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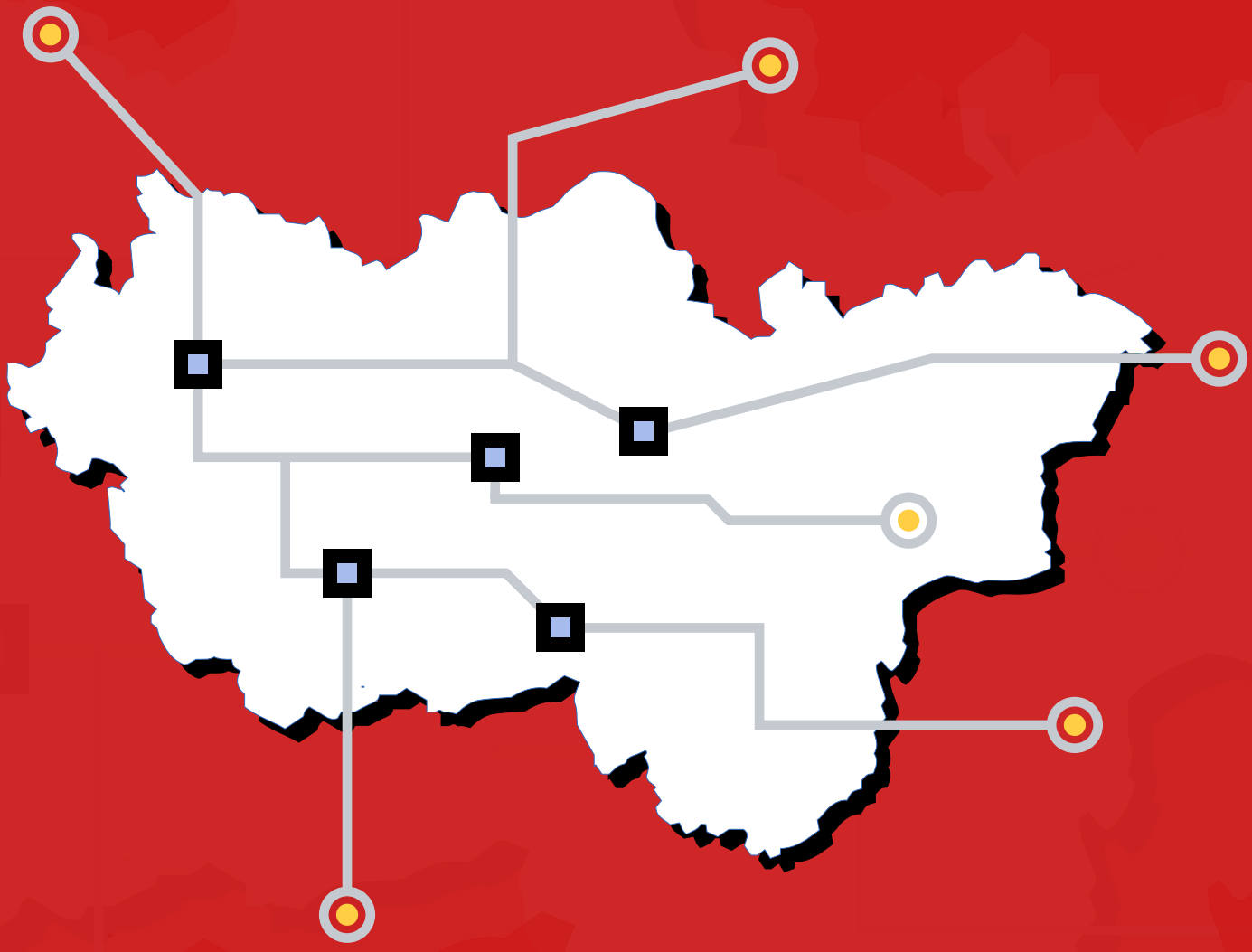
Regional Missions: Big Dreams on a Small Scale



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Abstract

This thesis examines the impact of mission-oriented policy design and place-based policy on regional innovation systems, with a focus on the Ruhr Hydrogen Model Region. It explores how geographical proximity, organisational structures and network dynamics influence collaboration and innovation in this context. The study uses expert interviews to examine the behaviour of diverse stakeholders in the hydrogen sector. Findings suggest that geographical proximity is crucial for collaboration, although large companies and academic institutions seem to have a wider geographical network due to their size and existing connections. Findings on organisational structure are consistent with literature emphasising the need for a strong, agile state actor to foster a risk-taking, experimental approach to effective mission implementation. Moreover, network dynamics show that mission-oriented initiatives can catalyse new cross-sectoral collaborations, enhancing innovation capacity. The research contributes to the understanding of how mission-oriented and place-based policies can be used synergistically to foster regional innovation, and highlights the need for tailored, context-sensitive policy design to address complex societal challenges.

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1. Introduction

In November 2022, The Economist unveiled a cover story with a bold headline, "Say goodbye to 1.5°," sparking widespread alarm and capturing global attention (The Economist, 2022). This headline pointed to the looming failure to meet the Paris Agreement's climate goals, specifically the target to limit global warming to 1.5°C above pre-industrial levels. The editorial team highlighted a recurrent challenge in contemporary politics: the habit of setting lofty goals with much fanfare, only to see them undermined by lack of focus, political deadlock, and, in this scenario, geopolitical conflicts (Hulme, 2016; Mazzucato & Kattel, 2020; Schleussner, Donges, et al., 2016).

This scenario begs an important question: Is it within the capacity of governments to devise and enact more effective strategies that concentrate their policy efforts on addressing and solving key societal challenges?

A burgeoning school of thought within innovation studies claims to have a solution: mission-oriented policy design (Edler & Fagerberg, 2017; Mazzucato, 2016; Wanzenböck, Wesseling, et al., 2020). This approach is characterised by the government adopting a specific, well-defined challenge or objective - the mission - and approaching it with a rigorous 'whatever it takes' attitude. Each mission is underpinned by a strict deadline, which creates a sense of urgency among those participating. The most famous example is the US Apollo mission to the moon in the 1960s. President John F. Kennedy announced it in 1961 with the words: "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth." (Kennedy, 1961). Initially perceived as a monumental, 'impossible' task, this moonshot mission catalysed an unprecedented collaboration between government, scientific and commercial organizations that led to its successful realisation. The innovations spawned by the lunar missions, particularly in computing, laid the groundwork for significant technological advances, most notably the rise of Silicon Valley. The mission's clarity of direction, motivational leverage and technological diffusion underscore its renewed appeal to today's policymakers (Mazzucato, 2021).

A key motivation for research on this topic is the potential synergy emerging in the literature with place-based policy, which emphasises the importance of local contexts and regional innovation systems in achieving policy goals. The possible combination of mission-driven and place-based approaches seems to be a logical next step with promising potential for the practical use of missions in enabling policy makers to develop tailored solutions that capitalise on regional strengths, foster collaboration between different actors and effectively address pressing issues in a context-sensitive manner. This research seeks to uncover the potential benefits of this integrated approach, ultimately leading to more effective and inclusive strategies for sustainable development.

While the concept of place-based policy design is not new, the innovative element lies in the development of new methodologies and applications of such policies. Place-based policy research has embraced these new ideas and preliminary case studies suggesting that this form of innovative policy can serve as a valuable enhancement to existing place-based approaches (Barca et al., 2012a; Craens, et al., n.d.).

In recent years, the academic literature has focused on examining the theoretical underpinnings of societal missions, largely due to the inherent differences between societal and technological missions and the broader divergence from conventional innovation policy approaches (Foray, 2018a; Mazzucato, 2016, 2021; Robinson & Mazzucato, 2019a; Wanzenböck, Wesseling, et al., 2020) (Foray, 2018b; Robinson & Mazzucato, 2019b)
The main focus of this literature has been to construct a robust theoretical framework for missions and to describe a novel, disruptive approach to addressing complex societal challenges (Mazzucato, 2016). However, the scarcity of realised societal missions has made it difficult for researchers to obtain empirical data and derive meaningful insights from real-world applications.

It is therefore important to look for and study examples of missions or mission-like initiatives to see whether the potential of this theoretically established policy framework can be realised in practice. The reaction of stakeholders is a crucial factor in social missions, as motivation and network behaviour are described as crucial in theory (Vedres, 2022). This is exactly what this thesis will investigate. The research question is therefore:

> ***What factors influence place-based innovation and collaboration in the context of mission-oriented policy?***

The focus is on three potential factors that can have a significant impact, particularly in regional settings, but which have not yet been extensively researched: Geographic proximity of actors, regional administrative and governance structures, and network dynamics.

The lack of empirical case studies on existing regional missions indicates a gap in the understanding of the potential of mission-oriented policy. This thesis aims to close this gap, which is why a case study was selected that comes close to the mission design from the literature. Among the numerous sub-missions of the EU Green Deal at the regional level is the Ruhr hydrogen model region (Regionalverband Ruhr, 2023). This case study was selected because it derives directly from the mission of carbon neutrality in the EU Green Deal, has a clear deadline of 2050, involves many different stakeholders and is limited to one region. The goal of the Ruhr region is to become the first climate-neutral industrial region in Europe. To achieve this goal, the Ruhr region has set itself the mission of creating a sustainable and competitive hydrogen market that decarbonises energy-intensive industrial processes. It is particularly interesting as it originates from a bottom-up initiative by private sector companies and research institutions, rather than being government-led. During this study, the mission was in the process of seeking government coordination. These hydrogen activities serve as an example to examine the various factors of actor behaviour within a mission.

This thesis starts with a comprehensive literature review aimed at establishing a theoretical foundation and deriving three expectations by assessing the impact of mission-oriented policy. The focus is primarily on the literature to explore the development and potential influence of mission-oriented policy on regions. Special attention is paid to the work of scholars such as Mazzucato, Wanzenböck and others, who have investigated the impact of missions on innovation systems. Their research is

reviewed to gain insights into potential shifts in innovation landscapes and to encourage dynamic governance, collaboration, and the concept of 'forbidden triads', which represents unused collaboration potential in an innovation network (Vedres, 2017). At the end of the literature review, three expectations derived from the literature on the three research themes are defined.

In order to verify these expectations, data is needed on the links and partnerships in hydrogen activities in the Ruhr area, on the organization and interactions with the state authorities, and on the processes and interactions of new collaborations. This data is best obtained through expert interviews with diverse stakeholders participating in the mission. A snowball sampling method was used to get as broad a picture as possible from a range of perspectives. Using this method, 14 interviews were conducted with high-level stakeholders ranging from initiative leaders, CEOs and senior management to several professors from academic institutions.
The employment of qualitative semi-structured interviews with the experts within the Hydrogen Model Region Ruhr enables an in-depth understanding of their experiences. The gathered narratives were thematically analyzed to uncover recurring patterns and insights that provide a richer understanding of the mission's dynamics and outcomes.

The results of the 14 interviews conducted show that a total of 10 themes have been identified. The Ruhr Hydrogen Model Region is not a "perfect" mission structure as described in theory, but it does show distinct systems. What makes this case study so appealing is the coordination phase that the bottom-up activities are going through at the time of the interviews. This means that the process of structuring and integration between public, private and academic actors is in full swing. This is relevant to this work for a number of reasons. Firstly, it is not the initial phase where it can be assumed that the experts' statements are based on speculation and planning. From the point of view of network dynamics, the phase within the process is intriguing because it is possible to infer from the statements which actors are involved in the mission, how they categorise themselves and, above all, how they are motivated to form new collaborations in the process. From an organisational point of view, the perspective is more complete once the mission has been completed. At the same time, in the organisational phase of the mission, different design directions can be drawn from the statements.

The analysis of the experts' statements show a strong tendency for actors of all kinds to work together in geographical proximity. This pattern is supported by a database of 191 connections compiled from the interviews. Different categories of actors behave quite differently, with large collaborations dominating funding mechanisms and lobbying, and a very strong and diverse networking of SMEs within the region. At the same time, the expectation that a regional mission can overcome geographical barriers through a shared vision cannot be confirmed.
In addition, the organisational structure is characterised by chaos and micro-management at the same time. This is due to the fragmentation of the administrative structures of the Ruhr area and a hesitant approach to establishing a central organisational body. At the same time, the multi-level-governance structure appears to offer a wide range of opportunities to engage with the various stakeholders. However, it hinders a quick and bold approach and the establishment of a hydrogen market.

Finally, it is shown that the hydrogen activities are a catalyst for the expansion of the existing network and, above all, for the establishment of a completely new cross-sectoral network with many different participants. In particular, regional authorities and academic institutions emerge as intermediaries, bringing potential partners together to make progress. There are also indications that the hydrogen activities will lead to value-adding and innovative partnerships between different stakeholders beyond the development of a decarbonised energy market.

2. Problem Statement

In the context of the preceding discussions, the policy design landscape reveals two notable and emerging trends. The first, mission-oriented policy design, continues to gain traction in academic circles due to its perceived potential to address multifaceted societal challenges. This approach aims to catalyse strategic, targeted and proactive solutions to complex societal problems, adding an innovative dimension to conventional policy frameworks (Janssen et al., 2021; Mazzucato, 2018a; Wanzenböck, Wesseling, et al., 2020).

The second policy approach, place-based policy, has long been a term in policy-making and is already being used more frequently. It promotes innovation by capitalising on local resources, strengths and contexts. This approach emphasises the importance of spatial and geographical dimensions in policy-making, with a focus on harnessing regional strengths to promote sustainable development (Barca et al., 2012a; European Commission. Joint Research Centre., 2020; OECD, 2011).
Although they operate within different paradigms, these two policy strategies promise interesting synergies. However, their integration remains a largely unexplored area, and the detailed exploration of their mutual enhancement has yet to be thoroughly undertaken.

