Siemens, the only OEM to have committed to transplantation, to hesitate over its preferred Alexandra Dock location; thereby keeping other locational options in play. A local development manager (H-RDA, March 2016) mused: "At that time Siemens could have gone south of the river if they felt it best suited their corporate interests. It was only an MoU with Siemens and ABP". It was a possibility that fostered significant friction between the incumbent actor, ABP, and, the new entrant, Able UK. In 2011 Able UK submitted a planning application for the development of the AMEP site and in 2012 the Infrastructure Planning Commission (the UK Government body for reviewing projects of national significance) announced that it would consider the proposal. In 2013, concerns regarding the environmental impact on bird habitat were raised by Natural England and the RSPB. In turn, Able UK responded with a proposed £30 million habitat mitigation scheme, thereby placing additional costs on valorising the green field site. However, just as resolution seemed achievable, ABP objected on the grounds that the project conflicted with its plans for a deep water jetty on the south bank. It was the start of an acrimonious legal process that would not be resolved until a Special Parliamentary Committee rejected ABP's objection in October 2014. Whether by default or design, ABP had kept Siemens committed to the north bank by neutralising locational choice on the Humber. Such seeming vested interest ensured that AMEP's potential for creating a cluster like "Bremerhaven" was obstructed at a time when a window of locational opportunity remained open. The acrimony between ABP and Able UK led to the firms' representatives being ejected from the Humber LEP Board, the successor to the RDA. It was a clear example of the limited institutional thickness on Humberside, whereby the collective could not arbitrate exclusive interest.

In summary, the dynamic UK regulatory context, with its emphasis on cost cutting and competition, disincentivised developers and supply chain firms from experimentation and long-term investment, leading to an absence of potential investors for the AMEP site. This curtailment of firm agency combined with seemingly rent seeking behaviour by the region's key asset owner, ABP, undermined potential co-location and clustering opportunities on Humberside; the solitary region in the UK to have seemingly secured transplantation of an OEM turbine manufacturing plant. Consequently, AMEP – the only site that could accommodate industrial agglomeration within the region - remained un-reconfigured in this episode and the following.

6.3.4 Utility firms continue transplantation

This analytical focus in regard to the path's development relates to the gradual expansion of O&M functions and employment at Grimsby linked to the continuing build out of offshore wind projects in the North Sea. These modest and intermittent O&M investments were shaped by an interplay of exogenous and endogenous institutional factors. However, this analytical lens also reveals how the nature and quantum of these functions and jobs were circumscribed by wider sectoral and technological dynamics and the dominance of a limited number of firm actors.

In this episode, the Humber estuary was in geographic proximity to seven designated offshore wind sites that were consented to developers by the UK Government, totalling over 7GW. Of these seven projects, five had secured support via the non-competitive ROCs subsidy (Lynn and Inner Dowsing, Lincs, Westermost Rough, Humber Gateway and Race Bank) thereby maintaining the activation of developer agency. However, although these projects were awarded leases under the Crown Estate's leasing rounds of 2001 and 2003, the long lead in times for planning, design and development meant that only two O&M bases had been established by 2013 (Centrica's O&M Grimsby bases for its Lynn & Inner Dowsing and Lincs projects).

Even so, despite an emerging less benign national policy landscape, the future remained relatively positive given the pipeline of projects with confirmed subsidy. In late 2013 RES, an O&M firm, confirmed construction of a dedicated facility for twenty engineers at the Fish Dock and E.ON, another of the UK's "Big Six", indicated that it would use the port as its east coast O&M base, creating fifty jobs. Both decisions were predicated on the completion of the upgrade of Fish Dock lock gates in 2013,

enabled through £500,000 of funding by North East Lincolnshire Council. In addition, Dong, the Danish publicly owned utility firm, announced an investment of £11 million[64] to reconfigure Grimsby's Royal Dock for the transplantation of O&M and construction functions for Westermost Rough Offshore wind farm.

Significantly, the character of Grimsby's O&M function was not only defined by its gradual formation but also by its circumscribed quality, a consequence of the developers' procurement choices. Centrica purchased Siemens turbines for both its Lynn and Inner Dowsing and Lincs offshore wind projects, as would other developers moving towards installation. However, Siemens was not only selling offshore turbines but also the ongoing technical support. Consequently, the higher value aspects of the O&M process were retained by Siemens. A former O&M manager (H-O&M2, May 2016) illuminated the inherent shortcoming of this O&M model for creating local high value jobs and preventing Grimsby becoming a low value node in the industry's wider division of labour (Bathelt et al, 2004; Coe et al, 2008):

> "90% [of O&M staff] live locally, lots come from Hull and commute. 10% are the Danish guys doing specific tasks such as a gearbox that has developed a vibration and that has been picked up in the monitoring centre in Denmark and then they despatch the very experienced guys. Two very clever guys then come over to use some very clever kit to find out what is going on and that the local manager may not even know about their despatch. Most of the local [O&M] guys undertake the routine servicing and maintenance. The local turbine technicians are the car mechanics who do the annual service, next technical step up is the person from Siemens, the top guys, the trouble shooters who make the money from the company, who can compare problems – 'Oh! We've seen this before on the east coast or in Denmark'…. Then the problem is you [the developer] have to buy spares from Siemens. You can't go far in your career, unless you're with Siemens. It's like a car dealership. Siemens do the turbine monitoring and the technically rich stuff. You only develop deep technical know-how if you work with Siemens".

Although by the end of this episode firm-led investment triggered by a benign institutional environment had further valorised Grimsby's port and adjacent natural

[64] With a contribution of £1.5million from the UK's Regional Growth Fund

resources, the path's development was slow and the resulting scale limited, reflecting both the time lag in the industry's project life cycle and uncertainty about the future policy and regulatory environment. Moreover, supply chain consolidation and related increasing technological path dependence that was a product of the UK state's growing emphasis on cost-cutting circumscribed the scale and quality of the path, especially in terms of the O&M function, the main focus for path employment. Strikingly these institutionally induced firm dynamics were occurring at a time when the government created the UK's largest Enterprise Zone in the region to promote and capture the presumed economic and industrial development opportunities of offshore wind.

6.4 Episode 3: Path Realisation, 2014 - 2015

During this episode of realisation, there was a revival of path growth. Whilst firm-led agency was more constrained than had been previously anticipated, largely as a consequence of changes to the extra-regional institutional environment, investment and reconfiguration at Hull's Alexandra Dock and Grimsby's port occurred on a notable scale (see fig. 6.5). This was accompanied by a pragmatic acceptance by state economic development actors that UK institutional changes made further significant inward investments and large-scale clustering unlikely in the short to medium term. The episode is also notable for the UK government becoming the sole state interlocutor with Siemens.

A local economic development manager (H-RDA, March 2016) summarised the altered nature of state expectations about path realisation in this period:

> "I've been in post four years and my view on what the industry is going to be has changed. Is it a cluster or parts of a supply chain? Our interpretation of its trajectory has changed rapidly over five years, probably due to initial naivety. Siemens is here but the majority of enquiries are about installation and O&M. Grimsby has seen investment in O&M and will only grow but now looking at £10m projects…. not £400m manufacturing projects."

This more modest, albeit positive, path outcome in terms of investment and job creation[65] was a consequence of changing nation state "rules" and consequent firm

[65] 1,000+ direct jobs related to the path by the end of this episode - based on figures provided by interviewees

uncertainty. Recalibrated expectations dis-incentivised supply chain firms to transplant their functions to Humberside, whilst incentivising the creation of European supply chains built around a few oligopolistic like principal actors, primarily Siemens and Vestas. However, in this period, there is also evidence of state actors attempting to mediate the path's development in terms of scale and quality via regulatory means and the development of local innovation capacity.

Figure 6.5: Principal regional actors on Humberside 2014-15

There are two key foci for exploring the realisation of the regional industrial path. These are: Siemens progression of its Investment at Alexandra Dock in Hull; and increasing investment in Grimsby Port in order to accommodate growing O&M and construction activity.

6.4.1 OEM anchor transplantation rescaled

A key analytical focus for understanding the path's realisation relates to Siemens decision in 2014 to commence construction of its proposed manufacturing facility at Alexandra Dock. Although the investment would still create 1,000 jobs, the facility's functions were notably scaled back to align with the OEM's wider European supply chain plans. Moreover, the power of local state actors to influence such decision making was notably limited, whilst the UK Government assumed the role of principal state interlocutor with the OEM in this episode. Finally, this analytical focus exposes

the challenge of creating a regional cluster and upgrading the quality of the regional path, in the face of changing extra-regional sectoral, technological and institutional dynamics.

Siemens' confirmed investment, announced in March 2014, was to be focused on the transplantation of technology for the manufacture of 75m blades for the new Siemens 7MW turbines, a labour intensive but relatively non-technical production process, and deployment and installation functions. This decision was predicated on the OEM's wider European supply chain plans. There was to be no turbine assembly on Humberside as previously proposed, rather that investment was to occur on the opposite side of the North Sea in Cuxhaven, thereby further entrenching Germany's higher value position in the industry's international division of labour. In late 2014, Siemens' subsequently revised its plans for Humberside focusing them solely on Hull's Alexandra Dock site, avoiding costly valorisation of the larger Paull site. It was a decision that signalled that subsequent opportunities for supply chain co-location were deemed limited by Siemens. An OEM manager (S-OEM, August 2016) recalled the corporate pragmatism that underpinned this decision:

> "It's a European supply chain. Siemens' is a world-wide business…. the UK is not their only business. Yes, local content is important but blades make sense. Denmark, UK and Germany represent a nice European foot print for Siemens. Factory foot print is good, therefore there's local content in all [principal] markets. Hull will supply Europe and early US projects with blades. It's our big blade facility….. The existing Danish operations is not suited for 75m blades and has already had 13 extensions in nine years."

Interviewees illuminated the interplay of changing policy and regulation with corporate decision making in shaping this outcome. A former senior UK Government regional official (H-UkGov1, March 2016) recalled:

> "We got ourselves in to contortions over state aids that could be offered….in the end no options emerged that could compensate for CfD uncertainty and therefore Siemens de-risked by scaling back plans…. focusing on blades."

A related consequence of changing policy and regulation was reinforcement of oligopolistic characteristics of the industry and its technological path dependence, both at the UK and European levels, which privileged incumbent firms which could

deliver required cost reductions premised on economies of scale. Moreover, such limited firm and technological diversity reduced the opportunities for the emergence of regional clusters. By the end of this episode, Siemens dominated UK turbine purchases with its new 7MW turbine model; whilst only a handful of developers led the deployment of the offshore wind farm projects, with the state owned Danish firm Dong accounting for nearly one third of UK developments. An OEM manager (S-OEM, August 20016) reflected that:

> "Due to the unintended consequences of electricity market reform [CfD] by default we have reinforced incumbents who are big enough to put a problem right…. it's almost impossible to bring something new to the market".

This lack of state prescience on the consequences of nation state regulation for industrial and regional policy was observed by a Treasury official (S-Uk Gov3, February 2016) who contended:

> "We get the market we reward. We accept the status quo but expect radical change. A portfolio approach would have encouraged the emergence of offshore wind [manufacturing and operations] hubs around the coast but the market operates in a way that militates against such benefits. The CfD competitive process drives counter intuitive disbenefits…. the consequences of the auction system minimise opportunities for collaboration and shared innovation between developers. We're looking at project specific solutions rather than east coast solutions."

In further considering the consequences of the state's changing regulatory framework for industrial agglomeration and co-location relating to Siemens's investment, an OEM director (H-OEM, March 2016) observed:

> "I've worked with them all [tower manufacturers considering Humberside] recently and it requires a £50m investment but you need clarity regarding the market to 2020 beyond, you need to be able to take the bigger picture.... to make these commitments. This is not something for the faint hearted."

However, it can be demonstrated that the absence of clustering was not solely due to insufficient state generated expectation of reward and the emergence of a European level oligopolistic value chain. A local government interviewee (H-LA1, July 2016) also cited secondary local supply side constraints: "Also skills was emerging as a

huge issue. Tower manufacturers required skilled fabrication and tractor welding skills not available on the necessary scale." Moreover, the limited number of sites that could be reconfigured with minimal cost to accommodate co-location was problematic. Given development of the auxiliary Paull site adjacent to Hull entailed a minimum £20 million investment and AMEP's associated enabling costs were even higher, there were no low cost co-location options on Humberside. Such entry costs deterred supply chain investors. For example, although it had been assumed by government actors that CS Towers, a South Korean turbine tower manufacturer would locate on Humberside, the firm in 2015 purchased a tower manufacturer on the opposite side of the UK on the Kintyre peninsula. In an uncertain market, the South Korean company was more willing to locate on the west coast of Scotland and incur shipping costs rather than significant infrastructural costs that it might never recoup.

Before going on to explore how state actors attempted to influence path quality, it is useful to note the direct role of the UK state in influencing Siemens' investment decision, thereby exposing the relative limited power of regional state actors in this episode and an ongoing lack of joined up and stable industrial policy. Regarding Siemen's investment decision, one senior LEP Board member (H-OEM1, March 2016) recalled: "Cameron [the Prime Minister] was dealing with it by the seat of his pants…. on the phone to them a lot….the Government gave a soft landing to Siemens". If a soft landing was provided, the terms of the deal remain undisclosed. Even so, the quote exposes how Siemens' decision was prompted by last minute transactional deal making rather long-term institutional frameworks that generated stable expectations and confidence (thus accounting for The Financial Times observation that Siemens' decision was surprising given disquiet surrounding UK energy policy[66]).

To close this focus of enquiry, it is also useful to observe that state actors attempted to mediate the path's size and quality by firstly utilising national regulatory powers and then secondly by building local innovation capacity. Thus, in a belated attempt to utilise regulatory powers to develop the UK supply chain, the new CfD subsidy framework required bidders to also submit a supply chain plan detailing how they

[66] Financial Times, 24 March, 2014

intended to optimise UK content in their projects. A UK civil servant (S-UKGov4, February 2016) recalled:

> "The Government [originally] took a decision that it was not worth sacrificing its open for business philosophy for a big part of the offshore wind supply chain. We made the decision not to emphasise UK content but the wider changes [the downturn in the UK's oil and gas and steel sectors]…. and recognition that we were a global leader in offshore wind generation but did not have an equitable share of the economic value, changed things."

However, an industry representative (S-OEM, August 2016) observed: "Government thinks if it shouts louder, [the UK] will get more local content but don't understand that the only thing that effects the supply chain is the [project] pipeline". Even so, despite such sentiment, it was accepted by many Humberside and London interviewees that the introduction of a regulatory obligation to increase UK project content was a contributing factor in Siemens belated decision to invest in Hull.

Secondly at the regional level, state and university actors attempted to mediate path quality by developing local innovation capacity. At the end of this episode, plans for a regional Open Access Innovation Centre (OAIC) were emerging. However, there was limited clarity on the role of the facility given limited overlap between a limited local research capability and the requirements of Siemens and a sector that exhibited increasing levels of technological path dependence (Boschma et al, 2017). A manager in Offshore Renewable Energy Catapult (H-RHE3, December 2015) observed:

> "How do you apply a strictly offshore local innovation agenda to Siemens, who are interested in labour costs, logistics, handling, productivity and automation of production in Hull? This is about cost cutting. They [Siemens] have a lot of in-house research capability and existing relations".

The complexity of linking industrial development with regional innovation capability was also recognised by a government funded regional R&D manager (H-RHE2, August 2016):

> "There was not a lot out there [in terms of local supply and demand]; the interest, ability, vision was just not there locally. We need to engage with corporates first, the Siemens' and Dongs, and understand their needs and

then work with the university. However, a big challenge is displacing R&D from Denmark to Humberside; there was a feeling of threat to the Danes. They didn't want to lose control".

In conclusion, Siemens' eventual confirmation of its investment in Hull represented a significant fillip for the new regional path. However, it was an investment that was circumscribed by changing extra-regional institutional and related corporate and technological dynamics. Moreover, the transplantation of new but routine technology did not represent a catalyst for supply chain co-location and clustering. However, the reasons for this are not only due to the institutional environment in which the path was embedded but also deficiencies in the regional asset base, relating to infrastructure and skills. Also, attempts by state actors at stimulating path upgrading, once the limitations of transplantation-led path creation were exposed, were belated and circumscribed.

6.4.2 Utility firms accelerate transplantation

This final analytical focus pertaining to the regional path's realisation relates to the increasing levels of investment by offshore wind project developers. By end of this episode four offshore wind projects close to Humberside were generating electricity - Lincs, Lynn and Inner Dowsing, Humber Gateway and Westermost Rough. Additionally, the Racebank and Triton Knoll projects were progressing towards construction and the massive 5GW Hornsea Zone was leased. Despite an increasingly uncertain UK policy and regulatory environment, this internationally significant project pipeline generated sufficient expectation of reward amongst project developers to incentivise further investment in Grimsby's port assets.

In 2014, Dong invested £11.5million to reconfigure shore side and marine facilities at Grimsby's Royal Dock to support the construction of Westermost Rough wind farm and accommodate the operation of three O&M vessels from the facility. In 2015, the Danish energy company also announced that it would construct the Race Bank windfarm from the Grimsby Fish Dock and that the port would be used as the O&M base for the 5GW Hornsea development as part of a projected £6 billion investment in the region's industry. In addition, E.ON's O&M base for its Humber Gateway project, deploying MHI Vestas turbines, was established at the Fish Dock in 2014, accommodating four O&M vessels. By the end of 2015, such activities supported

approximately four hundred local jobs and circa 30 vessels which made 4,000 O&M trips per year[67].

These investments and the related transplanted technologies also facilitated the successful diversification of regional firms. For example, in 2014, Humber based Rix Sea Shuttle had its fleet of new support vessels fully utilised for O&M and construction activities. In the same year, a Grimsby firm, Anglia Engineering Solutions, won a multi-million-pound contract to supply fabricated and machined components for offshore wind cabling. To support such diversification, the Grimsby Renewables Partnership, a local business forum with one hundred members, was officially launched in 2015 to encourage local sourcing.

By the end of the episode, a director of the local Council observed of the transformation of Grimsby port and the role of local state agency in its ongoing reconfiguration:

> "We had an absolutely transformed port estate, no longer run down and dependent on storage, vehicles and timber….(with) a very different offer for developers and [inward] investors…. with food companies that no longer needing quayside being helped to move to other sites to allow O&M. [The Council is] getting Growth Deal monies for managed workspace for local firms. ABP have now taken over contracting and contracts from Grimsby Fish Dock Enterprises and they've done a draft port masterplan…. that they haven't shared with us but they are coming to talk to us".

The above quote alludes to both the causal path creating interplay of actors, assets and mechanisms but also highlights the ongoing power of a monopoly asset owner, ABP, in determining this process.

6.5 Character of the Path and Effect on Regional Development

By the end of the third episode over 1,000 direct local jobs[68] were associated with the path, concentrated in the nodes of Hull and Grimsby on opposite sides of the Humber estuary. The south bank was synonymous with the transplanted routine functions of O&M and deployment and the north bank with the transplanted routine functions of

[67] Based on author interviews
[68] Based on figures provided by interviewees

turbine blade manufacturing; such industrial partition seemingly echoing the Humber's bisected economic and institutional history. The regional offshore wind path that had emerged was recognised as significant at the UK and European levels. Alexandra Dock was an important but lower value production and installation node in Siemen's European supply chain and Grimsby port had a globally significant concentration of standardised functions for supporting the exploitation of the adjacent natural resource. However, the varied proximities - cognitive, organisational, social and institutional (Boschma, 2005; Bathelt et al, 2014) – associated with higher value manufacturing and support functions, which were pronounced in the manufacturing hubs of the industry in Denmark and Germany, were not manifest on Humberside.

Therefore, by end 2015, the path that had been created, primarily through the mechanism of transplantation, had characteristics associated with both a branch plant economy and an extractive economy The Humber had developed an industrial path seemingly unrelated to its knowledge base and institutions by being the recipient of a disruptive dominant technology from a global system (Boschma et al, 2017). However, local firm and government actors had limited influence on the extra-regional institutions and technologies that had created the wider sectoral path, thereby having only partial power to ultimately control the valorisation of regional assets and the unfolding of the path, a feature synonymous with a branch plant economy. Moreover, the path's anchoring in the region was predicated on inward capital flows and legitimisation of extra-regional technology by primarily non-indigenous actors to exploit and valorise adjacent natural resources, analogous to an extractive economy, rather than on local knowledge mobilisation or creation (Binz et al 2016). By developing a path largely unrelated to its technological past, there was limited scope for pre-existing innovation capability to enhance the quality of the path through diversification, indigenous creation, transplantation of higher value supply chain activities or influence the rapidly consolidating technological regime's development. Therefore, higher level skills, functions and authority were predisposed to occur outside the region rather than in it, as evidenced by the concentrations of local lower value O&M jobs on the south bank and the routinized process manufacturing jobs on the north bank.

