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Agents of change: roles and mechanisms in realizing decentralized circular water initiatives

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Noor van Dooren, Jan Starke & Henk-Jan van Alphen

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Agents of change: Roles and mechanisms in realizing decentralized circular water initiatives

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Authors
Noor van Dooren, Dr. Jan Starke & Henk-Jan van Alphen

Quality assurance
Dr. Stefania Munaretto

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More information
Noor van Dooren
T +31 30 606 9617
E Noor.van.Dooren@kwrwater.nl

PO Box 1072
3430 BB Nieuwegein
The Netherlands

T +31 (0)30 60 69 511
E info@kwrwater.nl
I www.kwrwater.nl

KWR wice

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Executive Summary

This report is the result of activities 2 (governance analysis of organizational forms throughout the process) and 3 (governance analysis – finance and legislation structures) from WP3 (governance and social and economic analysis) of the Interreg North Sea project Anthropocene Nutrient and water Control for HOlistic resilience and Recovery (ANCHOR).

Introduction
This report examines how key individuals, referred to as agents of change, contribute to the realization of decentralized circular water initiatives and by driving propelling mechanisms that enable these initiatives to remain transformative over time, i.e. to remain radically different from the status quo. Using the ANCHOR cases as examples of small wins, the study investigates how individual agency contributes to spreading (becoming more numerous), deepening (gaining more in-depth knowledge) and broadening (moving beyond a certain field, sector or interest) of such initiatives in light of legal, financial and organizational barriers.

Conceptual framework
The report combines two theoretical perspectives. The Small Wins framework (Schagen, Metze, De Olde, et al., 2023) explains how pioneering initiatives contribute to transformative change through propelling mechanisms such as learning-by-doing, partnering and replicating. The Agents of Change framework (van Aalderen & van Dooren, 2024) identifies different actor roles, including visionaries, knowledge brokers, coalition builders and resource brokers. Together, these frameworks are used to analyse how individual actors contribute to transformative development pathways for the realization of decentralized circular water initiatives.

Methodology
A qualitative case-study approach was applied in four ANCHOR initiatives: De Nieuwe Dokken (Ghent, Belgium), Jenfelder Au (Hamburg, Germany), Oceanhamnen (Helsingborg, Sweden) and Superlocal (Kerkrade, The Netherlands). Data was collected through documents, workshops and semi-structured interviews with key actors. Interview transcripts were coded using an abductive approach. The analysis focused on identifying organisation, legislative and financial developments and challenges and identifying patterns of recurring co-occurrences between agent-of-change roles and propelling mechanisms.

Results
Organisation, legislation and finance
The four initiatives operate in different institutional settings but share an ambition to develop circular neighbourhood-scale water systems. All cases faced legal, financial and organizational barriers relating to resource recovery, decentralized treatment and governance arrangements. Successful implementation depended on a combination of political support, stakeholder collaboration, innovative financing and the ability to navigate existing regulatory frameworks.

Agency and propelling mechanisms
The analysis shows that different agent-of-change roles become important at different stages of project development. In the conceptual phase, visionaries, networkers and coalition builders were crucial for forming partnerships and mobilizing support. During development, knowledge brokers and resource brokers played key roles in learning-by-doing, professionalization and stabilization. In later

stages, legitimizers and knowledge brokers supported embedding, credibility and the transfer of lessons to other contexts. Across all cases, the most recurring co-occurrences were:

- Knowledge brokers with learning-by-doing;
- Coalition builders and networkers with partnering;
- Resource brokers with professionalization and stabilization.

Discussion

The findings demonstrate that propelling mechanisms are closely connected to human agency. Different roles become relevant at different stages of development rather than remaining fixed throughout a project's lifecycle. The study also identifies three broader insights: (1) successful initiatives often depend on a small group of highly committed individuals; (2) embedding innovations into mainstream structures creates a paradox, as it simultaneously strengthens continuity and may reduce transformative momentum; and (3) patterns of recurring co-occurrences between roles and mechanisms indicate meaningful relationships, although causal claims cannot be made without empirical validation.

Conclusion

Decentralized circular water initiatives can act as small wins that contribute to wider sustainability transformations. Their success depends not only on technological innovation, but also on the capacity of agents of change to create partnerships, mobilize resources, facilitate learning, establish legitimacy and transfer knowledge beyond the original initiative. The report concludes that transformative change emerges through the interaction between propelling mechanisms and the individuals who activate and sustain them throughout the different phases of an initiative.