This thesis enters this relatively unexplored field, focusing primarily on the expected changes in actor behaviour within regional networks driven by societal missions. This work delves into the intricate dynamics between mission-oriented policy design, place-based strategy, and the nuanced, adaptive responses of actor networks within regional innovation systems.

By analysing these interrelated elements, the study aims to bridge the gap between theoretical constructs and the pragmatic implications of implementing policy design for societal missions. It emphasises the need for a comprehensive approach that recognises the diverse, region-specific elements within innovation networks. The work also highlights the role of local contexts, regional innovation systems and stakeholder collaboration in designing effective policies.

In achieving these objectives, the thesis aims to make a significant contribution to the wider academic discourse on innovative, synergistic policy design, ultimately leading to the development of more effective and inclusive strategies for sustainable societal progress. It is about harnessing the full potential of the EU's regional diversity and turning it into a real-world laboratory for innovative approaches (Camagni & Capello, 2017). This requires bold but effective policies that turn diversity into strength.

The first dimension of place-based innovation research referred to in this thesis is the geographical proximity of actors in the project realization process. Extant research underscores the pivotal role of geographical proximity in fostering collaboration. Studies have demonstrated that actors situated closer to each other are more likely to collaborate and innovate (Balland et al., 2015; Simensen & Abbasiharofteh, 2022). The underlying reasons for this phenomenon are manifold. Firstly, geographical proximity facilitates knowledge exchange, allowing for quicker, more frequent and richer communication.

Secondly, it aids in establishing and maintaining trust, a critical component of collaborative partnerships (Morgan, 2004). Finally, proximity can increase the ease and frequency of face-to-face meetings, which are instrumental in brainstorming, problem-solving, and building relationships (Balland et al., 2015).

This centrality of geographical proximity gains further significance in the context of mission-oriented policies. Since missions necessitate coordinated effort and sustained engagement among diverse actors, the facilitative role of geographical proximity could potentially amplify the impact of mission-oriented initiatives (Craens, et al., 2022; Mazzucato, 2016).

In the light of these insights, this work posits that the geographical proximity among actors in regional innovation systems could be significantly influenced by regional missions. The forthcoming literature review will seek to define an expectation on this account. Based on the findings of previous research, an attempt is made to predict the potential behaviour and expected impact of a regional mission on the variable of geographical proximity.

The transformation of the role of the state in mission-oriented policy design is significant and calls for a more active, directive and risk-taking stance, as suggested by Mazzucato (Mazzucato, 2016). At the same time, innovation research highlights the need to include diverse actors in innovation processes, from large and small enterprises to civil society and academic institutions, in order to foster a robust and rich innovation ecosystem (Schot & Steinmueller, 2018). The literature indicates that the organizational structure of a mission has a major influence on the outcome, behaviour and therefore also the performance of the individual stakeholders (Mazzucato, 2018a).

Therefore, the second dimension to be explored is the role of the state and especially governance mechanisms that make processes between diverse stakeholders more productive. At the same time, the experts in the interviews will be asked which structures may be holding back innovation or the realization of a project.
Understanding this dimension is key to sustaining the argumentation structure of the thesis and illuminating the potential mechanisms through which mission-oriented policy design can transform regional innovation systems.

The third and last dimension to be examined in this thesis are network dynamics and the closure of so-called “forbidden triads” (Vedres, 2017). This analysis concentrates on the behaviors and interactions of actors within the framework of a regional mission, either during its formation or throughout its evolution. The potential of regional missions to engage a wide range of participants makes the study of emerging and existing linkages particularly relevant (Craens, et al., 2022). The aim is to understand how the relationships between actors transform, how the innovation network unites to confront the mission's challenges, and the nature of interactions among different stakeholders. Identifying the key attributes that influence these dynamics is crucial, with a special emphasis on understanding the role of the forbidden triads within these networks.

Exploring the forbidden triad is essential for uncovering its effects on the cohesiveness of the network and the overall success of the mission. This examination seeks to reveal the underlying patterns and social structures within the network, thereby enhancing our

understanding of the mechanisms that either support or impede the achievement of the mission's objectives. Through this examination, the study aspires to contribute valuable insights into the strategic coordination of network actors and the complex interdependencies that characterize mission-oriented initiatives.

In summary, the above considerations suggest that mission-oriented policy design embedded in a regional context offers an interesting field of investigation. The implications for geographical proximity, governance structures and the configuration of network interactions are particularly compelling. It is important to understand these aspects have yet to be thoroughly explored and understood in the context of regional missions.

The central research question guiding this study is therefore:

> ***What factors influence place-based innovations and collaborations in the context of mission-oriented policy?***

This broad question is further broken down into three sub-questions, each of which focuses on a specific aspect:

> Geographical proximity: ***Does the collaboration of geographically close actors strengthen innovation in regional societal solutions?***
>
> Governance and organizational structure: ***What governance structures and interactions encourage collaboration between diverse actors and which inhibit innovation capacity?***
>
> Network dynamics: ***How does the collaboration behaviour and network of actors change in the context of a regional mission?***

This research will contribute to the academic discourse on mission-oriented and place-based policy design by empirically investigating their impact on actor behaviour and network structure within a regional innovation system.

3. Literature Review

This chapter is dedicated to an exploration of the existing literature relevant to the core areas of investigation in this study: mission-oriented policies, the role of geographical proximity in innovation processes, regional governance and organizational structure of missions, and the network dynamics in the wake of a regional challenge. The aim is to understand how a regional mission can influence actor behavior by weaving together a nuanced understanding of these interrelated issues.

To achieve this, the literature review is conducted with a critical lens, focusing not only on the findings of previous studies, but also on their underlying arguments, methodologies and implications. This approach allows for a constructive evaluation of the literature, which is important in understanding the broader landscape of these research areas and formulating robust expectations for this thesis.

The conclusion of this chapter is to formulate informed expectations for this research, based on the broad understanding gained from existing research in these areas. In essence, this chapter serves to ground this study in current academic understanding, identify gaps and opportunities in the literature, and use these insights to guide the empirical research trajectory of this thesis.

Societal Missions

In recent times, mission-oriented policy has garnered attention for its innovative approach to tackling significant societal challenges while fostering economic growth (Bugge et al., 2022; Foray et al., 2012; Isaksen et al., 2022a; Mazzucato, 2021).

Missions are generally defined as directed and deliberate attempts to achieve specific grand challenges. While technological missions focus on tangible scientific or technological advancements, societal missions address more complex, multi-dimensional societal issues such as climate change, inequality, or public safety (Mazzucato, 2018a; Wanzenböck, Wesseling, et al., 2020). Notably, societal problems are often labeled as 'wicked' due to their multi-faceted nature, the diversity of actors involved, and the required systemic changes (Isaksen et al., 2022a; Janssen et al., 2021).

Traditionally, technological missions are characterised by top-down initiatives, striving for innovation within a distinct technological domain (Murray & Cox, 1989; Rhodes, 2012). This is different with societal missions(Isaksen et al., 2022a; Wanzenböck & Frenken, 2020).
A leading example of the complexity of societal missions is Sweden's 'Vision Zero'. This pioneering policy aimed to eliminate road deaths - requiring a unique approach to governance. The mission relied critically on a broad coalition that crossed the public-private split, weaving together national and local government agencies, civil society organisations and private sector actors into a resilient fabric of shared responsibility . This embodiment of shared responsibility underscored the reality that a top-down, traditional governance strategy would likely have stifled the dynamic interplay between these diverse actors, thereby impeding the mission's success (Craens, et al., 2022).

The interplay between different actors in the successful realisation of societal missions is an important point of discussion when comparing societal and technological missions. Technological missions can often be driven by a few major stakeholders, but societal missions, due to their inherent complexity, require the active participation of a diverse range of actors from academia, industry, civil society, and government (Janssen et al., 2021; Janssen & Abbasiharofteh, 2022; Mazzucato, 2016). Thus, the diverse network of actors becomes a potential catalyst in the innovation system.
Another distinguishing factor between technological and societal missions lies in the complexity and uncertainty of their objectives. Technological missions, with their clear and measurable objectives, contrast with the 'wicked problems' faced by societal missions (Schleussner et al., 2016; Wanzenböck et al., 2020a). This attribute necessitates a more adaptive, experimental approach to policy design, commonly referred to as 'experimentalist governance' (Sabel & Zeitlin, 2012). The EU's Green Deal demonstrates this very well. Even if major technological innovations are necessary to transform the current society into a climate-neutral one, social behavioural changes such as the reduced consumption of meat or policy innovations such as the ETS (Emission Trading System) are necessary to achieve the goal (Ellerman, 2008; Skjærseth, 2021).

The capacity to galvanize diverse actors into coordinated action represents a significant challenge in societal missions, as each stakeholder brings their unique perspectives, knowledge, and interests to the table. This multitude of viewpoints often results in what is described as a 'cognitive distance', a gap that often impedes effective collaboration (Simensen & Abbasiharofteh, 2022). However, mission-oriented policy design is poised to bridge this cognitive gap, stimulating collaboration by establishing a shared objective and aligning disparate interests towards its achievement (Bugge et al., 2022; Janssen et al., 2021; Mazzucato, 2021).

The role of public intervention in both types of missions is noteworthy. Mazzucato argues for the critical role of the state in funding and directing research and development, as seen in historical examples of technological missions (Mazzucato, 2021; Mazzucato & Kattel, 2020; Ruttan, 2006; Siddiqi, 2003) and in more recent societal missions such as the European Union's efforts to promote sustainable development (Mazzucato, 2016; McCann & Soete, 2020). This highlights the potential role of the state in shaping regional missions and managing diverse actors in the innovation process.

Transitioning towards regional missions, it becomes evident that these missions, with their bottom-up design and greater civil society involvement, hold substantial potential. Tödtling and Trippl argue that innovation policy should be tailored to regional and local contexts to effectively shape innovation outcomes (Barca et al., 2012b; Tödtling & Trippl, 2005). Thus, regional missions could serve as a promising approach to tackle societal challenges, incorporating the benefits of both technological and societal missions.

Regional Mission

At the intersection of societal missions and place-based policy lies the concept of regional missions, a blend of approaches that can provide effective, tailored solutions to

local needs and characteristics (Barca et al., 2012b). This place-based strategy recognises the differences between regions and emphasises the need for tailored solutions rather than a one-size-fits-all approach (Tödtling & Trippl, 2005). To illustrate this point, consider an urban mobility task in Amsterdam with a similar task in a car-centric city. The former may prioritise optimising existing cycling infrastructure and waterways due to the city's cycling culture, while the latter may push for a transition to electric vehicles due to the prevalence of car use.

Deeper, more differentiated engagement with civil society is another key strength of regional missions, facilitated by a proximity effect. Because missions are designed to address locally specific issues, they inherently have a direct, tangible impact on the local community. This proximity, both spatial and thematic, encourages public participation and cultivates a sense of shared ownership (Rodríguez-Pose & Crescenzi, 2008a). For example, tackling air quality in highly polluted areas would require the input of local residents, who can provide valuable insights into problem hotspots, contribute to the development of practical solutions, and actively participate in collective action to mitigate pollution.

The idea of regional missions functioning as 'real laboratories' taps into the essence of experimental governance where iterative problem-solving processes are used to navigate the complexities of societal missions. This implies that regions, in their diversity, serve as testing grounds for new policies and initiatives, enabling a more precise understanding of how these missions might unfold on a larger scale (Camagni & Capello, 2017; Sabel & Zeitlin, 2012). It is akin to a prototyping process prevalent in innovation, offering opportunities to identify potential pitfalls, unanticipated consequences, and areas for improvement before they are scaled up.
Further, this concept embeds learning and flexibility within policy-making, allowing the EU to adapt and react dynamically to ongoing results and feedback (McCann & Soete, 2020).

However, regional missions also present their own challenges. One of these is the inherent difficulty in finding or facilitating breakthrough solutions due to the narrow scope of the missions. Tailored solutions are beneficial in addressing local problems, but a hyper-focused approach may limit the potential for broad, paradigm-shifting innovations that could address larger societal challenges or benefit wider regions (Camagni & Capello, 2017; Craens, et al., 2022).

There's also the challenge of inter-regional cooperation. A key potential risk of regional missions is that their success in one region may not be effectively communicated or adapted to another, resulting in slowed or stalled progress and increased fragmentation within the EU (Asheim & Isaksen, 2002; Dijkstra et al., 2020; Iammarino et al., 2019). The rich regional diversity within the EU requires a balance between tailoring solutions to local contexts and ensuring effective interregional cooperation and communication to disseminate and adapt successful solutions.

Geographical Proximity

Geographic proximity, at its most basic level, refers to the physical proximity between two entities. This concept, a key construct in the innovation literature, is multifaceted and has far-reaching implications for collaboration, information exchange and innovation processes (Balland et al., 2015; Boschma & Frenken, 2006; Simensen & Abbasiharofteh, 2022). In a regional mission context, geographical proximity takes on a complex interpretation. Here it could mean actors on the same street, within the same city, one urban and one rural, in two different cities, or even bringing together actors from different regions.

The significance of geographical proximity in innovation and collaboration is profound, as it shapes the dynamics of how actors interact, learn, and create together. Proximity fosters an environment that enables the exchange of tacit knowledge, which is often unstructured, non-codified, and challenging to communicate through formal channels or over vast distance (Balland et al., 2015). Additionally, proximity enables frequent face-to-face interactions that are key in building trust and social capital, which are vital for successful collaboration (Asheim & Gertler, 2006a).

Beyond knowledge exchange, geographical proximity also influences the distribution of resources. Local networks and clusters can facilitate the sharing of resources, infrastructure, and skilled labor within a close geographic proximity, thereby supporting innovation activities (Porter, 1998a). This spatial closeness allows for an environment conducive to spontaneous interactions, casual exchanges of ideas, and faster feedback loops that often result in more rapid and dynamic innovation processes (Rodríguez-Pose & Crescenzi, 2008a).

