LUND UNIVERSITY

SCHOOL OF
ECONOMICS AND
MANAGEMENT

Multi-scalar view on niche diffusion

Understanding agency and institutional strategies in the process of diffusion of niche innovation

by

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May 2021

Master's Programme in Innovation and Global Sustainable Development (EKHS34)

Master's Thesis (15 credits ECTS)
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Examiner: Malin Nilsson
Word count: 14551

Abstract

Only recently has a geographical viewpoint on sustainability transitions opened up the containerized view on transition trajectories. Next to the important step of institutionalising niche logics transforming them into regime rationalities, the multi-scalar perspective reveals that niches, as well as regimes, can also upscale. This means that the socio-technical configuration of the niche or regime diffuses beyond the original territorial context. Different trajectories of how niche innovation could be institutionalized and upscaled were conceptualized. However, there is a gap in understanding what strategies intermediary actors implement in this process to achieve the diffusion. This is also because agency was not looked at from a geographical perspective yet. Therefore, this study combines an institutional perspective of transitions with conceptions of scale from human geography to develop a framework that analyses the strategy of actors looking at the engagement in institutional work at different spatial scales. The framework is applied on the case of the National Blue Ribbon Commission (NBRC) that aims at diffusing a transformative niche innovation of the water sector throughout the US. Results from a qualitative content analysis of publications by the commission demonstrate that scale is an integral part of institutional strategy in the process of diffusing a niche innovation. Moreover, the NBRC effectively accelerates the diffusion of the innovation and achieves political change in the highly regulated water sector. Policy makers could support the formation of multi-scalar actors such as the NBRC in order to make sustainable innovation spread in the fight of climate change.

Keywords: multi-scalar diffusion, transition trajectories, intermediary actors, institutional work

Acknowledgements

I would like to express my gratitude to Christian Binz and Miriam Hacker, who were supervising the research process with immense positivity.

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1 Introduction

1.1 Background

1.1.1 New water management paradigm

In the fight against environmental harms induced by climate change, human behaviour in terms of resource management needs a drastic change (Fox, 2010). In the domain of the resource water, sustainable consumption is increasingly important against the background of diminishing freshwater supplies, long-lasting droughts, and rapid urbanization (SFPUC & WERF, 2014). Cities need a transformed approach to water and wastewater management in order to ensure a resilient and sustainable water supply.

A potential solution are innovative systems, which diversify, reuse and conserve urban's water supply (SFPUC & WERF, 2014). Onsite non-potable water systems (ONWS) is such a solution that is being developed in places around the world. Although the issues in the water sector are urgent, only a few cities have put innovative systems such as ONWS into practice.

In the US, the adoption of this innovation has hitherto only been made mandatory in San Francisco for buildings with a floor surface above 250'000 square feet (Hacker & Binz, n.d.). Thanks to a national commission, the National Blue Ribbon Commission (NBRC), further health regulators are currently considering similar steps forward. Yet, an important question is, what processes make radical innovation like on-site non-potable water reuse diffuse beyond single isolated niche contexts?

1.1.2 Embeddedness in the geographic and institutional perspective on transitions

Answers can be searched in the sustainability transition literature. A key message in this line of research is the embeddedness of innovations in socio-technical systems, which makes it necessary to diffuse not only the innovation but the whole system around it (e.g. Geels, 2004). The system that is currently in place is referred to as socio-technical regime and involves the current field logic and rules (Fuenfschilling & Binz, 2018). The new, innovative logic or logics develop in so-called niches, which are protected incubation spaces where innovation can develop unaffectedly of the current socio-technical systems and its selection criteria (Elzen, Geels & Green, 2004).

A focus in transition literature was to analyse how an innovation evolves from a specific niche to being part of a transformed regime. Only recently has a geographical viewpoint opened up the containerized view on transitions (Binz et al., 2020). It changes the idea of transitions happening, for instance, on a national or city level to transitions happening at

various scales at the same time, or to the idea of niches and regimes getting translocally diffused (Sengers & Raven, 2015; Miörner & Binz, 2020; Loorbach et al. 2020).

Applying the geographical perspective, and specifically the multi-scalar perspective, on niche diffusion is a new approach. It has only been picked up by a few contributions, such as Miörner and Binz (2020), Sengers and Raven (2015), Wieczorek, Raven & Berkhout (2015). Miörner and Binz (2020) established a transition trajectory framework considering that transitions can evolve in two dimensions. The first dimension is the institutionalization of niches, turning them into regimes. This dimension of an institutional perspective on transitions makes sense since transitions are the deinstitutionalizing of a socio-technical system and the institutionalizing of another one (Fuenfschilling, 2019). The second dimension picks up the geographical perspective and captures the upscaling of niches or regimes to a different scale. While coming up with three different transition trajectories of how a local niche rationality can get diffused and later transformed into the global regime and dominant field logic, the role and strategy of actors in this process is not yet understood.

Although transition literature has been looking increasingly at "intermediary actors", this line of literature has neglected the importance of spatial diffusion patterns so far. Spatial diffusion patterns are nonetheless strongly interrelated with the role of intermediary actors, which is often defined as network building or bridging between actors, which accelerates transitions (Kivimaa et al., 2019a). Adding a spatial view onto this role, while also focussing on the strategy of actors in the phase of diffusing a niche rationality, would hence contribute to the intermediary actor conversation as well.

This is where the case of onsite non-potable water systems steps in. It is an innovation in the water sector that will be used as an emblematic case of a transformative innovation that has left its initial niche context and is now being diffused to various cities around the US by an intermediary actor, the National Blue Ribbon Commission (NBRC). Hence, it is opening a nice inroad to study the agency in diffusing niche rationalities between places and scales.

1.2 Reasoning and outline of this study

The objective of the study is to shed light on strategic agency in niche diffusion. The approach keeps the two dimensions of Miörner and Binz (2020) merging the geographic and the institutional perspective on transitions. The institutional perspective is incorporated in form of a practical perspective on agency whereby the focus lies on a typology of concrete practices and actions to create, maintain or disrupt institutions (Fuenfschilling, 2019). By explicitly connecting the typology of institutional work with the multi-scalar view on transitions, it can be captured what actions at what scale are used in the phase of diffusion. A conceptual framework is presented considering the different aspects of an actor strategy and empirically applied on the case study of the NBRC and its efforts to diffuse onsite non-potable water systems. The understanding of institutional work at different spatial scales in the process of niche diffusion can be extremely valuable for similar actors to the NBRC that also intend to diffuse a sustainable niche innovation which is tightly connected to a highly regulated sector such as the water sector.

Even more importantly, the approach of using institutional work for the analysis of multi-scalar diffusion of niche logics is an innovative contribution toward the transition literature and has the potential for analytical generalisability.

The purpose of the study is to provide actors with a strategy of institutional work activities on different scales, which will support the diffusion of niche solutions between places and make political actions in favour of the innovation follow. Understanding what diffusion strategies can be pursued by actors is crucial for widely accelerating sustainability transitions which are necessary due to the pressing impact of climate change on the water sector and other areas. Taking the agency perspective also provides the possibility of intervening in and directing the transition process.

The questions which need to be answered to be able to do so are:

- What type of institutional work enables the diffusion of niche rationalities between places and spatial scales?
- How can actors engage in institutional work at different spatial scales to support the diffusion of niche solutions that respond to environmental harms?

The results are derived from an analysis of publications by the NBRC, which intend to facilitate the adoption of ONWS. The key findings from qualitative coding of the documents suggest that the NBRC's strategy has three main characteristics. Firstly, the NBRC was positioned as a national actor, which was achieved through multi-scalar coalition building. The multi-scalar coalition is constructed to be a learning community that transfers the new rationality and learnings about the new innovation to the different scales.
Secondly, political strategies working on a supportive regulatory environment were prioritized and achieved by standardizing, vesting, and theorizing on all scales that have direct decision-making power on ONWS programs. This leads to the third point, which is that for each institutional work strategy, a different scale can be of importance and, thus, was chosen accordingly. This makes scale an integral part of the actor strategy.

The delimitation from other studies is that this study develops a conceptual approach looking at the transition process from an actor perspective. It analyses how institutional work actions can be used to make diffusion happen instead of taking an observing standpoint towards the transition phenomenon. The study also includes the novel viewpoint of human geography. Therefore, it informs actors how to utilize geographical and multi-scalar connections in combination with efforts to institutionalise a new socio-technical system to reach their transition goals.

The argument is elaborated as follows. First, I will review the geography of transitions literature. This novel stream of literature is then connected with existing institutional theory. Institutional theory has a persistent role in transition studies due to the interconnection between socio-technical transitions and institutional logic change. Derived from the combination of both lines of research, a conceptual framework that evaluates all necessary aspects of an actor strategy is developed. This framework will then be illustrated with the empirical case, which represents the case of a national commission that was founded in the process of niche diffusion to support this transition phase. I conclude by outlining my key contribution to transition studies and outlining further research avenues.

2 Literature Review

The idea of the review is to enrich the geographies of transition literature with a more specific look into the strategies of actors making use of spatial configurations in the transition process. Therefore, the starting points are transitions and the embeddedness of transitions in complex geographical structures. Furthermore, the focus will lie on multi-scalarity as one aspect of a geographical view on transitions and the different transition trajectories that result from adding a multi-scalar view to the institutional perspective on transitions. Then, literature on agency and institutional work is infused into the discussion in order to understand the actors and tools that drive transitions forward. Finally, a framework is presented that helps to evaluate what strategies in terms of institutional work actors implement in the process of diffusing a niche innovation and how actors can engage in institutional work at different spatial scales to support the diffusion process.

2.1 Transition studies

Transitions are defined as fundamental shifts from one socio-technical system to another (Fuenfschilling & Truffer, 2014). The system which is referred to in this definition is composed of actor-networks, material infrastructures, routines and institutional frameworks and has co-evolved around a technology (Geels, 2004). It builds the current 'regime' (Geels, 2010). The evolution of the socio-technical system, including institutionalized rules, took time and became locked-in (Kemp, Schot & Hoogma, 1998; Markard & Truffer, 2008; Smith, Voß & Grin, 2010). This makes it very hard for novel technologies to trigger transitions aiming to complement or replace the dominant technology in place.

Therefore, the development of novel technologies or radical innovations usually happens in incubation spaces protected from normal market selection (Elzen, Geels & Green, 2004). These spaces are called niches, which is prevalent in the multi-level perspective, one of four major lines of inquiry in the field of transition studies. According to this theory, innovation develop in the niche until being able to change the regime selection environment.

2.1.1 Geography of Transitions

Transition theorizing had until recently neglected the geographical aspect of transitions that takes scales, spaces and places into account (Binz et al., 2020). A seemingly first attempt of opening up the niche concept from being seen as an individual experiment that scales up in a linear way is the local-global niche model by Geels and Raven (2006). However, the local and global concepts in the model are socio-cognitive and refer to the possibility of local lessons to be generalised and thus evolve to a global level where the generic knowledge gets fostered by a global network. It does not incorporate a truly spatial view.

The criticism from geographers (Coenen, Benneworth & Truffer, 2012, Hansen & Coenen, 2015; Raven, Schot & Berkhout, 2012) resulted in the right questions to initiate a growing number of empirical studies that specifically deal with the geographical aspects of transitions. The questions of these authors, which could not be answered with the approach of Geels and Raven (2006), were where niches emerge and why there, why transitions succeed in some places while failing in others and how niche innovations diffuse translocally.

The empirical studies that are trying to answer these questions were conceptualised by Truffer, Murphy and Raven (2015) into three main dimensions: socio-spatial embedding, multi-scalarity and issues of power. Similarly, Hansen and Coenen (2015) broadly categorise the literature into place-specificities and relations at different scales. Subsequently, the research streams on socio-spatial embedding or place-specificities answer the questions where and why niches emerge and why transitions succeed in some places, regions, cities while failing in others. The scalar perspective approaches the diversity of actors and scales connected to socio-technical systems and how they get in touch with each other, answering for instance, the above mentioned question of how niches diffuse (Truffer, Murphy & Raven, 2015). The most recent comment on the transition research agenda incentivizes the inclusion of geographical aspects by looking at scale, place and space (Binz et al., 2020).