Although Humberside was more than just a receptacle where economic activity was played out (Scott, 1998; Pike et al, 2007; Hudson, 2007) or a passive arena

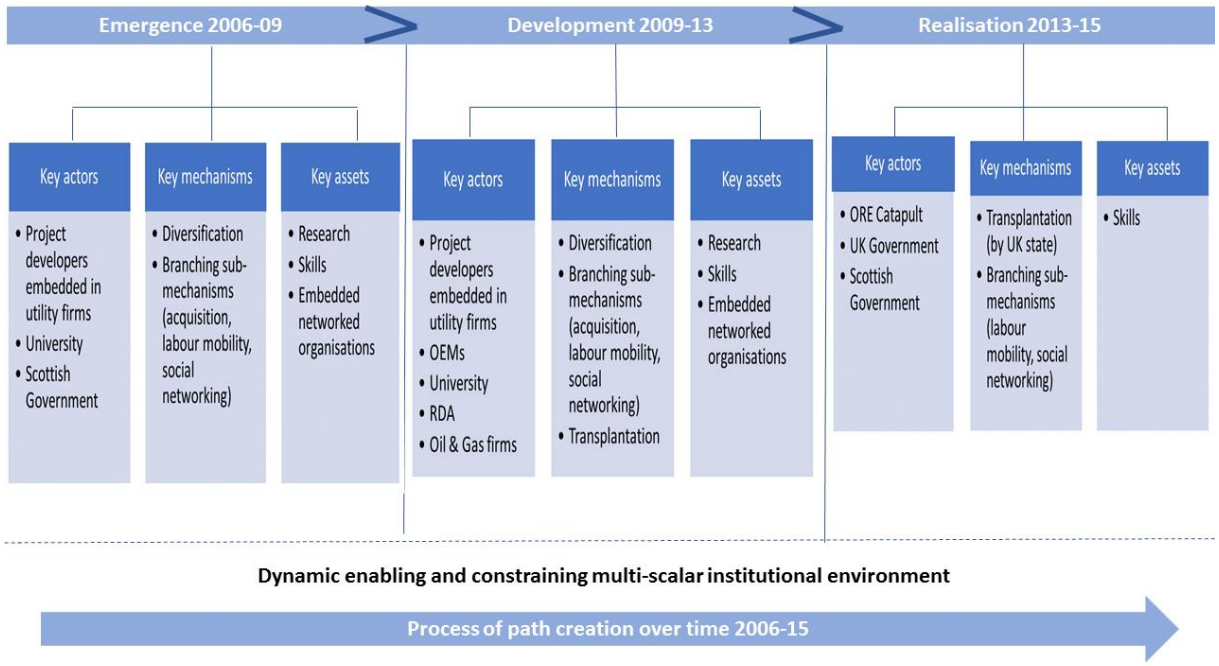
reshaped by national and international capital flows (MacKinnon, 2014), the region like so many lagging regions (Pike et al, 2007; Crescenzi and Rodriguez-Pose, 2011) did not possess sufficient power or outward facing networks for it to become a global centre of high value offshore wind expertise and functions, akin to Bremerhaven or Aberdeen with oil and gas (the cited ambition of a number of Humberside interviewees). The agency of local path actors was largely activated, mediated and bounded by extra-regional forces on which they had limited influence. Where the agency of government actors could have made a difference through the complementary development of sites on opposite banks of the Humber to facilitate clustering and co-location, there was insufficient institutional coherence, an enduring characteristic of the region's path dependence, to mediate the agency of a dominant monopoly asset owner and new regional firm entrants, as evidenced by the absence of co-location at AMEP and Paull.

Therefore, the region did not break from an economic past characterised by lower skills, wages and authority related to the exploitation of natural resources, as with fishing and agriculture, and lower value intermediary functions associated with the region's traditional dependence on carbon related and food processing industries. It is an eventual outcome that indicates a discernible level of related variety (Neffke et al, 2011) and path dependence between the new path and the established lower value industrial base from which it emerged. Therefore, the high quality jobs called for by the IBM and IEDC report commissioned in 2006 went unrealised.

6.6 Summary

The creation of Humberside's offshore wind path was the product of the novel knowledge of energy transition fusing with unique regional assets. The degree of fusion was contingent on the interplay of mutable aggregations of actors, mechanisms and regional assets, which was pointedly mediated by the multi-scalar institutional environment. These shifting aggregations and their interplay, occurring in unique temporal and spatial contexts, led to three discernible episodes of path creation over a decade – path emergence, development and realisation (fig 6.6). At the outset, the growing number of nearby Crown Estate leased offshore wind sites which were likely to receive UK state subsidy privileged Humberside as a prime location for O&M and supply chain inward investment. However, the time lag caused by the industry's project life cycle led to slow and muted valorisation of regional

assets. Also, a lack of regional institutional thickness meant that supply chain opportunities were pursued in a competitive rather than a strategic manner across Humberside's localities. This outcome was largely a consequence of ABP's near monopolistic position apropos the estuary's development and limited regional state power. Intra-regional competition and AMEP's associated valorisation costs, the only regional site that could accommodate significant co-location, led to Siemens selecting Alexandra dock for its manufacturing facility. Subsequently, uncertainty about the direction of UK Government policy and regulation led to a hiatus in Siemens' investment plans and related supply chain investments. Although region wide path planning and promotion became more evident, this did not constrain ABP from obstructing AMEP's development through a planning challenge. Even so, the path experienced resurgence as projects that had received subsidy were installed in the North Sea. This was on sufficient scale for Siemens' to progress its investment, albeit scaled back. Nonetheless, given the restructuring and consolidation of the industry at the national and European levels there were less opportunities for supply chain or higher value functions locating on Humberside.



Source: Own elaboration

Figure 6.6: Humberside's timeline of episodes of path creation

Chapter 7: Comparative Analysis

7.1 Introduction

This chapter contrasts the empirical evidence generated by the case studies and in doing so responds to calls for greater comparative analysis in evolutionary economic geography research (Boschma and Frenken, 2009; Coe, 2010; Gertler, 2010). By comparing key causal episodes in both cases, qualified and cross-referenced analytical observations can be drawn from the empirical evidence regarding path creation as it unfolds over space and time in differing regional contexts (Pike et al, 2016b). Specifically, the chapter will compare the path creating interplay of actors, assets and mechanisms caused by the stimulus of offshore wind in Glasgow and on Humberside. In particular, the research contrasts the role of multi-scalar institutions, especially those relating to the state, in enabling and constraining this interplay and the resulting timing, scale and nature of path creation. In doing so, the missing link (Dawley et al, 2015) regarding how institutional environments enable or constrain path creation and related agency will be addressed.

Reflecting the “path as process” conceptualisation (Martin, 2010), the chapter is structured around the three observed episodes of path creation in Glasgow and on Humberside. For each of these, the relationship between the stimulus of energy transition and path creation will be considered and compared. Consequently, there will be exploration of how extra-regional institutions enabled or constrained the path creation process in each episode, before consideration of the influence of regional institutions. Finally, a summary will consider the interplay of the extra-regional and regional institutional environments in shaping path creation in the respective case episodes; thereby providing insight to the inter-related effect of exogenous and endogenous institutional forces on the phenomenon. The chapter concludes with a comparison of the character of the resulting paths and their effect on the respective regional economies, before a synopsis of the comparative observations pertaining to the three episodes of path creation.

Notably, the comparative approach endorses the theoretical notion of path evolution as an ongoing process of change and continuity that occurs as differing actors attempt to deviate from the past by experimenting and strategizing in the present to achieve future outcomes (Martin, 2010; Steen, 2016; Evenhuis, 2017). However, the

empirical results promote refinement of Martin's model of local industrial change (2010) indicating that the struggle between continuity and change can create differing causal episodes within the period of path creation itself, thereby illuminating a more conditional, open and punctuated process. Therefore, the empirical evidence identifies a need for finer grained path analysis. Table 7.1 below identifies the three observed episodes of path creation in Glasgow and on Humberside around which this comparative chapter is structured.

Glasgow	Humberside
Path Emergence, 2006-09	**Path Emergence, 2006-11**
Path Development, 2009- 13	**Path Development 2011-14**
Path Realisation, 2013-15	**Path Realisation, 2014-15**

Table 7.1: Episodes of path creation in Glasgow and Humberside

7.2 Path Emergence Episode

7.2.1 The interplay of transition with assets, actors and mechanisms

This section will compare the relationships between socio-technical transition and key components of path creation. By adopting a comparative approach, four significant observations are revealed. Firstly, the interplay between path actors, assets and mechanisms was triggered by the transition to offshore wind and their subsequent interplay regulated the scale of path emergence. Secondly, the interaction of new knowledge with pre-existing regional assets and conditions, predisposed the principal mechanism of path creation in both regions. Thirdly, although a small number of firms and related mechanisms were observed as the primary causes of path emergence, other actors and mechanisms were evident, revealing levels of causal importance. Finally, there is evidence that the agency of regional state actors was not an essential pre-requisite for path emergence. Where the activity of such actors was conspicuous, it related to the important but auxiliary role of priming regional assets for firm valorisation.

Firstly, in both regions the triggering of the path creation process was caused by the broad, instituted and disruptive process of energy transition relating to the introduction of offshore wind to the UK's energy system. This largely exogenous stimulus acted as a catalyst for path creation in both regions based on the interaction

of actors, assets and mechanisms. This exogenous stimulus encouraged the utilisation of novel knowledge at the regional level which allowed path-related actors to break from their past via innovation. Such novel knowledge represented the integration of new and existing knowledge (i.e. terrestrial technologies, business models and processes adapted for an offshore context). In Glasgow such knowledge primarily related to offshore wind project appraisal, planning and deployment, whereas on Humberside it related to the routine processes of O&M and manufacture. In particular, in the case of Glasgow, the mixing of exogenous and endogenous sources of knowledge to create novel knowledge infers a complex causal interplay that is not always evident in the literature (Martin, 2010; Karnoe and Garud, 2012; Cooke 2013).

Moreover, the scale of interplay between actors, assets and mechanisms determined the level of utilisation of novel knowledge in each regional economy, thereby determining the degree of industrial change and continuity. This reflects the theoretical contention that an economy's past is linked to its future through innovation (Archer, 1996) and that the degree of innovation informs the degree of change (Cooke, 2002; Howells, 2005; Morgan, 2007). Therefore, the causal significance given to novel knowledge and innovation in path creation literature is borne out (Martin, 2010; Boschma et al 2017). However, the findings also indicate that the relative marginalisation of extra-regional stimuli for engendering novel knowledge, innovation and industrial renewal in the literature remains a theoretical shortcoming (Essletzbichler, 2012; Coenen et al, 2015; Trippl et al, 2017).

Secondly, the interaction of novel knowledge with pre-existing regional assets and conditions, predisposed the primary mechanism of path creation. In Glasgow it was observed that preformation assets of "value and rareness" (Maskell and Malmberg, 1999) - skills in electrical power generation and distribution, associated research and training, and locally embedded networked organisations - fused with novel knowledge to select diversification as the primary mechanism of path emergence. Thus the path's emergence from a pre-existing regional electrical utilities industry aligns with the notion of path branching associated with related variety (Martin and Sunley, 2006; Boschma and Frenken, 2009). Alternately, on Humberside, given an absence of technological antecedence, novel, primarily exogenous, knowledge fused with regional assets - natural resources, physical infrastructure, and maritime,

logistics and processing skills – to select transplantation as the principal mechanism of emergence (Martin and Sunley, 2006; Dawley 2013). Tellingly, in contrast with Glasgow, it was this interaction which created assets of “value” on Humberside (Maskell and Malmberg, 1999). Therefore, it can be inferred that the worth of regional assets is mutable, not static. Therefore, binary accounts of regional potential, such as positive and negative path dependence (Boschma, 2008; Stam and Garnsey, 2009; Martin, 2010) are arguably overly deterministic.

Thirdly, in terms of actors, case comparison reveals that the principal mechanisms of diversification and transplantation denoted the relative importance of path actors. Correspondingly, in Glasgow, project developers based within large electrical utility firms led path emergence, acting as key conduits of novel knowledge for other regional actors including higher education and consultancies. In the case of Scottish Power, its role was augmented by its acquisition by Iberdrola, not only increasing the regional actor’s access to new knowledge but also investment and markets. On Humberside, given the absence of industrial antecedence, the primary actor of path emergence was unrelated to the region. As in Glasgow, an electricity utility firm acting as a project developer represented the primary bearer of novel knowledge and the principal agent in valorising regional assets. In contrast though, the developer, Centrica, was focused on transplanting the post deployment function of Operations and Maintenance for a small offshore wind farm, thereby constraining the scale of fusion between novel knowledge and regional assets. In turn, the significance of transplantation as the principal mechanism of Humberside’s path emergence was underscored by Siemens’ proposal to invest in Hull. Although undergoing very different path creation processes, both cases reflect the theoretical contention that regional industrial change is dependent on access to and alignment of novel knowledge, investment, extra-regional networks and market opportunity (Bathelt et al, 2004; Binz et al, 2015).

However, it is telling that path emergence was also dependent on the operation of auxiliary but important actors and related mechanisms. In Glasgow, the role for higher education was significant in providing the labour and the testing and validation for exogenous OEM technologies on which local developer diversification was based. Also, a somewhat hidden role of the UK state was evidenced in the EPSRC’s part funding of Strathclyde University’s diversification from terrestrial to offshore wind

research which, in turn, assisted firm-led diversification. Such findings validate the attention that higher education actors are given in pertinent research on regional change (Goddard, 2012; Goddard, 2013 a,b). In the case of Humberside, transplantation was encouraged by firms diversifying from traditional core activities to provide sites for inward investment e.g. Grimbsy Fish Dock Enterprises and ABP (from carbon related transhipment). This empirical evidence exposes the often overlooked relational and non-firm nature of path creating actors and mechanisms and the need for greater analytical stratification of causal orders of importance. Moreover, both cases illuminate that the diversification of assets is as important as the diversification of actors (e.g. physical infrastructure on Humberside and research in Glasgow). Therefore, the tendency in the literature to present mechanisms as disaggregated or isolated and firm centric – for instance Martin and Sunley's (2006) path de-locking mechanisms, Boschma and Frenken's' (2009) knowledge spill-over mechanisms and Martin's (2010) intra-firm mechanisms - minimises the importance of their overlap and interplay.

Fourthly and finally, the role of state economic development actors varied across the cases. In Glasgow the role of devolved and regional state actors in regional path creation is limited. Notably, the Scottish Government actors based in the city were primarily focused on the creation of a national (Scottish) path. Alternately on Humberside, a more prominent role for state actors is evident. For example, Hull City Council and North East Lincolnshire Council aided firm transplantation and the diversification of firms and physical assets via planning (e.g. an LDO for Alexandra Dock) and infrastructure provision (e.g. upgrading of Grimsby lock quays), whilst the RDA, Yorkshire Forward, marketed the Humber to inward investors. Even so, the agency of individual local entrepreneurs linked to Grimsby's fishing industry was observed to be more important than state actors for capturing the opportunity of Centrica's initial O&M investment. Not only do these observations further indicate a requirement for more comprehensive, relational accounts of actor agency in path literature, they also flag the need to further "unpack" (MacLeod, 2001) the role of state actors in heterogeneous regional settings.

7.2.2 Extra-regional institutional environment in mediating path emergence

By utilising comparative analysis, the importance of the extra-regional institutional environment, especially in relation to the nation state, in enabling and constraining

path emergence in both regions is revealed. There are three significant observations. Firstly, nation state policies and regulation mediated path actor selection and mobilisation and the underlying temporal dynamics of the industry in which they were set. Secondly, the UK's institutional model of capitalism, especially in relation to electricity markets, predisposed the scope and nature of regional path emergence, especially in relation to the limited degree of firm and technological diversity. Thirdly, partial institutional co-ordination meant that synergies between energy, industrial and regional policies that could have enhanced regional industrial path emergence went unrealised.

Firstly, at the outset, it is worth noting that the empirical evidence reveals that nation state institutions had a critical bearing on the activation and latitude of path creating actors, supporting the theoretical contention that such institutions mediate actor participation via incentivisation (Steen, 2016). In particular, such state institutions regulated actor expectations, co-ordination and uncertainty, thereby shaping the scale and timing of the interplay of actors, mechanisms and assets in both cases. For instance, the decision to strategize and experiment by project developers, akin to mindful deviation (Garud and Karnoe, 2003), was activated in both cases by their expectation of reward premised on a benign state institutions, including subsidy, that led to diversification of a terrestrial industry to a marine environment.

Moreover, nation state institutions played a formative role in the creation of underlying industrial temporal dynamics (Van de Ven and Poole, 1995; Martin and Sunley, 2006). It was observed that state institutions and related institutional entrepreneurship (DiMaggio, 1988; Boschma et al, 2017), as evidenced by The Crown Estate's packaging and promotion of seabed sites via three UK leasing rounds, linked to clarity on subsidy and planning, set the timelines for actor agency in both regions. Moreover, it was telling that in both cases, the widespread dissemination of The Crown Estate leasing maps were catalysts for actor sentience and subsequent deviation from past practice, thereby exposing the value of framing and representing regional opportunity in a nationally co-ordinated spatial framework. Therefore, although Martin's model of local industrial evolution (2010) and Boschma and Frenken's (2009) notions of path branching and variety are welcome advances in conceptualising path evolution (2009), the relative marginalisation of the influence of

wider industrial life cycles and their extra-regional institutional context is something of a shortcoming.

In Glasgow, with a focus on earlier stages of deployment - project appraisal, planning, design and procurement - these institutionally derived timeframes meant that developer-led path emergence was pronounced in this first episode, as was the valorisation of assets and utilisation of mechanisms. Whereas on Humberside emphasis was on the latter stages of deployment, particularly O&M which was dependent on project completion. Thus, given its position in the new industry's life-cycle, Humberside's initial phase of actor, asset and mechanism activation was later in appearing. Consequently, in Glasgow by 2009 150 high skilled jobs had been created and mainly recruited from the regional labour market. In contrast, three years later only 100 jobs had been created on Humberside. Likewise, such temporal dynamics inclined the mindful deviation of supply chain actors to come late in this initial phase, as reflected in Siemens' plans for Hull only being announced in 2011. Table 7.2 below plots developments in the UK state's policy and regulatory environment with the observed deviation of project developers from past practice.

SCALE	2001-2006	2007	2008	2009
NATION STATE **Institutional Developments**	**Institutional Development** Crown Estate Leasing Rnd 1 (2001) and Rnd 2 (2003) Energy White Paper 2003 Energy Review 2006	**Institutional Development** Energy White Paper	**Institutional Development** Climate Change Act Crown Estate Rnd 3	**Institutional Development** Low Carbon Transition Plan National Renewable Energy Action Plan Renewables Obligation Banding Review
REGIONAL **Activation of Developer Agency**	**Developer Deviation Glasgow** 2006, Scottish Power est. offshore wind team 2006, Iberdrola acquire Scottish Power	**Developer Deviation Glasgow** Airtricity locate UK HQ in Glasgow	**Developer Deviation Glasgow** SSE acquire Airtricity	**Developer Deviation Glasgow** SSE and Scottish Power expand offshore wind teams

	Developer Deviation Humber 2006, Centrica and RES identify Lynn & Inner Dowsing O&M base at Grimsby	Developer Deviation Humber Limited deviation	Developer Deviation Humber Centrica and RES establish Lynn and Inner Dowsing O&M base in Grimsby Fish Dock	Developer Deviation Humber Limited deviation

Table 7.2: Nation state institutional developments and developer agency

The second key point relates to how the UK's model of capitalism engendered path evolution to evolve along distinct paths, thereby illustrating the ongoing importance of variegated models of capitalism to path analysis (Christopherson, 2002; MacKinnon et al, 2009; Gertler, 2010). By 2006, the UK's institutional model of electrical generation had privileged the emergence of a privatised oligopoly. Therefore, the observed number of terrestrial power firms whose diversification was activated by the benign institutional environment was limited at the outset. Hence in both cases there is no evidence of distributed agency of multiple actors at the regional level that is common in the literature (Neffke et al, 2011; Karnoe and Garud, 2012; Cooke, 2012). In Glasgow, the path creating interplay of actors, assets and mechanisms was primarily shaped by the deviation of Scottish Power and SSE. Similarly on Humberside, Centrica was the primary agent of path emergence. Such limited firm mobilisation accounts for the seeming veiled emergence of the paths in both regions, as mechanisms of path diversification were largely internalised within a few firms. Moreover, this exclusive industrial development process limited the options for a wider set of actors and mechanisms to utilise regional assets to enable path creation, such as disruptive new entrants with new business models, networks and technologies.

Critically for regional path creation, this oligopolistic-oriented industrial structure fostered sectoral and technological path dependence (Boschma et al, 2017), thereby limiting the potential for firm and supply chain diversity at the regional level. It was observed that technological diversification was stimulated by an oligopoly of terrestrial developers, including Scottish Power, SSE and Centrica, inclined to utilise existing terrestrial relationships with a small number of OEMs. Moreover, it was a disposition promoted by the preferences of other sectoral actors, such as investors and insurers. Additionally, the state's subsidy regime, which gave no additional

support to more costly deeper water technologies, by default incentivised the less costly adoption and deployment of incumbent terrestrial technology in shallow waters. These factors and significant cost barriers to entry discriminated against radical new technological entrants. Hence, incumbent OEMs, such as Siemens and Vestas, had greatest expectation of reward and incentive to deviate from past practice; thereby ensuring that the number of firms that could valorise Humberside's development sites or Glasgow's research capability was limited.