Despite these advantages, the impact of geographical proximity is influenced by several factors that may operate independently of, or in conjunction with, regional missions. These include levels of education, cultural context, mobility and technological capabilities. For example, highly educated actors are generally more adept at collaborating over distance, using global knowledge networks and digital communication tools (Tödtling & Trippl, 2005). Cultural context also plays a key role, as shared cultural understanding can facilitate collaboration and mitigate problems that may arise from geographical distance.

The advent of advanced technologies has revolutionised communication, rendering geographical distance less of a barrier to collaboration than before. However, despite these advancements, the benefits of physical proximity for collaboration remain significant, especially in contexts where the exchange of complex, tacit knowledge is paramount (Morgan, 2004). Moreover, the impacts of these factors are highly context-dependent and can vary based on the nature of the collaboration.

As regional missions are implemented, they potentially alter the dynamics of geographical proximity within an innovation landscape. They could act as a gravitational pull, attracting diverse actors within a region to align towards a shared objective, consequently influencing actor distribution and collaboration (Wanzenböck, Neuländtner, et al., 2020).

To illustrate this point, consider two cities in the northern Netherlands - Groningen and Leeuwarden. An actor from Groningen may have an easier time collaborating with a fellow Groninger, primarily due to closer proximity, shared institutional frameworks, and cultural similarities. Contrarily, collaborating with an actor from Leeuwarden, albeit not geographically far, might prove more challenging due to varying institutional policies and a perceived cultural boundary between the two cities. However, a compelling regional mission addressing a mutual societal challenge could reduce these perceived barriers, fostering collaboration.

These missions could stimulate supportive infrastructure development and foster an environment conducive to learning and knowledge exchange. They offer opportunities for actors from diverse backgrounds to interact and innovate, potentially redefining the spatial dynamics of innovation within their region (Wanzenböck, Wesseling, et al., 2020b).

Additionally, regional missions could extend their influence beyond regional boundaries, potentially attracting external actors aligned with the mission's objectives. The common interest in solving specific challenges could provide sufficient motivation for these external actors to overcome the physical distance and related barriers to innovation. However, the effectiveness of this pull will likely depend on various factors, including the nature of the mission, the existing networks of the actors, the institutional environment, and the specificities of the required knowledge and skills (Balland et al., 2015; Tödtling & Trippl, 2005).

Even so, while these missions might bridge some geographical barriers, they might not entirely overcome inherent obstacles like localized knowledge and cultural differences. Recognizing these limitations should still be vital for designing effective regional missions that could foster innovation, while acknowledging the diverse factors influencing collaboration.

Considering these factors, the following expectation can be proposed:

> ***A diverse set of actors are more innovative in the context of regional societal problems if they are geographically closer. However, a common mission can reduce geographical barriers while maintaining the same level of innovation.***

Regional Governance of diverse Actors

The regional governance approach in mission-oriented policy design plays an essential role in achieving comprehensive and long-term solutions. A core feature of regional missions is their reliance on a diverse range of actors, including civil society, academia, the private sector and public authorities (Robinson & Mazzucato, 2019b; Schot & Steinmueller, 2018b). While actor diversity enriches regional missions with different perspectives and unique capabilities, it can also serve as a double-edged sword, potentially creating challenges that hinder mission progress. Differences in cognitive distance, which refers to the different knowledge backgrounds and perspectives of

actors, can lead to misunderstandings, miscommunication and conflict (Janssen & Abbasiharofteh, 2022; Sabel & Zeitlin, 2012).

The transformation of the Danish island of Samsø into a carbon-neutral community within a decade provides a compelling example of successful regional governance and collaboration between different actors. This mission involved the integration of local residents, energy companies, academic institutions and government agencies.
The success of this mission was largely attributed to the bottom-up approach adopted, in which local residents were actively involved in the process. Their role went beyond decision making; they also invested in and managed renewable energy projects such as wind turbines and solar panels, instilling a deep commitment to the mission.
Energy companies and academic institutions facilitated technical training programmes, bridging cognitive distances and fostering a common understanding among stakeholders. Meanwhile, the local government played an enabling role, providing legislative support, financial incentives and coordinating the mission (Sperling, 2017).

However, the governance of these missions cannot rely on traditional bureaucratic methods. An innovative and dynamic approach, similar to that of DARPA, is required to manage and steer the mission. DARPA, an agency within the US Department of Defense, has been successful in developing revolutionary technologies through its ability to work across sectors and think beyond conventional frameworks. The agency's emphasis on experimentation and tolerance of failure is a cornerstone of its innovative potential (Bonvillian & Van Atta, 2011). Rather than acting as a traditional agency trying to balance different approaches, DARPA takes risks and funds disruptive technologies that will not receive private investment but are in the interest of the Department of Defence. This experimental and risk-taking approach has led to revolutionary technologies that have had an impact beyond the defence industry. One factor in its success is DARPA's ability to get diverse stakeholders to work together towards a common goal that they would not otherwise do (Mazzucato, 2021).

Bringing diverse stakeholders together is often an obstacle because they do not speak the same technical language, have different approaches or have different goals. Discrepancies extend beyond cognitive distance to include cultural norms, operational structures and individual interests. Differences along these dimensions can create friction between actors and hinder smooth cooperation. The unifying thread that weaves together different actors in a mission can unravel when stakeholders feel their interests are compromised or when cultural nuances are overlooked (Mazzucato, 2016; Simensen & Abbasiharofteh, 2022; Weber & Rohracher, 2012a).
Regional missions can exacerbate these problems, especially if local communities or bureaucracies perceive the mission as an infringement on their autonomy or a top-down imposition. Stakeholders who traditionally operate independently may resist or oppose the mission if they perceive a threat to their autonomy, even if the mission is in line with their broader interests. This resistance can slow or completely halt the progress of the mission, highlighting the complexity of managing diverse actors in regional missions (Mazzucato, 2016; Weber & Rohracher, 2012a). Therefore, it is imperative to proactively address these challenges in the governance structure of regional missions.

The Swedish Vision Zero initiative is a vivid example of an innovative governance approach

in the context of societal missions. This road safety mission was based on the principle of shared responsibility, involving different actors - public authorities, private sector participants, civil society and academia - in a coordinated effort to reduce road accidents and fatalities. Each stakeholder had a clearly defined role and shared responsibility for problem solving and strategy implementation, fostering a sense of ownership and mutual respect (Craens, et al., 2022).

What stands out in the example of Vision Zero is that the various stakeholders are better able to cooperate in the process through the "shared responsobility model". This change in processes and responsibilities seems minor at first glance, but in the big picture it is crucial for success (Craens, et al., 2022). Rather than relying on top-down mandates, the leadership prioritised facilitating stakeholder engagement and co-creation of solutions. By adopting a strategic framework that defined the mission's goals and roadmap while encouraging active collaboration, the leadership fostered an environment conducive to innovation and effective problem solving (Mazzucato, 2018b; Voß & Simons, 2014).

In summary, a dynamic governance approach in regional missions can be expected to lead to more inclusive, long-term solutions by fostering collaboration and innovation among diverse stakeholders. Conversely, a rigid, top-down approach may lead to resistance and hinder progress, highlighting the importance of a governance style that encourages active participation and a shared sense of ownership in achieving mission goals.

Considering these factors, the following expectation can be proposed:

> ***A governance framework to regional missions, where the state acts as a market participant with a risk-taking approach, leads to more long-term and comprehensive solutions to societal challenges.***

Network Dynamics

The exploration of network dynamics in the context of regional missions represents an emerging focus of academic discourse, particularly with regard to how such missions might influence the collaborative behaviour and configuration of actor networks (Janssen & Abbasiharofteh, 2022; Robinson & Mazzucato, 2019a; Vedres, 2022). While the direct impact of missions on regional networks remains underexplored in the empirical literature, theoretical insights offer a foundational understanding of their potential transformative effects.

Regional networks, pivotal in shaping innovation and collaboration landscapes, are inherently rich ecosystems prior to the onset of any regional mission. These networks, constituting a broad spectrum of stakeholders including businesses, academia, government agencies, and non-profits, are deeply embedded within specific geographical areas. Their essence lies in the social, economic, and technological ties that bind actors together, facilitating not just interaction but a shared commitment to regional development (Granovetter, 1985; Putnam, 1993).

Before the introduction of regional missions, these networks already serve as vital platforms for day-to-day business operations. The literature points to the integral role of such networks in driving economic development, with dense interconnections promoting competitive advantages and innovation outputs through knowledge spillovers (Cooke, 2001; Porter, 1998b). Despite their strengths, challenges like the potential for network lock-in highlight the necessity for maintaining an openness to new ideas and external innovations (Crespo et al., 2014).

The adaptability of regional networks and the significance of localized learning processes are particularly noted for their contributions to sustaining regional competitiveness and innovation (Asheim & Gertler, 2006; Crespo et al., 2014). Furthermore, the literature underscores the potential of policy-driven missions to stimulate these pre-existing networks, enhancing their capacity for innovation and responsiveness to technological or societal challenges (Rodríguez-Pose & Crescenzi, 2008).

Thus, well before the advent of regional missions, these networks are foundational to the innovation ecosystem, with their geographical proximity, diversity of actors and rich collaborative ties laying the groundwork for future innovation and economic growth. The research highlights not only the value of these networks in fostering economic development, but also the potential role of regional missions in revitalising and expanding these networks to prevent stagnation and promote continuous innovation (Asheim & Gertler, 2006).
The exploration of the transformative potential of missions within innovation ecosystems draws on the theoretical framework proposed by scholars such as Mazzucato, who advocate for the mission-oriented approach as a catalyst for broad societal and economic change (Isaksen et al., 2022b; Mazzucato, 2018b). This academic discourse posits that missions possess the capacity to significantly alter the dynamics of pre-existing networks. The theoretical underpinning suggests that by leveraging and expanding upon these established networks, regional missions can introduce new collaborative dynamics and foster an enriched environment conducive to innovation (Asheim & Gertler, 2006b).

Central to this theoretical potential is the notion that missions necessitate and promote the engagement of a broad spectrum of stakeholders, thereby diversifying the network beyond its traditional confines. Such strategic expansion is pivotal for integrating a wide array of innovative ideas and resources, essential for addressing complex societal challenges. The cross-pollination of ideas facilitated by this increased diversity is theorized to lead to breakthrough innovations, underscoring the value of cross-sectoral collaboration (Crespo et al., 2014; Janssen & Abbasiharofteh, 2022; Powell & Grodal, 2006).

Mazzucato envisions missions as platforms that not only aim to achieve specific objectives, but also facilitate broader economic and social development by transforming networks into more fluid spaces (Mazzucato, 2018b). The introduction of a new mission could bring with it a set of challenges that require a shift in the behaviour of network actors. This shift is crucial because it requires actors to adapt their traditional ways of working and to explore innovative collaborations that were previously outside their scope

of consideration. Such behavioural adaptations are said to be essential for the evolution of the network, encouraging a diversification of approaches and the formation of partnerships that leverage the unique strengths and capabilities of different actors. This process underlines the notion that new missions act as a catalyst for change, driving networks towards greater diversity and innovation potential (Vedres, 2022).

Within the intricate web of regional innovation networks, actors play diverse roles, ranging from central connectors who facilitate the exchange of information to peripheral innovators who bring fresh ideas to the table. The interplay of these roles within a network is critical for understanding how the network can integrate new missions effectively. Each role contributes differently to the network's innovation output, highlighting the complexity of networks and the necessity of role diversity for fostering adaptability and responsiveness to new challenges (Fritsch & Kauffeld-Monz, 2010; Reagans & McEvily, 2003).

The study of forbidden triads in regional innovation networks is an intriguing area of academic research, particularly in the context of regional missions aimed at catalysing collaborative innovation. This interest is driven by the potential of forbidden triads - situations where two network actors are indirectly linked through a common third party, but lack a direct connection - to open up new avenues for innovation (Vedres, 2017). The concept offers a unique perspective on optimising network structures to enhance collaborative dynamics. Regional missions could play a crucial role in bridging these gaps, thereby creating fully connected triadic relationships that enhance the innovative capabilities of the network (Burt, 2004; Vedres, 2022).

The possible ability of regional missions to facilitate the closure of forbidden triads underscores their strategic value in influencing network dynamics. By presenting a common goal or challenge, missions could encourage diverse actors who may not typically collaborate to form new partnerships. Previous research highlights the importance of network brokers in creating connections between disconnected actors, thereby boosting the network's cohesion and potential for innovation (Fritsch & Kauffeld-Monz, 2010). Within this framework, a regional mission could transcend its initial objectives, acting as a broker that not only identifies but also leverages untapped connections, aligning disparate network actors towards collective goals. Bridging forbidden triads through regional missions could enrich networks by introducing diversity and new perspectives crucial for innovation, and strengthens resilience and cohesion, enhancing the network's adaptability and collective innovation capacity (Burt, 2004; Granovetter, 1985; Vedres, 2022).

The possible catalytic role of regional missions in closing forbidden triads and enhancing network dynamics offers significant implications for both research and policy. By elucidating how missions can strategically optimize network structures for greater collaboration and innovation, this line of inquiry provides actionable insights for policymakers and mission planners (Vedres, 2022). It suggests that understanding and intervening in the network's structural nuances can significantly advance the objectives of regional missions, driving socio-economic development through improved network cohesion and innovation.

From these insights, the following expectation emerges:

> ***The initiation of a regional mission is expected to trigger novel collaborations and close so called forbidden triad relationships between different network actors that transcend traditional operational boundaries.***

4. Methodology

The methodology is designed to bridge the theoretical foundations of mission-oriented policy with its empirical realities. It adopts a dual methodological approach, integrating a literature review with qualitative research through expert interviews. This methodology aims to ground theoretical discussions in empirical evidence, drawing on the insights of individuals directly involved in the application of such policies.