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1. Introduction

This report is the result of activities 2 (governance analysis of organizational forms throughout the process) and 3 (governance analysis – finance and legislation structures) from WP3 (governance and social and economic analysis) of the Interreg North Sea-Project ANCHOR ((Anthropocene Nutrient and water Control for Holistic resilience and Recovery). The report examines how agents of change contribute the realization and ultimately spreading, deepening and broadening of decentralized wastewater initiatives through the activation of propelling mechanisms. It uses the demo sites included in the ANCHOR-project as case studies, approaching the demo sites as so-called small wins.

1.1. Motivation and relevance

The ANCHOR case initiatives are pioneers on a mission. Their mission is to achieve a future-proof, circular water service provision at neighbourhood scale. To this end, the five initiatives establish urban water management systems in different shapes and forms. A common system component is the source separation of water streams by means of vacuum sanitation. Moreover, the different urban water management systems entail divergent solutions and novel and innovative approaches for black water utilization (recovery of nutrients and energy by means of anaerobic digestion), grey water utilization (heat recovery, water reuse, local infiltration), as well as drinking water provision (for example, by treating and utilizing rainwater). These innovative urban water management solutions are implemented at neighbourhood scale in the five different cases. On this scale, further experimentation and adaptation is possible, while concepts are rolled out in real-world settings with real-world challenges. As pioneers, such initiatives play an important role in stimulating transformative change by innovation to address sustainability challenges (Schot & Steinmueller, 2018). Transformative change leads to outcomes that radically differ from established status quo practices. For instance, while current water service provision is organized in a linear manner, more future-proof approaches might require a circular organization, where the water demand is reduced, or water is reused, when an absolute reduction is not feasible (Bouziotas et al., 2019).

However, research shows that innovative pioneers become less transformative over time (Borrás & Schwaag Serger, 2022; Sen, 2014). For instance, during their evolving development pathways, initiatives might need to make compromises in light of legal, social or financial-economic barriers. The danger arises that - step by step - initiatives align with status quo practices and lose sight of their transformative ambition (Lasseur et al., 2026; Schagen, Metze, de Olde, et al., 2023; Silvius et al., 2023). For example, while an initiative might initially plan to be completely independent from the intake of public drinking water and therewith form a small-scale circular system, financial considerations or legal obligations might force an initiative to seek a connection to the public grid. Moreover, promising local initiatives seldomly spread to different settings, which would contribute to broader transformative change. In this sense, a recent report stated that “although interesting demonstration projects with decentralized solutions […] are underway in several world regions, actors developing and implementing this transformative innovation are not effectively coordinating their efforts and sharing the latest knowledge” (Binz et al., 2024, p. 3). These insights indicate that knowledge lacks on how pioneering initiatives for more circular and sustainable urban water management solutions remain transformative over time and contribute to larger-scale transformative change.

To contribute to this debate, this research zooms in on the mechanisms of how and to what extent the cases have remained transformative in the face of legal and financial challenges and the role of agents of change in driving propelling mechanisms within the initiatives. To this end, we analytically approach the ANCHOR cases as small wins. Small wins are "concrete, complete outcomes of moderate importance [that] build a pattern that attracts allies and deters opponents" (Weick, 1984, p. 40). Small win initiatives tackle complex societal problems by making first, small-scale, meaningful steps towards a desired direction (C. J. A. M. Termeer & Dewulf, 2019). For example, a single circular neighbourhood does not solve contemporary sustainability challenges in water service provision. However, such an initiative is a first step towards circularity-oriented urban water management systems. These first steps are important, because propelling mechanisms provide the energy and positive feedback to help maintain a self-enforcing dynamic, by which small wins scale up towards broader, systemic transformative change (C. J. A. M. Termeer & Metze, 2019). As other actors in different regions notice the successes of the circular neighbourhood, they might become inspired to develop similar solutions in other settings, or to adopt successful characteristics, while erasing failing ones. Small wins solidify their transformative character by means of three pathways: spreading, deepening, and broadening (Schagen, Metze, de Olde, et al., 2023). Since initiatives are copied or grow in their ambition towards addressing other aspects of sustainability challenges, small wins become more influential until they reach a critical mass that cannot be neglected anymore (C. J. A. M. Termeer & Metze, 2019). We will further explain and conceptualize these characteristics in more detail in the conceptual framework.

In this study we focus on the agency of individual actors in contribution to the realization of small win initiatives. We depart from the assumption that key individuals contribute to transformative change through distinct agents of change roles that foster propelling mechanisms of small win initiatives. Thus, we assume individuals are not only instrumental in realizing small win initiatives, but also in sustaining and advancing them overtime, through amplification pathways such as spreading, broadening and deepening. To analyse these contributions, we draw on the Agents of Change framework developed by KWR (van Aalderen & van Dooren, 2024). This framework distinguishes between nine complementary roles of agents of change through which actors influence transformative change. For instance, initiatives might require a visionary who keeps eyes on the original transformative ambition or a knowledge broker who is the organizational memory and keeps track of experimentation results and learning outcomes in the initiatives. In this study, we conceptually integrate agent of change roles with the propelling mechanisms stemming from the small wins framework. By doing this, we identify which actors, in which roles, and with what knowledge and resources are crucial in the different development phases of small win initiatives.