Thirdly and finally, the research illuminates the cogency of literature that identifies the importance to path creation of co-ordination between horizontal energy policy, vertical industry policy and territorial development policy (Dawley et al, 2015; MacKinnon et al, 2018). Moreover, the evidence supports the contention within institutionally orientated literature that the UK state customarily gives limited cognisance to the interaction of policies and the spatial consequences of non-spatially specific policies (Barca et al, 2012; Martin and Sunley, 2015). Across both cases, the UK state primarily perceived its role as that of a market maker. Therefore, the UK Government did not place comparable emphasis on the development of an industrial value chain or its regional manifestation, as demonstrated by the relative absence of a state-led industrial strategy, industrial forums and spatial co-ordination in this phase of emergence. In short, the UK state gave little cognisance to its institutional capability for arbitrating the fusion of disruptive novel knowledge and regional assets to address regional underperformance and imbalance, despite its essential role in leasing, consenting and subsidising offshore wind exploitation. Furthermore, in terms of devolved government, a reluctance to pursue regional prioritisation was observed in the Glasgow case. Edinburgh, like Whitehall, was focused on pursuing broader objectives. Whilst on Humberside, given the abolition of the RDA, there was no powerful devolved sub-national body. Thus, in both cases, it was left by seeming default to regional institutions to arbitrate the process of regional path creation. It is therefore apposite to consider the role of such institutions in shaping the interplay of assets, actors and mechanisms.

7.2.3 Regional institutional environment in mediating path emergence

This section compares the role of regional institutions in regulating path creating agency. By comparing and contrasting the empirical case evidence, two significant observations are revealed. Firstly, in both cases the role of regional institutions in

enabling regional level path creation is more muted and auxiliary than new regionalist literature would imply (Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Amin, 1999; Rodriguez-Pose, 2013). This is perhaps less surprising on Humberside given the limited level of industrial antecedence but in Glasgow with a mature electrical generation and distribution industry, this is a striking observation. Secondly, regional innovation systems (RIS) had only limited bearing on path creation in either region. This is somewhat predictable on Humberside where the RIS demonstrated the characteristics of an organisationally thin RIS of a peripheral region but in Glasgow where pronounced characteristics of an organisationally thick and specialised RIS can be identified (Trippl et al, 2017), the auxiliary role of the RIS is also notable.

The first important observation, which connects both cases, is in regard to the role of regional institutions in enabling regional path emergence. In Glasgow, a network of institutional arrangements can be easily observed (for instance, Scottish Power, SSE, University of Strathclyde, Scottish Government, consultancies). However, this institutional environment was orientated towards the wider sector's development (Martin and Sunley, 2006) and regional actors purposively framed their mindful deviation in the context of broader sectoral dynamics. As a consequence, there was limited evidence of regional economic actors actively championing and supporting the regional path; with state actors only becoming aware of the city's assets when undertaking an "audit" for a Chinese state visit. Conspicuously, although a concentration of diverse organisations and interactive networks, especially relating to the labour market, can be identified, two other vital characteristics of institutional thickness were largely absent i.e. structures of association that promote collective expectation; and mutual awareness of common purpose (Amin and Thrift, 1994b). This absence hindered regionally-oriented strategizing and common path representation. Therefore, institutional thickness played a more suppressed role in incentivising the path creating interplay of actors, assets and mechanisms at the regional level than the number of seemingly networked, highly visible organisations might imply. Thus, case evidence supports the theoretical contention that for institutional thickness to arbitrate and facilitate regional industrial evolution, all four dimensions of the phenomenon need to be operating (Henry and Pinch, 2001).

On Humberside, given limited related industrial antecedence, a regional concentration of diverse institutional arrangements and industrial networks was not present. Moreover, institutional arrangements that could have contributed to collective expectation and common purpose, namely Yorkshire Forward and ABP (as monopoly harbour authority and operator) were respectively compromised by local rivalries and rent seeking behaviour (Rodriguez-Pose, 2013). Tellingly though, it was observed that local authorities through their planning and development functions played noteworthy roles in engendering firm transplantation by priming local physical assets. However, such activities focused on promoting specific local spatial opportunities rather than those of the wider region. Thus, Siemens was encouraged by Hull City Council to select a site that would subsequently minimise supply chain co-location opportunities and restrict the development of the regional path. Therefore, in summary, it can be argued that regional institutional thickness was predisposed to privilege extra-regional development in the case of Glasgow and sub-regional development in the case of Humberside. Thus, literature requires to give further attention to the ambiguous overlap between regional institutional thickness and its scalar focus; the two need not be contiguous.

Secondly, in terms of innovation and path creation, the case results indicate that exogenously sourced technologies and knowledge were of critical importance to the phenomena. This was unsurprising on Humberside given limited industrial antecedence and the existence of a regional innovation system (RIS) with pronounced characteristics of an organisationally thin RIS in a peripheral region (Trippl et al, 2017). However, in Glasgow, despite identification of significant research networks between firms, government and an internationally preeminent university (Goddard et al, 2012, 2013), synonymous with an organisationally thick and specialised RIS (Trippl et al al, 2017), there was unexpectedly limited evidence of endogenous research and development capacity having a primary influence on regional path emergence. Rather the empirical evidence indicates that Glasgow's innovation system was conditioned by broader sectoral and technological path dependences, thereby leading to a RIS that tested, modified and applied exogenous incumbent technologies rather than generated radical technological alternatives. Therefore, nascent but rapidly emerging sectoral and technological path dependences operating across levels (Martin and Sunley, 2006; Truffer and Coenen, 2012; Boschma et al, 2017) promoted an auxiliary role for the RIS and the university,

thereby producing more restricted actor deviation, mechanism activation and valorisation of regional assets than current literature might imply (Cooke, 2012; Goddard et al, 2013; Trippl et al, 2017). Furthermore, observed proximities - cognitive, organisational, institutional (Boschma, 2005) – and links (Bathelt et al, 2004; Coe et al, 2008) privileged the exogenous; akin to an industrial node rather than a regional cluster, such as the developers' procurement links with OEMs and Scottish Power's relationship with its parent company, Iberdrola. Returning to Humberside, given the nature of its RIS, it is predictable that there is no evidence that regional innovation capacity, proximities (except for proximity to the natural resource) and networks influenced Centrica and Siemens decisions to select the region for the transplantation of exogenous technologies and processes. In short, the causal power of regionally centred institutional frameworks to promote innovation to activate path creating agency was evident in Glasgow but was not primary, whilst on Humberside it was negligible. Therefore, literature that champions endogenous innovation models may only offer partial insight on the possibilities and limits for regional industrial renewal (Porter, 1990; Morgan et al, 1999; Maskell, 2001; Hausman and Roderik 2003; Morgan, 2003, 2013b; Foray et al, 2011).

7.2.4 Summary of comparative observations for path emergence

Case comparison of the empirical evidence indicates that path emergence was a contingent phenomenon, whereby novel knowledge, linked to the socio-technical transition process of offshore wind, interacted with distinctive regional assets (for example skills in Glasgow and physical assets on Humberside) to select a process of path creation. In Glasgow this related to path branching and on Humberside transplantation. Additionally, the analysis reveals that such exogenous and endogenous interaction had a bearing on the determination on the relative value of regional assets, thereby exposing the conditional worth of such assets and regional competitiveness.

The principal agents of change in each case were associated with the respective mechanisms of path emergence. In Glasgow diversification was led by project developers embedded within large corporate entities. On Humberside, transplantation was led by a developer pursuing the direct exploitation of the resource at distance from its corporate base (Boschma et al, 2017; MacKinnon et al, 2018). Furthermore, the deviation of these primary actors was supported by a diverse

range of firm and non-firm actors and mechanisms, revealing a gap regarding the contingent and relative nature of these relationships in path literature.

Significantly, analysis confirmed that institutions regulated the scale of fusion between the exogenous stimulus and the region. Nation state institutions were observed to play an enabling role in triggering and structuring the process of transition relating to offshore wind and regulating the sector's temporal dynamics at the national and regional levels. However, a lack of institutional co-ordination between and within scales was conspicuous. Palpably, both paths emerged due to a degree of benign but relatively unplanned multi-scalar and intra-scalar institutional complementarity (Schroder and Voelzkow, 2016). There is limited evidence of an actively managed state-region nexus or state-devolved-region nexus to optimise actor deviation at the regional level (Martin, 2000). Although the agency of institutional entrepreneurs was identified (Boschma et al, 2017), particularly in regard to The Crown Estate and DECC, their roles related to sectoral path creation rather than regional emergence. Similarly, the agency of system builders (Hughes, 1987; Geels, 2004) to disentangle and mediate symbiotic dependencies between sectoral, technological and regional industrial path evolution was undetected. Rather, by default it was left to regional institutions to arbitrate this process. However, a surprising lack of regional institutional thickness to incentivise and co-ordinate change at the regional level in Glasgow and conflicted institutional capacity on Humberside led to an equivocal role for regional institutions.

Finally, extra-regional institutions and their seeming promotion of sectoral and technological path dependency had a greater causal bearing on the dissemination and utilisation of novel knowledge than regional institutions. Although Glasgow had a mature RIS relating to power generation and distribution, its presence supported diversification of the principal firm actors within the path and was not a principal cause. On Humberside, a limited RIS meant the role of regional institutional frameworks in enabling the utilisation of novel knowledge to promote path emergence was insignificant. The results indicate that the agentic powers of a RIS are circumscribed by extra-regional sectoral and technological path dependencies.

7.3 Path Development Episode

7.3.1 The interplay of transition with assets, actors and mechanisms

In this intermediary phase, the process of path creation was observed to be more pronounced in Glasgow than on Humberside. In exploring this divergence, the adopted comparative approach identified a more mutable and punctuated path creation process than Martin's (2010) linear model implies. In Glasgow the observed process of path branching (Boschma and Frenken 2009; Neffke et al, 2011) was enhanced by an increased fusion of new exogenous knowledge with regional assets caused by the mobilisation of multiple actors and related mechanisms. In contrast, on Humberside this interaction was restrained, exemplified by stalled transplantation at Alexandra Dock and AMEP. It is to understanding in greater detail this interplay of actors, assets and mechanisms in both cases that we now turn.

As in the previous episode, the principal mechanisms of path creation denoted the importance of path actors. In Glasgow, it was evidenced that project developers remained the primary agents of diversification and consequently asset valorisation. Nevertheless, given an increasing focus on deployment due to the industry's maturing project life cycle, they were encouraged to develop links with OEMs and oil and gas firms. In turn these new regional actors further valorised the region's research base, skills and networks. However, the empirical evidence also strikingly reveals the role of non-firm actors in attempting to shape path evolution and validates literature that seeks a more inclusive perspective on actor agency (Dawley, 2013; Dawley et al, 2015; MacKinnon et al, 2018). In this path development phase, the University of Strathclyde and Scottish Enterprise played a significant role in attempting to further fuse the exogenous stimulus of energy transition with regional research and skills assets, exemplified by a joint £100million investment in ITREZ. Conspicuously, the newly appointed Principal of the University of Strathclyde (who was also on the Board of Scottish Enterprise) represented a key individual agent of change, championing a path narrative both nationally and internationally. On Humberside, transplantation was still led by only one project developer, Centrica. This limited level of developer agency was conditioned by the industry's project life cycle and the region's related dependence on hosting O&M functions. Moreover, given that Siemens only confirmed its final transplantation plans in 2014, the role of OEMs remained muted in this episode. Thus there continued to be limited fusion between exogenous novel knowledge and

endogenous assets on Humberside. Moreover, this hiatus revealed the limited power of regional actors, even powerful ones, such as ABP, to influence this fusion. It was a position reinforced by their observed exclusion from the industry's "global pipelines" of knowledge and power (Bathelt et al, 2004; Binz et al, 2015), as reflected in Siemens' limited communication with Hull City Council and ABP during this episode, reflecting the region's branch plant / extractive economy status.

In comparison with Humberside, the evidence of multiple, near simultaneous triggering of branching sub-mechanisms by path actors in Glasgow is striking. Moreover, the evidence accords with Boschma and Frenken's (2009) recognition of firm dynamics, such as acquisitions, mergers and alliances, representing important means for regional industrial evolution. Moreover, the size of the firms employing these sub-mechanisms and their international nature builds a bridge between the these empirics and theory which readily accommodates global corporate strategy (MacKinnon et al, 2002; Bathelt et al, 2004; Coe et al, 2008; Elola et al, 2013; Dicken 2015; Binz et al, 2015). Notable in this regard, was SSE developing alliances and joint ventures with a range of international actors including Mitsubishi and the research alliance between Scottish Power, the University of Strathclyde and Gamesa. In this episode distributed actor agency akin to bricolage became evident (Garud and Karnoe, 2003; Martin and Sunley, 2006). Critically, the identified varied mechanisms were interactive and relational, dependent on the distributed agency of private and public actors for their activation; once again revealing a need for greater theoretical vigilance and stratification than literature might imply. Finally, the rapidly changing importance of differing actors and mechanisms exposed the ready mutability of the path creation process. It is to understanding the influence of institutional environments on this observed elasticity that the section now turns.

7.3.2 Extra-regional institutional environment in mediating path development

By utilising comparative analysis, the importance of the extra-regional institutional environment in enabling and constraining the causal interplay of actors, assets and mechanisms is further revealed. There are four significant observations apropos this episode of path development. Firstly, UK policy and regulation continued to regulate the tempo, scale and character of actor agency and its interplay with assets and mechanisms. Secondly, these institutions further promoted sectoral and technological path dependence, constraining the scope for a broader set of firms and

technologies to shape regional path creation across the cases. Thirdly, continuing policy misalignment constrained the interplay of actors, assets and mechanisms. Fourthly and finally, the contrasting fortunes of the cases was also a result of the Glasgow case being embedded in a benign devolved institutional environment.

Firstly, nation state institutions had notable causal effect on mediating the mindful deviation (Garud and Karnoe, 2003) of path actors in both regional paths in this episode. The cases correspondingly reaffirmed that the agency of firms was noticeably regulated by expectations of reward largely premised on the UK institutional environment (Essletzbichler, 2012; Steen, 2015). The tempo of the industry's development continued to be shaped by institutional developments such as The Crown Estate leasing rounds and related planning, consenting and subsidy frameworks. Once again, flagging the relative marginalisation of the interplay of institutions, industry life cycles and regional path creation in current literature.

In Glasgow, additional leasing rounds in 2008 and 2009 linked to increased subsidy introduced by an industrially expansionist Labour Government encouraged growth of offshore wind developer teams. As more offshore wind projects approached delivery or entered operation, developers placed greater focus on technological procurement and maintenance, thereby activating the agency of a wider set of path actors, including OEMs, oil and gas firms, consultancies and research bodies. Such agency, which accords with Martin and Sunley's (2006) notion of distributed path creating agency, further valorised regional assets relating to skills, research and networks. In turn, direct path employment doubled in this phase to c. 300 jobs, most of them highly skilled.

On Humberside, path attenuation was a feature of this episode, despite some modest investments, such as Centrica's second O&M base. As evidenced, this was partly a result of the industry's temporal logic which placed O&M later in the project life cycle, as compared with Glasgow's emphasis on planning and development. However, given this inherent time lag, the growing cost reduction agenda of the new Coalition Government was also increasingly detrimental to Humberside's path (signalled by the establishment of the Cost Reduction Task Force in 2011). This new cost cutting state disposition made electricity utility firms cautious about progressing investments on the scale previously anticipated. Uncertain expectations of reward circumscribed their incentive to deviate and, in turn, that of potential supply chain actors, such as OEMs.

Secondly, it was observed that the incentive to experiment by OEMs was dulled by Siemens' rapid domination of UK offshore wind turbine orders, a position based on its corporate technologies favouring expedient and economic exploitation of shallow waters. Such dominance when combined with a decreasing market size (due to the focus of the UK Government on cost reduction) dis-incentivised GE and Vestas from transplanting novel knowledge to Humberside and also dis-incentivised Doosan Babcock and Gamesa from doing likewise in Glasgow. Additionally, as observed, Siemens developed its own O&M model which developers purchased with the turbines. Consequently, the higher value, technically intense aspects of this model were undertaken by Siemens employees based outside Humberside, thereby further limiting the fusion of novel knowledge with regional assets on Humberside. Therefore, the growing attention in the literature to framing and analysing regional paths within wider sectoral dynamics is germane (Elola et al, 2013; MacKinnon et al 2018).

Thirdly, it was observed that the regional economic consequences of nation state energy policies and regulation on corporate dynamics were not mitigated on Humberside by increasing UK Government emphasis on industrial development, commencing with the creation of the UK's largest Enterprise Zone in 2011 (Humber Renewable Energy Super Cluster Enterprise Zone) and culminating in a national industrial offshore wind strategy in 2013. Rather, an unaligned nation state policy environment, induced by uncoordinated objectives and priorities across BIS, DECC, DCLG, Cabinet Office and The Treasury, led to limited alignment of horizontal energy policy, vertical industry policy and regional policy. As a result, the mindful deviation of a sufficient quantum of firms to transform Humberside's assets - excess labour, development sites and port infrastructure - was constrained. Thus by 2014 only 200 jobs largely relating to low to medium skilled O&M roles had been created. The evident significance of such institutional misalignment foregrounds the need for the link between agency and institutional co-ordination and change to be further developed in path literature. Although recent research (Boschma et al, 2017) has re-engaged with concepts such as system builders (Hughes, 1987; Geels, 2004) and institutional entrepreneurs (DiMaggio, 1988; Battilana et al, 2009), it primarily places such agents within the context of the firm rather than the state. Table 7.3 summarises the correlation between UK institutional change and firm agency on the Humberside.

SCALE	2011	2012	2013	2014
NATION STATE **Institutional Developments**	**UK Institutional Development** UK Renewable Energy Route Map Offshore Wind Cost Reduction Task Force LEPs established Centres for Offshore Renewable Engineering est.	**UK Institutional Development** Offshore Wind Programme Board Regional Development Agencies abolished	**UK Institutional Development** UK Energy Act Offshore Wind Industrial Strategy (OWIC) Offshore Wind Industrial Council (OWIS)	**UK Institutional Development** Contracts for Difference introduced
REGIONAL **Activation / Deactivation of Firm Deviation**	**Actor Deviation Humber** Siemens transplantation announced in joint MoU with ABP at joint Alexandra Dock and Paull sites	**Actor Deviation Humber** Siemens transplantation hiatus	**Actor Deviation Humber** Siemens transplantation hiatus ABP object to development of AMEP site Centrica establish Lincs O&M base in Grimsby Fish Dock	**Actor Deviation Humber** Siemens confirm transplantation and joint investment with ABP exclusively at Alexandra Dock

Table 7.3: Nation state institutional developments and firm agency on Humberside

Finally, the empirical results reveal that the contrast in experience between the cases was also a product of a notable difference in the extra-regional institutional environments in which they were embedded. This case evidence validates Gertler's (2010) contention that industrial evolution is conditional on interacting multi-scalar institutional architectures and Schroder and Voelzkow's (2016) proposition that regional industrial trajectories are conditioned by the interplay of multi-scalar institutions and that their mutual efficiency is contingent on their level of complementarity. Given the industry's institutionally informed timeline, Glasgow's

second episode of path creation commenced earlier than Humberside's while expectation of reward amongst firms remained high. However, in Glasgow, growth expectations were also augmented by a benign devolved institutional environment, as evidenced by internationally significant renewable energy targets, enhanced subsidies for specific offshore wind technologies, a national industry forum, and state investment in industrial and research infrastructure. Therefore, as the UK institutional context became increasingly uncertain, devolved institutional powers partially compensated. Even so, the observed abandonment of inward investment plans by OEMs demonstrate the limits of Scotland's devolved power as a substitute for UK power. Table 7.4 summarises the inter-relations of firm agency in Glasgow with developments in the UK and Scottish institutional environments.

SCALE	2009	2010	2011	2012	2013
NATION STATE **Institutional Developments**	**UK Institutional Development** Low Carbon Trans. Plan Renewable Energy Action Plan Renewables Obligation Review	**UK Institutional Development** Treasury Infrastructure Cost Review	**UK Institutional Development** UK Renewable Energy Route Map Offshore Wind Cost Reduction Task Force	**UK Institutional Development** Offshore Wind Programme Board	**UK Institutional Development** UK Energy Act FIDER introduced OW Industrial Strategy & Council
DEVOLVED **Institutional Developments**	**Scottish Instit. Development** Climate Change Act Renewables Plan Scottish Territorial Waters Leasing Marine Scotland est OW Ind. Group est	**Scottish Instit. Development** Offshore Wind Route Map	**Scottish Instit. Development** 100% electricity from renewables by 2020 target	**Scottish Instit. Development** Task Force on Licencing and Consenting Government Economic Strategy	**Scottish Instit. Development** Enhanced Renewable Obligations Scotland Refresh of Offshore Wind Route Map

	Actor Deviation Glasgow	Actor Deviation Glasgow	Actor Deviation Glasgow	Actor Deviation Glasgow	Actor Deviation Glasgow
REGIONAL **Activation/ Deactivation of Firm Agency**	SSE establish CEERE SP expand OW team Atkins develops OW team	SSE strategic Alliance with Mitsubishi Mainstream transplant developer function Wood Group purchase control in Sgurr Energy	Gamesa transplant turbine design function SSE open Hunterston turbine test centre SSE purchase turbine tower manufacturer Doosan Babcock announce turbine manu. investment Xodus opens office	Construction of ITREZ and Strathclyde Uni TIC SSE procurement alliance est. SP announce new corporate HQ office Gamesa scales back plan and Doosan Babcock halts plan	ORE Catapult locating to Glasgow announced DNV open office Gamesa mothball design office

Table 7.4: UK and Scottish institutional developments and firm agency in Glasgow

7.3.3 Regional institutional environment in mediating path development

This section compares the roles of regional institutions in enabling or constraining path development in both cases. In doing so, it firstly reveals the detrimental effect of the lack of regional institutional thickness on Humberside, whilst exposing the importance of its evolution in relation to Glasgow's path. Secondly, it reveals that although regional path actors in Glasgow attempted to enhance the power of the RIS, this was stymied by an unaligned extra-regional institutional environment.