The case study of the Hydrogen Model Region Ruhr is chosen as a central focus for empirical investigation. This project represents an application of mission-oriented policy, which facilitates an examination of its deployment across different sectors, including business, government and academic institutions. Through semi-structured interviews with these stakeholders, this study seeks to elucidate the operational dynamics, challenges and successes associated with the practical application of mission-oriented policy (Kallio et al., 2016).

Subsequent sections will elaborate on the justification for selecting the Ruhr region as a case study, the construction of the interview methodology, and the analytical frameworks employed for data interpretation.

Literature Review

The first phase of the research involves a comprehensive literature review to establish a theoretical framework for mission-oriented policy. This review serves to identify and articulate three key expectations regarding the implementation and effectiveness of such policies. These expectations, derived from the synthesis of existing academic discourse, guide the subsequent empirical investigation. The literature review not only grounds the study in the current state of knowledge, but also shapes the exploration of how these theoretical constructs become evident in the specific context of the Ruhr's hydrogen initiatives.

Expert Interviews

The qualitative component of this research features expert interviews, chosen for their ability to yield profound insights into the operational dynamics of mission-oriented policy within the hydrogen sector of the Ruhr area (Turner, 2014). These interviews engage with individuals who possess direct involvement or significant knowledge of hydrogen-related activities, spanning the private, public, and academic spheres. Such a diverse array of perspectives is crucial for understanding the multifaceted nature of implementing mission-oriented policy.

In order to ensure a broad understanding of the network under study, a two-method strategy is used to select experts for interviews. First, actors involved in hydrogen initiatives are approached through targeted email invitations, a method that, despite its lower response rates, provides an initial point of contact with key stakeholders. To complement this approach and overcome the limitations of direct contact, the study uses

a snowball sampling technique (Parker et al., 2019). Interviewees from the first round are asked to recommend other experts within the network, thus facilitating access to a wider range of participants. This snowball principle not only expands the pool of potential interviewees, but also introduces an analytical dimension to the research.
This method recognises the likelihood that recommended experts will have a positive relationship with their recommender, providing an indirect lens through which to examine network cohesion and patterns of collaboration. Furthermore, by capturing different perspectives on hydrogen initiatives, the research can construct a more differentiated picture of the network, highlighting areas of strong connectivity as well as gaps in collaboration.

The semi-structured interview provides a clear framework of key questions to be asked of each expert. In addition, there are pre-prepared follow-up questions and the freedom for the interviewer to ask spontaneous questions during the interview. It is designed to balance consistency with the flexibility needed to explore emergent themes and follow up on intriguing responses. Such flexibility is vital for uncovering rich, detailed narratives that standard questionnaire-based interviews might miss (Kallio et al., 2016).
The primary objective of these interviews is to empirically test the theoretical expectations outlined earlier in the literature review. By comparing these expectations with the lived experiences and perceptions of experts within the Ruhr Hydrogen Network, the research seeks to validate or challenge theoretical assumptions with on-the-ground realities. This comparison is critical in assessing the applicability and effectiveness of mission-driven policies in real-world settings, and provides critical insights into the challenges and success factors of their practical implementation.

The interviews are structured around five key sections to facilitate a coherent and thorough investigation of the subject matter. These sections include:

1. **Basic/Geographical Data**: This initial segment gathers fundamental information about the interviewee's role and their organization's involvement in the hydrogen sector within the Ruhr area, setting the stage for a contextual understanding of their perspectives.
2. **Hydrogen Targets**: This part focuses on the specific objectives and aspirations that the interviewee's organization holds regarding hydrogen production, usage, and technology development, providing insight into the strategic direction of hydrogen initiatives.
3. **The Network**: Here, the conversation shifts to identifying the key actors and stakeholders within the hydrogen network, aiming to map out the ecosystem of collaboration and competition in the region.
4. **Network Dynamics**: This section delves deeper into the operational aspects of the network, exploring how stakeholders interact, share information, and work together towards common goals, as well as the challenges they face in doing so.
5. **Policy Space**: The final part examines the influence of local, national, and European policies on hydrogen initiatives, assessing how regulatory frameworks and policy support shape the activities and strategies of network actors.

Data Evaluation

Thematic analysis, as articulated by Braun & Clarke (Braun & Clarke, 2012), was chosen for its robust and flexible framework, ideal for analysing complex qualitative data. This method fits with the sophisticated exploration required to understand place-based innovations in the context of large societal problems. Braun & Clarke emphasise the adaptability of thematic analysis to diverse datasets, making it particularly suited to the multiple dimensions of this study: geographical proximity, governance and organisational structure, and network dynamics (Braun & Clarke, 2012). In addition, Attride-Stirling highlights the method's ability to identify thematic networks, enriching the analysis by connecting discrete yet related concepts (Attride-Stirling, 2001). Nowell et al. emphasise its usefulness in ensuring methodological consistency, particularly in maintaining the trustworthiness and credibility of qualitative analysis (Nowell et al., 2017).

Geographical Proximity: The thematic analysis of geographical proximity is grounded in the examination of the main location of the interviewees and their relational dynamics within specific distances, urban, and regional boundaries. This approach is based on the work of Braun & Clarke, who advocate for an analysis that can capture the complexity of spatial relationships and their impact on innovation (Braun & Clarke, 2012). The method facilitates an exploration of how physical closeness among actors fosters stronger collaborative ties and influences the innovation landscape.

Governance and Organizational Structure: In analyzing governance structures and interactions, the focus is placed on interviewees discussions surrounding political organizations, local authorities, and similar entities. This dimension benefits from thematic analysis's ability to highlight underlying themes and patterns within institutional contexts (Attride-Stirling, 2001). By coding and categorizing statements related to governance, the method allows for a detailed examination of how various governance models and organizational interactions either support or inhibit collaborative efforts and innovation capacity.

Network Dynamics: For network dynamics, thematic analysis zeroes in on anecdotes and enumerations of partnerships, leveraging the method's strength in identifying thematic networks and the interconnectivity within data (Attride-Stirling, 2001). This focus enables the uncovering of themes related to the formation, evolution, and functionality of networks, guided by firsthand accounts of collaboration behavior. The approach is adept at capturing the multifaceted nature of network dynamics, including how actors within the network perceive and engage in cooperation, facilitating a comprehensive understanding of the network's role in regional mission-oriented initiatives.

Ethical Considerations

Prior to their participation, all interviewees were informed about the study's topic and objectives through email communications and a preliminary discussion. This initial interaction not only served to outline the research aims but also to emphasize the voluntary nature of their participation, ensuring that consent was informed and freely

given. To safeguard the privacy and confidentiality of the information shared during the interviews, all raw data was stored securely on a hard drive that is disconnected from the Internet, minimizing the risk of unauthorized access. Furthermore, in preparation for publication and broader dissemination, data was carefully anonymized, stripping away any identifiers that could potentially trace back to individual participants.

Access to the raw data was strictly limited to the individual responsible for the project and the project management team, ensuring a controlled environment for data handling and analysis. This approach to data management was designed to comply with the German General Data Protection Regulation (GDPR) and the data security standards established by the University of Groningen, reflecting a commitment to upholding the highest standards of data protection and ethical research practices.

In the reporting of findings, a commitment was made to uphold honesty and transparency, eschewing any temptation to alter data to fit preconceived notions or desired outcomes. This ethical stance extends to the acknowledgment of any limitations encountered during the study and the readiness to address unexpected ethical issues that arose, ensuring that the research contributes valuable, authentic insights into the dynamics of place-based innovation.

5. Introduction Case Study

Figure 1: Map of Ruhr Area

In recent years, the European Union (EU) has embarked on an ambitious and transformative mission known as the Green Deal, aiming to position the EU as a global leader in the fight against climate change and environmental degradation (Skjærseth, 2021). The motivation behind the Green Deal is multifaceted, rooted in the urgent need to address the escalating challenges posed by climate change, biodiversity loss, and pollution, which threaten not only the environmental sustainability of the continent but also its economic stability and social well-being. Recognizing these challenges, the EU has formulated the Green Deal as a comprehensive policy initiative to transition towards a more sustainable, resilient, and inclusive economy (Fetting, 2020).

The objectives of the EU Green Deal are bold and far-reaching, reflecting the EU's commitment to systemic change. Central to the Green Deal's goals is the ambition to make Europe the world's first climate-neutral continent by 2050.
The timeline for the EU Green Deal is therefore anchored, with interim targets set for 2030 to reduce net greenhouse gas emissions by at least 55% compared to 1990 levels. This interim target is not only a milestone on the path to 2050 but also serves as a critical measure of the EU's commitment and progress towards its broader environmental and climate objectives. The implementation of the Green Deal is envisioned as a dynamic and evolving process, with policies and measures subject to continuous review and adaptation in response to emerging challenges and opportunities (Fetting, 2020).

Within this comprehensive framework, hydrogen emerges as a pivotal element in realizing the ambitions of the Green Deal, particularly in the quest for climate neutrality. Recognized for its potential as a clean energy carrier, hydrogen is said to offer a versatile solution to decarbonize sectors where direct electrification is challenging, such as heavy industry and transportation. The strategic deployment of hydrogen technologies is envisaged to play a crucial role in transitioning Europe's energy systems towards

sustainability, complementing renewable energy sources by offering storage solutions and facilitating energy distribution across the continent (Kougias et al., 2021).

Regions across the EU have embarked on specialized trajectories within the broader spectrum of green transformation. This specialization reflects the diverse industrial legacies, geographical characteristics, and economic strengths of these regions, turning the EU into a veritable real laboratory for environmental and economic innovation. This approach not only underlines the EU's commitment to systemic change but also highlights the flexibility and adaptability of its regions to contribute effectively to the overarching goals of the Green Deal (McCann & Soete, 2020).

The Ruhr area, named after the Ruhr River which traverses its heart, is a prime example of this regional adaptation and specialization. Situated in the western part of Germany in the state of North Rhine-Westphalia, the Ruhr region encompasses a densely populated area of about 4,435 square kilometers. It is one of Europe's largest urban agglomerations, with a population of over 5 million people. This region is a confluence of several major cities alongside numerous smaller towns and communities. Historically recognized as the powerhouse of Germany's coal mining and steel production, the Ruhr area has an extensive network of rivers and canals, including not only the Ruhr River but also the Rhine, which plays a crucial role in its economic and social development. The industrial heritage of the Ruhr has significantly influenced its cultural landscape, leading to a unique blend of urbanization and green spaces, where industrial facilities coexist with parks and recreational areas (Hassink, 2010; LIPSIT, 2020).

However, the decline of the Ruhr's traditional industries in the late 20th century marked a sobering period of economic recalibration. The shuttering of coal mines and downsizing of steel production, driven by depleted resources, environmental legislation, and cheaper global alternatives, led to significant socio-economic repercussions. Unemployment surged, and the region grappled with the consequences of its industrial past, including pollution and urban decay. This downturn starkly contrasted with the Ruhr's previous economic vibrancy and necessitated a strategic rethinking towards economic diversification and structural transformation.
In the evolving economic landscape of the Ruhr region, the emergence of hydrogen activities marks a significant shift towards sustainable industrial practices. While the region's economic geography has been and remains anchored in heavy industries such as steel, energy and chemicals, the current shift towards hydrogen technology represents a welcome opportunity for weakened businesses. The EU's Green Deal has put considerable pressure on these sectors to innovate and adapt to more environmentally friendly processes. This has positioned hydrogen as a key solution for decarbonising industrial activities that are inherently difficult to electrify (Hassink, 2010; LIPSIT, 2020).

In this context, large companies within the Ruhr area, particularly those entrenched in the sectors of steel production and chemical manufacturing, have identified hydrogen technology as a crucial avenue for achieving sustainable transformation. This realization has not emerged in isolation but rather as a response to the political mission encapsulated by the Green Deal. Interestingly, the drive towards hydrogen innovation in the Ruhr area has been characterized by a bottom-up approach, where private

enterprises have taken the lead in steering the region towards hydrogen adoption (Regionalverband Ruhr, 2023).

Over the last five years, the momentum behind hydrogen activities in the Ruhr has gained substantial traction. Consequently, the Ruhr area has set ambitious goals to position itself as the European leader in hydrogen technology, aiming to become not only a pioneer in the use and production of hydrogen but also in its transportation.

This strategic orientation towards hydrogen is seen as an opportunity to rejuvenate the region's industrial base, leveraging its historic strengths in heavy industry while embracing the principles of sustainability and innovation (Hassink, 2010; Regionalverband Ruhr, 2023).

The Ruhr region's efforts to integrate hydrogen technology into its industrial framework, in line with the European Union's Green Deal, exemplify a pertinent case study for examining the intricacies of network and organisational structures in the context of regional social missions. This transition, which is particularly relevant to the study of sustainable transformation within historically industrialised regions, allows for a sophisticated understanding of the mechanisms through which regional entities respond to overarching environmental policy directives.

What makes the case of the Ruhr region particularly salient for academic study is the distinctive evolution of its hydrogen activities from bottom-up dynamism to a more orchestrated, centrally coordinated mission. This paradigm shift, which departs from conventional mission structures typically based on government-led interventions, has been significantly characterised by the proactive engagement of private sector entities and local actors. This combination of bottom-up innovation and strategic centralisation provides a unique vantage point for analysing how regional economies can adapt to, and influence, large-scale policy missions such as the Green Deal.

6. Findings

Building on the contextual foundations established in the previous sections, the findings chapter moves on to explore the empirical data gathered through 14 interviews conducted with relevant stakeholders in the hydrogen activities. The interviewees, a diverse group comprising startups, small and medium-sized enterprises (SMEs), corporations, non-university research institutions, universities of applied sciences, universities, and business development organisations and initiatives at different administrative levels, provided insights into the multifaceted nature of this mission.