Looking more profoundly into scale, niches, as well as regimes, were identified to be inherently multi-scalar, which makes them receptive to dynamics of different places and scales (Fuenfschilling & Binz, 2018; Sengers & Raven, 2015). There have been contributions to both topic areas. Regimes were conceptualised as global structures by Fuenfschilling and Binz (2018) based on the insight that sectoral semi-coherent guiding rationalities reach validity beyond specific territorial contexts. Resulting global actor networks then facilitate the codification and diffusion of these institutional rationalities, which become influential beyond their context of origin (Fuenfschilling & Binz, 2018). Likewise, niches and niche development were conceptualized by Sengers & Raven (2015) as multi-scalar co-construction of technologies and institutions (Truffer, Murphy & Raven, 2015). In the paper by Sengers and Raven (2015) three geographic perspectives on spatialities of knowledge transfer were infused into the transition literature, namely: buzz-pipelines, global production networks and policy mobility (Sengers & Raven, 2015). This way, they disentangled spatial connections and processes that made the niche around a transportation innovation (bus rapid transfer (BRT)) emerge and globally diffuse (Truffer, Murphy & Raven, 2015). Moreover, Sengers and Raven (2015) disproved that linear niche upscaling processes are the only way a transition trajectory can take place. In their case study, BRT as a new socio-technical configuration was globally mushrooming, becoming a global niche and challenging the global regime before even being institutionalized in the local context where it emerged. Summarising, both niches and regimes may depend on multi-scalar actor networks. However, the main difference lies in the degree of institutionalisation of rationalities and structure of the actor-network, which is much looser for niches than regimes.

2.1.2 Multi-scalar transition trajectories

On the note of different transition trajectories, Miörner and Binz (2020) developed a framework capturing alternative evolutions of transitions. They take a two-dimensional approach to transitions. The first dimension in their framework captures (de)institutionalization, which involves mechanisms to formulate and advocate the codification of a specific socio-technical configuration together with its underlying institutional rationality to transform it into a regime configuration. This dimension is based on the institutional perspective of sustainability transitions, according to which a transition substantially consists of gradual institutional change from one regime to another (Miörner & Binz, 2020).

The second dimension implements the previous idea of both niches, as well as regimes, being multi-scalar networks, leading to the realization that socio-technical configurations and rationalities are not only institutionalised in a transition but can also be *re-scaled* at any stage throughout the process. That being so, opens up more trajectory possibilities for, for instance, a local niche rationality to become a global regime rationality. Thanks to this approach, actors have the possibility to use strategies across different scales to reach their objectives. However, for this to be successful, certain parts of the (niche) rationality will have to be translated or combined with new logics to be applicable on another scale (Miörner & Binz, 2020).

The framework is presented below. The x-axis represents the first dimension, thus the (de)institutionalization process, while the y-axis illustrates the second dimension, namely re-scaling. Miörner and Binz (2020) present three transition trajectories. The linear upscaling, which is the traditional view on transition trajectories and two alternatives, which they call multi-locational diffusion and global advocacy. In short, the first trajectory describes the process from the localized niche to the localized regime, which gets upscaled to being the global regime. Multi-locational diffusion captures the case study of the mushrooming of BRT and therefore describes the process of a localized niche becoming a global niche, which then got institutionalized. Finally, the global advocacy trajectory argues for the plausible trajectory of a basic socio-technical configuration developed in the global niche by international actor networks getting re-scaled downwards and at the same time institutionalised globally. These trajectories are model trajectories and will mostly just resemble the actual scenario.

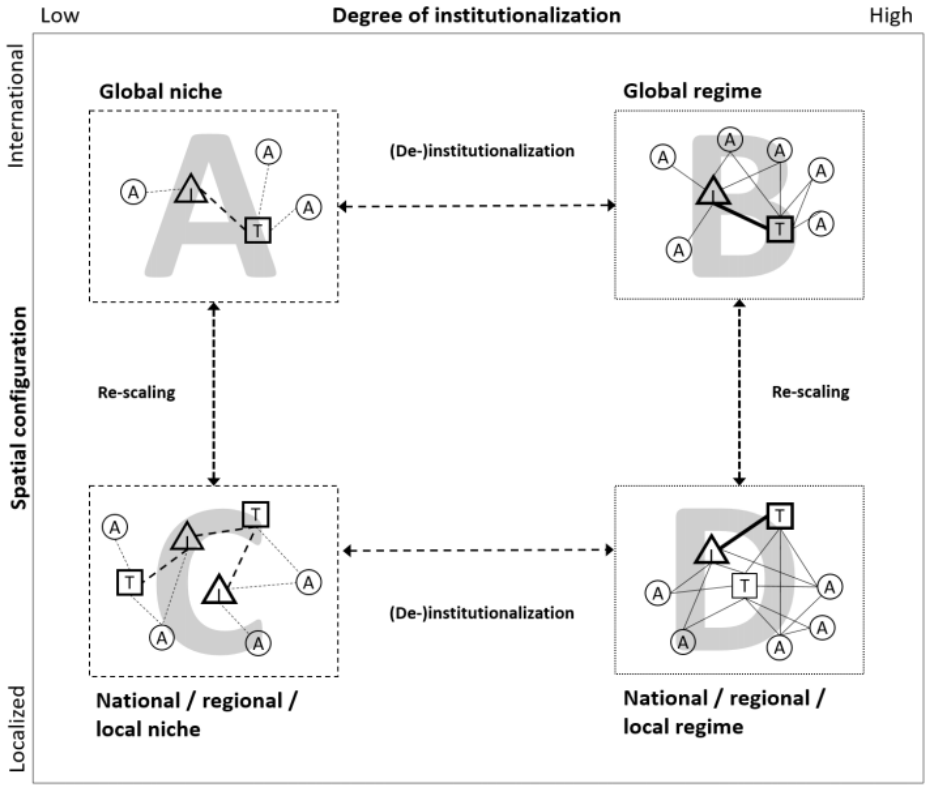

Figure 1 Conceptual Framework of Transition Trajectories by Binz and Miörner (2020)

I – Institutions, A – Actors, T – Technologies. Bold, solid lines indicate a deeply institutionalized configuration of institutions and technologies, dotted lines represent a more emergent, less institutionalized alternative socio-technical configuration.

The trajectory of the empirical case in the paper by Miörner and Binz (2020) supports that remark by starting off like a linear niche upscaling process, which then nonetheless involves features of both alternative trajectories. It is a case in the global sanitation sector with a strong global actor-network. Accordingly, the development of a global standards happens before a gradual upscaling process from scale to scale. Instead, the global standard is ex-post translated and 'down-scaled' into national contexts (Miörner & Binz, 2020).

While the contribution of the paper is of extraordinary importance, explaining parts of the geographical questions on transitions that are "whether, where and how sectorial transitions may come about" (Miörner & Binz, 2020, p.20), further specification is possible. As the paper mentions itself, looking into the role of agency in the context of transition studies and capture the scalarity of the actions is compelling. This can shed light on concrete measures which lead to the diffusion of a niche innovation and can explain how scale are used to achieve the actor's goals.

2.2 Institutional perspective on Sustainability Transitions

Following the previously mentioned argumentation and the first dimension of the transition trajectory framework, which is based on the institutional perspective on transitions, ”transitions towards sustainability are ultimately about the destabilization or deinstitutionalization of existing socio-technical configurations and the creation and diffusion, hence institutionalization, of new, potentially more sustainable ones” (Fuenfschilling, 2019, p.1). The shift happens gradually and therefore implies that regimes are not monolithic but instead semi-coherent constructions of different field logics, which are institutionalized to various degrees (Hacker & Binz, n.d.; Fuenfschilling & Truffer, 2014). The institutional perspective on sustainability transition is thus a constant, dynamic component of transitions and worth looking into.

Fuenfschilling (2019) generalises that institutional theory always assumed that institutions are socially constructed. Therefore, agents play a crucial role in this field of research. Institutionalists have written about which actors are in the position of changing institutions. However, there exists a controversy of “embedded agency”, which claims that agents are naturally conditioned but also enabled by existing institutions in place (Lawrence, Suddaby & Leca, 2009). Very often, “intermediary actors” are discussed due to their “morally sanctioned place of independence” (Binz et al., 2016, p.252), which makes them great facilitators of institutional change. An increasing body of literature has contributed to understanding the different types of intermediaries (Kivimaa et al., 2019a), the role of intermediaries in different phases of sustainability transitions (Kivimaa et al., 2019b) and the different functions or modes that intermediaries perform in the context of sustainability transitions (e.g. Michael, Simon & Harriet, 2013; Parag & Janda, 2014). A very recent contribution by Page & Fuller (2021) looks at *how* intermediaries accelerate change. Page and Fuller (2021) categorize the actions of intermediaries by operational interfaces in which the activities happen. Since they identify three main actor groups emphasising industry actors, the actions of the intermediaries happen in between those three groups and are divided into ‘industry-government interface’, ‘industry-industry interface’ and ‘industry-consumer interface’. The strong focus on relationships between the different actor groups in this paper comes at the cost of a clear categorization of activities that accelerate sustainability transitions. The typology of purposive actions to create, maintain or disrupt institutions by Lawrence and Suddaby (2006) called institutional work, can be of complementary value.

Although it is a relative novel line of research, there have been various contributions to the question of how actors can use institutional work to institutionalize and locally validate a competing rationality (e.g. Binz et al., 2016; van Doren et al. 2020). However, as Hacker and Binz (n.d.) point out, the transition process is not completed at the local validation stage. There is a diffusion phase and, finally, a general validation phase (Hacker & Binz, n.d.). While, as mentioned, institutional agency towards local validation has received attention, agency to support the process of diffusion of a socio-technical configuration is still to be understood.
In the conversation about intermediaries and institutional work applications in transitions, the geographical perspective was neglected. When adding the geographical view on institutional work activities by intermediaries in the phase of niche rationality diffusion, the diffusion

directions get multi-scalar options. Hence, it is necessary to develop a framework to capture how actors use institutional work across scale to diffuse a niche innovation.

2.3 Conceptual framework

The first aspect to cover by the framework is the type of purposive action which is implemented by the actor. Lawrence and Suddaby (2006) set the basis for the typology of institutional work and develop a catalogue of practical actions to create, maintain or disrupt institutions. Perkmann and Spicer (2008) categorise the types of institutional work differently into political, technical, and cultural strategies. Applied on a situation of diffusion, all three categories of Perkmann and Spicer (2008) are crucial. Looking into each of them specifically, political work is directed at the regulative pillar of institutions. This type is necessary for creating a favourable policy environment which enables the innovation to spread without regulatory barriers. Nevertheless, the innovation must also be understood on a cognitive-cultural level in order to be adopted and diffused, and this is where technical strategies come in. Lastly, cultural strategies help at influencing the normative pillar of institutions and target the wider audience by making an innovation appealing which again, accelerates diffusion. Based on the conceptualizations of Lawrence and Suddaby (2006) and on the categorisation of Perkmann and Spicer (2008), van Doren et al. (2020) have developed a list of key concepts and operational definition of institutional work types to analyse institutional work in diverse niche contexts. The conceptualisation is also relevant for analysing institutional work in the process of diffusion, as demonstrated in the application before. On account of this, the list is taken over and helps to capture and understand what actions are implemented in the process of niche diffusion.

The second aspect to capture is the scale which is targeted with the institutional work efforts and which opens up the option of different transition trajectories. This depends on how scales are viewed. From a political-economic perspective, scales are a result of social construction and relations and thus not fixed (MacKinnon, 2011). MacKinnon, moving on, adds a post-structural approach which shifts the attention from socially constructed scales by actors to "specific processes and institutionalized practices that are themselves differentially scaled" (MacKinnon, 2011, p.23) and this way, a notion of scale got created. Consequently, it depends on the case, the actor networks and the practices of interest to decide which scales are relevant for the diffusion of the specific niche innovation. This framework will not predefine scales, neither does the paper by Miörner and Binz (2020) that also encourages to use the socio-technical layers as specific as relevant. In this case study, the diffusion is strongly dependant on the regulative pillar of institutions and hence also the scale at which regulations are implemented. Moreover, the limit was set to look at the diffusion within one nation. Adapted to these preconditions, the local/city, the state and the national scale were picked. Additionally, the argument by Hacker and Binz (n.d.) is followed, which suggests that local can mean two things which are not free from overlap. An innovation can start locally, where it for the first time experiences potential friction of its field logic with the established regime in the phase Hacker and Binz (n.d.) call local innovation/ validation. Even so, this may happen on an even smaller scale, such as one pilot/demonstration project or small-scale adoption. This small-scale project is embedded in local institutions equally as if the innovation would be implemented on the "whole local scale" such as the city. It is nevertheless interesting to know if actors specify their institutional work options to concrete projects or starting at the

local level. Consequently, this case will be implementing the project, local, state and national level.