Therefore, the following research question arises: *How do agents of change contribute to the realization of decentralized circular water initiatives by driving the propelling mechanisms that help spread, broaden and deepen these initiatives?*

By analysing the ANCHOR cases as small wins operating in diverse institutional contexts, we derive insights into the role of agency in enabling transformative change which can contribute to successful replication elsewhere. In this respect, our approach complements institutional perspectives, such as that of Binz et al. (2024), which focus on the barriers and enabling conditions associated with the mainstreaming of pioneering initiatives. Whereas such approaches emphasise the institutional context, our analysis highlights the actor-level mechanisms through which transformative processes are initiated, sustained, and expanded.

This knowledge is scientifically relevant to unravel the actor dynamics that are the motor of small win propelling mechanisms. By doing this, we contribute to the literature on small wins and transformative change. The standing literature on the upscaling of small wins has so far focused on systemic characteristics, resulting in the identification and empirical investigation of propelling mechanisms (Schagen, Metze, de Olde, et al., 2023; Silvius et al., 2023; C. J. A. M. Termeer & Metze, 2019). The contributions of individual actors in stereotypical roles have received less attention, so far. Our analysis contributes to filling this knowledge gap. Moreover, the produced knowledge is also practically and socially relevant, because it helps initiatives to prioritize resources in the different development phases of ambitious initiatives. By means of the newly developed framework, initiatives in various settings can identify their own agent of change roles and couple them with individuals. This helps initiatives to maintain their transformative ambition as well as to increase and target their efforts towards contributions that effectively address societal grand challenges.

1.2. Reading guide

This research bundles the results of activity 2 and 3 of work package 3.2 or the ANCHOR project in one integrated report[1]. In Chapter 2 we explore the concepts of agents of change and propelling mechanisms of small wins. In Chapter 3 we sketch our method of (i) building case descriptions regarding the organisation, legislation and finance of the ANCHOR cases, (ii) identifying agents of change within the ANCHOR cases and (iii) assessing their contributions to propelling mechanisms. In Chapter 4, we present the results of our research, highlighting the organisational, legislative and financial barriers of the case studies (WP3.3) as well as describing the co-occurrences of agent of change roles and propelling mechanisms (WP3.2). We then discuss the relevance and significance of our findings and established knowledge on agency in small wins in Chapter 5. We finalize the report by synthesizing our conclusions in Chapter 6.

2. Conceptual Framework

Decentral neighbourhood scale urban water systems, such as those in the ANCHOR cases, contribute to the transition of the current central water system to a more circular water system. Transitions like this call for transformative change. Transformative change follows from continuous, in-depth change (Bours et al., 2021), and, over time results in fundamental changes of how things are done. It fosters radically different approaches and outcomes compared with the status quo.

2.1. Small wins

Small wins are concrete, in-depth changes (Weick, 1984) and can be seen as seeds of transformative change (Schagen et al., 2022; Termeer & Dewulf, 2019). Thus, transformative change is achieved through the way that small wins develop. Current problems and their proposed solutions, such as moving from the current linear economy to a circular economy, are problems of great magnitude and complexity. This magnitude and complexity reduce the quality and quantity of actions taken to solve the problem, due to feelings of frustration and helplessness (Weick, 1984). Recasting larger problems

[1] Work package 3 of the ANCHOR project relates to the *governance and social and economic analysis* of the decentralized circular water initiatives. Activity 2 of WP3 relates to the *governance analysis of organizational forms throughout the process* of developing and implementing the initiatives. Activity 3 of WP3 relates to the *governance analysis of financial and legislation structures* of the initiatives. The research design of this report bridges these two activities into one overarching and integrated study, relating the organisation of the initiatives to the financial and legal challenges they experienced through an agency perspective.

into smaller problems allows people to identify potential small wins. The ANCHOR cases are examples of potential small wins by contributing to the transition to a circular economy on a smaller scale, namely decentral neighbourhood scale urban water systems.

Small wins are described by Weick (1984) as concrete, complete, implemented outcomes of moderate importance. One small win might seem unimportant, but a series of small wins may result in a pattern that can be seen as a larger scale win. A successful small win can contribute to new opportunities for next potential small wins. However, it should be noted that this does not happen in a logical, linear manner, but rather in an unpredictable, fragmented manner. Thus, small wins cannot be preplanned.