On Humberside, the lack of regional institutional thickness (Amin and Thrift, 1994b) observed in the initial phase of path emergence remained an obstacle to realising the development of the region's assets. This was despite the launch of a regional brand, new institutional arrangements (the Humber LEP and the Single Conversation Group) and a number of regional strategies, plans and deals prioritising offshore

wind[69]. Strikingly, the contraction in the projected offshore wind market which fostered OEM consolidation led to competition amongst regional path actors, particularly in regard to influencing the final investment location of Siemens. This competition was exemplified by ABP's objection to Able UK's plans for AMEP, which effectively neutralised the only regional site that could enable large scale industrial clustering which the above regional policies and initiatives sought. Such regional competition also negated the agglomeration objectives of related UK initiatives, namely the CORE initiative and the Enterprise Zone.

Despite the observed influence of UK Government institutions on regional path creation on Humberside, regional institutions had limited leverage on them. It was observed that local development organisations perceived themselves to be locked out of critical corporate and UK Government decision making, assuming roles of lobbyists and supplicants. During this phase of development, local authorities were primarily involved in the downstream "nitty-gritty"[70] of inward investment, such as planning applications, infrastructure provision and skills and supply chain audits. This case evidence demonstrates the limited power of regional actors, if unsupported by extra-regional power. It is a finding that does not accord with the empowered actors found in "new regionalism" literature (Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Amin, 1999; Rodriguez-Pose, 2013).

In Glasgow, the influence of regional institutional thickness on path creation was more evident in this phase, revealing a rapid mutability of institutional thickness that is not often referenced in literature. A common institutional purpose and structure of association (Amin and Thrift, 1994b) relating to the path and its associated regional innovation system was observed in this episode. In 2012, the University of Strathclyde and Scottish Enterprise established ITREZ, a £100 million investment supported by research agreements with regional firms. The multi-actor initiative represented the evolution and physical representation of the RIS, facilitating mindful deviation and experimentation by firms through the co-ordinated and shared utilisation of regional research, skills and networks. Moreover, it was observed that ITREZ aimed to incentivise the creation of alternate technologies and related networks and proximities (Bathelt, 2004; Coe et al, 2008; Boschma, 2005) that could

[69] Hull and Humber City Deal, LEP Strategic Economic Plan, Humber Growth Deal, Humber Spatial Plan
[70] Cited by H-LA1, July 2016

challenge the rapidly emerging technological path dependence of the sector (Boschma et al, 2017). However, a long-term OEM partner, a stated pre-requisite for ITREZ's success, was not secured due to UK policy and regulation focusing on cost cutting, thereby discouraging new supply chain entrants and favouring incumbents. It is an observation which validates calls for greater theoretical vigilance of how regional development initiatives are circumscribed by broader policies and priorities of the state (Dawley et al, 2015; Trippl et al, 2017).

In many respects, ITREZ exhibited characteristics of the theoretical notion of a niche (Geels, 2004). It was an attempt to create instituted protected space which could foster alternate technologies through shielding, nurturing and empowering (Smith and Raven, 2012). However, ITREZ lacked the power to promote the multi-scalar institutional alignment required for the creation and operation of such space, a critical pre-requisite identified by Truffer and Coenen (2012). Although, the support of the Scottish Government for the initiative is evident, strategic alignment with the nation state policy and regulatory environment appeared lacking with limited strategic dialogue and touch points being observed. Therefore, although non-territorial and extra-regional accounts of instituted innovation systems are often marginalised in regional path literature, the empirical evidence foregrounds the necessity and opportunity to place regional path theory within broader notions of technological and sectoral change and institutional interdependence (Truffer and Coenen, 2012; Boschma et al, 2017).

7.3.4 Summary of comparative observations for path development

Case comparison in this phase exposes a non-linear, open and fluid process of path creation, in which alternate path trajectories, primarily relating to acceleration and attenuation, were engendered through differing institutional frameworks and economic and political choices. Such mutability is also observed in the shifting importance of differing actors and related mechanisms, with pronounced evidence of the agency of state and higher education actors in Glasgow's path development.

Such interacting institutional forces were triggers and brakes regulating the tempo, scale and character of actor deviation and their interplay with assets and mechanisms. A more constructive interaction of state, devolved and regional institutional forces is exposed in the Glasgow case, triggering more pronounced distributed agency as compared with the previous phase. Whereas on Humberside,

the unfavourable effect of nation state policy and regulation and regional institutional conflict exposed the braking influence that interacting institutional environments can exercise on firm-led path creating agency.

Despite these observations, there remained limited sign of a structured nation state-region nexus on Humberside or a nation state-devolved-region nexus in Glasgow. Therefore, unsurprisingly, there was evidence, especially on Humberside, of regional actors being frustrated by their marginalisation and lack of influence. Additionally, although institutional entrepreneurship (Boschma et al, 2017) is witnessed in the Glasgow case, for example in changes to Scottish marine planning which incentivised Glasgow based project developers, there was limited evidence of multi-scalar institutional coordination or holistic system building in either case (Geels, 2004). Thus, in the case of Glasgow, the attempt to create protected regional innovation space to challenge broader sectoral and technological path dependences was circumscribed. Whilst on Humberside, incumbent technological consolidation associated with a narrow set of firms led to less opportunities for regional and state actors to effect regional path scale and quality premised on firm diversity.

7.4 Path Realisation Episode

7.4.1 The interplay of transition with assets, actors and mechanisms

This section compares the regional industrial paths that were realised in the final episode of observed path creation. On Humberside path creation accelerated, whilst in Glasgow firm-led activity decelerated. To understand these path dynamics, there will be an assessment of how the exogenous stimulus of energy transition continued to interact with actors, assets and mechanisms. In turn, this facilitates consideration of the role of institutions, extra-regional and regional, in enabling or constraining this interplay. Finally, there will be a comparison of the character of the created regional industrial paths and their influence on the development of the respective regions, prior to a synopsis of the observations across the three episodes of path creation.

Case comparison reaffirms path creation as a more open and malleable process than path literature might imply (Stam and Garnsey, 2009; Martin, 2010), once again exposing the potential latitude of differing path agents to effect the path creating interplay of actors, assets and mechanisms. For example, the UK Government was a direct causal agent of regional path creation, in its roles as deal maker vis-à-vis

Siemens' investment and sponsor and adjudicator of the Catapult investment. In addition, the empirical evidence indicates that the selection of path creation processes remained contingent on novel knowledge interacting with regional assets. However, in Glasgow, firm attenuation was evident and the scale of path branching declined (Boschma and Frenken 2009; Neffke et al, 2011). In turn, the economic benefits that had seemed imminent in the preceding episode did not materialise. Moreover, many of the jobs associated with the path were now publicly funded. In contrast, on Humberside, the fusion of new exogenous knowledge and regional assets was pronounced. The creation of nearly 1000 jobs and the valorisation of neglected port sites on both sides of the Humber represented, albeit on a more reduced scale than anticipated, path resurgence based on asset utilisation by inward investors. However, it was observed that such transplantation did not arguably represent the region's de-locking from its historic industrial trajectory (Martin and Sunley, 2006) characterised by lower skills, wages and authority. The outcome indicates a discernible level of qualitative related variety (Neffke et al, 2011) between the new path and the industrial base from which it emerged; one dependent on the exploitation of natural resources and lower value intermediary functions. Strikingly, this observation can also be applied to Glasgow, given that the path was becoming characterised by public sector employment and investment and notable but auxiliary knowledge-based functions.

In Glasgow, the importance of previously key regional actors acting as creators and conduits of novel knowledge, especially Scottish Power and SSE, faded as the number of offshore wind projects being managed from Glasgow contracted. In addition, supply chain firms withdrew from the region. However, rapidly decelerating firm diversification was partially but conspicuously substituted by the UK Government establishing its offshore wind Technology and Innovation Centre, Offshore Renewable Energy Catapult, in Glasgow and recruiting c. 100 skilled staff. Notably, such nation state led "transplantation" does not sit neatly with orthodox conceptualisations of path creating mechanisms and firm-led inward investment (Martin and Sunley, 2006; Boschma and Frenken, 2009). Moreover, it identifies a mutability in the changing importance of differing scalar actors over time, both firm and non-firm, and justifies calls for disaggregating path dynamics over time and space (Pike et al, 2016b).

Conversely on Humberside, the process of path realisation was primarily led by extra-regional firms. However, where before project developers had been the primary agents of transplantation, the role of Siemens became pronounced. Although developers further invested in Grimsby, it was Siemens' £160 million investment in Alexandra Dock that represented the most significant example of asset valorisation in this episode. Moreover, the investment was augmented by ABP's diversification from its carbon based regional business model, as demonstrated by an additional £150m investment for site reconfiguration. Finally, and significantly, it was observed that the UK state played the central role in securing Siemens' investment, with regional actors cast as by-standers.

In short, comparison across the two cases in this final episode again exposes the malleability of actor agency across relatively short periods of time. The direct role of the nation state is clearly illuminated in both securing and sponsoring transplantation in both regions. Although Peck and Theodore (2007) usefully posit the notion of the elasticity of agency, it would appear that this notion can also be applied to the relative value of regional assets and the relational and conditional nature of mechanisms which valorise them. In short, the entire path creation phenomenon has such elastic properties. Therefore, it is appropriate to once again turn to the case evidence to understand how institutions pull, twist and mould this process.

7.4.2 Extra-regional institutional environment in mediating path realisation

In this episode, the comparative approach exposes the temporality of the effects of changes to the nation state institutional environment in differing regional contexts. In Glasgow such changes had a near immediate impact on firm-led path creation, whilst on Humberside it reveals a time lag in the accrual of economic and industrial benefits. Moreover, comparison also exposes the sub-ordinate, conditional causal power of devolved and regional institutions as compared with the nation state.

Firstly, in this third and final phase of path creation, the noted decrease in firm-led path creation in Glasgow can be attributed to the UK state's emphasis on cost reduction. As observed, the introduction in 2014 of a more restricted, competitive subsidy framework had a near immediate negative effect on planned projects in Scottish waters. Within months of the related UK legislation being enacted, Scottish Power dropped its only Scottish project that was in planning (one of the largest in Iberdrola's international project portfolio) and SSE abandoned plans for its only Scottish west coast project.

Moreover, the state's cost cutting imperative further incentivised developer activity in shallow, close to shore sites prevalent in English waters. Consequently, the case revealed that Iberdrola in response to diminution of expected reward in Scottish waters and corollary increase relating to English waters developed its offshore wind team in London and, in turn, the relative power and scale of the Glasgow office decreased. Likewise, SSE reduced its staff expansion plans in line with its needs for delivering only one Scottish project. Therefore, Glasgow's focus on the earlier stages of the industry's life cycle ensured that repercussions were quickly felt in the regional path. In turn, given the rapidly decreasing Scottish market and projected UK market contraction from 30GW to 10GW, supply chain firms withdrew from Glasgow. Significantly, the one notable new actor in this period, Offshore Renewable Energy Catapult (OREC), a competitively won state investment had a notable impact on the valorisation of regional skills, if not regional research. Therefore, this phase exposes that the nation state can have a rapid and direct bearing on asset valorisation, further refining firm-led and gradualist conceptualisations of path evolution (Martin, 2010).

Alternately on Humberside, the internal temporal logic of the industry led to an observable acceleration in path creation. Despite adverse state institutional changes that were constraining future prospects, Humberside was demonstrably benefitting from the earlier policy and regulatory environment and the related offshore wind projects that were now entering their period of construction and operation, once again illuminating a paucity of research linked to industry life cycles, institutions and path creation in literature. This increasing level of deployment encouraged further reconfiguration of Grimsby's docks and utilisation of its labour force through the transplantation of greater novel knowledge. Significantly, this cyclic upturn in deployment provided Siemens' with sufficient incentive to progress its investment in Hull. Moreover, the decision was aided by the Energy Act of 2013 linking the award of subsidy to levels of UK sourcing in (incentivising developers to purchase the blades that were to be made in Hull). Even so, it was observed that the anticipated size of the UK offshore wind market was insufficient to encourage Siemens' transplantation of higher value technologies and manufacturing processes from Germany or Denmark. Such market dynamics and the associated costs of reconfiguring the Paull and AMEP sites also discouraged co-location of supply chain inward investors, such as tower manufacturers. These deterrents to agglomeration were pointedly exposed by a South Korean investor purchasing an existing tower

manufacturer on the opposite coast from the main UK market rather than incur significant infrastructure costs on Humberside.

Secondly, the seeming inability of devolved and regional institutions to influence nation state power was notable. Despite continuing evidence of institutional entrepreneurship by the Scottish Government, exemplified by the use of enhanced subsidy to create a national innovation system for offshore floating wind projects (analogous to a national niche), UK institutional power had primacy over firm deviation. Moreover, the withdrawal by the UK Government of the devolved power to adjust subsidy illuminated a lack of institutional collaboration between scales of government, if not distrust. It was an act that pointedly illustrates the reserved sovereignty of the UK state and the conditional nature of sub-state economic development agency. This institutional disjuncture was also evidenced by misalignment between the University of Strathclyde's technology and innovation centre (funded by the Scottish Government as part of ITREZ) and OREC (funded by the UK Government). Finally, the direct intervention of the Prime Minister in the Siemens' negotiations not only revealed the pre-eminent power of the UK state compared with regional actors but also an absence of co-ordinated, stable and transparent state policies on which firms could depend (Barca et al, 2012; Martin and Sunley, 2015). The absence of regional input to these discussions and the undisclosed nature of the deal struck by the UK Government starkly illustrates a disinclination to systems building in the UK state (Geels, 2004; Boschma et al, 2017). This disposition is perhaps in part caused by the inadequate theoretical attention given to such issues in literature; albeit with notable exceptions (Dawley et al, 2015).

7.4.3 Regional institutional environment in mediating path realisation

Once again, comparative analysis of respective case evidence reveals that regional institutions played a more constrained role in this process than literature might imply (Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Amin, 1999; Rodriguez-Pose, 2013). In the case of Humberside, regional institutions had an auxiliary role in determining the magnitude of fusion between exogenous novel knowledge and the region, albeit remaining critical in priming regional assets for valorisation by firms. In Glasgow, the role of regional institutions in enabling path creation was less discernible in this episode of path realisation.

Firstly, it was observed that institutions on Humberside played a noteworthy if supporting role, for example local government actors and the LEP assisted transplantation and asset valorisation through the use of planning powers, investment in port infrastructure and skills and employability programmes. A good example of such activity is the use of local planning powers and regional growth funds to relocate food processing firms from Grimsby port to permit additional inward investment. However, it was a telling reflection of the respective power of regional institutions that local actors were effectively excluded from the final Siemens' negotiations with the UK Government. Therefore, Hull City Council and the Humber LEP could be viewed as public sector project delivery agents rather than strategic partners.

Finally, in this episode of the Humber's path realisation, plans for an Open Access Innovation Centre were progressed by the LEP and Hull University. However, the developed research networks of Siemens and the limited absorption capacity of the local business base, meant its agenda was to be shaped by incumbent extra-regional actors, reflecting the asymmetric relationships synonymous with an organisationally thin RIS in a peripheral region (Trippl, et al, 2017). The new regional path's evolution in relation to manufacturing, installation and O&M, was wholly conditioned by the wider sectoral and technological path dependence in which it was set (Boschma et al, 2017). This case evidence posits questions about the cogency and emphasis placed on Smart Specialisation and other endogenous models of development for lagging regions in the literature (Porter, 1990; Morgan et al, 1999; Maskell, 2001; Hausman and Roderik 2003; Morgan, 2003, 2013b; Foray et al, 2011).

In Glasgow, the regional institutional landscape was changed with the arrival of ORE Catapult, a nation state investment that further valorised regional skills. However, although the organisation added to the region's diversity of institutional arrangements, it did not add to the region's institutional thickness (Amin and Thrift, 1994). By having a mission largely focused on the UK state's cost cutting agenda with limited regional reference, the organisation did not contribute to regional common purpose. Rather ORE Catapult's sectoral relationships concur with Boschma's (2005) notion that knowledge proximities need not be geographic and Bathelt et al's (2004) notion of pipelines linking regional actors with external networks, thereby testing the primacy of territorial innovation models (Moulaert and

Sekia, 2003) . Therefore, the new actor did not contribute to the existing RIS on the scale anticipated nor did it encourage the development of a RIS with niche like characteristics; one which could challenge extra-regional technological path dependence (Geels, 2004; Truffer and Coenen, 2012).

Moreover, given the contraction of confidence and deviation in Glasgow firms, their funding of ITREZ stopped. In turn, ITREZ and the University of Strathclyde refocused commercial relationships on other low-carbon sectors. Thus, in this final phase of path realisation, Glasgow's institutional environment, including its established RIS, played a suppressed role in engendering the path creating interplay of actors, assets and mechanisms. Thus, validating Trippl et al's (2017) contention that a proactive and resourced regional innovation policy will only succeed in fostering industrial renewal if it is supported by wider exogenous institutional forces.

7.4.4 Summary of path realisation and effect on regional development

Case comparison in this final episode further reveals calibration between UK Government institutions and the scale and nature of path creation. Additionally, it was reaffirmed that the effect of such nation state "rules" (MacLeod, 1997; Peck, 1999; Gertler, 2010) can have differing gestation periods. In Glasgow, its rapid bearing on the dis-incentivisation of firm-led agency was observed, whereas on Humberside path creating firm agency was seen to increase when the UK institutional environment was disadvantageous due to the time lag in the industry's project life cycle. Strikingly, in this last phase, the primacy of nation state power compared with devolved and regional power in regard to path creation was exposed, vividly illustrated by the UK Government withdrawing subsidy powers from the Scottish Government and in its conduct of final negotiations with Siemens.

Furthermore, the causal power of the respective regional innovation systems were shaped and circumscribed by wider sector and technological path dependences. In terms of Glasgow, the case evidence indicates that although ORE Catapult represented a significant nation state investment, it had limited effect on enabling regional research, augmenting regional institutions apropos industrial path creation or the formation of sheltered innovation space. On Humberside, the proposed Open Access Innovation Centre, given an absence of regional research and absorption capacity, was framed by the technological requirements of incumbent actors, primarily Siemens.

Given the observed influence of interacting multi-scalar institutions on path creation, the evident deficit of institutional systems building (Geels, 2004; Boschma et al, 2017), institutional complementarity (Schroder and Voelzkow, 2016) or a nexus between scales of government (Martin, 2000) remains striking. If anything, the backdrop of Scottish independence made complementarity, let alone strategic alignment, between UK and devolved institutions all the more problematic in this episode.

In comparing the regional industrial paths that were realised, a number of dissimilarities and similarities are conspicuous. Both paths were different in terms of their place in the wider sector's division of labour, their respective size and the significance of private and public actors in their operation. Even so, a resemblance was witnessed regarding the relative inability of regional actors to mediate the regional industrial paths' evolution and engender alternate outcomes. It is in further exploring this variance and similarity that this summary of path realisation concludes.

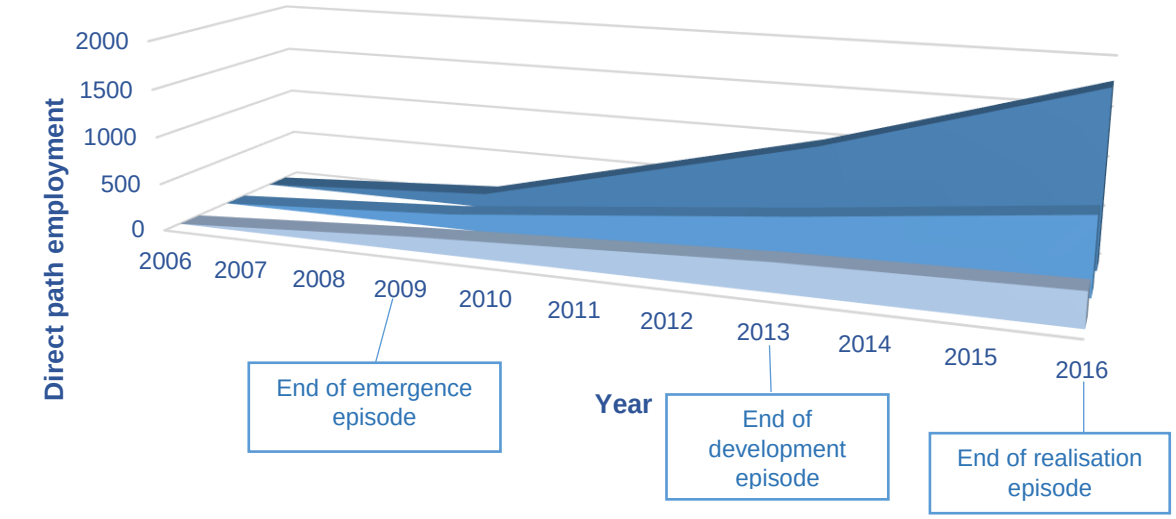
In the Glasgow case, approximately 350 high skill, direct jobs were attributable to the regional industrial path, the largest concentration of such offshore wind jobs in the UK outside London. The path that emerged represented a distinctive concentration of specialised capability relating to project development and research in the sector's national and international division of labour. Moreover, this was embedded in a regional network of actors with mature, diverse outward facing relations and proximities. Strikingly, nearly half of path employment was public sector funded. In turn, there was a noted sense of fragility about the path's future, especially in relation to private sector investment and employment and its status in the wider sector's division of labour.

By contrast over 1000 private sector direct jobs were associated with Humberside's path. The regional path which emerged was recognised as significant in terms of manufacturing and deployment in the sector's national and international division of labour. The south bank was synonymous with the transplanted routine functions of O&M linked to the exploitation of adjacent resources and the north bank with the transplanted routine functions of blade manufacturing. Therefore, the path had characteristics associated with both an extractive economy and a branch plant economy. Consequently, higher level skills, functions and authority were predisposed to occur outside the region.