Next, the actor itself becomes important. Actors being powerful and well-connected across scales facilitates the diffusion, including the upscaling of rationalities. Which subset of technical and social elements of a socio-technical configuration get institutionalized on the highest scale depends on the "specific actors that are in a structurally superior position to translate local ideas into global standards" (Miörner & Binz, 2020, p.3) or in this case national standards. Therefore, it is of interest to see if actors work on their own position in order to make a niche innovation diffuse. Thus, the institutional work the actors are implementing is going to be looked at through two lenses, namely internal level and external level. Internal institutional work involves institutional work intended to strengthen the actor's position across scales, while external institutional work will help diffuse the socio-technical configuration of the niche innovation. This gives a more layered understanding of strategies necessary for diffusion. The illustration below shows how the external activity is directed towards regime transformation, while the internal activity directly strengthens the actor position to be more powerful in the process of regime transformation. For further explaining the internal – external categorization, a second table follows the conceptual framework, which illustratively puts the institutional work types into the two categories.

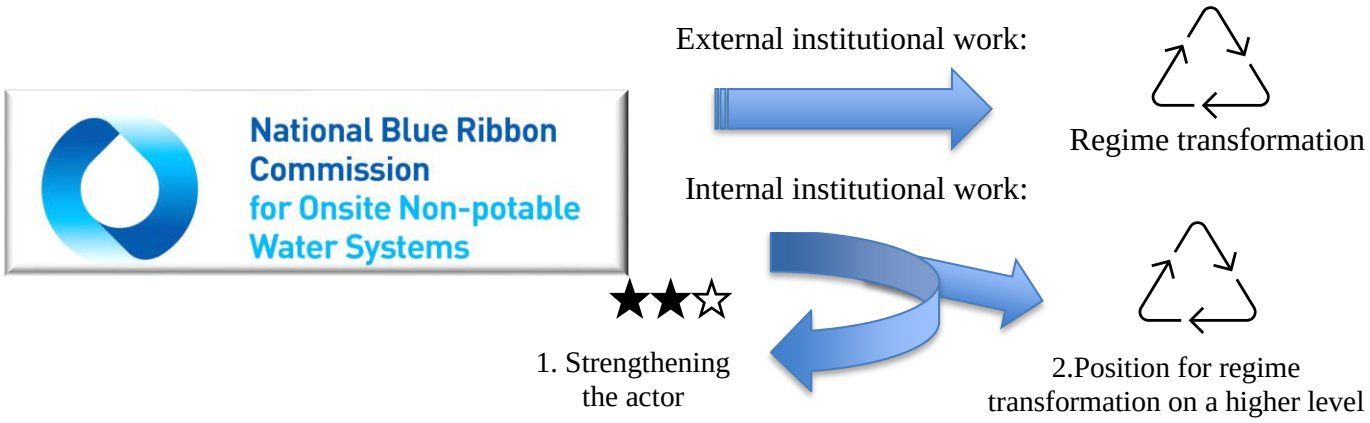

Figure 2 External and internal use of institutional work

Finally, as transitions and specifically diffusions are processes, the institutional work overtime is captured. This way, it can be detected if the application of institutional work types, intended scale and level are changing over time. This is inspired by Strambach and Pflitsch (2020) that have developed a transition topology to be able to integrally illustrate "interrelated organizational and institutional changes within their spatio-temporal contexts" (Strambach & Pflitsch, 2020, p.11). As the idea of this paper is to look into actor strategies to diffuse innovations, a temporal observation may help in this regard.

Beneath the conceptual framework is illustrated. It contains, as mentioned above, the list of key concepts and operational definition of institutional work types by van Doren et al. (2020). The individual strategies, political, technical and cultural, are further divided in institutional work types with a definition based on the work of Lawrence & Suddaby (2006), Perkmann & Spicer (2008) and adapted from van Doren et al. (2020). Firstly, political strategies consist of visioning, coalition building, advocacy and vesting. The definition of vesting was not adapted from van Doren et al. (2020) due to its distance to the intended meaning of the definition by the other authors. Hence, it was replaced by definitions from the other two papers. Secondly, technical strategies include demonstrating, theorizing, educating, standardizing and constructing learning communities. Thirdly, there are two cultural strategies, namely changing normative associations, assumptions and beliefs and the creation of new identities. The conceptual framework becomes complete by adding spatial scales, the internal and external level of activity and the time component as explained above.

Table 1 Conceptual framework (based on van Doren et al. (2020) and own elaboration)

Conceptual framework		***Definition***
Institutional work		Intentionality and effort to create, maintain or disrupt institutions.
POLITICAL STRATEGIES	Visioning	Creating a vision for change by defining problems, related to the dominant regime, and justifying how the innovation, can solve these problems **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
	Coalition building	The development of coalitions composed of actors, with different skills and knowledge, to mobilise collective action. **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)** Building national and subnational network for easy translation between layers of a socio-technical system (own interpretation)
	Advocacy	To gather political and regulatory support for a practice or innovation and **disconnecting rewards and sanctions regarding dominant institutions** through direct and deliberate techniques of political suasion **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)** Lobbying for resources, promoting agendas, and proposing new or attacking existing legislation, advertising/ awareness rising
	Vesting	The creation of rule structures that confer property rights Vesting interested parties **via rule-setting** and property rights attribution and defining **the social boundaries of adoption and usage** **(Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
TECHNICAL STRATEGIES	Demonstrating	The demonstration of the workability of an innovation and corresponding institutional arrangements **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
	Theorizing	The development of abstract categories, models, frameworks, and cause-effect relations regarding innovations, institutions, and events **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**

	Educating	The educating of actors in terms of skills and knowledge necessary to support the diffusion of the innovation **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)** People learning in peer-to-peer exchange, sharing best-practices, working on locally adapted processes, templates to facilitate engagement in new practice
	Standardizing	A standard is an 'instrument of control' (Brunsson and Jacobsson, 2010) that facilitates coordination, joint expectations and sanctions **(Slager et al., 2012).** The standardisation of products, business models, market mechanisms, or valuation techniques for the innovation **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
	Construction of learning communities	The construction of networks through which practices become normatively sanctioned and which form the relevant peer group with respect to compliance, monitoring, evaluating, and learning regarding an innovation **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
CULTURAL STRATEGIES	Changing normative associations, assumptions and beliefs	Awareness raising activities to shape the beliefs and perceptions of different stakeholders and to re-make the connections between sets of (new and existing) practices and the moral and cultural foundations of those practices **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
	Creation of new identities	Enhancing the attractiveness of innovations by connecting them to identities, roles, or values **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**
Scale		
	Project	Activities on project level
	City (referred to as local level)	Activities on a city level
	State	Activities on the state level
	National	Activities not directed at a specific utility or agency but activities on a national scale
Level		
	Internal	Activities that affect the organization NBRC itself, making it a more powerful and trustworthy actor
	External	Activities that affect the socio-technical system around ONWS
Year of publication		

Table 2 External-Internal use of institutional work (own elaboration)

	External (Activity directed towards regime transformation)	Internal (Activity directly strengthens the actor position to be more powerful in regime transformation)	Explanation
Visioning	x		Pointing at current regime problems and offer a solution
Coalition building		x	Mobilising collective actions with other actors including the **own organization**
Advocacy	x	x	Gathering support either for the **own organization** or the innovation
Vesting	x		Changing regime rules
Demonstrating	x		Showing the workability of the innovation
Theorizing	x		Conceptualizing the knowledge around an innovation
Educating	x	x	Educating the **own organizational members** or possible stakeholders of the innovation
Standardizing	x		Creating benchmarks for utilizing the new innovation
Construction of learning communities	x	x	Uniting people with the purpose of knowledge exchange about the new innovation either only stakeholders of the innovation or **own organizational members** as well
Changing normative associations, assumptions, and beliefs	x		Changing the beliefs about the regime logics
Creation of new identities	x	x	Connecting attractive values to the innovation or to the **own organisation**

2.4 Conceptual proposition

Knowing the above categories, a few propositions about NBRC's expected strategy can be made. As the NBRC is an actor at the national level wanting to spread ONWS throughout the US, their political strategy, one could assume, can be lobbying and changing regulations at the national level. Translated into the institutional work typology, this means vesting and advocacy on a national scale. While vesting clearly categorizes as external strategy, advocacy can be internal or external. Lobbying for resources, for instance, elevates the capacities of the actor and is thus internal and promoting agendas of ONWS is an example for external advocacy. Kivimaa et al. (2019b), who examines the role of intermediaries in different phases of transitions, identify the creation of new rules as part of the diffusion process which supports the proposition.

In regard to technical strategies, two elements are expected to be essential parts of the external strategy. First of all, standardizing is expected since standards represent "core values and professional arrangements that have been legitimised beyond single territorial contexts" (Miörner & Binz, 2020,p.3). Hence, homogenous national standards could facilitate the adoption of ONWS and serve as an orientation to all ONWS projects in the diffusion process. Second, orientation through standards won't be enough unless the potential stakeholders understand the innovation, its benefits and functioning of it. Kivimaa et al. (2019b) confirm this by stating that knowledge exchange and learning support is part of the strategy of intermediaries in the acceleration process of an innovation. In terms of scale, the standards are similar as the political strategies probably implemented on a national scale. For other technical strategies, like educating, the state scale comes to mind. This is because stakeholders that can directly decide to implement ONWS programs should assumably be targeted while at the same time targeting the highest level possible will reduce the scope of the national diffusion efforts.

The last proposition looks at the sequencing of the actions, Binz et al. (2016) have created a proposition that some sequences of institutional work are more plausible than others when legitimizing new technologies. They link the sequence of institutional work actions to the stage of maturation of the innovation's socio-technical system. Their argument claims that in an undeveloped stage of the socio-technical system it is rather hard to influence for instance key regulations or strong societal beliefs. This can also be projected on intermediary actors. The better the intermediary's access to resources and level of political influence the higher the complexity of institutional work the actor engages in (Binz et al., 2016). Thus, the complexity of institutional work is according to this argumentation increasing over time with rising power of the actor. It can be argued that political strategies intending to change the regulatory environment are the most complex. Then, cultural strategies follow, and lastly technical strategies are the least complex. This is how the case from Binz et al. (2016) presents it. First, technical strategies without public awareness were initiated. Then, the complexity rose with public opposition and the need to implement cultural strategies. Lastly, political work was only started in the general validation phase. Summarising, this proposes that the NBRC starts with technical strategies, implements cultural strategies on the way and lastly, engages in political strategies to generally validate the innovation.

2.5 Chapter Summary

The key takeaways from the chapter are that transitions are not happening in pre-set spatial containers but that niches, as well as regimes, are inherently multi-scalar. This opens up the possibility of different transition trajectories which make use of scales. Strategies of actors to induce institutional change, and thus transition, in multi-scalar dimensions are not well understood, especially in the phase of niche diffusion. Therefore, a conceptual framework was offered that captures the type of institutional work, scale, level and time in order to get an understanding of actions that lead to niche diffusion, including the diffusion across scales. A conceptual proposition was developed that guesses to see all types of institutional work, mainly on the national and state scale and following the order of initiating technical strategies, then cultural strategies and finally political strategies.

3 Methodology

3.1 Research Approach

In order to answer the emerging questions on transition processes, a qualitative research approach was chosen. The questions were triggered by inserting a geographical perspective on transitions and by moving forward in the transition process to the diffusion stage. The qualitative research approach suggests itself due to the exploratory nature of the questions seeking to understand the types of institutional work that enable the diffusion of a niche innovation and explore the process of how actors can engage in institutional work at different spatial scales to support the diffusion process. The approach which was chosen is an abductive process (Philipsen, 2018). The process starts with the development of a conceptual framework and propositions that are built deductively from the literature. These are then juxtaposed with an illustrative empirical case. Through the case study, the key propositions can be validated and an emergent new theory further specified ”building from particular to general themes” (Creswell, 2014, p.32).

3.2 Research design and case study approach

There are various ways to theory building. A case study is the right approach when little is known about a phenomenon, the current perspective does not serve anymore, and the building on new empirical evidence seems necessary (Eisenhardt, 1989). This is what can be argued in this case, as agency in the diffusion process of transformative niche innovation has not yet been analysed and in particular, not from a geographical view on transitions. Yin (2018) strengthens the choice of a case study by defining the purpose of case studies to be the intent to illuminate a set of decisions, which is the exact goal of this research when looking at actor strategy and, therefore, actor decisions. Another specific argument is given by van Doren et al. (2020), saying that “[c]ase studies allow for a deeper insight into what strategies institutional entrepreneurs employ and how actor characteristics and field-level conditions shape diversity in institutional strategies” (p. 120). This explains why in the following, an instrumental case study is described, which perfectly matches the research interest.