Identifying small wins can be challenging. However, if they remain unrecognized, they are not able to contribute to large-scale transformative change (Termeer & Metze, 2019). To better identify and recognize small wins, Termeer and Dewulf (2019) have distinguished four characteristics of small wins. Termeer and Metze (2019) adapted these characteristics into five characteristics of small wins contributing specifically to the transition to a circular economy (Table 1). Following these characteristics, we analytically treat the five ANCHOR cases as small wins.

Table 1 *Five characteristics of small wins that contribute to the transition to a circular economy with identified indicators and contra-indicators (Termeer & Metze, 2019).*

Characteristic	Indicator	Contra-indicator
Concrete outcomes of moderate importance	Visible results and lived experiences Intermediate results Micro or macro level	Promises and ideas only Fixed best practices Large scale
Contribute to a circular economy	Clear context specific narrative of current and potential contribution Partly linked to circular economy indicators or the ladder of circularity	No clue Small losses for many actors
In-depth changes	Second-order change[2] Radical new practices	More of the same Quick wins Low hanging fruit
Have overcome resistance and barriers	Have overcome technical, financial and/or regulative barriers Faced resistance	Mentioning barriers only (Too) easily achieved
Connection technical and societal change	Various modes of synergies	Technological innovations only Societal innovations only

One small win does not necessarily accumulate into more small wins and thus transformative change (Termeer & Dewulf, 2019; Weick, 1984). So called propelling mechanisms contribute to the development of small wins into transformative change through amplifying pathways (Termeer & Metze, 2019; Weick & Quinn, 1999). Following Schagen et al. (2022), we distinguish between three different amplifying effects, namely: (1) spreading, (2) deepening, and (3) broadening. *Spreading* refers to an initiative becoming more numerous. The initiative itself does not change but rather expands to other places or gains more members. *Deepening* refers to gaining better and more in-

[2] First-order change relates to improving current practices without altering underlying assumptions. Second-order change relates to changes to current practices, but also structures and processes related to those practices, taking notice of underlying assumptions. Third-order change relates to altering values, frames and logics underlying the current system (Bartunek & Moch, 1987; K. Termeer et al., 2024).

depth solutions to problems, for example moving from second-order change to third-order change[2]. *Broadening* refers to the consequences of an initiative moving beyond its' own field, sector or interest to others. Propelling mechanisms that contribute to these amplifying effects can be defined as "non-linear chains of events that reinforce themselves through positive feedback loops that create increasingly favourable outcomes" (Termeer & Dewulf, 2019). Schagen et al. (2022) clarified the positive feedback loops and in doing so identified eight propelling mechanisms (Table 2) that play an important role in fostering continuous transformative change through spreading, deepening and broadening small wins (Figure 1).

Table 2 *Definitions of the eight propelling mechanisms (Schagen, Metze, De Olde, et al., 2023)*

Mechanism	Definition
Learning by doing	Uncover resources and barriers, provide quick feedback on the effectiveness of strategies, offer immediate insights into system reactions, and encourage reflection on personal and other belief systems.
Partnering	The pooling of resources, competences and capacities between different relevant actors, who defined shared norms and interests within preferably long-term cooperation. Expanding and connecting the level playing field of the initiative.
Stabilizing	The advantages of the practices and narrative of an initiative and the disadvantages of the status quo are internalizing in the minds and routines of actors such as members, partners, and institutions; making them resilient to resistance and ensuring continuity.
Embedding	The embedding of an initiative implies the adoption and integration of its design, approach or outcomes into existing local structures (institutions, regulations, planning, agenda and ambitions) and/or communities of practice.
Logic of attraction	Financial and human resources tend to flow toward winners (Weick, 1984) and create the preparedness and goodwill to lower financial or legislative barriers. Moreover, positive results discourage the usual opponents and lower existing political and societal resistance.
Professionalization	Becoming (formally) recognized as a serious player instead of an outsider or temporary experiment. This is for example reflected in the ability to acquire funding and subsidies or being invited to official meetings.
Energizing	Concrete outcomes and visible results provide actors with the excitement that these are attainable, thereby encouraging them to look ahead for the next step. A reassuring process of commitment, optimism, and trust in the actors involved and the results.
Replicating	The effect when other individuals, companies and organizations start copying the approach or/and practices of an initiative.