The process of gathering these insights began with the planned approach outlined earlier in the methodology section. A diverse group of stakeholders were identified through internet research and existing knowledge of the region. These stakeholders were then contacted by email and invited to an interview. As expected, the response rate to such a mailing was low, but resulted in 3 initial interviews. These 3 interviews led to a snowballing of 10 further interviews after the interviews and a further round with the possibility of more. However, due to the diversity and quantity of interviews conducted, it was decided that these 14 provided a sufficiently detailed holistic picture of network behaviour.

The thematic analysis identified a total of 10 themes across the three research areas that ran through all 14 interviews. Irrespective of the research questions, however, all participants unanimously confirmed that hydrogen activities in the Ruhr area are "defined and determined by political objectives rather than by economic conditions". For this reason, government action is seen as leading the way, whether in terms of subsidies, regulation or infrastructure. The region's focus on hydrogen evolved from the original energy transition idea of electrifying industrial processes. However, this did not seem feasible to stakeholders, especially in the traditionally energy-intensive steel and chemical industries. The interviews also show that the hydrogen activities originate from the bottom up from the solution finding process of the energy intensive industry. In terms of the current status, there were some clear differences, ranging from "We don't really have any major challenges left" to "There are massive delays". However, the majority of respondents agreed that the biggest challenges at the moment were “cost effectiveness for day-to-day use”, “green energy production” and “transportation infrastructure”.

The results of the interviews suggest that the Ruhr's ambition is a mission-oriented structure, but not in the specific sense that Mazzucato and other researchers in the field emphasise. On the one hand, the objectives are politically driven by the EU Green Deal, but at a completely different administrative and geographical level. On the other hand, the regional effort has been bottom-up, driven mainly by energy-intensive industrial companies. There is no single authority, as described in the literature, acting as an active market player and shaping the mandate.

In the following chapter, the themes found within the three research areas (geographical proximity, organisational structures and network dynamics) are elaborated and supported by quotes from the expert interviews.

1. Geographical Proximity is key for collaboration

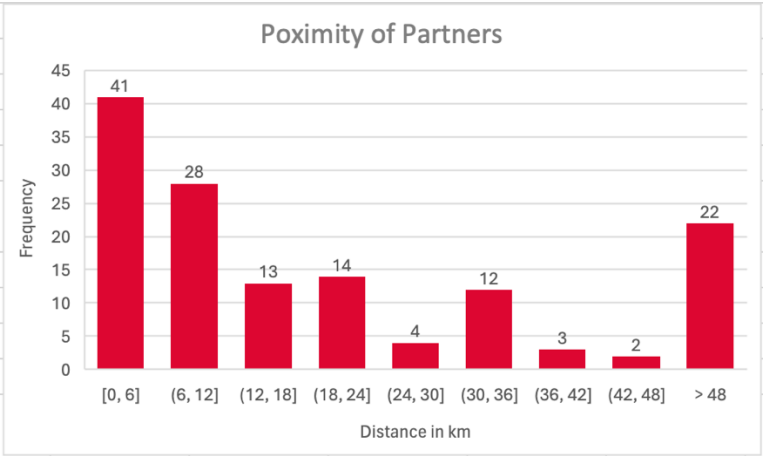

Figure 2: Distribution of direct distance to project partners in hydrogen actvities

The methodology for mapping the network connections among stakeholders in hydrogen projects was structured around initial discussions concerning the objectives of the organizations and their evaluations of the hydrogen development landscape. Following this, interviewees were encouraged to recount their experiences with hydrogen projects, focusing on both triumphs and challenges across past, ongoing, and future initiatives. Each project mention prompted further queries about its specifics, progress, and the parties involved, enabling an assessment of the project's significance and the extent of involvement among the actors. This iterative questioning continued until all remembered projects were disclosed. It's important to note that the recollections shared may not have been exhaustive, often reflecting the most impactful or memorable collaborations and interactions. When a complete list of project participants was provided, these connections were noted distinctly. Through this approach, a network comprising 141 principal connections was established.

Nonetheless, the first findings were derived not from the compiled database of connections but rather from the method of collection itself, specifically the snowball sampling technique. As highlighted in the methodology section, there was a tendency for interviewees to recommend further contacts, typically those with whom they had strong connections, at the conclusion of their interviews. Content analysis also revealed the presence of significant hydrogen clusters in various locales across the Ruhr region, indicating areas with a high concentration of hydrogen-related activities. This phenomenon underscores the critical role of geographical proximity in the formation of these networks. Post-interview observations indicated a predominance of connections within these clusters, with fewer extending to other clusters also noted for hydrogen activities. This pattern, consistent across all initial contacts despite geographical dispersion, illustrates the first sign of the significance of local ties in network formation.

In subsequent phases of snowball sampling, the initial clustering effect appeared to slightly diminish, likely due to the establishment of connections with network multipliers or highly interconnected actors. Analysis of the distribution of the 14 interviewees

indicated a lack of representation from two clusters where hydrogen activities were confirmed, lending further support to the observed trend.

An examination of the 141 connections also revealed a tendency for actors to engage with geographically proximate partners. The majority of connections were either within the same city or neighboring cities, highlighting the influence of institutional and geographical boundaries. This local focus was succinctly articulated by a stakeholder from a medium-sized enterprise, emphasizing the convenience of having most necessary partners within the local area. To quantify this proximity, the straight-line distance between the main workplace of the interviewee and the project partner's location was calculated, with an average distance of 85.41 kilometers. However, this figure is skewed by outliers, and a median distance of 12.55 kilometers more accurately reflects the general trend towards local collaboration.

Thus, in line with the expectations formed from the literature review, the findings suggest a preference among actors for collaborating with geographically close partners in hydrogen initiatives.

2. Different Geographical Behavior in catagories

The results of the previous section show a general trend towards geographically closer players. However, there are some very considerable differences between the types of actors. Overall, the 141 actors were clustered into three categories, each with three subcategories:

1. **Private Sector**:
    - International Corporations
    - Established Small and Medium-sized Enterprises (SMEs)
    - Hydrogen Startups
2. **Public Sector & Initiatives**:
    - Supra-regional Institutions
    - Regional Authorities
    - Municipal Agencies
3. **Academic Sector**:
    - Non-university Research Institutions
    - Universities of Applied Sciences
    - Universities

One of the most noticeable patterns was that the existing large corporations in the region in particular were well networked within the region and are moving closer together with their peers as a result of the hydrogen activities. In addition, the hydrogen activities in terms of partners with these actors often cross regional borders. There is therefore only a smaller tendency towards geographically close participants.
The picture is similar for the academic sector. It appears to be very well networked both within Germany and across the region. In contrast, large corporations rarely mentioned smaller partners within the region.

The established SMEs have the most connections within the region, especially companies that would be described as "Mittelstand" in Germany are very well networked within the region in their hydrogen activities. The clustering in so-called hydrogen networks, which are often also geographically bound, is particularly noticeable.

The public institutions stick very closely to their administrative and geographical boundaries. Although there are individual project partners outside these boundaries, these are not the norm. In general, the initiatives and institutions emphasized that their remit is geographically bound. For this reason, public sector actors have the most connections in terms of quantity and the most diverse connections in the narrowest geographical area.

Overall, these different patterns show the diversity of the network and hydrogen activities. These patterns already give different indications of the network actor behaviour. However, the general pattern of geographical proximity remains the same for all of them.

3. Network Meetings are good to make tacit knowledge spillovers

The interviews provided additional insights into the impact of geographical proximity on the hydrogen sector, in particular through tacit knowledge spillovers facilitated by numerous regional networking events. These events, organised by both bottom-up initiatives and public institutions, have become so frequent that participants are now selective in their attendance, with one interviewee pointing to the need for strategic choice and another describing the volume as excessive. This proliferation of events has led to a slight competitive atmosphere among organisers, who strive to increase the attractiveness of their events. This issue will be discussed in more detail later.

The general sentiment towards these networking meetings remains positive, with significant emphasis on their importance for advancing hydrogen activities. A representative from a large corporation highlighted the exchange of information at these events as "essential" for progress, while a leader of an initiative noted that such gatherings had led to the practical application of best-case systems among member companies. Furthermore, the speed and efficiency of networking within the hydrogen topic were praised, indicating that the sector's collaborative dynamics are not hindered by a lack of exchange. This view was supported by the majority of interviewees, suggesting a robust network that facilitates timely advancements in hydrogen projects.

4. Hydrogen activities as a pull factor into the region

Figure 3: Map of Germany of the Federal Government's hydrogen pipeline network planning (BMWK, 2023)

While geographical proximity significantly influences collaboration within the hydrogen sector, the initiatives also seem to catalyze connections beyond regional confines, manifesting in two distinct developments.

Firstly, the Ruhr region's positioning benefits from new external connections, as interviewees noted engagements with entities outside the region now collaborating on solution development and project implementation with local stakeholders. This influx of knowledge and investment into the region is said to be a direct consequence of the heightened focus on hydrogen, attracting international firms and fostering previously non-existent connections, with e.g. North America or South Korea. Such developments partially validate the hypothesis that shared missions can transcend geographical barriers, although it remains to be seen if a mission-oriented structure inherently facilitates this. Notably, a pronounced increase in interaction with Dutch actors was observed, driven by mutual interests in hydrogen development, signifying not competition but partnership potential aimed at bolstering economic ties between adjacent regions.

The other side of this international networking is that the high level of global interest in the hydrogen economy creates competition for knowledge and expertise between the locations. As one interviewee from a start-up reported: "We want to orientate ourselves more towards the USA [...] Things are faster there [...] There is more money from the American market". This sentiment was echoed by an international corporation citing the Inflation Reduction Act's (a subsidy program by the US government to attract private investment) financial incentives as a lure to the U.S. Thus, while the region's pioneering efforts attract knowledge and investment, they also face outward competitive pressures, underlining a dualistic pull effect wherein the region not only draws in resources and expertise but also contends with the loss of potential innovations and collaborations to more attractive international locales.

In concluding this chapter, it's clear that the expectation regarding the role of geographical proximity in hydrogen activities within the Ruhr region presents a mixed picture. Contrary to initial expectations, the data and expert testimonies collected do not clearly support the idea that the collective ambition of the hydrogen model region effectively bridges geographical barriers. Instead, the inherent nature of the hydrogen infrastructure, in particular the reliance on pipelines, appears to inherently favour and even necessitate geographical proximity, leading to a clustering of stakeholders within the region. But this goes beyond the technical boundaries. Local actors tend to collaborate with other local actors, even if the collaboration is not tied to infrastructure conditions that require close links.

5. Bottom-up Networks

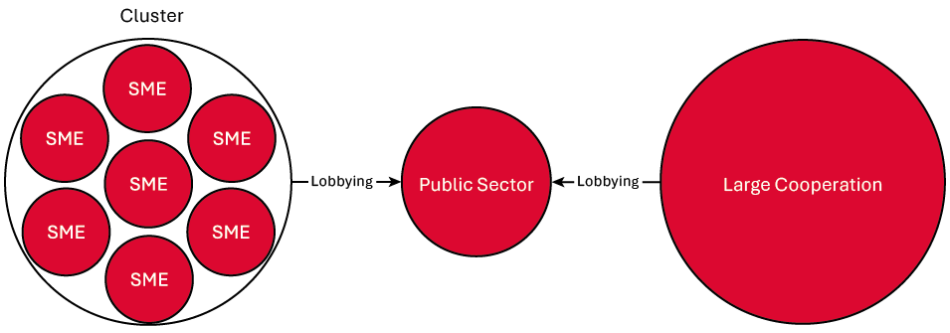

Figure 4: Graphical representation of the intention behind the clustering of SME interests

The decentralized structure of hydrogen activities within the Ruhr region is a significant characteristic, primarily shaped by the emergence of the previously mentioned bottom-up business networks. These networks, initiated by research pioneers and key players in the region's energy-intensive industries, embody a collaborative ethos, recognizing that the successful integration of hydrogen within their operations hinges on having enough potential off takers, cooperating with pipeline network operators, and fostering innovation in hydrogen applications. The sentiment shared by an expert from a medium-sized company encapsulates this outlook: "I believe that innovation is based on cooperation (in this field)". Moreover, a critical function of these networks is to advocate for support, whether through subsidies or regulatory advantages, to propel research and pioneering

projects forward. The genesis of these organizational structures often traces back to informational events, demand surveys, or individual pioneers, drawing together diverse actors from sectors previously disconnected. An initiative participant remarked on the connections within these networks, highlighting instances where neighboring companies were previously unaware of each other's activities.

These collaborative networks, while primarily focused on advancing hydrogen technologies, also navigate differences in goals, with some prioritizing hydrogen exclusively and others adopting a broader scope. However, the initiatives are also seen as a means to an end. For example, a stakeholder in one initiative exaggerates: "I don't think that my job, the next 50 years, still has to be done, but that we just have to accompany the transformation". The importance of these joint initiatives was confirmed by all those interviewed. The emergence of these initiatives has a decisive influence on the structure and implementation of hydrogen activities. One expert labelled the number of these networks as “too many to count”. It is difficult to determine the exact number due to the lack of definition of what such a network is, various delimitations and combinations of projects. The quantity of these initiatives is considered by many experts to be too high. At the same time, one stakeholder stated that there is a consolidation phase due to advanced planning and that the micromanagement of networks in projects is decreasing and the market is now moving towards a more coordinated approach.

Contrastingly, advancements in the hydrogen sector are predominantly driven by large corporations, designated as "anchor customers" by pipeline operators. This segment encounters less complexity due to fewer involved stakeholders and benefits from economies of scale, which simplifies implementation. However, this has led to differing perspectives on market development strategies, particularly evident in lobbying efforts where contrasting positions emerge between these large entities and the broader network of smaller actors.