3.2.1 Case selection: The diffusion of onsite non-potable water systems (ONWS) by the National Blue Ribbon Commission (NBRC)

The case of the NBRC happens to be the case of an actor aiming at diffusing a transformative innovation in the water sector, namely onsite non-potable water systems, throughout the U.S. Choosing the case of the NBRC has two main reasons.

The first reason to choose this empirical case is the stage in the transition process that the rationality of ONWS is currently at. San Francisco started as a city pioneer with the implementation of ONWS driven by droughts, uneven topography and a desire to diversify its water portfolio. By 2015 the new rationality had been added to the regime field logic, implementing a local ordinance that mandates all new building projects with a floor surface above 250'000 square feet to install and operate an on-site water reuse facility. In 2020, San Francisco was recognised as "utility of the year" for the third straight year due to its leading role in advancing onsite non-potable water systems. This reflects that the innovation has been locally validated and hence, has passed the first steps in the process of solving institutional complexity talked about by Hacker & Binz (n.d.). According to their phases model, the diffusion and general validation phases are next. The current development of the transition also indicates the linear upscaling trajectory, which, in a similar manner, had been observed in the case study of Miörner and Binz (2020). The empirical case of Miörner and Binz (2020) started as a linear upscaling trajectory but then scaled up to the global level in the diffusion phase. Consequently, the next phase of diffusion is the one of interest, and ONWS is currently at this stage.

Secondly, in the process of diffusion, an intermediary was created with the purpose of supporting the use of onsite non-potable water systems throughout the US. At the beginning of the diffusion phase, ONWS innovation was spreading from San Francisco to other cities in California and was started to be adopted by large tech companies throughout Silicon Valley with the goal of accelerating their sustainability and obtaining accreditation from LEED and the Living Building Challenge. Then, a regulation on state-level was passed, the California State Senate Bill 966, providing a favourable regulatory environment for the adoption of ONWS throughout the state of California. Along this process, the San Francisco Public Utilities Commission (SFPUC) started a coalition. In 2016, the coalition created a national commission resulting from a partnership between the US Water Alliance and the Water Research Foundation. This commission is the National Blue Ribbon Commission, which is chaired by the SFPUC. It is the ideal case of strategic agency in multi-scalar diffusion due to the fact that the NBRC exists for the sole purpose of supporting the diffusion of ONWS. This makes the interpretation of its actions straightforward. Apart from that, the intermediary was created by a coalition between a city utility and national non-profit organisations, which elevates the innovation on a national level and places the intermediary in-between scales. The goals of the NBRC are to serve as a learning community, provide resources of best practices in the implementation process of ONWS, guide policymaking by developing frameworks and water quality criteria and further develop the research agenda in the field of ONWS. Their strategy in terms of institutional work targeting different scales and levels over time provides an emblematic case for studying multi-scalar institutional work in the diffusion of a niche innovation.

3.3 Data Collection Method

As a data source, documents that were published on the website of the National Blue Ribbon Commission were selected. These eleven documents are available under the 'resources' tab and are introduced as "documents prepared by the commission and other resources for developing onsite non-potable water reuse programs in your community" (NBRC | US Water Alliance, 2021). This uncovers the aim of the documents, which is supporting the adoption of ONWS by communities. Additionally, eleven 'Training modules' PowerPoint presentations with the same aim and developed by the NBRC were included, which are one of the NBRC's more recent research accomplishment. The source of twenty-two publications was chosen as it is a primary source providing a comprehensive overview of the commission's activities and the narratives chosen to diffuse the ONWS idea in space. In addition, the documents provide information that represents the standpoint of the entire commission instead of individual perspectives.

3.4 Data Analysis

3.4.1 Coding process

The documents were analysed by thematically coding with the software Dedoose Version 8.3.45 (2021). For coherence in the coding procedure, a coding dictionary with definitions and examples was developed. It was coded for the institutional work types according to the definitions in the conceptual proposition (Table 1), in parallel, the scales and levels were added as overlapping codes and a time descriptor assigned to each document. The described process was following the steps suggested by Creswell (2014), starting with the read through all data. After this, the codification with Dedoose started, and themes and descriptors were added. Along the way, it was reflected on the qualitative narrative that begins to show and how this can be represented, which served as preparation for the interpretation of the findings.

Various difficulties occurred along the coding process. A clear differentiation must be made that distinguishes between institutional work types that are only stated versus those that were undertaken. For instance, a sentence beginning with "[w]e are committed to [...]" (NBRC, 2017a, p.1), which then lists an action falling into an institutional work category, cannot be coded as such since it is no proof of the action. However, some forms of institutional work are fulfilled only by statements. For example, the action of visioning, which is by definition the creation of a vision for change by defining problems and justifying how the innovation can solve problems (van Doren et al., 2020), can be coded as such when sentences in the documents were fulfilling the definition. Consequently, through the documents, actions of institutional work can be captured that were undertaken and then reported in the publication, while the publication itself includes various types of institutional work in the form of different statements.

Moreover, some institutional work types needed to be triangulated extensively with literature on institutional work in order to make a clear cut in the categorization of the different types. This is also the case because the documents were not written respecting institutional work

categories, which means that terms indicating a specific institutional work type could have been misused. To illustrate the complexity, developing 'frameworks' belongs according to van Doren's list of institutional work types to *theorizing*, as does developing abstract categories and models and cause-effect relations. However, 'templates', which are defined by Lawrence and Suddaby (2006) as "frameworks that provid[e] other actors with an outline, or template, for action" (p. 227), fall under the institutional work category of *educating* because they are a tool to support the actor's ability to complete a task. Hence, although 'templates' were defined as frameworks as part of the definition of the institutional work type *educating* and 'frameworks' are belonging to *theorizing*, the reflection which must happen is the question of what objective each action has rather than being highly oriented towards specific wording. In this manner, the right categorization was ensured.

The next challenge in the coding procedure occurred when the objectives of the institutional work types were similar but differently reached. *Theorizing*, *standardizing* and *vesting* needed a clear conceptualization because all three types wanted in the case of ONWS to fix things and make them generally applicable to all projects and scales. However, *theorizing* is putting the conversation on a high level by, for instance, naming things uniformly or by broadly categorizing (Lawrence and Suddaby, 2006). In comparison, a standard is very concrete, like for instance, specific water quality standards. The standards serve as a concrete benchmark with regulatory power (Slager, Moon & Gond, 2012). This is where the distinction happens between *standardizing* and *vesting*. *Vesting* fixes criteria always on the regulatory level, while standards can be only applicable on a normative level, such as standard monitoring criteria for ONWS. Nevertheless, very often standards are made part of a regulation like in the case of water quality standards. To sum up, all three forms of institutional work wish to facilitate coordination and joint expectations. Yet, standardizing and vesting additionally facilitate sanctions on a normative and regulatory level.

The final point to raise in the process of coding is that some cases asked for the application of various scale codes at the same time. The scale codes were applied according to the targeted scale of the purposive actions by the NBRC. As mentioned in the conceptual proposition, the project and the local level are not free from overlap and hence in various cases applied simultaneously. In addition, a frequent overlap between local and state level appeared. This is explained in the publications since "[o]nsite non-potable water system programs can be developed and implemented through regulation at the state level, an ordinance at the local level, or a combination of the two" (NBRC, 2017b). Lastly, to some codes, no specific scale was applicable. Generally speaking, some actions by the NBRC can have an impact on various scale or not one scale specifically, which strengthens the viewpoint of non-containerized scales.

Table 3 Coding Dictionary (own elaboration)

Definitions of codes same as in the conceptual framework, for full version with examples see Appendix A.

Code	***Subcode***
Institutional work	
POLITICAL STRATEGIES	Visioning
	Coalition building
	Advocacy
	Vesting
TECHNICAL STRATEGIES	Demonstrating
	Theorizing
	Educating
	Standardizing
	Construction of learning communities
CULTURAL STRATEGIES	Changing normative associations, assumptions and beliefs
	Creation of new identities
Scale	
	Project
	City (referred to as local level)
	State
	National
Level	
	Internal
	External
Year of publication	

3.4.2 Conceptual mapping

After the coding process, the aim was to identify the predominant purpose in terms of institutional work and main targeted scale of each document. In this manner, every document and its prevalent institutional work types are placed on the right scale along a timeline which shows the years of publication. As a result, an insight of every document's contribution to the NBRC's strategy over time can be made visible. Another reason for switching the analysis to the document level was to balance out the bias that would have occurred if a document with a certain predominant institutional work type is the longest in number of pages and, therefore, has the highest number of applied codes representing one type of institutional work. Then, it would seem like the institutional work type of that document was central to the entire strategy of the NBRC. By looking at it, document by document, the institutional work types and purposes of each document are equally weighted.

For finding the predominant institutional work type and scale, an excel table was created which, first of all, distinguished between the external and internal level to separately capture the institutional strategies of both levels. Secondly, the institutional work types were listed against the different scales. This is because it is not only of interest what type of institutional

work is used, but also how spatial scale is integrated into the application of the institutional work types or generally the strategy. By filtering the results of the coding process, a frequency of institutional work type at a specific scale for each document could be put down in the table. Throughout the process a colour scaling scheme helped to make the most repeated purposive action of the NBRC in the particular document stick out. Below Figure 3 illustrates the described excel table with an excerpt of the table.

MEDIA TITLE/External	Scale	Political strategies				Technical Strategies					Cultural strategies		
		Visioning	Coalition building	Vesting	Advocacy	Demonstrating	Theorizing	Educating	Standardizing	Construction of learning communities	Changing normative associations	Creation of new identities	TOTAL
NBRC_Utility-Case-for-ONWS_032818.pdf.pdf													
	Project					1	1 1/2		1/2				3
	Local	6		2	2	6	2	7	1 1/2		7	7	40,5
	State			1			1/2						1,5
	National	1		1	1	2			2			3	10
	n/a			2	1		1	1	2			4	11
Total: Local level Educating, both cultural strategies and visioning		7	0	6	4	9	5	8	6	0	7	14	66

Figure 3 Illustration of an excerpt of the excel table with coding frequencies

Mapping predominant institutional work and scale for the document "Making the Utility Case for Onsite Non-potable Water Systems", External Level.

On a practical level, one adjustment was necessary. Granted an activity by the NBRC targeted more than one scale at the same time, fractions were used to represent these circumstances. For example, the main tasks of stakeholders of an ONWS project were standardized, and the coding process has captured standardizing on a project and local level since it involves the local regulator and the design engineer, system owner, operator and program administrator. Then, in the table, standardizing was not entered once on the project scale and once on the local scale. Instead, a fraction was used to enter half for standardizing on the local scale and half for standardizing on the project scale. In this manner, no extra weight was allocated to a singular occurring institutional work type with impact on various scales. To illustrate this part of the data analysis the Figure 3 was inserted as well as the entire table as Appendix B.

3.5 Validity and Reliability

As touched upon in the data analysis part, the detecting of institutional work types was not only relying on the researcher's understanding of the definitions from the typology by van Doren et al. (2020), instead it was made sure to read definitions from Lawrence and Suddaby (2006) and Perkmann and Spicer (2008) and triangulate extensively until being able "to build a coherent justification for themes" (Creswell, 2014, p.251). This ensures to look at a theme from different angles and examine the own judgement several times.

Apart from that, an extensive description of occurring difficulties and thought processes during the phase of coding and analysing is also meant to add to the validity of the findings. The insights into the process allow to track the foundation of the results and hence prove the validity of the research. This merges with the point of reliability which askes for documentation of the process. To that end, the used coding dictionary is inserted, including a fixed code definition that has not changed during its whole application (Creswell, 2014). Moreover, the developed excel table is illustrated in an example sequence in Figure 3 and in the Appendix B.

Due to the kind of data, no transcription was necessary, which eliminates a possible source of error. The primary source was analysed as the commission itself approved to publish it. Nevertheless, there are still shortcomings. By reflecting on the limitations in the next section, the quality of the research is further improved.