Despite such apparent divergence, by 2016 the development choices of regional path actors in both cases were decidedly circumscribed by the wider sector's market and technological evolution, the scale and nature of which were largely shaped by nation state institutional forces. Although this had been a constant characteristic of Humberside's path creation, this had been formerly less overt in the Glasgow case. However, the formative power of path actors, such as Scottish Power and SSE, waned over time. This was exemplified by the growing importance of Iberdrola's London office for offshore wind at the expense of its Glasgow office.

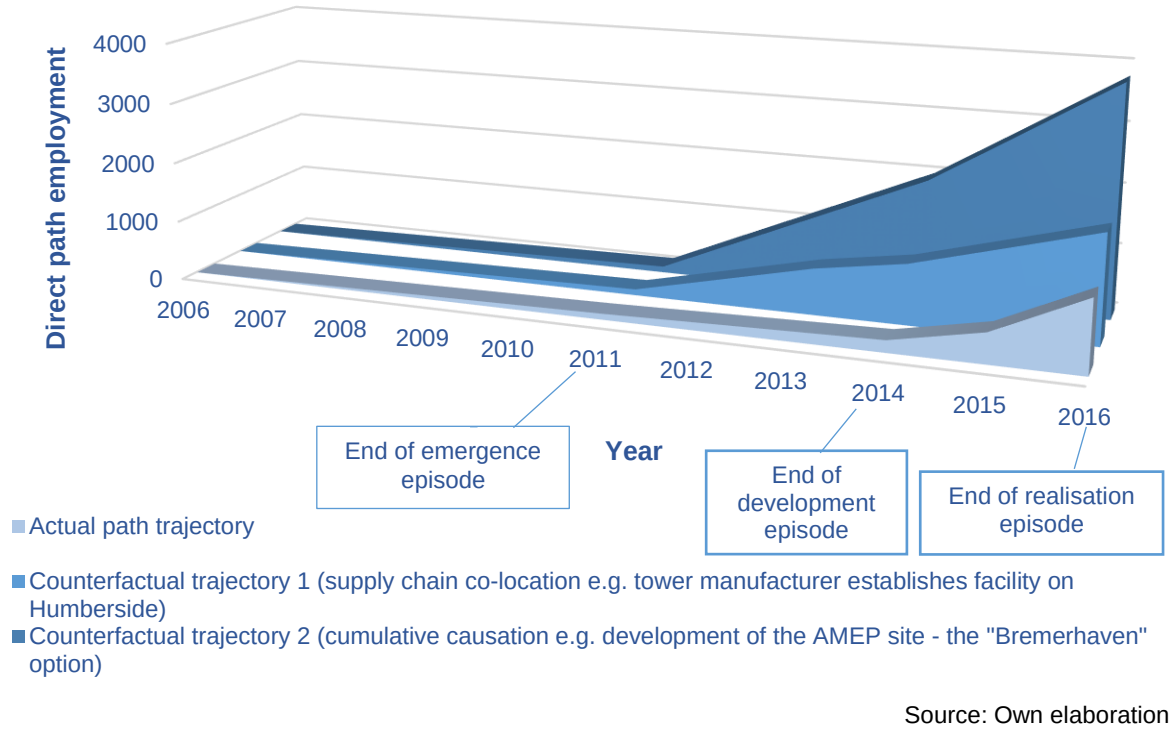
Therefore, although both regions were more than just passive receptacles where economic activity was played out (Scott, 1998; Pike et al, 2007; Hudson, 2007), regional institutions possessed only partial power to influence the open and fluid processes of path creation to realise sought after path outcomes. In particular, an inability to shape often uncoordinated nation state rules for regional benefit was evident. This relative institutional weakness denied both regions the means to optimise opportunities to create the volume of private sector, knowledge intensive jobs and firms that both the Glasgow Economic Forum and the Hull IBM/IECD reports called for in 2006. Nor was either region able to achieve their ambitions; that of being a "super cluster" in the case of Humberside and a "global hub" in the case of Glasgow.

To illustrate these missed opportunities, the graphs below (fig 7.1 and 7.2) compare realised employment outcomes for each region with potential employment outcomes that may have been achieved had multi-scalar state institutional complementarity been more pronounced. Such complementarity would have promoted a greater level and diversity of firms and investments, thereby enhancing the fusion of novel knowledge with the respective case regions. Drawing on research interviews, board and policy papers, marketing materials and press releases, job creation data relating to potential projects in each region has been aggregated. For example, it was predicted that SSE's proposed centre for offshore wind engineering in Glasgow would create circa 300 jobs and GE's anticipated Humberside investment would create circa 1000 jobs; when in fact neither project was realised. While such counterfactuals are the stuff of debate, they illuminate possible alternate trajectories that could have been realised had the open and malleable nature of path creation been differently influenced by state actors co-ordinating between and across levels.



Source: Own elaboration

Figure 7.1: Alternate path creation scenarios – Glasgow



Source: Own elaboration

Figure 7.2: Alternate path creation scenarios – Humberside

Finally, limited consideration by state actors of the interplay between extra-regional sectoral and technological dynamics and regional change and continuity is telling. By neglecting this symbiotic interaction, the deep-rooted nature of regional path dependence in both regions went unaddressed. Hence, in Glasgow, as in the past, a new industrial trajectory predicated on the region's exceptional skills, research base and networked organisations was only partially realised in terms of scale and function; one that if fully realised could have challenged the region's industrial decline, related public sector over-dependence and the established international centres of the industry. Likewise on Humberside, the sought after increase in higher value industrial activity and skilled employment based on the estuary's pan-regional assets was only partly attained. In short, as in the past, incoherent institutional frameworks constrained industrial path creation in both regions and maintained their path dependent economic structures and performance. Strikingly, the paths that emerged exhibited a pronounced degree of related variety in terms of their quality and function vis-à-vis the industrial base they had emerged from (Neffke et al, 2011).

7.5 Comparative Analysis Synopsis

In taking an overview of the three episodes of path creation, it can be observed that the scale of interaction between the stimulus of energy transition and the respective regions determined the scale of path creation i.e. the level of regional industrial change and continuity. Moreover, the scale of this fusion was determined by the magnitude of causal interplay between actors, assets and mechanisms.

Critically, it was observed that in both cases the timing, intensity and nature of this agentic interplay (Emirbayer and Mische, 1998) was mediated by the degree of multi-scalar and intra-scalar state institutional complementarity. Moreover, the preeminent causal power of nation state institutions as compared with devolved and regional institutions was revealed. The former fostered broader sectoral and technological evolution, which had direct bearing on regional path creation, whereas the latter assumed a more auxiliary role, such as priming regional assets in order to optimise the economic benefits associated with offshore wind.

These interacting extra-regional and regional institutional environments regulated the shifting quantum and variety of firms (and technologies) at the regional level. In turn, the resulting level of distributed agency determined the scale and nature of asset

valorisation via the operationalisation of multiple relational mechanisms, which were informed by regional industrial antecedence. The malleable nature of path creating agency meant it was highly receptive, often over short periods of time, to changes in the institutional environment. Therefore, the relative path creating power and actuation of differing path actors could alter quite rapidly according to institutional incentivisation and disincentivisation, creating a more open, uncertain, and punctuated process of path creation. This complex yet institutionally structured interplay of actors, assets and mechanisms indicates that a range of rapidly unfolding path episodes are possible, beyond those observed in this empirical study, including path stasis, reversal and collapse.

Despite the obvious power of these interacting institutional environments to enable or constrain path creating agency, there was no evident state co-ordination across scales, leading to inferior outcomes in terms of path size and quality. Thus mitigating the positive effect of the new paths on their respective regions' economic development and historic trajectories (see figures 7.1 and 7.2).

In terms of resulting path evolution, this led to three observed episodes of path creation in both cases over a decade, representing, unique dynamic aggregations of actors, assets and mechanisms in time and space, as summarised in figure 7.3.

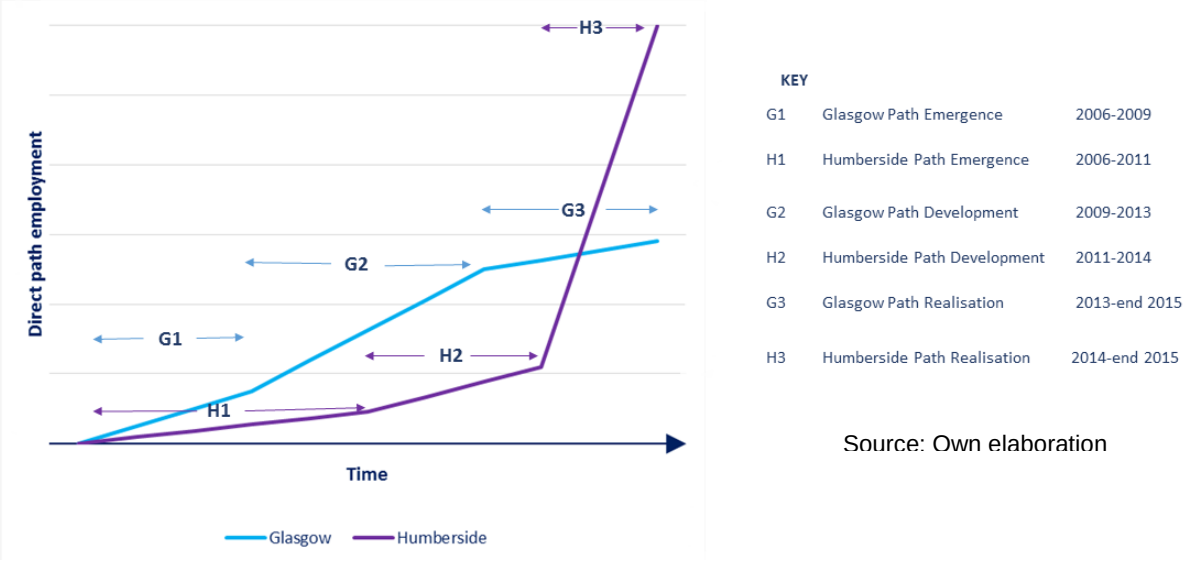


Figure 7.3: Episodes of path creation over time

In Glasgow's episode of path emergence, complementarity between UK and devolved institutions enabled actor diversification to fuse regional assets with new

exogenous knowledge leading to the emergence of a path employing c. 150 highly skilled persons. On Humberside similar UK institutional dynamics were shaping the path's emergence, albeit with an observed time lag, to create via transplantation a path with c. 100 low to medium skilled O&M jobs. However, the institutionally derived oligopolistic nature of the UK's power generation industry meant that path creation in both regions was driven by a narrow set of firms, thereby limiting actor and technological diversity to further valorise regional assets and counter emergent sectoral and technological path dependence.

In Glasgow's episode of path development, pronounced complementarity across institutional scales incentivised experimentation and strategization by a diverse range of firm and non-firm actors, thereby challenging sectoral and technological path dependence, and resulting in the path doubling in size. On Humberside, where the phase of path development commenced two years after Glasgow, regional institutional competition and a more uncertain nation state institutional environment, leading to consolidation of supply chain actors, engendered a path that created c. 200 low to medium skill jobs largely dependent on the ongoing transplantation of standardised O&M technologies.

Finally, in Glasgow's episode of path realisation, misalignment between UK and Scottish institutional levels and pronounced sectoral and technological path dependence markedly reduced firm-led distributed agency and its interplay with regional assets, reflected in attenuation of firm diversification and transplantation. However, this disincentivisation of firm experimentation and the adverse economic implications were somewhat masked by the location of a major UK state anchor investment, ORE Catapult, revealing the significance of direct state agency and mechanisms. On Humberside, despite limited co-ordination between UK and regional institutions and pronounced sectoral and technological path dependence, there remained sufficient incentivisation for Siemens to progress investment in Hull and project developers to further invest in Grimsby, thereby creating c. 1000 largely low/medium skilled jobs. However, a constraining institutional environment ensured that there were limited opportunities for the co-location of diverse supply chain firms and technologies to augment the path.

Chapter 8: Conclusions

8.1 Introduction

This thesis contributes to evolutionary economic geography theory by providing further insight in to the process of regional industrial path creation. In particular, it brings greater specificity to what represents an enabling or constraining institutional environment for this process. My findings were informed by multi-scalar, multi-actor analysis in order that the "deep-seated [and] wider relations, positions and contexts of actors in inter-related structures unfolding over space and time" (Pike et al, 2016b, p 132) were more comprehensively explored and explained. In turn, this approach provides further understanding of the interplay of exogenous and endogenous forces on regional path creation.

By fusing this research with my practical experience of economic development, I sought to build a bridge between the worlds of theory and policy and practice, specifically in understanding how new regional industrial paths are created, especially in relation to socio-technical transition. The timing seemed apposite given an increasing focus in this regard in both theory and policy. Moreover, I wanted to ensure that this research focused directly on geographically uneven development and the scope for the state to effect quantitative and qualitative regional industrial renewal (Martin and Sunley, 2013). To this end, the research was informed by three questions.

- *What are the key forms of agency that shape regional path creation?*
- *How do multi-scalar institutional environments enable or constrain this process?*
- *What is the scale and character of the resulting path and its effect on regional development?*

Building on theory, the analytical framework facilitated exploration of the effect of socio-technical transition, in this instance relating to offshore wind, on the path creating interaction of actors, mechanisms and assets in two lagging regions. Critically, given the observed missing link regarding the role of institutions in mediating this interaction (Dawley et al, 2015), the framework promoted investigation

of the role of regional and extra-regional institutional environments in enabling or constraining path creating agency and path outcomes.

In this concluding chapter, the empirical findings will be firstly framed in the context of the research questions and, in turn, the main theoretical contributions presented. To link this world of thought to the world of action, key implications of the research for economic development policy and practice will be subsequently presented. Finally, an agenda for future research will be offered.

8.2 Empirical Findings Relating to Research Questions

This section will address each of the three research questions in light of the empirical findings of the Glasgow and Humberside cases and synthesise these findings into a conceptual framework.

What are the key forms of agency that shape regional path creation?

A number of differing forms of actor agency across time and geography were evident in relation to the process of regional path creation in Glasgow and on Humberside. Prior to identifying these varied forms, two overarching empirical findings regarding agency merit illumination. Firstly, path creating agency is a malleable phenomenon. During the respective cases of path creation, the diversity, quantity and relative importance of actors altered. This malleability, echoing Peck and Theodore's (2007) notion of agentic elasticity, contributed to the observed episodic evolutionary process of path emergence, development and realisation over a decade; with each of the three episodes representing unique dynamic aggregations of actors, assets and mechanisms in time and space. Secondly, actor agency is primarily framed, if not bounded, by the dynamics of broader sectoral and technological path dependences, validating recent research on the interplay of agency and regional and extra-regional path dependences (Boschma et al, 2017), In short, regional path creating agency can be a contingent, relatively reflexive response to wider sectoral and technological dynamics (Martin and Sunley, 2006).

As regards differing forms of agency, the centrality of firm agency is readily evidenced. The research confirmed that firms represented primary conduits of novel knowledge relating to energy transition on which the reconfiguration and valorisation of regional assets were largely contingent. Moreover, the central mechanisms of path

creation, diversification and transplantation, were primarily firm led. In both cases, the relative importance of these mechanisms denoted the relative importance of firm types. In Glasgow, where the path creation process was largely driven by diversification, firms with historical associations to the region were the initial primary agents of change. On Humberside, given the absence of industrial antecedence, private sector inward investors were critical to the path's inception and subsequent evolution. However, in Glasgow, extra-regional firms, such as Iberdrola, became increasingly important for providing the regional path with access to extra-regional finance, markets, knowledge and technology, reflecting the contention that regional path creation represents an alignment process of regional and extra-regional heterogeneous factors (Binz et al, 2015). Whilst on Humberside, the diversification of regional firms was important for promoting and reconfiguring regional sites and infrastructure for utilisation by inward investors. Therefore, firm agency is central to path creation and its nature is multi-scalar, relational and malleable over time.

Path creation was also dependent on the operation of non-firm actors, especially the state, validating a growing cognisance of state actors in path literature (Dawley et al, 2015; MacKinnon et al, 2018). Although the agency of state actors could be identified across all three episodes, there was a variance and malleability in their relative causal power. At the level of the nation state, the Crown Estate and DECC were vital for creating the market on which both paths were predicated by developing an incentivised national spatial framework for resource exploitation. Also, as both paths evolved, the direct intervention of the nation state at the regional level became pronounced via the facilitation of anchor flag-ship investments: Siemens on Humberside and ORE Catapult in Glasgow. Moreover, the latter investment demonstrates the potential for central government to act as a primary agent of regional asset valorisation. In Scotland, agents of devolved government, namely Scottish Enterprise and Scottish Development International, facilitated firm transplantation and invested in research infrastructure relating to the Glasgow path. However, the efficacy of such agency became less obvious when unaligned with UK state policy and agency. On Humberside, the agency of local authorities became more prominent after the abolition of the RDA. However, although their agency promoted and facilitated firm-led valorisation of assets, such agency was driven by a desire to optimise economic benefit at the local level rather than the regional, despite the LEP's attempts to arbitrate such vested interests. Therefore, it can be inferred

that the agency of local state actors may lead to sub-optimal path outcomes at the regional level in the absence of powerful means of co-ordination.

Strikingly, although the agency of higher education and research organisations is commonly cited as a key source of industrial renewal (Hausman and Roderik 2003; Foray et al, 2011; Goddard et al, 2012, 2013b; Morgan, 2013a), the role of such agency on Humberside was negligible and in Glasgow it was equivocal. The research indicates that the path creating agency of a major research university or a national technology centre, even if seemingly aligned with the path's technological realm, can be relatively muted; their agency being framed and circumscribed by broader sectoral and technological dynamics and non-spatial proximities (Boschma, 2005; Truffer and Coenen, 2012; Boschma et al, 2017).

A final form of agency that is worthy of note relates to actors who adapt and transform institutions to enable path creation or work across domains to facilitate techno-industrial change which catalyse regional path creation. The role of such actors has enjoyed a degree of renewed attention in recent literature refreshing previous accounts of institutional entrepreneurs and system builders (DiMaggio, 1988; Geels, 2004; Boschma et al, 2017). The findings indicate that institutional entrepreneurs played a vital role in creating the UK offshore wind market and adapting the market at the Scottish level. In regard to system builders, despite the seeming need to connect and co-ordinate domains of economics, technology, research and politics to promote complementary sectoral and regional path development, there was limited evidence of their agency. Lastly, the literature's tendency to perceive such forms of agency as primarily firm-led appears partial.

The final point in regard to agency relates to its fluid associational nature. For instance, during the path creation process individual agents were significant at key moments e.g. in terms of promoting Grimsby's port assets or Glasgow's research strengths. Moreover, the initiation of path creation in both regions was dependent on a small number of actors, thereby indicating that bricolage is not essential for path creation (Garud and Karnoe, 2003). However, as the path creation process evolved distributed agency of firm and non-firm actors became more evident at the regional level. Nevertheless, a trend toward oligopoly at the UK and European levels reduced the number of potential firms in the value chain, thereby reducing the variety of firm agency at the regional level.

Notably, collective agency at the regional level manifested itself in three discernible ways: priming; portraying; and promoting. The distributed agency of regional actors played a critical role in priming regional assets, for instance in regard to preparing sites on Humberside for inward investors and developing regional research capacity to test and validate exogenous technologies in Glasgow. Such collective agency also portrayed path actualisation, creating a path profile, narrative and awareness within and beyond the respective regions. In Glasgow, such path representation was deferred due to regional actors being initially predisposed to frame regional offshore wind activity in the context of the broader sector. On Humberside, regional actors, such as Team Humber Marine Alliance and the LEP, successfully branded the emergent offshore wind path as an estuary wide opportunity despite local rivalries. Finally, regional actors promoted the path's quantitative and qualitative evolution in relation to the wider sector's division of labour. For example, in Glasgow this was done via the establishment and funding of ITREZ by both public and private actors and on Humberside this was progressed via the creation of a forum of key regulatory actors.

To summarise, key forms of path creating agency can be fluid and relational across time and spatial scales. Although firms are critical primary agents of change, non-firm actors play a crucial role, especially the state in creating the market and harnessing related regional economic opportunity. It is to understanding how institutional environments enable or constrain the path creating process that we turn.

How do multi-scalar institutional environments enable or constrain this process?

Although the empirical findings demonstrate that both exogenous and endogenous institutional environments are important for enabling and constraining path creating agency, a causal hierarchy was identified. Extra-regional institutions shaped the scale and nature of transition, influencing the speed, scale and nature of broader sectoral and technological path creation, whereas regional institutions played a vital but narrow and bounded role in realising the resulting development opportunities at the regional level.

Nation state institutions were observed to play a formative role in triggering market and technological disruption through incentivising the agency of a narrow set of firms, akin to an oligopoly. Moreover, such institutions determined the underlying sector's

temporal logic and related market and industrial value chain dynamics (Van de Ven and Poole, 1995). In turn, these broader market and industrial value chain dynamics primarily informed the phasing, scale and character of both regional industrial paths. Like Prometheus bringing fire from the heavens, firms were the primary conduits of novel knowledge fostered by disruptive energy transition. However, the ignition and intensity of the flame was regulated by nation state institutions. Moreover, given that such institutions promoted the activation of a limited number of developers and OEMs, thereby increasing sectoral and technological path dependence (Boschma, 2017), the requisite level of firm and technological diversity to promote clustering in both regions was not generated.