The organizational landscape within the Ruhr region thus presents a dichotomy between large corporations, which engage at a national level, and the intricate networks of smaller stakeholders, leading to a dynamic yet challenging coordination of projects and funding. Despite this, the distinction is not absolute, as many large-scale corporate projects also engage with regional networks, indicating a complex interplay between the different market actors.

6. No recognized Leader

The findings from the interviews underscore a critical gap in the governance of hydrogen initiatives within the Ruhr region: the absence of a designated state entity with clear responsibility. This gap is a stark departure from the framework posited by scholars like Mazzucato, who argue for the state's pivotal role as a market actor or even a market-architect in mission-oriented initiatives, where it is expected to set the pace and direction (Mazzucato, 2016). In the Ruhr region, however, the self-organizing nature of business networks, supported by municipal and regional economic development agencies, indicates a decentralized approach rather than one guided by state orchestration.

This decentralization has fostered a competitive landscape among regional organizational structures, characterized by a multitude of municipal and small-scale initiatives vying for funding and attention. The competition, while energizing in some aspects, has led to what some describe as an "incredible number of municipal and small-scale regional initiatives that all try to set accents with more or less power," highlighting the fragmentation within the region's hydrogen efforts. This sentiment is echoed in the observation that "the question is always whether there are too many initiatives and whether it would be better to cluster them," suggesting a need for more streamlined coordination. The competitive dynamic among these initiatives is further evidenced by comments noting that "network overkill" and "the project ideas are always in competition with each other," pointing to the challenges of achieving synergy in such a fragmented ecosystem.

Amid this competitive environment, there is a significant investment of resources by municipalities, regions, and the state, which, paradoxically, might exacerbate the competition as individual administrative units prioritize their interests. The proliferation of personnel in economic development and environmental departments, described by one stakeholder as needing to be "slimmed down," reflects concerns over creating "too many duplicate structures" that do not contribute to the efficiency or effectiveness of hydrogen initiatives.

Despite these challenges, there is a discernible move towards more centralized coordination, albeit tentative and with limited financial backing. The cautious embrace of new structures for regional coordination suggests an awareness of the need for alignment. Yet, the modest scale of these efforts, as highlighted by stakeholders noting that "collaboration with these structures is still somewhat new" and "these are not powerful institutions," underscores the constraints faced by initiatives aiming to bring coherence to the region's hydrogen activities.

Interview feedback consistently emphasizes the necessity for a centralized coordinating authority in steering the Ruhr region's hydrogen initiatives. This unified body is envisioned as pivotal for setting clear strategic directions and ensuring investment stability, thereby acting as a catalyst for collective efforts toward hydrogen development. Multiple interviewees but not everyone advocate for this centralized approach, stressing its importance in harmonizing the diverse array of projects and activities within the region.
One interviewee underscored this sentiment by stating, "There needs to be a strong, central co-ordination and information centre that establishes all the links", reflecting a widespread desire. Another added: "Politicians need to make clearer announcements about the direction they want to promote in order to create investment security for companies", pointing to the perceived lack of clear decisions by government organisations. Furthermore, the comment that "we are committed to our own city" highlights the prevailing localised focus and underlines the need for a broader, region-wide perspective to overcome fragmented efforts and realise the full potential of the region's hydrogen capabilities.

In conclusion, the landscape of hydrogen initiatives in the Ruhr region is characterised by a dynamic yet fragmented array of efforts, which while indicative of the region's commitment to hydrogen technology, also highlights the challenges of operating without

a unified, government-led direction. Stakeholder insights reveal a complex interplay of competition, investment and nascent efforts towards centralisation, underscoring the need for strategic, cohesive leadership to realise the full potential of hydrogen as a key enabler of the region's energy transition.

7. Multi-Level Governance

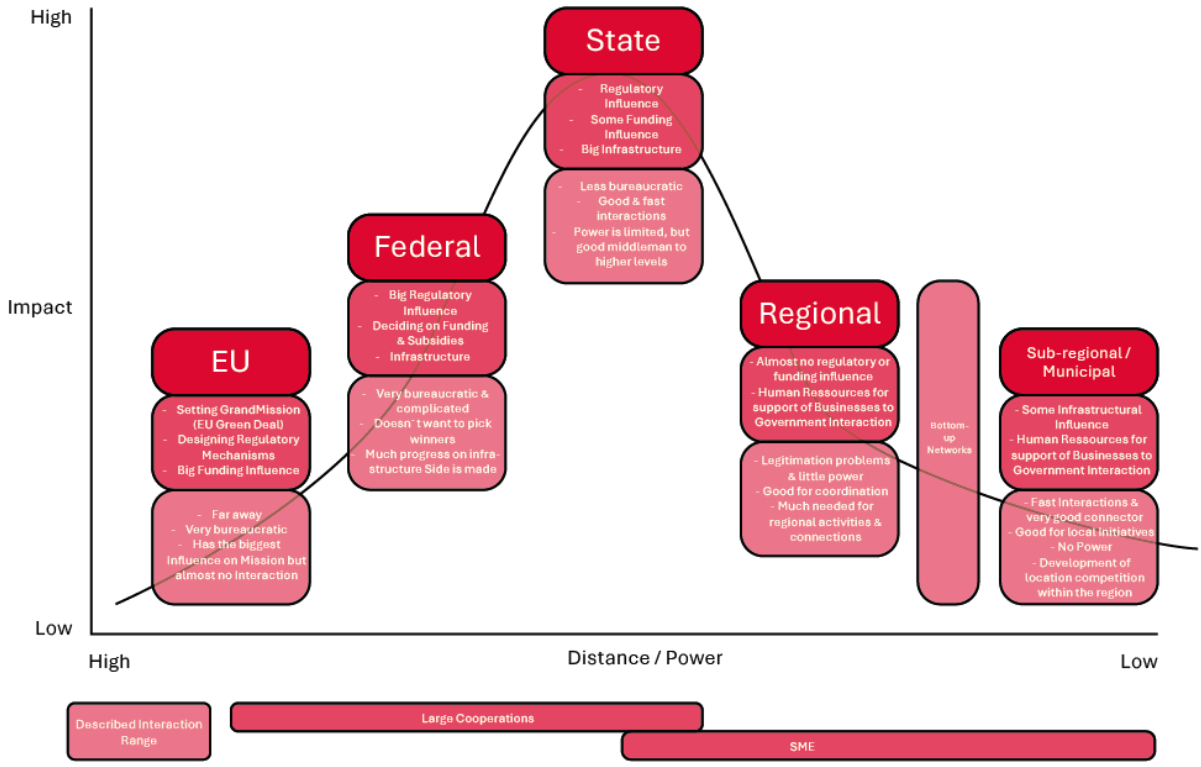

Figure 5: Illustration of the perceived distance/power to the actors in relation to the potential impact that each governance level has on hydrogen activities in the Ruhr region

Within the multi-level governance landscape affecting hydrogen initiatives in the Ruhr Area, a detailed examination through expert interviews reveals a complex interplay of influences, opportunities and challenges across different administrative levels. This multifaceted portrait underscores the significant yet distinct roles played by entities at the EU, national, state and sub-regional levels, each contributing to the facilitation and regulation of hydrogen projects, while also presenting distinct hurdles to their implementation and development.

At the highest level, the EU and national levels have the greatest influence in terms of funding availability and regulatory scope. However, these top levels are perceived as distant from the realities of project implementation on the ground, characterised by a bureaucratic slowness that can be almost paralysing. This distance manifests itself in long project timelines, exacerbated by a cautious approach to the selection of initiatives for support, leading to a scenario where "projects take a very long time due to a complex funding structure and extensive approvals" and "it takes two to three years for funds to

flow at EU level", illustrating the temporal and procedural disconnects that impede rapid project progress.

The state level emerges as a crucial intermediary, bridging regional initiatives with the broader framework of national and EU policies. Its role is generally seen as positive, even though it offers less funding and regulatory influence than the higher levels. The relative efficiency and responsiveness of the state level is well suited to the operational needs of medium to large enterprises, particularly the Mittelstand, which finds the state offering more in line with its strategic objectives than the more cumbersome federal structures. The prompt and effective communication highlighted by one interviewee, "With the state level, communication is good and fast", reflects a favourable view of the state's role in supporting hydrogen initiatives.

Conversely, the sub-regional level, characterised by competition between networks and municipalities, struggles with a lack of significant regulatory or funding power. The scenario is often described as over-managed yet under-powered, raising concerns about the potential ineffectiveness or even counter-productivity of these efforts. The bureaucratic barriers are starkly illustrated by one expert's observation of "a list of more than five pages of administrative and regulatory hurdles for hydrogen activities", highlighting the formidable challenges that impede innovation and project implementation.

Despite the overarching challenges, local support at the municipal level is recognised for its speed and helpfulness, particularly in areas where hydrogen is a priority. However, the limited capacity of municipalities to influence broader regulatory or funding frameworks is a notable limitation, highlighting a structural challenge within the governance architecture. Nevertheless, the potential for hydrogen availability to emerge as a critical factor in site selection, as suggested by one interviewee, indicates a recognition of the strategic importance of local support in the broader hydrogen development landscape.

Regulatory differences between states add another layer of complexity, with multi-state companies navigating a patchwork of regulations. This environment, described by one expert as sometimes obstructive, highlights the need for strategic lobbying and political engagement as essential strategies for navigating the governance landscape. The effectiveness of such engagement is further emphasised by another small business expert's advice on the importance of good contacts and compelling narratives at state level.

In summary, all experts describe bureaucracy and the lack of dynamism between different levels of government as a barrier to progress. In particular, there is a gap between influence and accessibility. The higher levels have a very strong influence on the projects and the lower levels are close to the projects but have little influence. The state level was rated most positively, as it occupies a sweet spot between proximity and influence.

8. Network Dynamics of smaller Stakeholders

The dynamics within the hydrogen sector in the Ruhr region, especially as they pertain to network formation and interaction, underscore the nuanced challenges and strategic maneuvers that small and medium-sized enterprises (SMEs) and startups navigate. This landscape is marked by a blend of cooperation, competition, and a quest for funding, which significantly influences their operational and strategic frameworks.

A number of interviewees reported that SMEs, in particular, are in a fragile position due to the early stage of the hydrogen market and are heavily dependent on external support mechanisms. This dependence on research funding, subsidies or investment from larger companies. While the rapid formation of networks is beneficial, it also highlights the inequalities in access to resources, as illustrated by the concerns of SMEs about "falling through the cracks" of funding programs. The assertion that "when in doubt, you can always find the network that already exists" underlines the crucial role of established networks in overcoming these challenges.

The funding landscape is pivotal for SMEs and startups, where the absence of a mature market for hydrogen technologies leaves these smaller entities in a vulnerable position. The need for a more inclusive approach to funding is echoed in suggestions like "clusters should be able to apply for funding programmes," aiming to bridge the gap in support structures for innovative SMEs struggling to secure traditional funding sources.

The strategic behavior of SMEs in response to the dominance of large companies is noteworthy. The formation alliances among smaller stakeholders is a tactical move to ensure their voices are heard within the political and economic landscape of the hydrogen sector. This strategy not only amplifies their political influence but also underscores the shared objective of decarbonization. An illustrative anecdote of this collective action is the collaboration between two competitors, working together to advance the agenda on hydrogen, showcasing a remarkable instance of cooperation in pursuit of common goals.

The reliance of startups and SMEs on external support mechanisms is particularly pronounced by one interviewee, given the current market's embryonic stage. The absence of a well-defined market for hydrogen technologies necessitates a nuanced approach to sustainability and growth for these smaller entities. As elucidated by one startup, "there is no business case on the market yet,". This scenario mandates reliance on research funding, subsidies, or strategic partnerships with larger corporations to navigate the market's uncertainties until it matures.

The suggestion of one interviewee from the academic sector for funding organizations to "strategically select" project partners aims to get SME players into the programs. Under this request, the public authorities would be able to compose the actors in a project. At present, applications are submitted as a group of partners, which is the other way round. By adopting this approach, there's supposed to be an opportunity to broaden the range of participants in projects, ensuring that a variety of entities, beyond those with established connections, can contribute to and benefit from the subsidies and the industries early stages. This method seeks to prevent the concentration of resources among a select few.

At the same time, this demand speaks in favor of greater state intervention and against the bottom-up nature, where the actors choose who is collaborating with whom.

9. Domination of large cooperations

Building upon the previous section's exploration of the Ruhr region's hydrogen initiatives, it's evident that the dynamics of network formation and collaboration are significantly influenced by the mission.

Large companies, particularly those in sectors like steel production and chemical manufacturing, have been pivotal in driving the region's sustainable transformation efforts, aligning closely with the EU's Green Deal ambitions. This leadership role of large companies in hydrogen technology adoption has cascaded down to affect network dynamics, emphasizing the asymmetrical relationships between large corporations and smaller entities like SMEs and startups.

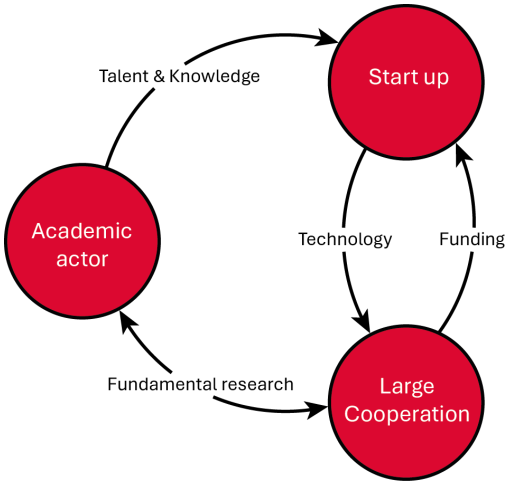

Figure 6: Presentation of the network process of how technology comes into practice from research to application

"The biggest investment drivers are large companies," as noted by an expert, encapsulates the central role these entities play in the hydrogen sector.
An interviewee succinctly put it, "Startups work a lot with large companies to really scale the technology. And startups can't do the scaling alone," highlighting the symbiotic relationships that are emerging within the hydrogen ecosystem. This dependence on large companies for scaling underscores the critical role of economies of scale in making green hydrogen competitive.