3.6 Limitations of data source

This section reflects on the inherent limitations of the study's data source to present a transparent picture. A first limitation is that specific institutional work types may be especially dominant due to the type of source. As mentioned earlier, the publications are reporting institutional work activities by the NBRC, but include institutional work types in themselves in the form of statements, frameworks or regulations. By way of example, the development of abstract categories, models, frameworks, and cause-effect, hence theorizing is best transmitted to the target audience in a written publication. In return educating of NBRC members, which happens internally in, for instance, not reported conferences are not captured in the used data source. Consequently, institutional work activities that are executed in a non-written way and which are not reported may be underrepresented, whereas institutional work types that can best be transmitted to the outside in the form of a publication may be overrepresented. Nevertheless, the database is capturing the strategy of the NBRC suitably for the themes of interest, which are institutional work types for the diffusion of niche innovation. From the document which reports the NBRC accomplishments, it can be seen that only peer-to-peer exchange highlights, webinars, conferences and 'other publications' are not covered by the data source. The accomplishments in the categories publications, research accomplishments and policy impact are reflected in the data source. Therefore, core strategic moves of the NBRC are included in the used source.

A parallel argument is that the data source is targeted at the public, which means it will naturally contain more external institutional work than internal institutional work. Although internal institutional work is meant to strengthen the external power position of the actor, activities to achieve this can happen, which are not included in the published documents. A way of compensation could be to reach out for internal conference notes if available.

In general, the significance of the study could be elevated by including a second source of data. Options are to include interviews as a second primary source or to amplify the number of documents by including a secondary source such as media articles. Both extensions contribute to a broader perspective on the work by the NBRC, which would improve the understanding of the strategy for niche diffusion the commission is implementing. Hence, the scope of a 15 ECTS study is to that effect a limiting factor. Adding another source to the analysis could be done in a future next step.

Another reflection on limitations is the presence of researcher bias. A big part of the empirical research is based on deeply reading and interpreting the information provided in the document database. This process is subjected to bias and can only be limited in its effect if the researcher first reads upon state of the art in current literature to have an informed view and to be able to detect important pieces of information throughout the creation of a conceptual framework. At the same time, an open mind needs to be kept for not interpreting to much into the data or missing new aspects. This is achieved by developing themes from the case, only based on the empirical evidence. In the final step, both views, framework and case, are compared and discussed. Despite of the limitation, this approach attributes a novel analysis and discussion in the next section.

3.7 Chapter Summary

The insights of the chapter describe the decisions which were made to find the right approach to answer the research questions. Exploration of the multi-scalar perspective on diffusion and implemented institutional strategies lead to the choice of an instrumental case. The case of the National Blue Ribbon Commission fits the aim because of the role of this agent in the current stage of diffusion of onsite non-potable water systems. Furthermore, an unfiltered primary source of publications on the NBRC’s website was identified as a good source for the analysis. Qualitative content analysis coupled with thematic coding and an analysis of aggregated generic patterns from the codes was applied to the source. Finally, validity and reliability were achieved by triangulating between different sources, a thick description and documenting of processes, keeping definitions coherent from the start until the end of the research process and eliminating sources of error from the process due to the primary data source without the need of transcribing. The limitations reflect upon constraints of the data source, the scope of the project and researcher bias.

4 Analysis and Discussion

4.1 Contextual embedding of the analysis

Analysing the NBRC's strategy starts with understanding the intermediary itself. The NBRC resulted organically from a nation-wide group of utilities and public health agencies that had existed since 2014 (SFPUC, 2021). Under the lead of the San Francisco Public Utilities Commission and the US Water Alliance the partnership was formalized in 2016 (SFPUC, 2021). The US Water Alliance is a nationally recognized non-profit organization composed of diverse members from the public and private sector working on a sustainable water future (Our Members | US Water Alliance, 2021). After the formalization, several other national actors joined the effort, which was crucial for the NBRC's success. The Water Research Foundation and the Water Environment Reuse Foundation, which since 2018 have integrated the two organisations into the Water Research Foundation, are providing funding for NBRC's projects.

Since no national standards around ONWS exist, a key achievement before the NBRC came into being was the development of a risk-based regulative framework for ONWS. This framework includes "risk-based log10 reduction targets (LRTs) to inform selection of appropriate treatment process trains, management of systems based on risk level, and continuous monitoring with autonomous controls to ensure protection of public health" (Lackey et al., 2020, p.6). Accordingly, the framework ensures the protection of public health while still maintaining the flexibility of communities which can decide how to manage the ONWS systems respecting their local context.

The NBRC steps now in and uses the guidelines on the basis of which the commission develops model regulations. To date, no federal regulation exists, however, states are using the risk-based framework, model policies and templates developed by the NBRC (Lackey et al. 2020). Hence, the goal of the work by the NBRC is to provide help with the "safe, practical and sustainable implementation of ONWS" (Lackey et al. 2020, p.6). This goal is pursued by a cooperation between public health agencies and water/ wastewater utilities. Lackey et al. (2020) report 31 commissioners from 11 states and the District of Columbia as the current membership numbers of the NBRC, status 2020, which matches with the website of the NBRC now. Of these states, California, Colorado, Minnesota, Oregon, Washington, and Hawaii are advancing regulations or policies in support of ONWS, while Texas and Alaska are contemplating to follow (NBRC, 2019). A major contributor to this broad accomplishment was the development of the Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems by the NBRC.

However, there remain challenges. The flexible approach of the risk-based framework has partially lead to difficulties (Lackey et al. 2020). One of these difficulties is for instance, that the used risk-based framework recommends using field-verified technology. Yet, there exists no understanding or standard protocol for field verification (Lackey et al. 2020). This and

further guidance on protocols are points that need more specification by the NBRC and are part of the most recent publication, the Onsite Non-Potable Water System Guidance Manual. Other recent focus areas concern training of the workforce for ONWS systems since it differs from centralized systems. Different possibilities for the creation of workforces exist. The responsibility can lie with the building owner or when ONWS expand, also third parties or even utilities manual (Lackey et al. 2020). A challenge is the cross-sectoral nature of the workforce required to design, permit and maintain ONWS, which is why the NBRC has collaborated with the environmental firm Trussell Technologies to develop an ONWS training manual (Lackey et al. 2020). Apart from that, quantifying the economic benefits of ONWS systems more thoroughly, further reducing the complexity of integrating ONWS, responding to research needs and finding a way of further standardization that eliminates disagreements about the flexible risk-based framework will be part of the NBRC's future agenda (Lackey et al. 2020).

4.2 Identifying the core aim of the documents by means of content analysis and code frequencies

Taking the contextual knowledge and moving forward to the analysis of the coded documents, a first look at the colour-scaled frequencies of institutional work types on different scales had the following outcomes. Generally speaking, all types of institutional work were present in the documents, which means that political, technical and cultural strategies were found in the data source. Apart from that, each document did not only focus on one specific type of institutional work but rather integrated various strategies (political, technical, cultural) to keep the momentum of introducing, trying to win support and reaching the target audience in different ways. For instance, an introductory paragraph including visioning was generally a common start to introduce the problematic situation and present ONWS as a solution. Another example is the reappearing explanation of the coalition the NBRC has resulted from and the number of members from different fields forming the commission, which stresses the coalition building the NBRC is engaged in and its national positioning.

To further understand the use of the institutional work by the NBRC, the contextual knowledge was expanded by a content analysis of each document. This includes an interpretation of each's document main target group and theme. The insights into each document's content were then, together with the colour-scaled frequencies of each code from the data analysis part, translated into the core aim of the document. In case that the code frequency was not in line with what would have been expected from the document's content analysis, an explanation is searched by diving deeper into the context and content of the document. The term core aim refers to the intended usage of institutional work types that each document shows and which is the interest of this study. Below the used documents, their short name, title, and year of publication are listed.

Table 4 List of analysed documents

Short name	Year of publication	Title
Blueprint_vfin_web.pdf	2014	BLUEPRINT for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems
nbrc_factsheet_120417_a.pdf	2017	NBRC Fact sheet
NBRC-GUIDEBOOK-FOR-DEVELOPING-ONWS-REGULATIONS.pdf	2017	A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems
MODEL-LOCAL-ORDINANCE_FINAL.docx	2017	A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems: Model Local Ordinance
MODEL-PROGRAM-RULES_FINAL.docx	2017	A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems: Model Program Rules
MODEL-STATE-REGULATION_FINAL.docx	2017	A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems: Model State Regulations
NBRC-GUIDEBOOK_APPENDIX_FINAL.pdf	2017	A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems Technical Appendix
Risk-Based-Framework-for-DNWS-Report_FINAL.pdf	2017	Final Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems
NBRC_Utility-Case-for-ONWS_032818.pdf.pdf	2018	Making the Utility Case for Onsite Non-potable Water Systems
Training modules (combined): Modules 1-10 + Training module Handouts with notes	2019	ONWS Guidance Training Manuals HANDOUTS
2016-2019_NBRC-Accomplishments.pdf	2019	Highlights and Accomplishments March 2016–April 2019
DRPT-4909.pdf	2020	Onsite Non-Potable Water System Guidance Manual

Starting with the first document published in 2014, the Blueprint for Onsite Water Systems was developed by the San Francisco Public Utilities Commission with representatives from local, state, and federal public agencies across North America, along with research institutions. The resulting document discusses “the barriers, opportunities, and research needs” (SFPUC & WERF, 2014) of ONWS and is a roadmap of ten steps to creating a local program to manage ONWS. The group that should be involved in the process and therefore the target group of this document is a “group of public health, planning, and building officials along with water and wastewater utilities that have jurisdictional authority in your area”(SFPUC & WERF, 2014). The main institutional work types are changing normative associations, assumptions and beliefs due to its extensive introduction talking about the creation of a “new water paradigm” (SFPUC & WERF, 2014). In addition, it is standardizing because of the intent of not only fixing the steps towards the creation of a local program but also touching upon the standards that exist in the water sector, which can be built upon for ONWS purposes and deciding on process requirements such as reporting requirements.

In 2017, the year after the creation of the NBRC, the NBRC factsheet introduced the commission in a condensed manner to everyone who is interested in ONWS. It talks about the context, the goals of the commission, the commissioners who form the commission and the guiding principles of the NBRC. It involves many types of institutional work strategies at once. However, due to the extensive list of guiding principles which in other documents is not entirely listed but only touched upon by naming a few values in the accurate moments, this document was categorized to create a new identity for ONWS by connecting it to a full list of attractivity enhancing values.

In the same year, the project "Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems" was published, which included five connected documents. All the documents have the same goal, which is responding to the lack of "existing public health-based standards and a streamlined permitting process" (NBRC, 2017c). The document series targets state and local public health regulators. Consequently, vesting is the overarching institutional work type for the documents. The NBRC Guidebook document and the Model-Local Ordinance document reflected the objective and showed vesting as the most used institutional work type. Examples like

> *"[W]ithin 90 days after passage of this ordinance, the Local Agency shall issue program rules regarding the operation of ONWS systems necessary to effectuate the purposes of this ordinance to protect public health and safety. These program rules shall address, at a minimum: i.Operation of an ONWS to achieve the mandatory minimum treatment performance standards for blackwater, graywater, and roof runoff as set forth in Table 1 that represent ninety-fifth percentile log reduction targets (Log10) based on three reference pathogens (enteric viruses, enteric bacteria, parasitic protozoa) […]"(NBRC, 2017c, p.7)*

illustrate the institutional work type vesting, here. Nevertheless, from the coding frequencies, some deviations from this main goal were visible. The technical appendix categorised as educating because it includes treatment examples and monitoring templates which support the target group to learn know-how and processes connected to local ordinance, state regulation and program rules. The Guidebook sections "Model-Program Rules" and "Model-State Regulation" also showed a stronger tendency towards using standardizing instead of vesting. The Guidebook introduction itself gives an explanation for this, which is that NBRC's goal is, as said before, assisting regulators in establishing water quality criteria for ONWS, which are implemented in regulations. Yet, apart from that, does the NBRC help regulators in the process of adapting and using ONWS at the local or state level, which can be "transferable from state to state and community to community" (NBRC, 2017c). To this end, the commission standardizes processes to facilitate the adoption. It uses technical strategies aiming at a political outcome.

The last document from 2017, is the Risk-Based-Framework targeted at public health regulators and water utilities. As mentioned in the context section, this publication is not by the NBRC, but it is integral to the role of the NBRC and thus also published on the commission's website. The goal of this publication is to prepare recommendations on water quality pathogen targets, monitoring regimes for water quality, management considerations for systems, strategies for permitting projects, applications, and end uses of treated alternate water sources (Sharvelle et al., 2017). Since it is the first attempt to fix water quality criteria and processes around ONWS, standardizing is a prevalent institutional work type. Next to standardizing, theorizing can be identified, which is putting the conversation on a higher level and keeps it abstract. This is due to the general nature of this publication, which does not target a specific scale and leaves room for local interpretation, as mentioned earlier.