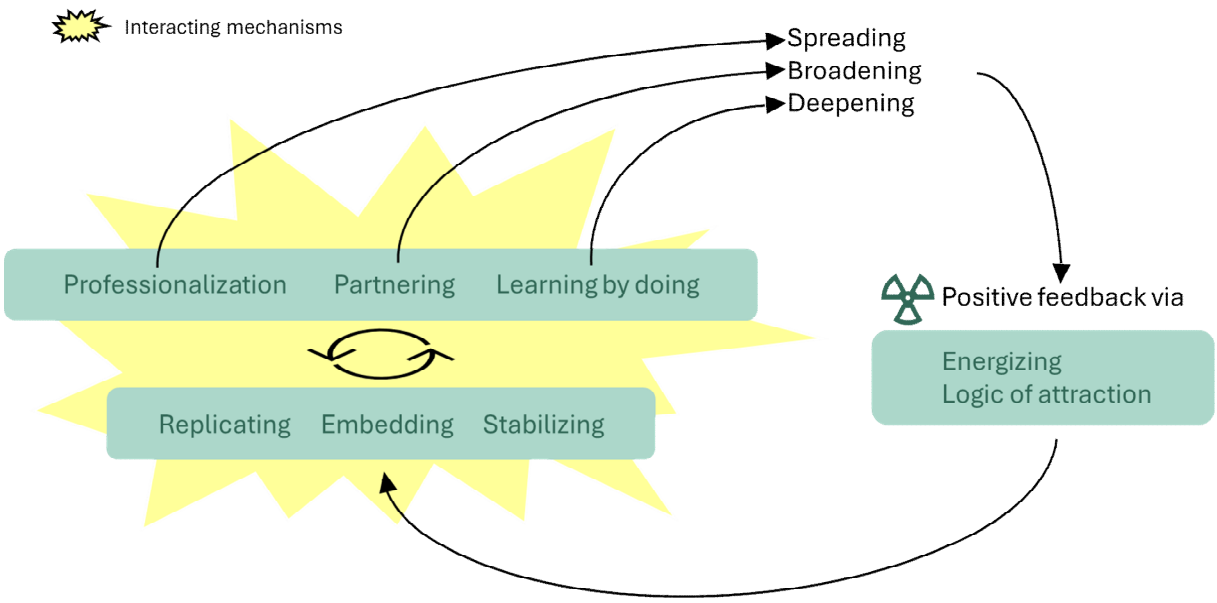

Figure 1 *Dynamics of propelling mechanisms and spreading, broadening and deepening (adapted from Schagen, et al. (2022)*

2.2. Agents of change

While Schagen et al. (2022) gained useful insights into the different mechanisms that drive initiatives to achieve transformative change, there is little focus on which actors play important roles in activating these mechanisms.

Actors that could play an important role in activating these mechanisms to achieve continuous transformative change are so called agents of change (in literature also often referred to as policy entrepreneurs or change agents). Most definitions of the concept of agents of change refer to them as actors that strive for substantial and fundamental change and are willing to invest resources (such as time, energy and money) and take risks to achieve this change (Brouwer & Biermann, 2011; Mintrom & Norman, 2009). They actively create, anticipate for, recognize, frame and use opportunities to realize their intended change (Cairney, 2018; Dunn et al., 2017; Gliedt et al., 2018). These actors thus manoeuvre themselves in the complex playing field of achieving change, often within the domain of their professional environment, and can play a key role in initiating and directing new ways of operating. In a recent study, van Aalderen and van Dooren (2024) provided conceptual clarity within the broad field of literature on agents of change and the plethora of qualities ascribed to these actors. Based on an extensive literature review, they developed a conceptual framework of the different roles, actions and qualities of agents of change (Figure 2).

Van Aalderen and van Dooren (2024) distinguish between four categories that shape the actions of agents of change: (I) idea advocacy, (II) relationships, (III) coupling and (IV) substantiation. Within the category of idea advocacy, agents of change take on the role of a *knowledge broker*, focusing on learning and developing new knowledge and/or ideas, and the role of a *visionary*, anticipating, creating and advocating for unconventional future trajectories. The second category focuses on

building and maintaining relationships, with the roles of networker and coalition builder. The roles in the third category build upon these relationships. As *boundary spanners*, agents of change can identify, exploit, and create windows of opportunity to suggest appropriate policy responses. Furthermore, they can act as *issue linkers* by identifying multiple problems and connecting them to solutions and opportunities, thereby enhancing policy responses. Lastly, as a *problem broker*, they can frame proposed solutions as the most appealing policy options. The final category, substantiation, is more strongly focused on the practical realization of the intended change, with the role of *resource broker*, mobilizing power and resources, and *legitimizer*, demonstrating feasibility of an initiative.