Strikingly, although nation state institutions underpinned spatial management and exploitation of the natural resource, through an integrated leasing, consenting and subsidy framework, there was limited evidence of co-ordinated nation state horizontal (energy), vertical (industrial) and spatial policies required to optimise industrial development in either region. It is a finding that accords with recent literature which notes an absence of effective UK policy co-ordination for regional development (Barca et al, 2012; Martin and Sunley, 2015; Martin et al 2015). Limited multi-scalar co-ordination also diminished the causal power of devolved government. It was observed that Scottish Government policies and regulation could augment the speed, scale and nature of market development and Glasgow's path emergence; validating the theoretical contention that complementary multi-scalar government architectures aid industrial development (Gertler, 2010; Schroder and Voelzkow, 2016). However, the relative effectiveness of these devolved institutions was delimited by their degree of alignment with the broader UK institutional environment in which they were nested.

In terms of the regional institutional environment, the regulatory and planning powers of local government was vital on Humberside; the case region in which the reconfiguration of legacy infrastructure and development sites was imperative to the path. In Glasgow, such powers were less crucial, given the path's knowledge intensive nature. In both regions, institutional thickness (Amin and Thrift, 1994b) was of equivocal importance to path creation. In Glasgow, despite an evident density of local private and public institutions, limited powers of association and common purpose inclined regional institutions to be more focused on broader commercial and industrial goals than regional path emergence. However, the mutability of regional

institutional thickness in terms of its form and focus was demonstrated by its growing importance during Glasgow's episode of path development. On Humberside, regional institutional thickness was undermined by local rivalries and vested interests which arguably promoted sub-optimal regional-level path outcomes. Even so, structures of association were sufficiently strong to promote common regional branding and proposition, and co-ordinated regulatory planning for the estuary's development.

As regards Glasgow's organisationally thick and specialised regional innovation system, its significance was shaped and circumscribed by the broader sector's development, which was informed by UK policies and regulation (Dawley et al, 2015; Trippl et al, 2017). Therefore, the scope for regional policy makers to create shielded, nurturing and empowered regional innovation space was conditioned and delimited by extra-regional institutions (Smith and Raven, 2012; Tuffer and Coenen, 2012). The finding is striking given Glasgow's noteworthy networked innovation capacity (Morgan, 2003) and the presence of an internationally renowned university related to the path's technology (Goddard et al, 2012, 2013b).

Therefore, to précis, extra-regional institutions mediated the timing, scale and nature of socio-technical transition, whilst regional institutions (and particularly local ones on Humberside) facilitated the fusion of the related industrial opportunity with the respective regions. Crucially, the power of the latter was notably framed and bounded by the former. Therefore, regional capability to determine path evolution was markedly constrained by multi-scalar institutional dynamics in both regions. Moreover, in terms of causal orders of importance vis-à-vis regional capability and related path creation, the extra-regional was more significant than the regional.

Building on Peck and Theodore's (2007) notion of the elasticity of agency, it can also be stated that multi-scalar institutional environments represent interacting triggers and brakes which regulate the elasticity of actor agency in terms of timing, scale and nature, thereby mediating their interplay with assets and mechanisms and eventual path outcomes. The observed agentic power (Emirbayer and Mische, 1998) of these differing institutional environments composed of interacting triggers and brakes is detailed in table 8.1.

Tellingly, despite the significant causal power of these interacting environments, there was a near absence of evidence relating to the operation of a systemic nation

state / regional nexus or a systemic nation state / devolved / regional nexus to coordinate across scales (Martin, 2000). In addition, there was limited indication of the agency of state system builders working across and between policy domains (Geels, 2004; Boschma et al, 2017). Finally, as previously noted, there was evidence of state institutional entrepreneurs (Di Maggio, 1988; Battilana et al, 2009) but it was limited and spasmodic. Institutional complementarity, when it occurred, was relatively uncoordinated (Schroder and Voelzkow, 2016). These circumstances led to a sub-optimal state-led economic development process between and across scales.

Scale	INSTITUTIONAL ENVIRONMENT					
	ENERGY		INDUSTRY		SPATIAL	
	Triggers of Actor Agency	***Brakes on Actor Agency***	***Triggers of Actor Agency***	***Brakes on Actor Agency***	***Triggers of Actor Agency***	***Brakes on Actor Agency***
UK (Nation State)	**Institutions *positively* regulating expectation:** **OW Market** *ROCs subsidy 2002* *Energy White Paper 2003* *Energy Review 2006* *Climate Change Act 2008* *ROCs subsidy enhancement 2009* *Low Carbon Plan 2009* *UK Renewable Roadmap 2011*	**Institutions *negatively* regulating expectation:** **OW Market** *Cost Reduction Task Force 2011* *Offshore Wind Programme Board 2012* *Energy Act 2013* *CfD subsidy 2014* *DECC "reset position" 2015*	**Institutions *positively* regulating expectation:** **Value Chain** *Building Britain's future – New Industry, New Jobs' 2009* *OREC announced 2012* *Offshore Wind Ind. Strategy and Council 2013* *UK Content Plan 2014*	**Institutions *negatively* regulating expectation:** **Value Chain** *Developers Forum 2010* *Cost Reduction Task Force 2012* *CfD subsidy 2014* *DECC "reset position" 2015*	**Institutions *positively* regulating expectation:** **OW Market** *Crown Estate UK Leasing Rounds 2001, 2003 and 2009* **Value Chain** *RDAs <2010* *Enterprise Zones 2011* *Centres for Offshore Renewable Engineering 2012*	**Institutions *negatively* regulating expectation:** **OW Market** *Wind farm planning delays 2010 onwards* **Value Chain** *Abolition of RDAs 2012* *Planning challenges*

Scotland (Devolved)	**Institutions *positively* regulating expectation:** **OW Market** *ROCs (Scotland) 2002* *Climate Change Act 2009* *Route Map 2009*	**Institutions *negatively* regulating expectation:** **OW Market** *ROCs Scotland closure 2015*	**Institutions *positively* regulating expectation:** **Value Chain** *Economic Strategy 2007* *Offshore Wind Industry Group 2009* *Offshore Wind Route Map* *National Renewables Infrastructure Plan 2010*		**Institutions *positively* regulating expectation:** **OW Market** *Crown Estate Scottish Leasing Round 2009* *Marine Scotland 2011*	**Institutions *negatively* regulating expectation:** **OW Market** *Wind farm planning delays 2010 onwards*
Glasgow & Humber (Regional)			**Institutions *positively* regulating expectation:** **Value Chain** *Scottish Govt. OW Team established in Glasgow 2009* *OREC established in Glasgow 2013*		**Institutions *positively* regulating expectation:** **Value Chain** *Planning approvals for Alexandra Dock and Grimsby Docks 2006>* *Green Port Regional Growth Fund (Hull) 2012* *SE part fund ITREZ / TIC in Glasgow 2012* *UK grant for site prep. at AMEP 2014* *Open Access Innovation Centre on Humberside launched 2015*	**Institutions *negatively* regulating expectation:** **Value Chain** *Intra-regional competition re development sites on Humberside 2008>* *RSPB lodge concerns* *ABP object to development of AMEP site 2013>*

Table 8.1: Horizontal, vertical & spatial institutional triggers and brakes regulating actor agency

Therefore, in conclusion, it can be evidenced that an enabling institutional environment is one in which multi-scalar institutional triggers are sufficiently aligned or complementary, and institutional brakes are minimised, to optimise the agentic power of social actors to deploy mechanisms in order utilise regional assets to create a new path. Whereas, a constraining environment is one in which institutional triggers are poorly associated and institutional brakes predominate across and between spatial scales. Moreover, this interplay of multi-scalar and intra-scalar institutional environments regulate the diversity and magnitude of path related actors and mechanisms at the regional level, thereby shaping the scale and character of path

creation. Moreover, these dynamics regulate regional capability (such as innovation capacity and institutional thickness) and the efficiency and effectiveness of the state-led economic development process. Finally, this institutionally structured interplay of actors, assets and mechanisms indicates that a range of rapidly unfolding path episodes are possible, beyond those observed in this empirical study, including path stasis, reversal and collapse. It is to the question of quantitative and qualitative path outcomes that we now turn.

What is the scale and character of the resulting path and its effect on regional development?

In Glasgow and on Humberside deficient multi-scalar and intra-scalar institutional complementarity led to paths that did not meet expectations in regard to scale and character. Institutional mediation restricted the variety of firms and technologies within the UK's offshore wind sector, thereby limiting the subsequent quantitative and qualitative nature of both regional paths and the scope for agglomeration. Furthermore, the path outcomes did not profoundly tackle either region's historic path dependences or structural weaknesses.

On Humberside, the new path created over a thousand jobs. However, this fell short of previous hopes, rather than being a "super cluster"[71] the path exhibited characteristics of a lower-value supply chain node based on prevailing technologies owned and utilised by an oligopoly of firm actors. In Glasgow, the regional industrial path was of modest employment scale compared with earlier predictions and increasingly dependent on public sector employment. It too displayed features of a supply chain node, albeit one premised on knowledge assets, and fell short of previous aspirations to be a "global hub"[72]. Characteristics associated with more qualitative industrial forms, such as clusters and niches, were difficult to discern in either case. In terms of the international division of labour of the sector, neither path challenged leading centres of the industry in Denmark or Germany.

Despite the outcomes representing net economic benefit to the respective regions, the opportunity to address longstanding industrial decline and un-competitiveness was only partially realised. In Glasgow, the resulting scale and function of the new

[71] Renewable Energy Super Cluster Enterprise Zone publication (2011)
[72] Scottish Enterprise Board Paper (2011)

industrial trajectory did not challenge the region's industrial decline and related public sector over-dependence. On Humberside, the sought after increase in higher value industrial activity and jobs was only partially realised. In short, the institutionally constrained interplay of actors, mechanisms and assets was insufficient to meaningfully address the regions' path dependent economic structures and performance.

Furthermore, these respective path outcomes indicate a discernible level of qualitative related variety (Neffke et al, 2011) between the new paths and the industrial bases from which they emerged; on Humberside this related to the exploitation of natural resources and lower value intermediary functions; and in Glasgow this related to public sector functions and a concentration of knowledge functions that were highly reactive, if not vulnerable, to extra-regional market and government signals. Thus it can be ventured that path creation need not lead to a region de-locking from its historic industrial trajectory (Martin and Sunley, 2006).

The seeming multi-scalar institutional incoherence that shaped both region's economic histories continued. Although both regions were more than just passive receptacles where economic activity was played out (Scott, 1998; Pike et al, 2007; Hudson, 2007), regional institutions possessed only partial capability to influence the open and fluid path creation process. In addition, an inability to shape nation state rules for regional benefit was evident.

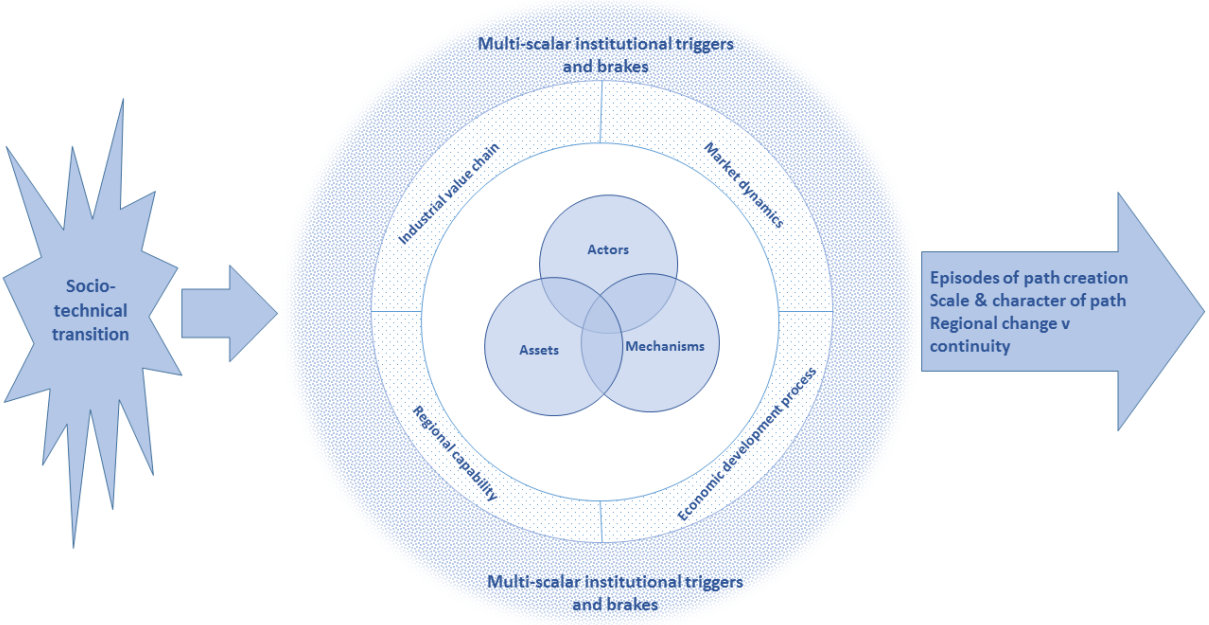
Synthesising the empirical findings: a conceptual framework

In light of the empirical findings in regard to the three research questions, the original analytical framework can now be presented as a developed conceptual framework (fig 8.1). Path creation is exposed and explained as a highly elastic process, moulded and shaped by the multi-scalar institutional environment in which it is set. This environment represents a dynamic and complex set of interacting institutional triggers and brakes, regulating the catalytic path creating power of socio-technical transition.

Notably, meso-level institutional constructs relating to the market, the industrial value chain, the economic development process and regional capability possess significant but shifting influence on the incentivisation and dis-incentivisation of path creating actor agency and its co-ordination. Therefore, these constructs have a critical bearing

on the selection of actors, their respective causal power and the associational nature of their agency (individual, narrow, distributed etc.). Moreover, the mutability of these meso-level configurations are markedly mediated by the wider policy and regulatory environment in which they are set.

In turn, this shifting institutionally mediated process engenders the assembly and interplay of differing aggregations of actors, mechanisms and regional assets over time and space, thereby creating the episodic nature of regional path creation. Accordingly, this process determines the scale and character of the resulting path, thus shaping the degree of regional economic change and continuity.



Source: Own elaboration

Figure 8.1: The elasticity of the regional industrial path creation process

8.3 Theoretical Contributions

My contributions to the advancement of evolutionary approaches in economic geography have been shaped by a desire to understand how socio-technical transition can be harnessed to create new industries in lagging regions, whilst recognising their relevance to other regional types. Moreover, the research has been guided by the aspiration to make evolutionary economic geography more applicable to economic development policy in “a real world in flux” (Massey, 1984). To this end, the thesis contributes to the literature in three areas: the open and conditional nature

of path creation; enabling and constraining institutional environments for path creating agency; and path creation and policy prescription. In each of these three areas, specific theoretical contributions to current literature are identified.

Before exploring these contributions, it is important to recognise that they are based on findings relating to one particular transition related industry, offshore wind. Like all industries, it is distinct, especially in relation to its dependence on state policy and regulation. Therefore, although these theoretical contributions advance understanding of path creation, they need to be set against industrial heterogeneity in future research.

8.3.1 The open and conditional nature of path creation

The malleable nature of the path creation over time

The research endorses the notion of path evolution as an ongoing process of change and continuity that occurs as differing actors attempt to deviate from the past by experimenting and strategizing in the present to achieve future outcomes (Martin, 2010; Steen, 2016; Evenhuis, 2017). However, the research also reveals that the ongoing struggle between continuity and change can create differing causal episodes within the period of path creation itself, thereby illuminating a more conditional, open and punctuated process.

The identification of three differing episodes of path creation – emergence, development and realisation – over a relatively short interval refines less delineated, gradual and deterministic accounts (Martin and Sunley, 2006; Boschma and Frenken, 2009; Neffke et al, 2011). Therefore, the research enhances the common linear model of path creation (Martin, 2010) and identifies path creation as an intrinsically malleable phenomenon. Such malleability implies that a range of rapidly unfolding path episodes within the path creation process itself are possible, in addition to path emergence, development and realisation, including path stasis, reversal and collapse.

Although Peck and Theodore (2007) usefully posit the notion of the elasticity of actor agency, this notion can also be applied to the value of regional assets and the nature of mechanisms which valorise them. It is the malleability of these unique and dynamic aggregations of actors, assets and mechanisms over time and space that shape the scale and character of path creation. This innate conditional openness

exposes the ongoing opportunity for strategic state agency to influence the path creating interplay of actors, assets and mechanisms to shape path outcomes (both quantitative and qualitative) and the path's respective position in the wider sector's division of labour (Dawley, 2013; Dawley et al, 2015; MacKinnon et al, 2018).

Finally, it was demonstrated that the instituted process of socio-technical transition can act as a catalyst for the initiation of path emergence and subsequent evolution. Such an exogenous stimulus encourages the utilisation of novel knowledge at the regional level which allows actors to break from their past via innovation. The interaction of exogenous and endogenous knowledge and new and existing knowledge to create novel knowledge infers a complex causal interplay that is not always evident in the literature (Martin, 2010; Karnoe and Garud, 2012; Cooke 2013).

The conditional nature of regional assets and regional path dependence

The value of regional assets apropos regional industrial change is revealed as relative and changeable, rather than absolute and static (Maskell and Malmberg, 2009). For example, seemingly dilapidated physical assets and infrastructure or path dependent human capital can be repurposed by fusion with novel knowledge relating to an exogenous stimulus such as energy transition (Essletzbichler, 2012; Kasabov and Sundaram, 2016). Furthermore, the magnitude of valorisation is dependent on the scale of fusion with novel knowledge. Consequently, positive and negative regional path dependence are illuminated as contingent phenomena, as is the latent regenerative potential of regions (Stam and Garnsey, 2009). Hence, the exogenous stimulus of grand societal challenges, such as decarbonisation, represent significant opportunities for regional industrial renewal. Therefore, the contention that lagging regions are locked-in to industrial decline given limited competitive assets or structural weaknesses is revealed as overly deterministic (Boschma, 2009; Stam and Garnsey, 2009; Martin, 2010). In short, the transformative power of regional assets is conditional and mutable on their latitude for fusion with novelty.

The shifting and relational nature of actors and mechanisms

The final contribution in regard to the open and conditional nature of path creation, relates to the varied nature of path actors and mechanisms and their shifting, relative nature (Jessop, 1997; Dawley, 2013). Although firms do indeed act as the primary conduits of novel knowledge (Boschma and Frenken, 2006; Martin, 2010) by which

regional assets are reconfigured and valorised they are supported in this role by a diversity of non-firm actors, including state actors, universities and individual agents. Significantly, the state can act as a primary agent in the valorisation of regional assets, for example in regard to the establishment of industrial innovation and test centres (Goddard et al, 2012). In addition, actor agency can be distributed, oligopolistic or individual in nature, with shifting emphasis during the fluid path creation process.

Similarly, although primary mechanisms (Martin and Sunley, 2006; Boschma and Frenken, 2009), such as diversification and transplantation, lead the process of path creation they are contingent on the operation of a range of auxiliary mechanisms. Also, mechanisms can be internal to the firm (Martin, 2010) and intra-firm diversification can mask a path's emergence to external actors. The research also revealed that key path creating mechanisms can be public sector driven, such as state transplantation or state sponsored diversification of university departments, thereby effecting the character of the path in terms of balance between private and public ownership. At a more abstract level, it can be proposed that all regional industrial path creation is essentially the diversification of assets, for instance skills and infrastructure, triggered by the transplantation of novel knowledge to a new productive domain by incentivised social actors.

8.3.2 Institutional environments and path creation

The relative importance of differing institutional scales

The research validates the theoretical contention that actors are incentivised by institutional frameworks to mindfully deviate from past practice and to strategize and experiment in the present to attain future outcomes (Emirbayer and Mische, 1998; Bakker, 2014; Steen, 2016). Also, the influential role that institutions play in managing and co-ordinating actor agency is reaffirmed (Bathelt and Gluckler, 2014; Steen 2016). In effect, path creation represents complex yet institutionally structured interplay of actors, mechanisms and assets. Building on this, the research exposes how multi-scalar state institutional environments represent an interacting system of triggers and brakes for regional path creating agency. Additionally, an acute temporal calibration of agency with institutional change is identified which augments more gradualist interpretations (Martin, 2010). Notably, an institutional causal hierarchy has also been identified.

The research reveals path creation as a contingent, relatively reflexive by-product of wider sectoral and technological dynamics. Therefore, the extra-regional institutions that mediate these wider dynamics are exposed as critical to regional path creation. In particular, nation state institutions play a central role in determining the magnitude of the exogenous stimulus of energy transition (Truffer and Coenen, 2012), shaping national market and industrial value chain dynamics which regulate the potential for path creation at the regional level. Additionally, these dynamics shape the level of industrial competition and consolidation, thereby regulating levels of firm and technological variety. Tellingly, changes in nation state policy and regulation not only incentivise firm agency but can also rapidly dis-incentivise it, making firms retreat from major investments in relatively short periods of time. Furthermore, the devolved institutional environment can indeed play a notable role in triggering sectoral and related regional path emergence (Gertler, 2010; Rezvani, 2016). However, it is auxiliary and contingent on wider state institutional dynamics.