The NBRC Utility Case from 2018 falls out of the pattern of vesting, theorizing and standardizing to support the creation of a favourable regulatory environment and supports the implementation of ONWS in a different way. By presenting case studies as "demonstration projects" (NBRC, 2018), a range of institutional work types consisting of educating and both cultural strategies followed by demonstrating and visioning is applied to diffuse ONWS to other utilities and to further build an understanding of ONWS among utilities.

The shift in institutional efforts continues in 2019 with the Training Modules (Training Handbook and Modules 1-10) and NBRC's Accomplishments document. The Training Modules target stakeholders from the local or project level, which are the design engineer, regulator, operator, program administrator and system owners. Over the period of ten training modules, different subjects are being treated, such as public health goals or treatment selection and overview. Some modules are more relevant for certain stakeholders than others but are part of the general awareness for of all the stakeholders. Clearly, educating is the prevalent institutional work type in all modules. This fits into the context of starting to educate a workforce for the successful implementation of ONWS.

The NBRC Accomplishments deals for the first time primarily with the NBRC itself and targets all interested groups of ONWS. Although the goals of the NBRC are listed, which results in a variety of institutional work types, the focus was lying on the commission as a national organisation that lobbies for resources, promotes agendas, proposes new or attacks existing legislation, advertises and raises awareness for ONWS. These activities all stand for advocacy and strengthen the position of the NBRC.

The last document, the ONWS Guidance Manual, targets the same stakeholder group as the Training modules. Instead of guiding regulators, this manual seeks to "provid[e] more detail for how to implement an ONWS project based on the public health regulations" (NBRC, 2020). Hence, it builds on the suggested public health regulations of 2017 and moves on to specifically guiding project-level implementations of ONWS. Referring to the context, it responds to the difficulties arising from the flexibility of the risk-based framework. Translated in institutional work types, further theorizing, but especially important, more standardizing is included.

4.3 Results

In order to identify a clear strategy, the documents and their core aim will be depicted by putting them down on a timeline. Additionally, the geographic view on the strategy is included in the conversation by placing the documents on the scale, which was targeted with the document's core aim. Below the external diffusion strategy used by NBRC through published documents is illustrated.

4.3.1 External diffusion strategy by the NBRC

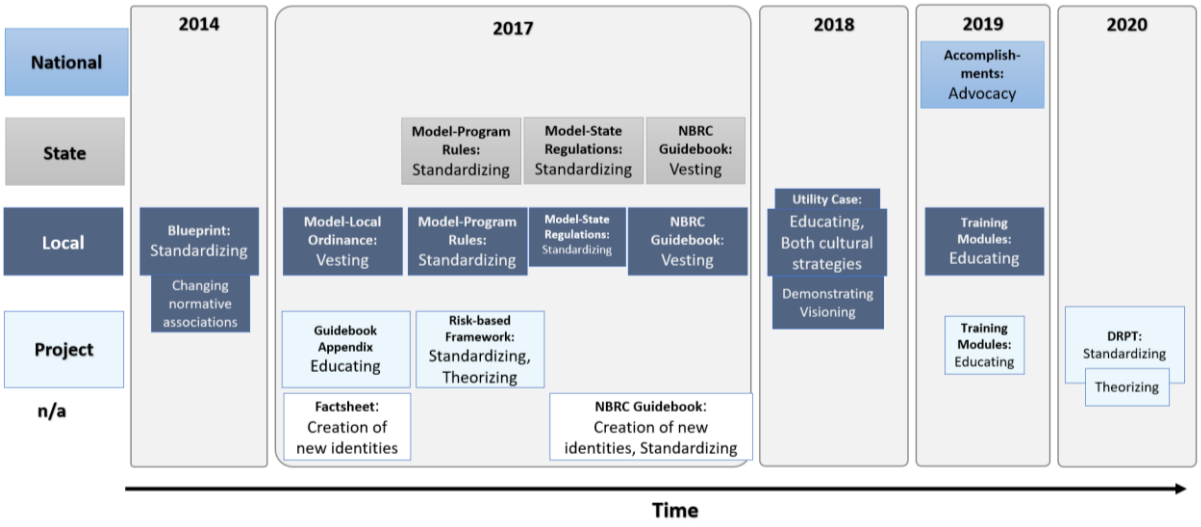

Figure 6 External diffusion strategy by NBRC through published documents

For each document, the identified core institutional work types were put down into squared boxes and placed on the targeted scale throughout a timeline. Several documents have more than one box. If a box is smaller than the other, it means that the institutional work type in the smaller box was stressed less throughout the document and being less represented in terms of code applications. If a document has one box each on two scales, it is usually because the same institutional strategy was carried out parallelly on two different scales. Sometimes the boxes on two scales even include different institutional work types (see internal strategy).

When looking at the illustration as a whole, it gets apparent that the national commission focussed their efforts primarily on the local scale, followed by specifically intervening on the project scale and, in some cases, including the state level in parallel to the local level. This has various explanations. As mentioned earlier, the possibility of implementing regulation for ONWS at the local and/ or state level makes the NBRC target both scales in their efforts of modelling regulations. Furthermore, the SFPUC serves as a role model making the experiences of the local utility the baseline for all recommendations. Nevertheless, another pattern got apparent. Adaptability to the local context is a very important value to the NBRC. Even though the flexible approach did not work out without difficulties, the NBRC did not start working on national standards. Instead, the commission concretized and standardized more profoundly on a project level. This could be an indication for a strategic approach, which avoids implementing national standards in order not to hamper the further innovation development and arising complementary niche technologies by implementing rigid, decontextualized national standards as it did in the case of Miörner & Binz (2020). Accordingly, a major part of the NBRC's strategy is to diffuse ONWS at the small scale. An excerpt from the NBRC Guidebook expresses the purpose of the NBRC to be the advancement of best management practices to support the use of ONWS in individual buildings or at local level, which is hence reflected in the results.

The types of institutional work in Figure 4, which have been prevalent throughout the activities of the NBRC, are in chronological order standardizing followed by educating and the creation of new identities, followed by vesting and theorizing. However, as commented in the description of the coding process, standardizing, vesting, and theorizing seem to be coupled together due to the common goal of facilitating coordination and joint expectation. These three types reflect the work which was specially done for "[d]eveloping and [i]mplementing regulations for Onsite Non-potable Water Systems" (NBRC, 2017c) as part of the Guidebook project as an example. Therefore, the combination of two technical strategies and one political strategy was used to achieve political outcome, which is rather surprising. Technical strategies were the main used institutional work category aiming at influencing the cognitive-cultural level of possible ONWS stakeholders. These stakeholders are also targeted on a normative level with cultural strategies. However, the focus lies on technical strategies since the documents are mainly targeting people who stand in relation to the water sector. This makes it more important to make them understand the transformative innovation and make them see the benefits by using technical strategies, rather than focussing on the normative level using cultural strategies.

There are two possible reasons that could explain the focus on standardizing. The first reason may be the security that is ensured when standardizing entire processes. The NBRC does not only focus on developing criteria and standards which can be implemented in regulations and serve as a benchmark for action but standardizes whole processes. These standardized processes accompany the entire path of implementing and running ONWS. Hence, they give a lot of security and orientation when introducing a niche innovation. Security is necessary in a highly regulated sector such as the water sector with its connection to public health. Apart from that, the speed of adopting ONWS is increased when the steps to success are clearly predefined. Consequently, standardizing processes can be seen as a strategic action for diffusion. The second reason may be that standardizing is the normative step before elevating standards on the regulatory level, and the NBRC is therefore doing the preparation for regulators who then need to sign the suggestions and standards into law. Hence, the NBRC engages in technical strategies that are meant to facilitate political outcomes next to engaging in the political strategy vesting.

Vesting has a major role in the strategy since the permission of public health authorities is a precondition for successful ONWS diffusion. Still, the NBRC did not decide on streamlined national regulations but chose a more loosely coordinated diffusion process. This process is based on the same standards but allowing for local specificities. A possible reason for it was to give the ONWS innovation room for development along the diffusion process and leave it mainly influenced by the local context or niche. However, it is remarkable that a national level organization tries not primarily to lobby the federal government but facilitates the city-to-city or state-to-state diffusion of a 'best practice' model.

Theorizing is done throughout the process by, for example, defining terms such as ONWS, Blackwater and Greywater. It supports the clarity and uniformity of the recommended regulations, standards, and processes that are then understood in the same way across space, which facilitates its spread. Theorizing is an essential institutional work type in connection with political and technical strategies in the diffusion process.

Educating represents the main technical strategy of the NBRC to make the innovation be understood on a cognitive-cultural level, which is crucial for adoption of an innovation. However, it can be an additional way of diffusion as well because the learned rationalities are

spreading through people within multi-scalar actor networks. This is what one of the key messages of the multi-scalar view on niches and regimes is standing for, saying that educated ‘transfer agents’ mobilise policy diffusion.

Lastly, the creation of new identities is the most used cultural strategy by the NBRC. The objective of this strategy may be twofold. First, it is aimed at utilities to convince them that engagement with the innovation is a strategically advantageous step for them to reach the “One Water Goals”. These goals represent the opinion that all water has value and should be managed in a sustainable, inclusive and integrated way (US Water Alliance, 2016). Moreover, a reappearing theme within this cultural strategy is the honouring of the local context, which enhances the attractiveness of the innovation by personalizing the solution to each context. Second, all stakeholders might have doubts about this new way of water treatment which is why the connection of ONWS to safety is emphasized. Hence, building legitimacy on a cultural level is an integral part of the diffusion strategy.

After having looked at the targeted scales and main institutional work types, the development of the strategy over time is of interest. Over time, the effort was first focused mainly on the creation of a supportive regulatory environment and the standardizing of implementation and running of ONWS. Thus, from the year 2014 until 2017, this was the focus for the institutional work on the local and state level. In parallel, efforts to educate about ONWS and to create a new water paradigm have started, too. In the following years, 2018-2020, the local and project scale were central to educate and convince utilities and project stakeholders of the implementation of ONWS. Apart from educating and convincing through various cultural, technical and political strategies such as demonstrating, visioning, changing normative assumptions and creating new identities, the standardizing process was expanded with more detail for the project level.

4.3.2 Internal diffusion strategy by the NBRC

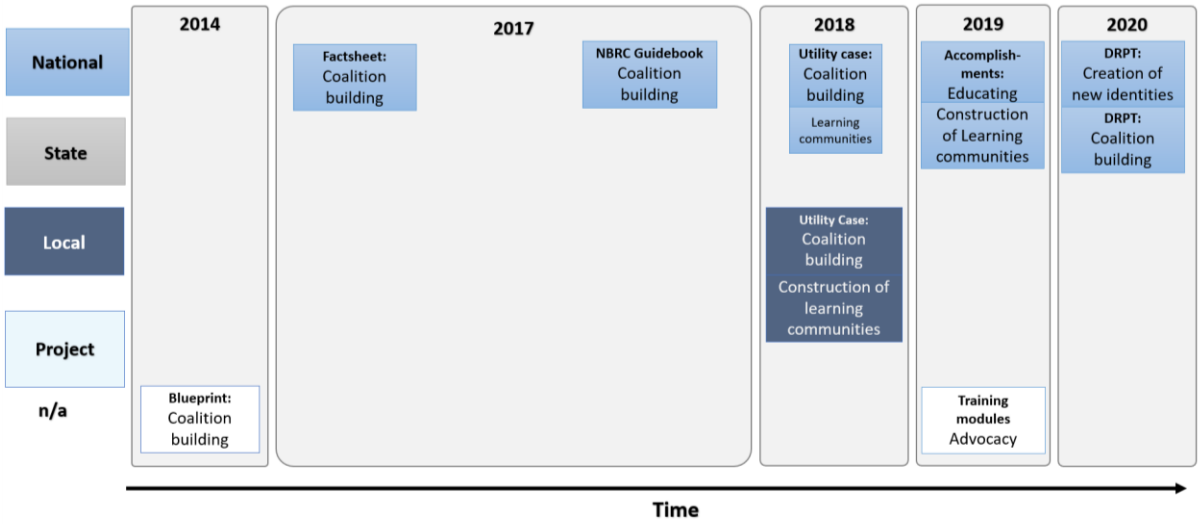

Figure 7 Internal diffusion strategy by NBRC through published documents

Looking at the internal institutional work strategy, the core level of institutional efforts is at the national level. The internal strategy is meant to strengthen the position of the organization to have a higher influence on the diffusion process. Accordingly, the commissioners have positioned the NBRC from the beginning as a national actor, which is the highest scale and provides reach for diffusing ONWS to any other scale if correctly translated. The fact that the NBRC already benefits from a good positioning may also be a reason why not a lot of internal institutional work was identified.