While these collaborations are essential for progress within the hydrogen sector, the approach of some large companies is perceived as aggressive, potentially complicating the dynamics of these partnerships. Despite these challenges, several projects are being realized in this constellation, illustrating a pragmatic approach to leveraging the strengths of large corporations.

Competition for the favour of large companies is not limited to start-ups. As an expert from a large company revealed: "It's more the case that the alliances approach us to get us involved in the initiatives so that we can offer the entire value chain", indicating a wider trend of smaller projects seeking the involvement of large companies to increase their viability and scale. This trend is further complicated by the observation that large companies often secure funding and support more frequently, a development attributed to their less complex project structures, smaller number of stakeholders and well-established informal political contacts.
This complex interplay of interdependencies, competition and collaboration within the Ruhr region's hydrogen sector highlights the multifaceted challenges of fostering a balanced and inclusive innovation ecosystem.

10. State as connector

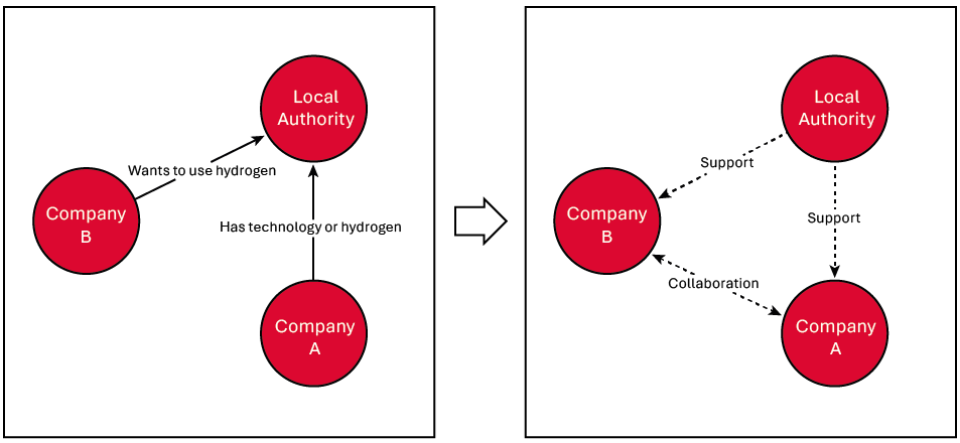

Figure 7: The networking process and the role of local authorities in the creation of new hydrogen activities

Government involvement in hydrogen initiatives is primarily focused on coordination. This involvement is particularly pronounced at the regional and municipal level, where authorities articulate their role as critical connectors within the ecosystem, acting as hinges between different stakeholders. This is underlined by the recognition of the challenges faced by smaller companies, as highlighted by one representative: "These are often smaller companies that may not yet see the perspective or have the manpower to engage with the topic".

One observation of a small company highlights the integral support provided by the state, which acts as a crucial link between small companies and larger companies: "The other side is the government, we are very much behind them for support. They are very much connectors between the diverse stakeholders." This statement not only underscores the government's role in providing support but also in actively creating connections that might otherwise be challenging to establish due to the disparate nature, location, and scales of these entities.
Similarly, one experts institution account of having "built one or two bridges here to, let's say, project developers or companies", further illustrates the hands-on approach taken

by local authorities in crafting opportunities for collaboration. This proactive stance ensures that even smaller companies, which might lack the visibility or resources to engage with larger players independently, are integrated into the broader ecosystem, thereby enhancing their potential for contribution and growth.
The significance of such governmental intervention in creating a fertile ground for collaboration is succinctly captured by another expert: "Added value is created when projects arise because we bring the right partners together." This perspective highlights the transformative impact of strategic facilitation by the state, where the deliberate act of connecting diverse partners not only amplifies the potential for innovation but also cultivates a more dynamic and interconnected hydrogen sector.

Integrating the role of public authorities in the formation of so-called "forbidden triads" offers a compelling narrative on the dynamic orchestration of network dynamics within the Ruhr region's hydrogen sector. One of the most illustrative instances of this intervention involved a local authority acting as the crucial link between two companies of different sizes, from distinct cities and sectors, which had not previously collaborated. This initiative not only enabled the launch of a pilot project under the regulatory umbrella of the authority but also catalyzed further collaborations, extending beyond the initial project into ongoing partnerships. This scenario exemplifies the transformative potential of local authorities in bridging gaps within the innovation ecosystem, thereby enhancing the network's cohesion and innovative output. Several other anecdotes of such networking by the regional authorities were reported, although this one was the most precise one. In most cases, the regional authorities stay on board with these projects and advise and help the participants with regulatory issues.

Moreover, the role of public authorities extends to facilitating cross-regional collaborations, addressing the need for technologies or partnership opportunities beyond the immediate geographic confines. As highlighted by one interviewee, "If we want to acquire something supra-regionally, the regional public players are definitely our contacts for this." This statement underscores the role of local authorities in transcending regional boundaries to foster collaboration across the broader hydrogen sector.

The endeavor to integrate the civilian population into hydrogen initiatives within the Ruhr region underlines a move by public authorities towards fostering societal acceptance and education. Recognizing the potential challenges akin to NIMBYism, similar to those faced by wind turbine projects, the authorities have initiated concerted efforts to engage the public actively. Statements from two institutions, "The issue has not yet reached the citizens," and "Our aim is to involve the civilian population more in the future," respectively, underscore the perceived gap in public awareness and the ambition to bridge this gap through targeted outreach and involvement strategies.

The role of academic institutions in shaping the Ruhr region's hydrogen ecosystem was mentioned by many experts as well, serving as crucial nodes in a network that spans from foundational research to industrial application. Through a deeply collaborative model, universities, non-university research institutes, and a spectrum of industrial partners are engaging in a symbiotic relationship that not only advances scientific understanding but also ensures the practical applicability of research outcomes, as was explained by one interviewee. These collaborations try to underscore the strategic alignment of academic

pursuits with the pragmatic goals of the hydrogen sector, bridging the gap between theoretical innovation and its real-world implementation.

This relationship is further exemplified by the active role academic institutions take in consortia formation, often bringing together companies and research bodies that previously had no interaction. This role of academic entities is enabling a cross-pollination of ideas and resources that is said to be essential for the sector's growth and sustainability. One experts reflection from a regional comapny, "Research institutions have always networked us with other research institutions," speaks to the support provided by these academic bodies. By acting as hubs for knowledge exchange and collaborative engagement, these entities significantly contribute to the ecosystem's adaptive capacity.

11. Connection through topic

The hydrogen initiatives have spurred increased networking among all stakeholders driven by the economic logic of economies of scale in hydrogen procurement. The high initial investment required for hydrogen infrastructure, such as pipelines, necessitates substantial purchase volumes to justify the project for operators. This situation has fostered an environment where companies, recognizing the mutual benefits of collaboration, have increasingly come together to achieve the requisite scale. This collaborative trend is eloquently summarized by one institution: "But if Company A is suddenly interested in hydrogen, it had relatively little to do with the Sector B before," illustrating how hydrogen initiatives are prompting companies to bridge traditional sectoral divides.

Moreover, the connection data shows that the push towards hydrogen as a key element of the region's energy transition has encouraged entities from vastly different sectors to forge relationships, united by a shared vision. This phenomenon, where even competitors find common ground in their hydrogen ambitions, is a testament to the missions unifying potential. One expert reflects on this dynamic, noting, "So I believe that, as I said, the transformation means that sectors that didn't need it before have to be linked together." Such observations underscore the transformative impact of hydrogen on regional business networks, facilitating unlikely alliances in pursuit of collective decarbonization goals.

However, this burgeoning network of cross-sectoral collaborations is not without its tensions, as highlighted by one representative: "Of course, there are also tensions when you try to unite so many different players behind one goal." Despite these challenges, the overarching drive toward hydrogen adoption has led to proactive support mechanisms from larger companies within the ecosystem. One large companies commitment, "It is very important for us to support the other stages of the value chain," exemplifies the collaborative ethos permeating the region, where support extends across the value chain to ensure the holistic development of the hydrogen sector.

In summary, hydrogen activities have had and continue to have a strong collaborative effect between different actors. At an individual level, the new collaborations with

different actors in the immediate geographical area are mainly due to the fact that clusters are being formed in order to obtain a faster connection to hydrogen pipelines. In addition, the new cross-sectoral links are stimulating because they show that existing networks are expanding as a result of the stakeholders' commitment to hydrogen. In the interviews, public actors in particular, but also academic actors, were identified as catalysts for this expansion. This suggests that in a politically driven mission, actors need at least a nudge, as they do not network directly out of business interest. At the macro level, the different approaches, competition and interdependencies between large and small actors should be highlighted. The lack of an organisational structure enables asymmetric structures to emerge.

7. Discussion & Implications

Geographical Proximity

In the context of the Ruhr region's hydrogen activities, the interplay between geographical proximity and the mission-driven approach provides a nuanced understanding of innovation dynamics within regional societal problems. The empirical evidence gathered underscores a clear affirmation of the initial expectation regarding geographical proximity: that a diverse set of actors, when located closer to each other, tend to exhibit higher levels of collaboration and innovation. This finding resonates with established academic literature on economic geography, which has long posited the advantages of geographical proximity in fostering collaboration, knowledge exchange, and consequently, innovation (Balland et al., 2015; Janssen & Abbasiharofteh, 2022). The Ruhr region, with its dense industrial landscape and concerted push towards hydrogen as a unifying mission, exemplifies this principle in action. The region's approach, combining technological innovation with infrastructure development, underlines a hybrid mission that is neither purely technological nor purely social, but rather a strategic fusion aimed at establishing a market for political reasons.

The observed clustering of hydrogen initiatives in the Ruhr region demonstrates the role of geographical proximity in catalysing collaborative networks, particularly among smaller actors with limited resources. This clustering, which is inherently linked to the region's industrial base and infrastructure needs, not only capitalises on the benefits of physical proximity, but also aligns with the overarching mission driving the hydrogen agenda. The mission itself acts as a magnet, drawing together a wide range of actors. This is exemplified by the interaction between entities traditionally separated by industrial domains, as highlighted by many interviewees.

Furthermore, this clustering effect underscores a dynamic where geographical proximity and shared infrastructural objectives synergize to create a fertile ground for collaboration and innovation. This environment is conducive to the exchange of ideas, resources, and capacities, particularly beneficial for smaller entities navigating the complexities of forward-looking themes outside their immediate operational scope. The mission-centric approach of the Ruhr region, therefore, not only facilitates but also amplifies the inherent

benefits of geographical proximity, crafting a robust ecosystem where collaborative ventures are both nurtured and accelerated.

However, the narrative becomes more nuanced when examining the ability of a common mission to mitigate the constraints of geographical distance while maintaining the momentum of innovation. The findings present a mixed picture, suggesting that while mission has indeed broadened the horizons of collaboration, extending networks across regional and sometimes national boundaries, it has not clearly removed the value of geographical proximity. This suggests a complex interplay between mission-driven initiatives and the traditional benefits of proximity, where the former extends the reach of stakeholder engagement, but the latter remains a critical factor in deepening collaborative relationships. While the evidence highlights instances of cross-regional collaboration fostered by the Hydrogen Mission, it stops short of presenting a definitive trend towards a diminished role of geographical proximity in innovation networks.

The lack of extensive international networking, as highlighted in the interviews, suggests that while the mission has a broadening effect on stakeholder engagement, it predominantly reinforces and extends existing networks rather than creating entirely new paradigms of collaboration. This outcome prompts further investigation, especially in contexts where infrastructure is not a limiting factor, to discern whether less infrastructure-intensive missions might yield different dynamics in overcoming geographical barriers.

Organisational Structure

The organisational structure of hydrogen activities in the Ruhr region reveals a complex landscape characterised by a plethora of bottom-up networks, embodying a chaotic yet vibrant ecosystem driven by a political mission. This chaos, while initially perceived as detrimental, reflects the network dynamics of a free market and suggests an approach where market forces are allowed to determine the trajectory of projects without external intervention. However, the unique context of hydrogen activities, deeply intertwined with the political ambitions of the European Union's Green Deal, presents a scenario where such laissez-faire tactics could lead to the premature stagnation of initiatives or their monopolisation by large corporations.

The challenge lies in the inherently political nature of the hydrogen market's development, aimed at advancing sustainability goals. Experts unanimously agree that a market-driven ramp-up of hydrogen would falter in the face of cheaper natural gas alternatives, a situation unaltered by geopolitical shifts such as the severance of the Nord Stream pipelines. This underscores the hydrogen market in the Ruhr area as a colossal infrastructure endeavor, requiring substantial seed investment and strategic oversight, roles traditionally within the purview of state mechanisms.

The state's current role in this orchestration appears paradoxically multifaceted, characterized by both a perceived absence of clear leadership and tendencies towards micromanagement. This dichotomy emerges from a bottom-up focus, where individual

initiatives, driven by the desire to accelerate and amplify their impact, inadvertently fuel a competitive scramble for limited resources. Such competition not only dilutes the efficacy of initiatives but necessitates higher-order coordination, paradoxically consuming resources that could otherwise fuel direct action. This scenario, where the coordination budget becomes a counterproductive sink, echoes the critiques of overextension and underpowerment at various administrative levels within the public sector.