Likewise, although the findings validate the important role accorded to the regional institutional environment in triggering actor agency, its role is more auxiliary than new regionalist theory implies (Saxenian; 1994; Kanter 1995; Ohmae, 1995; Storper, 1995; Amin, 1999; Rodriguez-Pose, 2013). Critically, regional institutions are not sufficiently powerful to substitute for nation state power in the case of energy transition. However, the regional institutional environment can play a key role in facilitating the *priming* of regional assets, *portraying* the path's actualisation within and beyond the region, and *promoting* the path's quantitative and qualitative evolution in relation to the wider sector's division of labour.

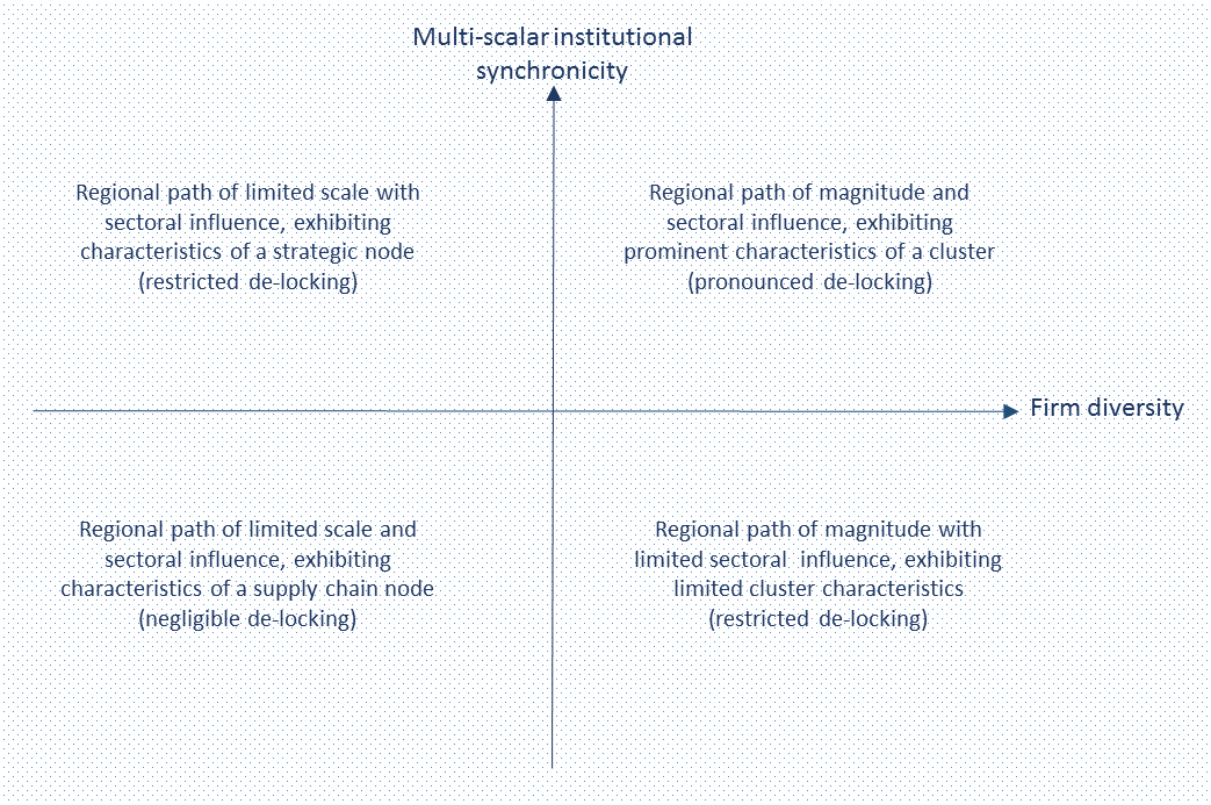
Institutional synchronicity is a pre-requisite for an enabling environment

In regard to enabling and constraining institutional environments, the research reveals that the degree of multi-scalar and intra-scalar institutional synchronicity has significant bearing on regional path dynamics and outcomes. Although systematic institutional co-ordination is not revealed as a pre-requisite for path creation, the research develops theory which contends that complementarity between institutional scales is an enabler of industrial change (Schroder and Voelzkow, 2016). Institutional synchronicity, even if strategically un-coordinated, enhances path creating agency; whilst misalignment has the opposite result. For example, it was demonstrated that the level of alignment determines the potential for agglomeration; as regional policies

which promote clustering are dependent on nation state policies which foster firm and technological variety, not consolidation and oligopoly.

Furthermore, the research also indicates that actor diversity, even related firm variety (Boschma and Frenken 2009; Neffke et al, 2011), is insufficient in itself for the process of path creation in lagging regions to lead to de-locking from historic industrial trajectories. In order for regional path dependence to be countered and path creation to lead to a region occupying an influential position in a sector's division of labour, multi-scalar institutional synchronicity is also required. Such synchronicity will ensure that extra-regional sectoral and technological path dependences (Boschma et al, 2017) and regional path dependences (Martin and Sunley, 2006) are mediated to optimise the scale and quality of path creation at the regional level.

Therefore, a key contribution is that firm diversity coupled with multi-scalar institutional synchronicity is required to create regional industrial paths of sufficient magnitude and sectoral importance to tackle the challenge of industrial renewal (figure 8.3).



Source: Own elaboration

Figure 8.2: Interaction of institutions and diversity on regional path outcomes

The research also enhances literature on the need for coordination across nation state policies (Barca et al, 2012; Martin and Sunley, 2015) by observing that synchronicity on each institutional scale influences the elasticity of path creating agency (Peck and Theodore, 2007). Thus, unaligned horizontal, vertical and spatial policies at the nation state level and un-coordinated regional institutional thickness (Amin and Thrift, 1994a) constrain regional path creating agency. Finally, it is worth noting that the quantity of regional institutions does not represent a reliable measure of regional institutional thickness or capability; common purpose focused at the regional level and common expectation also require to be evident.

Framing RIS concepts in broader institutional and technological contexts

The research demonstrates that the power of regional innovation systems (Cooke et al, 2004; Asheim et al, 2011b) to enable path creating agency can be circumscribed by extra-regional market and industrial value chain dynamics which are considerably shaped by nation state policy and regulation. Therefore, the research responds to recent calls in the literature to assess how extra-regional institutional environments mediate the causal power of regional level economic development initiatives and capability (Dawley, 2013; Pike et al, 2017b; Trippl et al, 2017). The influence of a RIS on path actor agency, even an organisationally thick and specialised RIS (Trippl et al, 2017) or one with a world class research university at its centre (Goddard et al, 2012, 2013b), is contingent on broader technological path dependences, which are regulated in the case of energy transition by the nation state. Moreover, the ability of regional actors to create institutionally protected innovation space to challenge technological path dependence, akin to a niche (Geels and Schot, 2007; Boschma et al, 2017), is dependent on the degree of alignment between the regional and extra-regional institutional environments and the interplay of varied proximities and pipelines connecting the region with the wider sector's development (Bathelt et al, 2004; Boschma, 2005; Coe et al, 2008).

In short, RIS theory requires greater accommodation of nation state institutions and wider technological dynamics if it is to generate further insight on the power of instituted innovation frameworks, regional capability and universities to enable actor agency, especially in lagging regions (Goddard et al 2012, 2013b; Morgan, 2013a).

8.3.3 Regional path creation theory and policy prescription

Responding to the limits of endogenous-oriented theory and related policy

The research qualifies the efficacy of endogenously orientated theory and concepts which currently have a significant bearing on regional development policies, for example Smart Specialisation (Hausman and Roderik 2003; Foray et al, 2011), Clusters (Porter, 1990; Maskell, 2001) and those relating to regional higher education and research (Morgan et al, 1999; Morgan, 2003, 2013b; Goddard et al, 2012, 2013a, b). In effect, the utility of such theoretically informed policies for facilitating industrial renewal is conditional on their recognition of, responsiveness to and rapprochement with extra-regional institutional, sectoral and technological dynamics. Similarly, Constructing Regional Advantage (Todtling and Trippl, 2005; McCann and Ortega-Argiles, 2013), an analytical policy tool closely associated with evolutionary economic geography, should more fully reflect and accommodate the multi-scalar reality in which regions are set.

Furthermore, the research reveals that integrated multi-scalar policies are required to enable the sustained interaction of regional assets with exogenous stimuli to enable regional industrial path creation, especially in lagging regions. Tellingly, un-coordinated policies may only create new paths with similar qualitative deficiencies to the established regional industrial base from which they emerged. Therefore, the notion of related variety need not only have positive connotations, as inferred in associated literature (Boschma and Frenken, 2009; Neffke et al, 2011; Cooke, 2012).

Reconceptualising the role of state agents in the economic development process

The research responds to calls for the role of state actors in regional economic and industrial development to be reconsidered (Cooke, 2006; Martin et al, 2015; Pike et al, 2016a). Given the process of regional path creation is dependent on multi-scalar institutional synchronisation which enables or constrains actor agency, regional development and industrial renewal cannot be determined exclusively at any one level. Therefore, the need for state actors to act as system builders (Geels, 2004) and institutional entrepreneurs (DiMaggio, 1988; Battilana et al, 2009) is strikingly exposed. Such state actors have a critical role in reconciling and influencing the multi-scalar interplay between three forms of path dependence which mediate regional path creation and outcomes: sectoral, technological and regional (Martin and

Sunley, 2006; Boschma et al, 2017). In order to achieve this mediation, state actors need to connect and co-ordinate the domains of economics, industry, research and politics through the synchronisation and adaptation of institutions. In doing so, state actors can engender the mobilisation of firms and related mechanisms to repurpose and utilise regional assets in a manner that optimises industrial and economic benefits at both the national and regional scales.

8.4 Implications for Public Policy

As noted earlier, a principal aim of my research is to strengthen the bridge between the worlds of economic geography theory and economic development policy and practice, specifically in relation to how new regional industries are created and the role of the state in this process. Therefore, this section considers the broad implications of my research for policy and practice. To this end, the section identifies general messages for state agency and then postulates on what state actors could have done differently to enhance the outcomes which were witnessed in the observed cases of Glasgow and Humberside. However, before doing so, the significant potential of socio-technical transition for regional industrial transformation and the accompanying need for redesign of the economic development process is considered.

The research has demonstrated that socio-technical transition can act as a catalyst for regional industrial renewal, albeit one that is highly susceptible to changes in the institutional context in which it is set. As public concern and political action increases vis-à-vis climate change and sustainability, greater policy attention will be given to how the industrial opportunities and challenges of related socio-technical transitions can be respectively optimised and mitigated. For instance, these relate to opportunities for industrial renewal based on energy transition and decarbonisation and, conversely, the challenges for regions that are dependent on carbon intensive industries, such as coal mining, oil and gas, and the transhipment of carbon fuels. In addition, the sustainable utilisation of natural resources, such as those in the marine environment, and the development and repurposing of societal infrastructure in light of climate change offer opportunities for industrial renewal. In all these areas state agency will or can be determinative in addressing the related opportunities and challenges.

The research has exposed and explained that regional industrial path creation based on socio-technical transition is premised on the interplay of region specific and extra-regional factors. Moreover, this process of industrial change is dependent on the incentivisation, mobilisation and co-ordination of diverse actors and the operation of related mechanisms (diversification and branching, transplantation etc.) in order to revalorise and reconfigure regional assets in line with industrial need. Critically, both regional institutions and extra-regional institutions regulate the interaction of changing aggregations of actors, mechanisms and regional assets through space and time and, in turn, shape the resulting scale, nature and timing of new regional transition related industries. Therefore, state policies and practice need to be cognisant of and responsive to: i) the endogenous drivers (such as unique regional assets and institutions) and exogenous drivers (such as wider sectoral and technological dynamics) of regional change; and ii) the centrality of institutions (policies, regulation, behaviours, organisations, networks etc.) in framing and shaping the effectiveness of state agency.

In order to integrate these requirements into policy and practice, the common approach to regional industrial development in the UK needs adapted. The prevailing supply-side policy focus of state actors (Pike et al, 2016a) has remained largely unchanged for over a generation. Despite its endurance, the relative industrial decline of many UK regions has not been halted. Moreover, current approaches do not adequately utilise the observed power of the nation state and institutional synchronisation, as evidenced in the Glasgow and Humberside case studies, to engender and optimise industrial change and demand at the regional level.

The orthodox regional industrial development model facilitates regional industrial change via incentivisation of firm behaviour through the utilisation of tools relating to innovation, investment, skills etc. The approach has a tendency to operate in isolation from and with little influence on the extra-regional dynamics which shape broader sectoral and technological developments. Therefore, the model has a tendency to overlook the fact that new regional industrial paths are the reflexive by-product of wider industrial dynamics. Hence, in this research, a number of state actors were observed to be taken unawares by the adverse effect of extra-regional energy policy and regulatory changes on firm agency at the regional level. Moreover, this approach to industrial development is often synonymous with regional state

actors with limited power to influence the vested interests and rent seeking behaviour of powerful regional firms or the exogenous institutional landscape. Moreover, the UK Government's challenge funds and sector deals linked with the UK's new industrial strategy have a predisposition to incentivise limited numbers of often incumbent firms. Such bespoke deals risk promoting narrow sectoral and investor benefits at the expense of wider economic and societal benefits. The UK's closed and narrow public and private partnerships for the development of the offshore wind industry and Prime Minister David Cameron's undisclosed final negotiations with Siemens are reminiscent of this approach.

Therefore, it is proposed that there are four key policy and four key practice messages generated by this research for state actors if the opportunities and challenges for socio-technical transition are to be addressed. Underpinning these messages is the recognition of the multi-scalar, multi-actor, institutionally conditional nature of regional industrial path creation. Notably, these lessons are not only pertinent to lagging regions pursuing industrial renewal via socio-economic transition but also have a relevance to differing regional types and industries.

Key messages for policy

i. The process of regional industrial path creation is open and fluid and thus a variety of future industrial development trajectories are possible. Lagging regions are not inevitably locked in to a negative equilibrium, rather they have ongoing opportunities for industrial renewal. Moreover, the path creation process is highly susceptible to changes in the multi-scalar institutional environment in which it is set. Therefore, policy makers have an ongoing ability to influence the emergence and evolution of regional industrial paths within relatively short timeframes; so long as they are cognisant of and shape the appropriate institutional triggers and brakes that respectively incentivise and dis-incentivise path creating agency.

ii. The catalyst for path emergence and subsequent path evolution is the fusion of novelty with regional assets; a process that is shaped by the interaction of differing aggregations of actors, mechanisms and regional assets through time and space. Moreover, the magnitude of fusion determines the extent of industrial change. As was observed in the research, regional assets, even

ones that were seemingly latent or could be termed a liability (such as old derelict docks), could be repurposed and valorised relatively rapidly. Critically, the state can play a leading and formative role via institutional synchronisation in promoting firm agency and co-ordination and the related activation of mechanisms to valorise and reconfigure regional assets. In addition, the state can also directly influence this process through the transplantation of and investment in research, education and policy functions to utilise regional assets. Therefore, the deterministic contention that lagging regions are locked-in to historic industrial decline, stasis and underperformance due to limited or obsolete assets is misleading, rather the transformative power of regional assets is conditional on their latitude for fusion with novelty.

iii. A dynamic regional research and science system and higher education sector or pronounced regional institutional thickness are no guarantors of industrial renewal. Therefore, related policies such as Smart Specialisation need to be supplemented with policies that transplant institutional power and influence, novel knowledge and investment to regions.

iv. Given that the process of regional path creation is dependent on multi-scalar institutional synchronisation which incentivises, coordinates and de-risks actor agency to valorise regional assets, regional industrial renewal cannot be determined exclusively at any one level. Extra-regional state institutions can and do have significant bearing on the underlying temporal logic of the wider industry and the related evolution of associated market dynamics, competition and the industrial value chain[73], this is particularly the case in regard to socio-economic transition. As noted, new regional industrial paths are the reflexive by-product of wider industrial dynamics conditioned by wider institutions. However, regional state institutions can and do play a critical role in facilitating the priming of regional assets and portraying and promoting the path at the regional level. Therefore, in order to optimise the scale and quality of the regional path, synchronisation of state institutions between and across scales is required. This will ensure that the spatial consequences of aspatial policies

[73] All three have a key influence on firm diversity at the national level. In Glasgow and on Humberside national industrial consolidation and oligopoly mitigated options for clustering

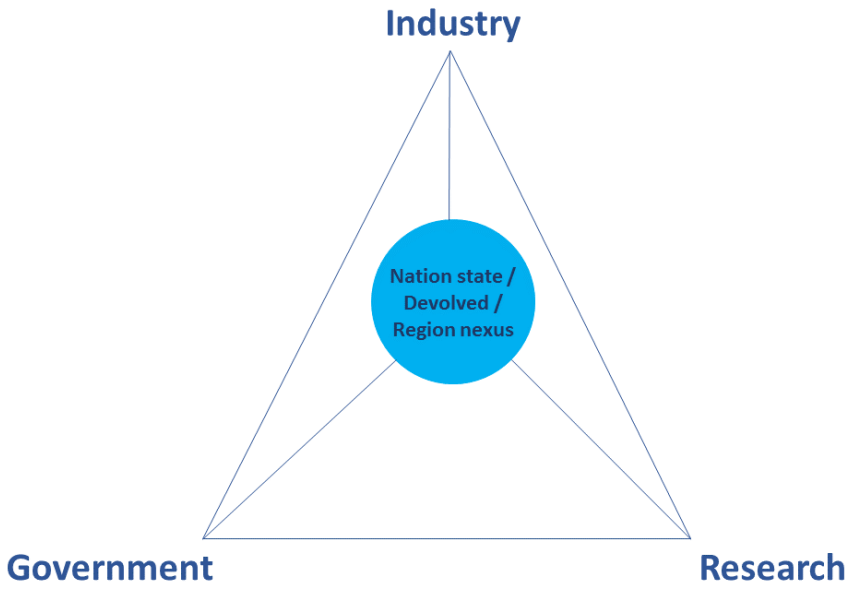
(such as energy and competition) are understood and impediments and trade-offs vis-à-vis the pursuit of regional industrial renewal can be assessed and addressed. Moreover, a deficit of explicit co-ordination can still lead to a path of scale but such a path may exhibit similar qualitative deficiencies and characteristics to the established regional industrial base from which it emerged. In order to create regional industrial paths of magnitude which possess higher value functions within the industry's national and international division of labour, akin to leading internationally competitive clusters, there needs to be high levels of both institutional synchronisation and firm diversity.

Key messages for practice

i. In order to facilitate regional path creation, the state's capacity to comprehend institutional causal relationships and subsequently synchronise institutions across and between scales of government needs developed. Such a change in capacity involves the innovative reconfiguration of state skills, tools, methods, behaviours and collaborative models. Although comprehensive co-ordination of the multi-scalar institutional environment is challenging if not impossible, the greatest level of alignment should be sought to optimise quantitative and qualitative industrial outcomes and their temporal manifestation. By adopting this approach, the interrelated dynamics of sectoral, technological and regional change and continuity (i.e. interacting path dependences) can be mediated to enable industrial development and renewal at the nation state, devolved and regional levels. In turn, such co-ordination will minimise inefficient displacement, deadweight and inter-regional competition. Although elimination of narrow vested economic and political interests, such as rent seeking behaviour, is unrealistic, institutional co-ordination and collaboration would mitigate their practice and consequence.

ii. A new type of state agent, akin to the System Builder (Geels, 2004) or an Institutional Entrepreneur (Di Maggio, 1988; Battilana et al, 2009), is required within the economic and industrial development process. Such actors would work between and across differing scales of government (i.e. nation state, devolved and regional) to optimise institutional synchronisation to promote industrial renewal and related quantitative and qualitative outcomes. Central to their role would be the utilisation, manipulation and restructuring of institutional

frameworks to incentivise path actor agency, co-ordination and firm diversity. Moreover, a key role of these state actors would be to recognise and reconcile the respective policies and functions of different scales of government. For example, in the case of offshore wind, the UK Government had the primary role in creating the market and the industry's temporal logic and value chain, whilst the Scottish Government had a subsequent key role in shaping its specific industrial manifestation (for example in relation to floating wind), whilst regional / local government primed regional assets for valorisation by firms. These state agents would also promote collective governance, transparency and legitimacy across geographic scales. The operational domain of these agents of change would be the nexus relating to the interface of industry, research and the varying scales of government (see figure 8.3).



Source: Own elaboration

Figure 8.3: Domain of state system builders

iii. Greater integration is required between a predominantly transactional approach to state-led regional industrial development, based on the distribution of resources for prescribed outcomes, and a relational approach, based on the synchronisation of formal institutions, such as policy and regulation, and informal institutions, such as common purpose and collaboration. Therefore, there is a requirement to enhance the state's proficiency in integrating relational and transactional practices. Furthermore,

for a more relational approach to be successful, further power needs to be transferred to regions in order that they too can influence such institutional synchronisation, thereby ensuring that regions are not just passive arenas reshaped by capital flows and extra-regional policies but active and empowered places.

iv. Although path dependence and path creation theories and concepts represent a common framework in academia for exposing and explaining regional and industrial continuity and change, and how geography shapes regional economic and industrial evolution, they have not exercised the prominence in the world of economic development practice one might anticipate. Given their utility in analysing a region's unique circumstances and legacies in terms of its institutions, knowledge, skills, competences, experiences, infrastructure, physical and natural resources, such a framework merits integration into the mainstream analytical approaches of state actors. By embracing and utilising these theories and concepts, regional heterogeneity and the opportunities and choices for industrial renewal that such regional distinctiveness offers would be more readily exposed, as well as the related options for state agency.

Finally, in light of these proposed adaptations to policy and practice, it is appropriate to briefly reflect on what state actors could have done differently to enhance the observed path outcomes in the two cases studies (see figs 7.1 and 7.2).