The national positioning was achieved through two main institutional work types. In the first place, coalition building of national water organisations and the inclusion of commissioners from different scales and localities has led to the favourable position of the commission. The NBRC is composed of 31 representatives from different municipalities, water utilities and public health agencies from 11 states and the District of Columbia (Lackey et al. 2020). However, this coalition was only formalized when a nationally recognized non-profit organization, the US Water Alliance, stepped in. This elevation in position was probably the key factor for attracting the Water Research Foundation, which is a crucial provider of funding for the NBRC. Therefore, a national position is in many ways important to be recognized and a relevant recipient for funding. Then again, only with enough resources can the intermediary engage in more complex institutional work, which is necessary for the diffusion phase. Secondly, making the NBRC a learning community which helps to overcome barriers associated with ONWS and the coordination of stakeholders helps to transmit the new institutional rationality to the members. This way, the members can implement the new ideas directly to their place and scale which makes the legitimation of ONWS spreads.

From a time perspective, not many changes to the strategy happen over time apart from referring more to the need of local coalitions and convincing actors to form local working groups in the 2018 document as a necessary success factor of running ONWS. To sum up, the NBRC has ensured to be a coalition which includes actors from different scales while at the same time having a national status which makes reaching out in any direction possible and facilitates diffusion goals.

Reflecting on the success of the NBRC's multi-scalar strategy, "[r]ecent trends mark an increase in the onsite recovery of water at the building scale. Cities in several states are developing more robust or full-scale programs" (Lackey et al. 2020, p.9). Each project is uniquely adapted to the local needs. A project in Santa Monica, for instance, focuses on collecting primarily stormwater and urban water runoff since it is seen as the main source of pollution. Meanwhile, in New York a residential and mixed-use building area benefits from waste and rainwater reuse. These are only two of the case studies presented in the document "Making the Utility Case for Onsite Non-potable Water Systems" (NBRC, 2018). The other cities that are mentioned are San Francisco, Tucson, Portland, and the town Foxbourough. However, these cases are only examples and no exhaustive list. Lackey et al. (2020) for instance, further mentions Seattle and Albuquerque in New Mexico. Among these cases, significant cities such as New York, Seattle, San Francisco and Portland are represented. The commission reports diffusion successes more often as regulatory successes on the state scale, like in the "Highlights and Accomplishments March 2016–April 2019" Document. This document lists eight states that have either implemented or are on the way to implementing regulation around ONWS. Thinking about the start of the NBRC, when San Francisco was the only pioneer and only California was moving towards signing new regulation into law, the success of the NBRC within 3 years becomes visible. On the national scale, a success for the NBRC as an organization was to receive the President's Award of Excellence during the 34th

annual “WateReuse Symposium”, held by the national trade association, The WateReuse Association (WateReuse Association, 2021). Consequently, acknowledgement for the organization as well as visible results indicate the success of the NBRC.

4.4 Discussion

The findings to the research questions asking what type of institutional work would enable niche diffusion and how actors could engage in institutional work at different spatial scales to support the diffusion were compared to the conceptual proposition.

Starting with the sequencing of the institutional work strategies, the proposition supposed an increasing complexity of institutional work activities. Referred to the three types of institutional work strategies, the proposition concluded that this would mean to start with technical strategies, implementing cultural strategies on the way and lastly, engage in political strategies to generally validate the innovation. The results show a major difference. The NBRC prioritizes to first engage in defining and diffusing a standardized regulative framework and then engages mainly in technical strategies since it is intended to transmit the functioning of ONWS to stakeholders in the water sector. Cultural strategies, and therefore the normative pillar, are also infused into the strategy in order to reach these stakeholders successfully. Consequently, in the case study’s diffusion strategy, it is crucial to achieve a supportive regulatory environment first. This is followed by reaching out to significant stakeholders with technical strategies. Cultural strategies are complementarily infused into both steps in order to reach regulators and ONWS stakeholders with all possible measures.

Since the commission is a national actor, it was supposed that all political actions would happen on the national level. However, the results have shown that rather the local and state level were targeted. These are the scales that have direct decision-making power regarding the implementation of ONWS programs. Moreover, the only experience from a pioneer functioning as a role model is on the local level. Additionally, the idea behind this approach could also be that the NBRC wants to respect the ‘state of the art’ of the innovation, giving it the possibility to further develop along the diffusion process without hampering the development by implementing national standards that are disconnected from the local context as in the case study of (Miörner & Binz, 2020). Another unforeseen feature of the political strategy is that political outcome was hoped to be achieved mainly through one political and two technical institutional work types. These are vesting, standardizing and theorizing that are hence, in many ways important for the diffusion. Concrete actions were developing model regulations, standardizing processes to implement and run ONWS, developing standards for regulatory use and homogenising ONWS definitions and theory. Especially remarkable was the standardization of processes, in the case of political strategies for regulators, which is a strategy to facilitate the adoption of an innovation to a maximum degree.

The next part of the strategy concerns the enhancement of the implementation of the transformative innovation by the relevant water sector stakeholders. The conceptual propositions expected the technical strategies, which are used to this end, to happen on the state scale. The reason behind this proposition was the aim to tackle the highest scale, which still has a direct influence on the implementation. The case study, on the contrary, targeted the project and local scale by standardizing and educating on the smallest scales. Consequently,

the NBRC works towards the adoption of ONWS on the ground level where the innovation is physically applicable. This ensures that the measures taken by the NBRC match the needs in the field and leave no gap that could hinder the adoption.

Switching to the internal diffusion strategy, the NBRC engages in multi-scalar coalition building making actors from different spatial scales and places to commissioners. Thanks to this constellation and by creating a learning community, it is ensured that the introduced rationalities find a way to all scales through the members of the commission. These members act as "transfer agents" (Sengers & Raven, 2015), giving the commission the ability to reach all the scales of its multi-scalar network. A condition for successful reach is the facilitation of the translation process (Miörner & Binz, 2020). Since the NBRC predominantly targets small scales in the institutional work, it is indicated that the translation processes are successful. The conceptual proposition mentions advocacy and, more specifically, lobbying for resources as a possible internal strategy. This brings to the important realization that the national status of the NBRC was only reached through the support and funding of existing national organisations. This starting point is necessary to be able to advance the diffusion of ONWS by being able to engage in 'complex' institutional work (Binz et al., 2016). This position was not reached solely through the application of the institutional work types coalition building and creating of learning communities but needed external support by national organisations.

A big realization for the geography of transition literature from looking into the diffusion strategy of the NBRC is the strong embeddedness of the actions in spatial scales. For each institutional strategy, a different spatial scale was chosen. Although the actor is a national actor, its intention was still to act as close, specific and relevant to the implementation scale of the ONWS innovation as possible. The position on the national scale was solely used for achieving a strong standpoint with which the commission is able to access resources, reach all scales and have the ability to engage in complex institutional work falling into political strategies. Starting the strategic activities with political work proved very efficient. Nevertheless, the other strategies needed to follow as well for making the diffusion happen and diffuse the entire socio-technical system around the technology. Having a national intermediary proves to be an effective way of enhancing the diffusion of an innovation, even or especially in a highly regulated sector that needs cross-sectional work. Sectors with similar structure and bonding to the public sector could benefit from the implementation of an intermediary to advance sustainability transitions, for instance, in the energy or construction sector, which are also important for urban management. Different results are expected if an innovation has a less strong connection to socially constructed scales, which makes it harder for the intermediary to adopt the strategy accordingly

4.5 Chapter Summary

This chapter answered the question of what type of institutional work is needed for the diffusion of a niche solution. Summarising, process standardization, developing standards for regulatory use and normative orientation, developing model regulations, homogenise ONWS definitions and theory, educating transfer agents and creating a new identity for ONWS are the main institutional strategies by the NBRC. Next, the interconnectedness between actor strategy and scale was identified on an external and internal level and turned out to be a crucial aspect for the strategy's success. This is because, for each institutional strategy, the

most relevant scale for action was specifically chosen. Finally, the meaning of the findings for the geography of transition literature was outlined.

5 Conclusion

This study aimed at exploring what institutional strategies actors are implementing to diffuse niche innovation between places and spatial scales and how they make use of scales in the diffusion process. By linking the multi-scalar perspective on transitions with an institutional work typology, a conceptual approach was developed. This framework looked at actor activities and allocated an institutional work type, a scale, either an internal or external level categorization and a time component to the activities. This approach contributes to transition studies as it sheds light on the role of intermediary actors in the process of niche diffusion and makes it possible to understand intervention possibilities to accelerate sustainability transitions.

The empirical case study of a national commission trying to diffuse an innovation in the water sector uncovered a truly multi-scalar diffusion strategy. The internal strategy aimed mainly at making the commission itself a multi-scalar coalition and learning community. Yet, the NBRC would not have reached its current position without external help of national organizations. The external strategy had a two-step mission so far. First, standardizing, vesting, and theorizing for a favourable policy environment. Then, aligned with the previous step, educating and creating of new identities and again more specific standardizing for accelerating the acceptance on a technical and cultural level. The political change was tackled at the scale, which is relevant for deciding about ONWS program regulations, in this case, the local and state scale. The technical and cultural change strategies were implemented at the level of implementation of the innovation, which is the project and local scale.

These findings imply that an efficient way of diffusing innovation in highly regulated sectors is to start with engagement in regulatory change. Nevertheless, diffusing the socio-technical system around an innovation does not end with changing the political environment. Therefore, technical and cultural strategies are equally important to enhance the broad adoption of an innovation by stakeholders in the relevant sector. Furthermore, for each institutional work strategy, a different scale can be of importance and thus, be chosen accordingly. It was the local and state scale for regulations but rather the smaller project or local scale for technical strategies and cultural strategies to convince projects or cities to adopt ONWS. Finally, the actor itself is in the best position to diffuse niche logics if being a multi-scalar actor. In this manner, rationalities are transferred through members to different places and scales. Consequently, the scale on which the institutional work is completed is depending on the objective, and the actor needs to make sure to be able to reach a certain scale for a certain objective. This shows the embeddedness of the actor strategy in spatial scales.

There are various takeaways from the findings above. First, similar dynamics may exist in other highly regulated sectors as for example, the energy sector or construction sector, which would be the most obvious candidates for transferring the findings from the water sector. Then, the framework has the potential for analytical generalizability. When applied to diffusion scenarios in other sectors or countries and cross-comparing between them, a more general theory on successful multi-scalar diffusion strategies for niche innovation can be

developed that help intermediaries to accelerate the adoption of sustainable innovations broadly. Finally, a policy implication resulting from this research could be to provide the mentioned external support to create intermediaries and not wait until intermediaries such as the NBRC are organically created. By enhancing multi-scalar connections with the aim of creating a national actor and providing national funding, intermediaries which spread sustainable niche solutions can be brought about.

The future research opportunities resulting from the mentioned points are the further applications of the framework to different sectors and scenarios. Apart from that, a connection to institutional entrepreneurship, which deals with where, why and under what conditions agency is enabled (Fuenfschilling, 2019), could be brought into the discussion to optimize the policy recommendations on how to create a diffusion intermediary. On this note, a new intermediary type for organizations like the NBRC can be explored and added to existing intermediary typologies. Furthermore, actor strategies in the last phase of the transition trajectory, which is the general validation phase, are of future interest. To conclude, there are many more important avenues for future research to get a full understanding of actor strategies in multi-scalar transitions. This study wants to encourage future investigations to open up the possibility of acting deliberately and directing sustainability transitions towards success.