It should be noted that the roles, actions, and qualities attributed to agents of change are not mutually exclusive, and some roles can be performed or pursued in a strongly interconnected manner. Additionally, an individual can switch roles or assume multiple roles simultaneously, influenced by factors such as career development, policy changes, or a sense of urgency. The contribution of agents of change is expected to vary across the conceptual, development and impact phases of small-win initiatives. Consequently, the analysis examines not only which roles are present, but also when they become most influential.

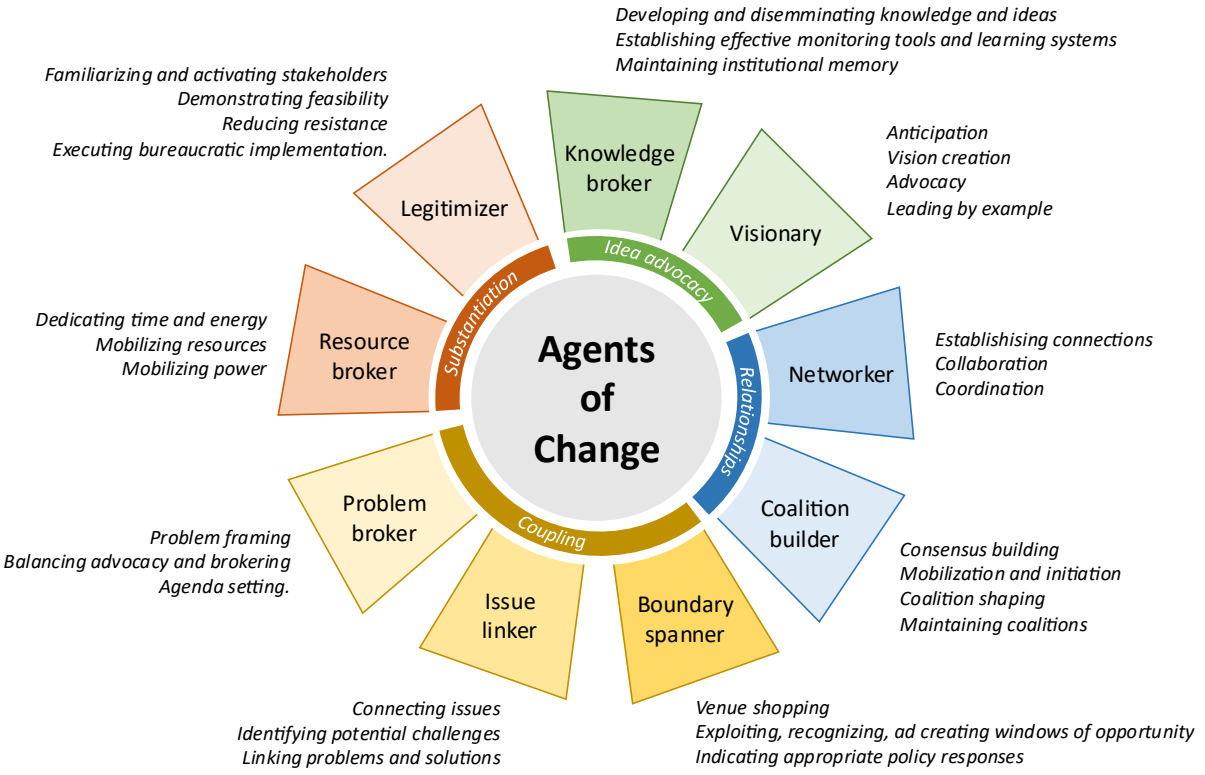

Figure 2 *Conceptual framework of nine different roles agents of change can take on, including the strategies that define these roles. The roles are divided into four categories: idea advocacy, relationships, coupling and substantiation (adapted from Van Aalderen & van Dooren, 2024)*

3. Methodology

This research aims to identify through which roles agents of change have influenced the realization of the initiatives and which propelling mechanisms for spreading, broadening and deepening they have activated. We understand mechanisms from a social dynamics perspective, as "the cogs and wheels of the causal process through which the outcome to be explained was brought about" (Hedström & Ylikoski, 2010, p. 50). Instead of statistically accessible cause-effect relationships, social mechanisms zoom in on the process of how a societal outcome has come about. In our case, the outcome for an initiative is to remain or become more transformative. The point of reference is currently predominant, linear practices of water management systems at the negative bar and the initiative's own ambition towards a more circular system on the positive bar. Instead of identifying and measuring independent variables for this outcome, we trace the processes of how this outcome has come about (Flyvbjerg, 2006). Especially, we aim to identify patterns in co-occurrence of and relationship between different agents of change roles and propelling mechanism.