In regard to Glasgow, greater strategic co-ordination between Westminster and Edinburgh could have allowed Scottish projects which had been leased prior to the introduction of the Contracts for Difference to still receive the anticipated ROCs subsidy in light of Scotland's more challenging waters. The retention of these projects would have encouraged the progression of significant regional investments by Gamesa and Doosan Babcock and further experimentation amongst the city's electricity utility firms, thereby leading to the valorisation of ITREZ's research capability. In addition, the UK Government's ORE Catapult technology and innovation centre could have been further integrated with local knowledge assets; whilst a component of Glasgow's £1.1billion City Deal could have been invested to boost the local path's position in the broader sector's international division of labour and knowledge, for example regarding deeper water technologies. Finally, the

presence of an offshore wind regional industrial forum could have co-ordinated regional path actors, facilitating common purpose and path promotion.

In terms of Humberside, the grouping of several offshore wind projects into a common development and procurement framework by the UK Government could have encouraged development of shared onshore infrastructure (e.g. for installation and construction) and offshore infrastructure (e.g. cabling). Such industrial scaling-up would have encouraged greater investment by supply chain actors on Humberside. In reality, the rollout of projects was intermittent and fragmented, mitigating economies of scale and investor confidence. In addition, had the UK Government linked award of subsidy to the utilisation of the UK supply chain prior to 2014, Siemens' and other supply chain investments could have occurred earlier. Finally, significant pan Humber strategic planning powers or greater institutional thickness could have countered the monopolistic vested interest of ABP. This, in addition to the other measures noted above, would have boosted the valorisation of AMEP on the Humber's south bank, the only site in the region that could accommodate substantial supply chain co-location.

8.5 Future Research

My enquiry indicates promising future research in a number of areas of path theory. These namely relate to path creation in relation to differing regional types and enabling and constraining institutional environments. Moreover, future research should further utilise comparative analysis across sectors and regional and national settings.

The research has affirmed the necessity to undertake further empirical enquiry in lagging regions to generate more comprehensive, refined and purposeful theory and mitigate the preponderance of theory derived from observation of successful regions (Pike et al, 2007; MacKinnon et al, 2009). If "the issue of geographically uneven development" is truly the fundamental concern of our discipline (Martin and Sunley, 2013, p 32), empirical enquiry needs to place further emphasis on less dynamic regions and embrace the rich diversity of options for path investigation across regional types.

In regard to enabling and constraining institutional environments for path creation, the research exposes a rich vein of future research pertaining to: the alignment of

nation state and devolved state actors to generate mutual industrial benefit; the influence and interaction of differing policy paradigms and conventions across scales of government on regional path creation; and the direct role of the state actors and mechanisms (e.g. transplantation) on regional path creation. Also, given the continuing paucity of RIS and endogenous-led models vis-à-vis lagging regions, a promising departure point for future enquiry relates to the construction of fuller relational conceptualisations of regional innovation frameworks and Smart Specialisation.

Furthermore, the research has demonstrated the methodological feasibility and value of integrating path research objects, subjects and levels into a holistic framework (Martin and Sunley 2006, 2013; Pike et al, 2016b). Therefore, this methodology could be readily transferred to analyse the interplay of institutions and regional path creation in other economic and industrial contexts. Moreover, the demonstrated value of comparative analysis based on immersive longitudinal case studies indicates that the methodological approach should be further embraced in future research across industries, regions and nations.

Finally, on a more general point, future enquiry should place continued emphasis on the needs of policy makers and practitioners operating in the sphere of economic and regional development, in order that economic geographers “seek to not only make social life intelligible but also to make it better” (Gregory, 1994, p 10).

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Appendix A

Glasgow primary research interviewees

Firm Actor Code	Type of Firm	Ownership	Actor Position	Interview Location	Interview Date
G-Dev1	Project developer/ Electricity Utility Firm	UK owned	Director	Glasgow	15/1/16
G- Dev2	Project developer /Electricity Utility Firm	Foreign owned	Manager	Glasgow	8/1/16
G-Dev3	Project developer	Foreign owned	Manager	Glasgow	2/8/16
G-Con1	Consultancy (project development)	UK owned	Director	Glasgow	9/12/15
G-Con2	Consultancy (engineering and technology)	UK owned	Manager	Glasgow	21/7/16
G-Rep1	Business Chamber	Membership organisation	CEO	Glasgow	13/1/16
G-Rep2	Renewables Industry Representative	Membership organisation	Manager	Glasgow	28/1/16
Government Actor Code	**Type of Government Organisation**	**Jurisdiction**	**Actor Position**	**Interview Location**	**Interview Date**
G-RDA1	RDA	Devolved govt.	Manager	Glasgow	3/12/15
G-RDA2	RDA	Devolved govt.	Manager	Glasgow	10/12/15
G-RDA3	RDA	Devolved govt.	Director	Edinburgh	22/12/15
G-FDI	Inward Invest' Agency	Devolved govt.	Manager (retired)	Glasgow	16/12/15
G-MS	Marine Scotland	Devolved govt.	Manager	Edinburgh	21/12/15
G-SGov1	Scottish Government	Devolved govt.	Manager	Glasgow	15/12/15
G-SGov2	Scottish Government	Devolved govt.	Minister (former)	Glasgow	11/1/16
G-CE	Crown Estate	Nation state govt.	Manager	Edinburgh	22/12/15
Research & Higher Edu Actor Code	**Type of Organisation**	**Jurisdiction**	**Actor Position**	**Interview Location**	**Interview Date**
G-RHE1	University	Devolved govt.	Principal	Glasgow	17/2/16
G-RHE2	Technology and Innovation Centre #1	Devolved govt.	Director	Glasgow	22/12/15
G-RHE3	Technology and Innovation Centre #2	Nation state govt.	Manager	Glasgow	11/12/15

Appendix B

Humberside primary research interviewees

Firm Actor Code	Type of Firm	Ownership	Actor Position	Interview Location	Interview Date
H-OEM	OEM (MNC)	Foreign owned	Director	Hull	21/3/16
H-PO1	Port Operator	UK owned	Manager	Hull	21/3/16
H-PO2	Port Operator	UK owned	Director	Immingham	24/6/16
H-O&M1	Logistics & Transport	UK owned	CEO	Hull	22/3/16
H-O&M2	Training Organisation	UK owned	Manager	Grimsby	25/5/16
H-Rep1	Business Chamber	Membership organisation	CEO	Hull	26/5/16
H-Rep2	Marine Industry Representative	Membership organisation	CEO	Hull	22/3/16
Government Actor Code	**Type of Government Organisation**	**Jurisdiction**	**Actor Position**	**Interview Location**	**Interview Date**
H-UKGov1	Dept Business Innovation and Skills	Nation state govt.	Director (retired)	Leeds	22/3/16
H-UKGov2	Dept Business Innovation and Skills	Nation state govt.	Senior Manager	London	9/2/16
H-RDA	Local Enterprise Partnership	Nation state / Local govt.	Manager	Hull	3/2/16 & 21/3/16
H-LA1	Local development	Local govt.	Director	Hull	13/7/16
H-LA2	Local development	Local govt.	Economic Dev Officer	Hull	26/5/16
H-LA3	Local development	Local govt.	Director	Grimsby	25/5/16
H-LA4	Local development	Local govt.	Manager	Grimsby	25/5/16
H-UKCC	City of Culture Office	Nation state govt.	Manager	Hull	21/3/16
Research & Higher Edu. Actor Code	**Type of Organisation**	**Jurisdiction**	**Actor Position**	**Interview Location**	**Interview Date**
H-RHE1	University	Nation state govt.	Pro Vice Chancellor	Hull	26/3/16
H-RHE2	Regional Innovation Prog.	Nation state govt.	Director	Hull	15/8/16
H-RHE3	Technology and Innovation Centre #2	Nation state govt.	Regional co-ordinator	Glasgow	23/12/15

Appendix C

Wider sectoral research interviewees

Firm Actor Code	Type of Firm	Ownership	Actor Position	Interview Location	Interview Date
S-Dev1	Project developer/ Electricity Utility Firm	UK owned	Director	Glasgow	3/2/16
S-Dev 2	Project Developer/ Electricity Utility Firm	Foreign owned	Managing Director	London	8/2/16
S-OEM	OEM	Foreign owned	Manager	NE England	2/8/16
S-Con	Energy Technology Company	UK owned	Director	London	10/2/16
Government Actor Code	**Type of Government Organisation**	**Jurisdiction**	**Actor Position**	**Interview Location**	**Interview Date**
S-UKGov1	Dept Energy & Climate Change	Nation state govt.	Manager	London	9/2/16
S-UKGov2	Dept Business, Innovation and Skills	Nation state govt.	Manager	London	9/2/16
S-UKGov3	The Treasury	Nation state govt.	Senior Advisor	London	9/2/16
S-UKGov4	Dept Energy and Climate Change	Nation state govt.	Manager	London	10/2/16
S-CE	Crown Estate	Nation state govt.	Manager	London	10/2/16
Research Actor Code	**Type of Organisation**	**Jurisdiction**	**Actor Position**	**Interview Location**	**Interview Date**
S-R1	Welsh Government	Devolved govt.	Regional Co-ordinator	Cardiff	17/12/15
S-R2	Technology and Innovation Centre #2	Nation state govt.	CEO	Glasgow	29/12/15
S-R3	UK Innovation Agency	Nation state govt.	Manager	Glasgow	27/1/16
S-R4	UK Innovation agency	Nation state govt.	Lead Technologist	London	10/2/16

Appendix D

Discussion Themes for Glasgow Case Interviews

PART A : Views on path emergence and evolution (c 15m)

1) Role of interviewee and organisation

2) From your perspective, why do you think the Offshore Wind industry emerged in the Glasgow area (GA)? What were key causal moments? (refer to Fallon & OREC, 2013, corporate decisions influenced by climate change legislation and related subsidy)

3) How important were local assets in its emergence? e.g. unique knowledge, skills, business practices / competences

4) How would you describe the evolution of OW industry in GA in terms of its

   - Growth e.g. planned, unplanned; stable, disjointed
   - Structure e.g. functional mix; integration; type & nature of relationships
   - Quality e.g. economic value of services, functions and products; levels of autonomy

PART B: Views on agents and mechanisms that facilitated emergence and evolution (c 15m)

5) What were the prominent firms & other organisations - at a local, national, UK, international levels - involved in OW emergence and evolution in the GA – and why? SE role?

6) What were the firm development processes re the development of the OW industry in the GA e.g. FDI, diversification and R&D?

PART C: Views on institutional arrangements that facilitated emergence and evolution (c 25m)

7) Are there examples of how local organisational arrangements (leadership, networks, organisations and shared learning processes):

- Enhanced creation and sharing of knowledge and innovation re OW in the GA

- Assisted radical industrial & tech. experimentation beyond industry norms in the GA?

8) Comparatively how important were UK Government policies towards OW in enabling, constraining or shaping emergence & evolution of the industry in

the Glasgow area? (e.g. energy market regulation RO>FID>CFD; energy mix policy; OWIS; CfD supply chain dev.)

9) What was degree of alignment (formal & informal) between local, Scottish & UK levels (e.g. Eco Leadership Board, OWIG/SG Energy Advisory Board, OWIC // OW Route Map & OWIS // SDI & OWIO/UKTI)?

10) How much did sub-state organisations and arrangements (e.g. SE, Scot Govt, OWIG) shape UK policies?

PART D: Future Prospects (5m)

Appendix E

Discussion Themes for Humberside Case Interviews

SEP Ambition: "Humber to become a renowned national & international centre for renewable energy"

PART A : Views on path emergence and evolution (c 15m)

1) Role interviewee and organisation

2) From your perspective, why do you think the OW industry emerged in the Humber area? What is emerging – O&M and manufacturing /assembly / deployment/ installation? What were key causal moments? (Leasing rounds; Siemens MoU 2011/announce 2014; CFD supply chain)

3) How important were local assets in its emergence (e.g. geog; infra; competences e.g. logistics, engineering; energy & chemicals)? Legacies that hindered development?

4) How would you describe the evolution of OW industry and why, in terms of:

   - Co-ordinated, smooth; stop, start; sub-optimal (Siemens MoU 2011, decision 2014, 2 sites to 1 site and blades, Able MEP, wider supply chain) – Andrea Leadsom "payback"
   - Structure - integrated functions; supply chain; ind. community (Enrgy Estuary rivalry?)
   - Quality e.g. functions; scope for innovation; autonomy; "internationally renowned"

PART B: Views on agents and mechanisms that facilitated emergence and evolution (c 15m)

5) What were prominent firms - at a local (ABP), UK (utilities), international levels (Dong, Siemens) - involved in OW emergence and evolution – and why? What were other prominent organisations (RDAs/Las/GPH) involved in OW emergence (geog)– and why?

6) What were the firm development processes re OW development e.g. FDI, diversification?

PART C: Views on institutional arrangements that facilitated emergence and evolution (c 25m)

7) Are there examples of how local organisational arrangements (leadership, networks, organisations and shared learning processes ref. GPH, City Leadership Board, GRP, SC pilot):

- Assisted emergence?
- Assisted industrial & tech. innovation created inside and outside region?
- Specifically, views on proposed open access innovation centre led by Uni of Hull?

8) Comparatively how important were UK policies towards enabling, constraining evolution? (e.g. energy mix policy; ROCs>CFD; supply chain; OWIS; CORES, EZs, Growth & City Deals)

9) Degree of alignment with UK insts. (BIS, OWIO, DCLG, DECC) & role of UK insts in location?

10) How much did Humber organisations and arrangements shape UK policies; and the geog manifestation of industry and manage rivalries (Hull & Siemens v Immingham, S bank)?

PART D: Future Prospects (5m)

Appendix F

Discussion Themes for London/UK Case Interviews

PART A : Views on path emergence and evolution (c 10m)

1) Role of interviewee and organisation

2) What do you think were key causesfor the emergence and evolution of the OW industry over the last two decades? (refer to Fallon re OREC and Siemens in Hull)

PART B: Views on role of institutions (c 30m)

3) What was the role and relative importance of govt industry strategy in shaping OW's evolution in terms of nature, scale and localities & regions (OWIS only launched in 2013)?

4) What was the role and relative importance of government subsidy in shaping evolution in terms of nature, scale and geography (NFFO, ROCs, CFD)? Influence of horizontal policies with national actors (i.e. energy market etc)?

5) Since 2000 how has the govt's disposition re intervention in industry and role of the state - and changes to this outlook - evolution of OW in terms of nature, scale and geography?

6) How has partnership working (OWIC, OWPB, OWA etc) shaped emergence and evolution in terms of nature and scale? Given the small number of large international actors, how was the risk of group-think been mitigated? Also Auction model?

7) Any thoughts in regard to alignment to promote cost reduction and economic benefit in i) government (primarily UK but also EC and Scotland) and ii) between government, industry and research (refer to BVG report)?

How do national institutions and strategies relate, understand and shape things happening in localities & regions. What do they make of sub-national geography of the industry and also the institutions and strategies connecting to, and emerging from, local and regional scales?

PART C: Views on role of innovation (c 20m)

8) Why do you think the UK performs well re publishing research papers on OW but registers few patents? (Is this due to the nature of the OW global industry? Incumbent corporates and related technologies? Issues of NIS / Triple Helix?)

9) How would you characterise UK innovation policy re OW e.g. in terms of objectives, timescales, actors, international interaction (what is your view on the contribution of ORE Catapult in the context of a NIS or a triple helix model)?

10) What are implications of increasing emphasis on cost reduction for innovation policy?

Appendix G

Codes for Collation of Primary Data

Based on Analytical Framework

1) Actors

1.1 Regional actors and relationships

1.2 Extra-regional actors and relationships

1.3 Primary and auxiliary actors

1.4 Strategic Priorities

1.5 Nature of related agency (individual, collective, distributed)

1.6 Strategic purpose; mindful deviation; happenstance

2) The state (local/regional, devolved, state, supra)

2.1 Strategic Priorities

2.2 Arrangements and Partnerships

2.3 Alignment / misalignment of scales, rationales & interventions

3) Processes and Mechanisms

3.1 Process of creation (phasing and related characteristics)

3.2 Mechanisms (path creating, branching, others)

3.3 Primary and auxiliary

4) Regional Assets

4.1 Technological, knowledge, scientific offering and relationship with demand

4.2 Evidence of RIS / niche characteristics

4.3 Skills and competences / Feedstock / human capital creation / skills supply

4,4 Churn and retention

4.5 Embedded networks, stickiness and alumni

5) Institutions and their Configurations in enabling or constraining

Incentivising; Co-ordinating; De-risking, Moulding, Legitimising agency

5.1 Institutions (scales) in shaping nature and scale of market demand

5.2 Institutions (scales) in shaping nature and scale of market supply

5.3 Institutions shaping Technological Demand & innovation environment

5.4 Technological Institutional Environment (RIS, niche, clusters, regime)

5.5 Institutional alignment /misalignment, co-ordination and flexibility

6) Path interaction wider sector

4.1 Influence of path on sector

4.2 Influence of sector on path

7) Nature of regional industrial path

7.1 Characteristics

8) Key causal moments

Open coding classifications (examples)

1) Taxonomies, definitional boundaries and narratives of path evolution

2) Implications of physical geography of resource for path evolution (west coast / east coast, Crown Estate Rounds and maps etc)

3) Spatial prescience / affiliation of path actors

4) Counterfactuals of regional industrial path creation outcomes

5) Previous expectations regarding path development

Appendix H

Example of plotting Glasgow case temporal dynamics: key instances of actor agency; institutional developments; and technological change

2006	07	08	09	10	11	12	13	14	2015
SP est OW team	Airtrcity locate	SSE acquire Airt'city	SSE and Strath Uni announce CEERE	SSE Strategic Alliance with Mitsubishi	SSE 'HQ' CEERE / create proc'ment alliance / procure tower manu	Constructio n of TIC (ITREZ) starts	ORE Catapult est	OREC locates ITREZ + merges with NAREC	OREC takes ownership of 7MW turbine
Iberdr'la acquire SP				Wood Group acquire stake in Sgurr	Gamesa opens design office	SP announce new corporate HQ in city centre	Sgurr acquires Strath Control	Atkins JV on floating wind – acquire Princple	Danish K2 announces relocation from London
				Mainstrm Renewabl s locate in Glasgow	Doosan B announce plan for manu facility	Doosan B / halts plan/ Gamesa scales back	Nor. DNV open Scottish energy HQ		
				Atkins develop OW Team	Xodus opens office		SSE, SP & Technip collaborat e via TIC		
					"Economist" article + SR		Gamesa mothball'd		
2006	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**2015**
UK Energy Review	EU targets gh gas	UK Climate Change Act	UNFCCC Copen / EU Renew Ener Directive binding tgt	UK Coalition	UK Renewable Energy Roadmap	EC Blue Growth	UK Energy Act 13 / LCF	EC Energy W' Paper non-bind targets	Cons Gov
	UK Energy White P	DECC created	UK Low Carbon Transtn Pln	Rd 3 for SP and SSE	SNP majority Gov	OW CRTF recommend s + £100 target / OWPB est	OWIS & OWIC (replaces OWDF)	CfD intruced	Rudd Reset Speech
	SNP Gov	Rd 2 SP Duddon Sands	Prefer'tial Roc band	Treasury Infra Cost Review	Scottish Routemap with 100% target (update of AP 2009)	CORES est	FIDer intruced	Scottish Sites for Floating Wind Ass't	Chinese UK State Visit
	Scot Gov Eco Stra'gy	Rd 2 Airtricit builds G' Gbrd	Building Britain's Future	UK OW Developer Forum est		GES 2	Scot Gov enhanced RO S	Glasgo w CR Deal	GES 3
	Rd 1 SSE Beatric e Dm live		Clim Chnge Scot Act + SR Actn Pln	Scot Gov OW Routemap		SG Taskforce on Licencing Consenting	Refreshed SG OW Route Map		Paris December
			STW for SSE, SP and MR	Chinese Visit / IPA Report					
			Marine Scot. est	Glasgow Economic Comm'n					
			Scot OW Ind Grp est						
				OFGEM Project Transmit Launched			Project Transmit Position Statement	Project Submit further Consult 2016	

2006	07	08	09	10	11	12	13	14	2015
		SET Plan	Statoil Hywind floating demo	Siemens 80% EU market	Siemens 100%UK purchases	Vestas Sheerness dropped	Dominance of 4 developers / Dong	Siemns Mou March/ Revised Plan Sept	Adwen (Gam & Areva) > Siemens
					Siemens MOU March	Samsung announce Fife 7MW	MHI Vestas created	MHI Vestas Blade Manu Isle of W	Cuxhaven Siemens
					2B Energy Ann' for Fife	MoU Areva		Samsung drops	Areva, Gamesa and Mit formally drop Scot plans
					Doosan B announce investment in turbines	Doosan B stops		MHI 8MW Prototyp (2016 purchasefor Blyth)	Permision given for Hywind floating
3MW Vestas (Barro') - 2MW Vestas (Blyth 2000)	Siemns 3.6 MW deplyd Burbo Bk-buy Bonus				Gamesa progress turbine plans		Samsung 7MW installed Fife	SP East Anglia 1 Consntd Siemns 7MW	Kincardine preparing appli for licence
							Siemens 6MW Gun Fleet Sands Demo		SSE Beatrice – Siemens 7MW
									EU market Siemns 60% Adwen 18% MHIV 13%

Blue shading - horizontal (energy) policy and regulatory environment

Red shading - vertical (industrial) policy and regulatory environment

Green shading - spatial policy and regulatory environment