Delving deeper into the insights garnered from expert interviews, a compelling narrative emerges, underscoring the necessity for a significant recalibration of the state's role in fostering innovation and market development. The consensus among stakeholders points toward a critical need for establishing a central authority, characterized by clear responsibilities, a comprehensive budget, a time-bound operational framework with defined milestones, and sufficient regulatory leeway. This paradigm shift is seen as crucial for overcoming the current challenges of fragmentation, competitive resource allocation, and the lack of decisive leadership hindering the region's transition towards a sustainable hydrogen economy.

The envisaged central authority is a strategic response to the nuanced complexities of implementing mission-driven policies at a regional level. Stakeholders underline the importance of such an entity not only as an administrative body, but as a dynamic force capable of steering the hydrogen mission with focus, agility and visionary leadership. This involves not only bridging the gap between the numerous bottom-up initiatives, but also aligning these efforts with the broader objectives of the EU Green Deal, thereby catalysing a coherent and impactful transition to sustainable energy solutions.

The establishment of clear milestones and a time-limited mandate ensures that the authority operates with a sense of urgency and purpose, driving forward the mission with measurable progress and accountability. The provision for regulatory freedom, within this framework, is essential for enabling adaptive responses to emerging challenges and opportunities, allowing the authority to navigate the intricacies of market creation and infrastructure development with the necessary flexibility. This approach aligns with the theoretical underpinnings of mission-oriented policy as advocated by Mazzucato and other researchers. However, it extends these principles to a place-based level, recognizing the unique dynamics and potential of regional innovation ecosystems. By advocating for the establishment of such mission authorities, the Ruhr region's experience illuminates a path for realizing the European Union's vision of transforming regions into real laboratories for groundbreaking missions (Camagni & Capello, 2017).

In this context, the establishment of place-based mission authorities emerges not only as a tool for operationalizing mission-oriented policy but also as a critical mechanism for enabling regions to act as incubators for sustainable, innovative solutions to societal challenges. This model could offer a blueprint for harnessing the collective capacities of diverse stakeholders, leveraging regional strengths, and aligning efforts towards common goals, thereby embodying the essence of a real-world laboratory for mission-oriented innovation.

Further research into this model, especially within the context of place-based missions and the operational dynamics of such authorities, holds significant potential for advancing our understanding of how to effectively mobilize resources, coordinate efforts, and drive progress in addressing complex societal challenges. By exploring the implications, challenges, and successes of establishing place-based mission authorities, scholars and policymakers can glean valuable insights into the practical application of mission-oriented policy frameworks, potentially charting a course for more effective, impactful, and sustainable innovation ecosystems across the European Union and beyond.

Network Dynamics

The findings from the semi-structured interviews and thematic analysis highlight a significant shift in network dynamics, confirming the expectation that the initiation of a regional mission catalyses novel collaborations and bridges previously unexplored triadic links, or 'forbidden triads', between different network actors. This transformation transcends traditional operational boundaries and fosters a rich web of interactions across the hydrogen value chain.

The activation of these unused connections, particularly through the facilitation of local authorities and academic institutions, underscores a strategic pivot towards a more integrated and collaborative regional ecosystem. These entities, leveraging their extensive and diverse contact networks, have emerged as pivotal brokers in the network, effectively connecting actors from different sectors who might not have engaged otherwise. This role is crucial in knitting together the region's hydrogen activities into a coherent mission, aligning with the broader objectives of the European Union's Green Deal.

Local authorities and academic institutions, through their efforts, have systematically reduced cognitive distances among stakeholders, laying a foundation for innovative collaborations. By bringing together geographically proximate actors from disparate sectors, these brokers have facilitated an environment ripe for the exchange of ideas and resources. This scenario not only validates the literature's emphasis on the creative potential unleashed by diverse stakeholder collaboration but also points to the broader economic and social benefits emerging from these new networks. The formation of these networks, driven by the regional mission, not only advances the immediate objectives of hydrogen adoption and infrastructure development but also seeds the ground for enduring economic resilience and innovation capacity beyond the mission's scope.

However, the empirical data also suggest an important need for further research to dissect the complexities of these network transformations. Questions remain about the mechanisms that enable or impede the rapid formation of such linkages, the barriers to collaboration, and the specific conditions under which regional missions such as the Ruhr's hydrogen initiative can most effectively catalyse these dynamic network changes.

The implications for policy and future research are manifold. Firstly, the findings advocate for a more pronounced role of local authorities and academic institutions in steering regional missions, suggesting that policies should bolster their capacity to act as network brokers. Secondly, the observed network dynamics underscore the necessity for mission-oriented policies to be adaptive and sensitive to the unique collaborative landscapes of regional ecosystems. Finally, the closing of forbidden triads, facilitated by the regional mission, offers a valuable lens through which to explore the potential of such missions to serve as a model for addressing complex societal challenges through enhanced collaboration and innovation.

8. Limitations and further research

As emphasised earlier, this thesis primarily serves as a review of the theoretical framework through the lens of a case study. Due to the different structure and regionality of the Mission, this case study is very context specific. This will continue to be the case when researching place-based policy. Therefore, further case studies of regional missions should be conducted beyond this work to see which trends and phenomena are pervasive, which are context-specific, and to what extent. This will provide a more accurate picture of the dynamics behind regional missions and enable policymakers to make more informed decisions on policy design.

Furthermore, the 14 expert interviews provided a very clear and comprehensive picture, but not a complete one. Although a balanced selection was made, it is possible that the interviewees did not reflect certain tendencies within the mission. In addition, there is always some form of bias in face-to-face semi-structured interviews, both on the part of the interviewee and the interviewer. With the intention of publishing this work, experts may not reflect their accurate observations, but follow their own interests. This opportunism is limited by the diversity of the interviewees, but cannot be ruled out. At the same time, an unconscious weighting in the evaluation could lead to a distorted picture in the results.

The Ruhr Hydrogen Model Region should be re-examined at a later date to see which form of organisation has prevailed. In addition, a retrospective analysis of the network dynamics is very important in order to investigate how the collaborations that are now in place have continued and which ones have been more successful and which ones have not. In addition, as mentioned above, a regional mission, which is not as strong in terms of infrastructure as the hydrogen topic, should be examined as a case study to see if this changes the tendency towards geographical proximity.

At the same time, theoretical research should continue to question the "whatever it takes" mentality of missions, as it has the potential to be effective in addressing societal challenges, but at the same time runs the risk of being undemocratic, inefficient and arbitrary. These risks need to be explored and mechanisms for risk mitigation or accountability developed. Researchers need to work with policymakers to develop a holistic policy framework to realise the potential without running into potentially greater challenges.

Finally, the observation and identification of forbidden triads and their closure remains difficult in this context. The existence and potential of these connections was repeatedly mentioned in the interviews but does not lead to a definitive and satisfactory research result. Further research must find more focused methods to better identify this phenomenon.

9. Conclusion

The findings from this thesis offer a nuanced perspective on the dynamics influencing stakeholder collaboration within innovation networks, particularly under the umbrella of mission-oriented policy design. This exploration reveals a complex landscape of factors affecting collaboration, with geographical proximity emerging as a significant determinant, aligning with current research that underscores its importance in fostering collaborative endeavors. Despite the broadened network due to hydrogen-related activities, these expansions do not markedly deviate from the usual business interactions, constrained partly by the infrastructural dependencies unique to hydrogen, such as pipelines and waterways. This suggests a potential avenue for further investigation into regional missions where infrastructure does not play a central role, to better understand the impact of geographical proximity.

The study also highlights varied tendencies towards geographical closeness among different types of organizations. Academic institutions and large corporations, due to their wider operational scope and existing networks, exhibit different patterns of geographical preference, though large companies' abilities to extend their reach are somewhat mitigated by the economies of scale in hydrogen production.

In terms of organizational structure, a strong state actor with clear responsibilities and the capability for risk-seeking and experimental approaches is deemed essential for implementing mission-oriented policies effectively. The call for decisive leadership and streamlined bureaucracy resonates across expert opinions, suggesting a preference for a governance model that empowers specific authorities with special regulatory and funding rights, albeit within a time-bound framework. This model's practicality and ethical implications warrant further investigation, especially concerning its transferability and democratic integrity.

The potential for new topics like hydrogen to catalyze cross-sectoral collaborations is evident, with emerging partnerships forming triangular connections that enrich the network's diversity and innovation capacity. However, the specifics of these collaborative dynamics and the exact role of 'connector' actors need deeper exploration to fully leverage their potential in enhancing network cohesiveness and innovation outcomes.

This thesis ultimately underscores the transformative power of mission-oriented approaches, as reflected in the enthusiasm and pioneering spirit of the stakeholders involved. The identity-forming nature of missions hints at their broader applicational scope, suggesting that further research into regional missions could provide valuable

insights for policymakers seeking to harness the full potential of this innovative policy design. The confirmation of the theoretical potential of mission-oriented policies within the empirical context of this work reinforces the need for continued exploration of this promising field.

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11. Appendix

Interviewguide

	General questions	*Possible Follow-up Questions*	*Information*
Theme 1: Ice-Breaker	- 1 What is your name? - 2 Which organisation do you represent in the HyMR project? - 3 What is your main geographical place of work? - 4 How did you come to participate in the HyMR project?	- 3 Is this the place where you do your main work at HyMR? If no, which location is it? - 4 If not answered in question: How long have you been involved in the HyMR project?	- Basic personal data - Geographic Data - First connection in the particular network - First Network Actors
Theme 2: Problem-Definition	- 1 Could you talk about the specific challenges (technological, social, administrative...) that your organisation faces in the field of hydrogen? - 2 What are the specific goals your organization tries to reach through the HyMR-Project?	- 1 How do you think this challenge could be overcome? - 2 Can you describe the role of your organisation in the HyMR project? - 2 How does your organisation contribute to the HyMR project? - 2 To what extent does your involvement in the HyMR project coincide with your organisation's objectives?	- Information on the motivation - Information on location on the supply chain and role in the project
Theme 3: The Network	- 1 What is a success/failure story of your organisation/company in solving the challenges mentioned before? - 2 Can you name the main actors you frequently interact with in the HyMR project? Can you explain the nature of these interactions? - 3 Are there partnerships that you have built up within the framework of the project that did not exist before?	- 1 What was the trigger for the success/failure/connection? - 1 Which actors were involved? - 1 How did the project come about? - 1 What was the role of the actors? - 1 Where is the actor located geographically? - 1 How was/is the relation to the actor? - 1 What kind of organization is it? (legal form, size, age...) - 1 Loop: Are there other successes/failures?	- Network ties - Detailed Interaction Data - Geographic data - Diversity Data
Theme 4: Forbidden Triads	- 1 Were there cases where you acted as a bridge between two unrelated actors within the project? - 2 Did one company or public organization act as a match maker between you and antother actor?	- 1 Can you describe these cases? - 1 Why did you connect these actors? - 2 What were the results of the connection? - 2 Why did match making worked? - 3 Why do you want to interact with these actors?	- Possible Information about the closure of forbidden triads

	- 3 Are there actors with whom you would like to have more interactions in the project?	- 3 If so, what are the barriers to these interactions?	
Theme 5: Policy Space	- 1 Can you describe the challenges your organisation faced/is facing in the HyMR project in terms of organisation or project set-up? - 2 Describe the actions and interactions with the governing body - 3 How does the HyMR project management influence your activities and decision-making process?		- Interaction data with governing body - Perception of project management

Declaration of Independence

I, Alexander Gill, hereby declare that this thesis titled, “Regional Missions: Big Dreams on a Small Scale,” submitted in partial fulfillment of the requirements for the degree of Master of Science in Economic Geography at the Rijksuniversiteit Groningen, is my own original work. Except where due acknowledgment is made in the text, this work has not been previously submitted to this or any other institution for any degree, diploma, or other qualifications.

I affirm that all insights, findings, and conclusions drawn from the analysis are productively discussed and rightfully attributed to their original sources. The primary data collection conducted through expert interviews adhered to ethical standards, ensuring voluntary participation, confidentiality, and the right to withdraw at any time without consequence.

All data collected during the research process was managed in accordance with GDPR principles, ensuring the protection of personal data and privacy of the participants involved. The thematic analysis and interpretations presented are solely the result of my scholarly work under the guidance of my thesis advisor, Milad Abbasiharofteh, PhD (Innovation & Technology Management, University of Groningen).

Signature: 

Date: 09.05.24

Privacy and Ethics Statement

This thesis, "Regional Missions: Big Dreams on a Small Scale," incorporates data collected through expert interviews within the hydrogen sector, focusing on the Ruhr Hydrogen Model Region. In adherence to the General Data Protection Regulation (GDPR) and the high ethical standards of the Rijksuniversiteit Groningen, I, Alexander Gill, have implemented the following measures to ensure the protection of participants' privacy and data:

1. **Informed Consent**: Prior to participation, all interviewees were fully informed of the study's aims, the use of the data collected, and their rights within the research process. Consent was obtained explicitly and documented.
2. **Anonymity and Confidentiality**: Personal data, including names and affiliations, were anonymized in the thesis. Direct quotations or information that might indirectly identify a participant were used only with specific consent.
3. **Data Storage and Security**: Data collected, including interview transcripts, notes, and digital recordings, were stored securely in encrypted formats. Access to this data was restricted to myself and my thesis advisor, ensuring no unauthorized access.
4. **Ethical Considerations**: The research approach was designed to respect the dignity, rights, and welfare of all participants. The study avoided any form of harm or discomfort to the participants.
5. **Transparency and Integrity**: The research process was conducted with honesty and integrity, without fabrication, falsification, or inappropriate data manipulation. The findings presented are a truthful representation of the research conducted.

By adhering to these principles, this thesis upholds the privacy and ethical standards expected by the Rijksuniversiteit Groningen and the general GDPR regulations, ensuring that the research process is both ethical and respectful of participant rights.

Signature: 

Date: 09.05.24