To examine how small-win initiatives are realized and subsequently contribute to wider transformation, we depart from two complementary analytical perspectives: the agent of change framework and the framework of propelling mechanisms for small wins. We chose to depart from both the small wins and agents of change models, because the small wins literature specifically focuses on maintaining the transformative ambition of small-scale initiatives, which is the primary focus of our analysis. However, this branch of literature could benefit from a specific focus on the actor level as agents of transformative change. Adding conceptual building blocks from the 'Agents of Change' framework provides such a focus. Rather than assuming an integrated relationship between the two frameworks from the outset, we use an empirically grounded approach to investigate how they interact in practice. The purpose is to identify patterns of co-occurrence between different agent roles and propelling mechanisms and based on these patterns, develop an integrated understanding of how small wins are enabled, consolidated, and potentially upscaled.

The purpose of combining the frameworks is thus not to suggest that particular agent of change roles inherently produce particular propelling mechanisms. Rather, the empirical analysis is used to identify how particular forms of agency activate, enable, reinforce, or sustain particular mechanisms in specific contexts. In this sense, the combination is an abductive and empirical rather than deductive exercise. The two frameworks retain their distinct analytical meanings, but their co-occurrence provides a way to examine the relationship between actors and processes that is not captured by either framework alone. Rather than the production of law-like, predictive, and context-independent knowledge, this analysis aims to produce concrete, context-dependent knowledge of the four case studies (Flyvbjerg, 2006) which can provide insights for replication elsewhere.

3.1. Casing strategy and case study overview

The selected cases are analytically approached as four small win initiatives towards circular water service provision at neighbourhood scale (see Table 3 for an overview). Cases are determined by the

ANCHOR project[3] and therefore not necessarily theory guided. Still, this pragmatic selection is suitable for our purposes, since the cases are included in the ANCHOR project as frontrunner initiatives with comparable characteristics and in comparable institutional, economic, and political settings in North-Western Europe (see also Yin, 2008). All cases are beyond the conceptual development stage, partly operational, but still developing. The casing strategy does not target a comparison to assess cause-effect relationships; instead cases are regarded cumulatively to identify distinctive and relevant characteristics for theory development (Yanow & Schwartz-Shea, 2015).

Table 3 *Overview of case characteristics, based on (van Duuren, 2020), amended.*

Case	Location	Number of households (HH) and inhabitant equivalents (IE)	Transformative ambition	Management structure
De Nieuwe Dokken	Ghent, BE	244 HH 1,200 IE	High-quality, future-proof neighbourhood	Municipality in the lead; private contractors
Jenfelder Au	Hamburg, DE	835 HH 2,000 IE	Circular and liveable neighbourhood	Water company in the lead; private contractors
Oceanhamnen	Helsingborg, SE	343 HH 1,500 IE	Circular and liveable neighbourhood	Municipality in the lead; private contractors
Superlocal	Kerkrade, NL	129 HH 250 IE	Focus on circular construction; future-proof water management system	Public sector initiative (municipality and water board); private contractors

3.2. Data collection and analysis

As first step, we gathered existing grey literature and reports. These reports were partly identified by internet search and partly provided by consortium partners with long-standing experience in the analysed cases. Based on these reports, we conducted desk research to write extensive case descriptions[4], which were fact-checked by the case owners. Case owners are consortium partners with a standing work history on the different cases. They usually have positions in the public sector initiative-takers of the different cases. These case descriptions included insights on the development of the initiatives, the water systems they use, their legal and financial structures and challenges, and the governance context the initiatives are located in. These findings are summarized in Chapter 4.

Second, we identified entry points for the identification of potential agents of change. Individuals who have played a key role in the conceptualization, development, and knowledge dissemination in the eyes of case owners, are considered potential agents of change. To this end, we had introductory talks with all case owners. To come up with potential agents of change that do not come up spontaneously in the minds of case owners, we facilitated an agent of change identification workshop in September 2024 in Hamburg, alongside a consortium meeting. During this workshop, we presented the conceptual, ideal-typical agent of change roles from the literature and identified matching individuals in all cases.

[3] In the ANCHOR project, five demo sites are represented. However, only four of these demo sites were included as case studies in work package 3. The case of Schoonschip was not examined in this specific work package. However, we did conduct a short governance analysis related to the legal and financial context of Schoonschip which can be found in Annex I.
[4] Outcome of WP3.3

Third, we developed a semi-structured interview guide (Weiss, 1995). To this end, we distilled questions from the developed provisional conceptual framework. Case owners were involved in cross-checking these questions and added further questions of particular interest. The interview guide is enclosed as annex II.

Fourth, we interviewed potential agents of change. Interviews were semi-structured, allowing us to zoom in on interesting aspects that emerged during the interviews. These interviews lasted for 30 to 60 minutes. All interviewees provided informed consent, and all interviews were audio-recorded. An overview of all conducted interviews in provided in annex III.