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Appendix A

Coding Dictionary		*Definition*	*Example*
Institutional work		Intentionality and effort to create, maintain or disrupt institutions.	
POLITICAL STRATEGIES	Visioning	Creating a vision for change by defining problems, related to the dominant regime, and justifying how the innovation, can solve these problems **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*Ensuring the responsible and sustainable use of our future water supply takes a nationwide effort, and we are proud to be helping to lead this movement.* *…a promising One Water strategy for thriving cities, reliable and resilient water utilities, and competitive business and industry is the integration of smaller onsite systems that collect, treat, and reuse water within individual buildings or across nearby properties* *In order to secure a sustainable water future, we need diverse approaches to water management.*
	Coalition building	The development of coalitions composed of actors, with different skills and knowledge, to mobilise collective action. **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)** Building national and subnational network for easy translation between layers of a socio-technical system (own interpretation)	*By August, the two organizations launched the National Blue Ribbon Commission for Onsite Non-potable Water Systems. Shortly thereafter, The Water Research Foundation (WRF) joined the effort as a national funding, convening, and research partner.*
	Advocacy	To gather political and regulatory support for a practice or innovation and **disconnecting rewards and sanctions regarding dominant institutions** through direct and deliberate techniques of political suasion **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)** Lobbying for resources, promoting agendas, and proposing new or attacking existing legislation, advertising/ awareness rising	*Identify additional research needs in the field.* *Identify and develop a research agenda to further advance the field of onsite non-potable water systems* *Leveraging two years of funding from The Water Research Foundation (WRF), the Commissioners participated in the development of the following research…* *The mission of the National Blue Ribbon Commission for Onsite Non-potable Water Systems is to advance best management practices to support the use of onsite non-potable water systems for individual buildings or at the local scale.*

	Vesting	The creation of rule structures that confer property rights Vesting interested parties **via rule-setting** and property rights attribution and defining **the social boundaries of adoption and usage** **(Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*Craft model policy guidelines;* *Policy templates* *Templates for state and local jurisdiction to use as their craft regulations, adopt policies, and develop and implement programs for ONWS.*
TECHNICAL STRATEGIES	Demonstrating	The demonstration of the workability of an innovation and corresponding institutional arrangements **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*[…] demonstrate how these systems can help utilities meet their One Water Goals* *As a proven, yet emerging practice […]* *The case study in this report demonstrate the benefits that onsite non-potable water systems can provide to the building owner, utility and the broader community.*
	Theorizing	The development of abstract categories, models, frameworks, and cause-effect relations regarding innovations, institutions, and events **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*Craft guidance and frameworks for ONWS regulation*
	Educating	The educating of actors in terms of skills and knowledge necessary to support the diffusion of the innovation **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)** People learning in peer-to-peer exchange, sharing best-practices, working on locally adapted processes, templates to facilitate engagement in new practice	*Develop case making resources for water utilities based on best practices and lessons learned in the design, development, integration, and operation of ONWS* *These meetings were an important peer-to-peer exchange opportunity for Commissioners on the status and progress of ONWS implementation* *Site visits to expand working knowledge*
	Standardizing	A standard is an 'instrument of control' (Brunsson and Jacobsson, 2010) that facilitates coordination, joint expectations and sanctions **(Slager et al., 2012).** The standardisation of products, business models, market mechanisms, or valuation techniques for the innovation **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems (2017): To help develop water quality criteria and standards for ONWS and present pathways for implementation and management of these systems at the local and/or state level* *The goals of the Blue Ribbon Commission are to foster peer-to-peer learning and address key issues including,creating*

			consistent water quality standards from state-to-state, promoting risk-based water quality standards, and encouraging local oversight programs
	Construction of learning communities	The construction of networks through which practices become normatively sanctioned and which form the relevant peer group with respect to compliance, monitoring, evaluating, and learning regarding an innovation **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*Serve as a forum for collaboration and knowledge exchange*
CULTURAL STRATEGIES	Changing normative associations, assumptions and beliefs	Awareness raising activities to shape the beliefs and perceptions of different stakeholders and to re-make the connections between sets of (new and existing) practices and the moral and cultural foundations of those practices **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*The National Blue Ribbon Commission developed this report to help water and wastewater utilities, local government agencies, and other interested stake holders understand the benefits and drivers behind onsite non-potable reuse* *Green building programs, like the LEED® rating system and Living Building ChallengeTM, often encourage onsite water systems as a sustainable water management tool.*
	Creation of new identities	Enhancing the attractiveness of innovations by connecting them to identities, roles, or values **(Van Doren et al. 2020, Lawrence and Suddaby, 2006; Perkmann and Spicer, 2008.)**	*In cities throughout the world—New York, San Francisco, Seattle, Tokyo, Sydney, and many others—onsite water systems are being utilized to meet non-potable needs* *Honor local context* *based on best-in-class science and are protective of public health.*
Scale			
	Project	Activities on project level	
	City (referred to as local level)	Activities on a city level	*To help develop water quality criteria and standards for ONWS and present pathways for implementation and management of these systems at the local and/or state level*
	State	Activities on the state level	*Provides template state legislation for establishing regulatory programs for ONWS*
	National	Activities not directed at a specific utility or agency but activities on a national scale	*This meeting was the first national convening of public health and water leaders to share knowledge on onsite*

			nonpotable water systems (ONWS) and discuss ways to help communities overcome policy barriers to implementation *The Commission has served as an example and inspiration, shifting the conversation on non-potable water reuse nationwide*
Level			
	Internal	Activities that affect the organization NBRC itself, making it a more powerful and trustworthy actor	*Leveraging two years of funding from The Water Research Foundation (WRF), the Commissioners participated in the development of the following research* *These meetings were an important peer-to-peer exchange opportunity for Commissioners on the status and progress of ONWS implementation* *Today, the group is comprised of more than 30 members representing 12 states and the District of Columbia*
	External	Activities that affect the socio-technical system around ONWS	*The collaborative has made significant research contributions and advanced policies and regulations for onsite water reuse over the years.*
Year of publication			*2017, 2018*

Appendix B

EXTERNAL LEVEL

		Visioning	Coalition building	Vesting	Advocacy	Demonstrating	Theorizing	Educating	Standardizing	Construction of learning communities	Changing normative associations	Creation of new identities	
MEDIA TITLE/External	Scale	Political strategies				Technical Startegies					Cultural strategies		TOTAL
Blueprint_vfin_web.pdf	Project					1							1
	Local						1		3		1 1/3	1	6 1/3
	State										1/3		1/3
	National										1/3		1/3
	n/a	1											1
Total: Standardizing Local level		1				1	1		3		2	1	9
2016-2019_NBRC-Accomplishments.pdf													
	Project				1/2			1/2	1		1/2		2 1/2
	Local			1	1/2		1	1/2	1		1/2		4 1/2
	State			2					1/2				2 1/2
	National				4				1/2		2	1	7 1/2

	n/a			2	2				1					
Total: Advocacy National Level				5	7		1	1	4		3	1	17	
brc_factsheet_120417_a.pdf														
	Project												0	
	Local			1/2		1	1		1				3,5	
	State			1/2									0,5	
	National				1								1	
	n/a	2										5	7	
Total: No specific level: Creation of new identities		2	0	1	1	1	1	0	1	0	0	5	12	
MODEL-LOCAL-ORDINANCE_FINAL.docx														
	Project			1			1/4						1,25	
	Local	1		4			1/4					1	6,25	
	State			1			1/4						1,25	
	National						1/4						0,25	
	n/a												0	

Total: Local level vesting	1	0	6	0	0	1	0	0	0	0	1	9
DRPT-4909.pdf												
Project				1/2		4	1/3	8 1/2				13,3333333
Local	1		2 1/2	1		2	1/3	1/2				7,3333333
State			1/2	1/2			1/3	1/2				1,8333333
National				1				1		1		3
n/a			1			1	1	2				5
Total: Project level Standardizing followed by Theorizing	1	0	4	3	0	7	2	12,5	0	1	0	30,5
MODEL-PROGRAM-RULES_FINAL.docx												
Project								1				1
Local								1 1/2				1 1/2
State								1 1/2				1 1/2
National												0
n/a						1						1
Total: Local and State level Standardizing	0	0	0	0	0	1	0	4	0	0	0	5

MODEL-STATE-REGULATION_FINAL.docx													
	Project							1 1/2					1,5
	Local			1/2			1	2					3,5
	State			1 1/2				3 1/2					5
	National												0
	n/a						1						1
Total: State level standardizing		0	0	2	0	0	2	0	7	0	0	0	11
NBRC_Utility-Case-for-ONWS_032818.pdf.pdf													
	Project					1	1 1/2		1/2				3
	Local	6		2	2	6	2	7	1 1/2		7	7	40,5
	State			1			1/2						1,5
	National	1		1	1	2			2			3	10
	n/a			2	1		1	1	2			4	11

Total: Local level Educating, both cultural strategies and visioning	7	0	6	4	9	5	8	6	0	7	14	66
NBRC-GUIDEBOOK_APPENDIX_FINAL.pdf												
Project							5 1/2					5,5
Local							1/2					0,5
State												0
National												0
n/a							1					1
Total: Project level Educating	0	0	0	0	0	0	7	0	0	0	0	7
NBRC-GUIDEBOOK-FOR-DEVELOPING-ONWS-REGULATIONS.pdf												
Project				1	1	3 1/2		3				8,5
Local			5 1/2	1		2 1/2		1 1/2			2 1/2	13
State			5 1/2			1		1/2			1/2	7,5
National				1				2				3

	n/a				1	1			5			6	13
Total: Local State Level: Vesting; Standardizing & new identities on no spefific level		0	0	11	4	2	7	0	12	0	0	9	45
Risk-Based-Framework-for-DNWS-Report_FINAL.pdf													
	Project						3 1/2		3				6,5
	Local			1			2 1/2		1/2				4
	State			1					1/2				1,5
	National		1									1	2
	n/a								2				2
Total: Project level: Theorizing and Standardizing		0	1	2	0	0	6	0	6	0	0	1	16
Training modules													
	Project				1/3		1 1/2	1 1/6					3
	Local			1/2	1/3		1/2	2 1/6					3,5
	State			1/2	1/3			2/3					1,5
	National												0
	n/a				1							1	2
Total: Educating Local		0	0	1	2	0	2	4	0	0	0	1	10

INTERNAL LEVEL

		Visioning	Coalition building	Vesting	Advocacy	Demonstrating	Theorizing	Educating	Standardizing	Construction of learning communities	Changing normative associations	Creation of new identities	
MEDIA TITLE/Internal	Scale	Political strategies				Technical Startegies					Cultural strategies		TOTAL
Blueprint_vfin_web.pdf	Project												
	Local		1/3										1/3
	State		1/3										1/3
	National		1/3										1/3
	n/a												
Total: Coalition building throughout scale			1										
2016-2019_NBRC-Accomplishments.pdf													
	Project												
	Local							1/2		1			1,5
	State							1/2					0,5
	National		2		2	1		2		2			9
	n/a												0
National level Educating, Construction of learning communities			2		2	1		3		3			

brc_factsheet_120417_a.pdf													
	Project												0
	Local											1	1
	State												0
	National		3							2			5
	n/a												0
Total:National level: Coalition building and construction of learning communities		0	3	0	0	0	0	0	0	2	0	1	6
MODEL-LOCAL-ORDINANCE_FINAL.docx													
	Project												0
	Local												0
	State												0
	National												0
	n/a												0
Total:		0	0	0	0	0	0	0	0	0	0	0	0
DRPT-4909.pdf													
	Project												0
	Local												0
	State												0
	National		1									1	2
	n/a												0

Total: National Coalition building and creation of new identities		0		1	0	0	0	0	0	0	0	0	1	2
MODEL-PROGRAM-RULES_FINAL.docx														
	Project													0
	Local													0
	State													0
	National													0
	n/a													0
Total:		0		0	0	0	0	0	0	0	0	0	0	0
MODEL-STATE-REGULATION_FINAL.docx														
	Project													0
	Local													0
	State													0
	National													0
	n/a													0
Total:		0		0	0	0	0	0	0	0	0	0	0	0
NBRC_Utility-Case-for-ONWS_032818.pdf.pdf														

	Project			1/2			1/2					1
	Local		2	1/2			1/2		1			4
	State											0
	National		1						1		1	3
	n/a										1	1
Total: Local level coalition building, followed by constructio of learning communities and new identities		0	3	0	1	0	0	1	0	2	0	2	9
NBRC-GUIDEBOOK_APPENDIX_FINAL.pdf												
	Project											0
	Local											0
	State											0
	National											0
	n/a											0
Total:		0	0	0	0	0	0	0	0	0	0	0	0
NBRC-GUIDEBOOK-FOR-DEVELOPING-ONWS-REGULATIONS.pdf												
	Project											0
	Local											0

	State													0
	National		2							1		1		4
	n/a													0
Total:	National level:Coalition building	0	2	0	0	0	0	0	0	1	0	1	4	
Risk-Based-Framework-for-DNWS-Report_FINAL.pdf														
	Project													0
	Local													0
	State													0
	National													0
	n/a													0
Total:		0	0	0	0	0	0	0	0	0	0	0	0	
Training modules														
	Project				1/2									0,5
	Local				1/2									0,5
	State													0
	National		1											1
	n/a				1									1
Total:		0	1	0	2	0	0	0	0	0	0	0	3	