Fifth, we performed a qualitative content analysis of all interview data. For this purpose, interview recordings were transcribed. A code book was developed based on the roles in the agents of change framework and propelling mechanisms from the small wins framework. This code book was applied to analyse the transcribed interviews using MAX QDA. In this analysis, we focused on what actions of individuals contributed could be related to the different roles of agents of change and the different propelling mechanisms. The co-occurrence of particular agents of change roles and propelling mechanisms was analysed to identify potential influences and relationships[5]. This was done by separately coding the occurrence of agent of change roles and propelling mechanisms, and later identifying co-occurrences. These findings were triangulated based on insights from the document analysis and multiple interview transcripts. Analysis results are summarized in Chapter 4.

[5] Outcome of WP3.2

4. Results

This chapter analyses the organisational, legal, and financial dimensions of the five ANCHOR case studies. It examines how pioneering projects in Belgium, Germany, Sweden, and the Netherlands have organised ownership and responsibilities, addressed regulatory barriers, secured political and stakeholder support, and developed viable financing arrangements. The case studies demonstrate that there is no single governance model for water-wise city neighbourhoods. Instead, successful implementation depends on finding context-specific solutions that align technological innovation with supportive institutions, enabling regulations, and sustainable business models.

4.1. Nieuwe Dokken, Ghent [BE]

4.1.1. Organisation, legislation and finance

Development and background

Ghent is a medium-sized city in Belgium with approximately 260 000 inhabitants in 2020. The city is aiming to become climate neutral in 2050 (Ampe et al., 2021). In 2011, the Municipal Development Agency (Sogent) launched a call to develop an old industrial site known as the Oude Dokken into a residential neighbourhood. A partnership between investment fund Clean Energy Innovative Projects and three real estate companies (Revive, Van Roey and CAAAP) won this call, particularly for their focus on sustainability and financial components (Ampe et al., 2021). This led to the establishment of DuCoop in 2014, which was later joined by other investors such as Trividend and EnerGent. Following, the old industrial site Oude Dokken was repurposed as a residential neighbourhood called De Nieuwe Dokken. This neighbourhood consists of 400 apartments, 40 commercial buildings and two communal buildings (Ampe et al., 2021).

Integrated urban water system innovation

De Nieuwe Dokken is serviced by a decentralized water system, which serves approximately 1200 people equivalent. DuCoop focused on creating a large-scale urban demo site with closed cycles for energy, water, and raw materials from waste processing (European Commission et al., 2023). The project development followed the concept of Zero Wastewater with Energy and Nutrient Recovery (ZAWENT) (Crabbé, 2017).

The decentralized water system works with small-scale treatment technology. Wastewater streams are separated into black (excreta and organic food waste) and grey (water from showers, sinks and washing machines) water streams, which are treated separately. The black wastewater stream is highly concentrated with organic waste and is fed by vacuum toilets and food grinders. The vacuum toilets are installed by Roediger and only use approximately one litre of water per flush. The black wastewater stream is led to a digester and converted into biogas, which provides sufficient energy for 1-2% of the heating demand. The residual product is struvite (a fertilizer), which can be used for city parks (Ampe et al., 2021; OVAM, 2018). From the grey wastewater heat is recovered, which covers approximately one-third of the heating demand. The remaining two-thirds are covered by residual heat from nearby soap company Christeyns (Block & Dehaene, 2022). In return, treated grey water from De Nieuwe Dokken serves as process water for Christeyns (Crabbé, 2017; OVAM, 2018).

Challenges

According to municipal guidelines, child-sized toilets were mandatory at the school located in De Nieuwe Dokken. The manufacturer that provided vacuum toilets for DuCoop, however, did not make such toilets. As DuCoop had to follow the guidelines, they installed regular child-sized toilets (no vacuum) which had a collector attached to them instead (Ampe et al., 2021; OVAM, 2018).

Moreover, the importance of using the decentralized wastewater system to its full capacity formed another challenge for DuCoop. Until the beginning of 2022, only 200-300 people lived in De Nieuwe Dokken, which meant that there was too little inflow of wastewater. This restrained the production of fertilizer and reusable water that was accounted for in the business model (Terlou, 2022). It could take up to 2028 until full capacity of the process plant is reached.

Legal structure and key developments

Since October 2023, Flemish legislation states that the implementation of installations that catch and infiltrate rainwater is mandatory when (re)building houses. In some houses in De Nieuwe Dokken, the harvested rainwater is used in homes. Excess water can be infiltrated into the ground (Flemish Government, n.d.; van Duuren, 2020; Vanacker, 2021). The municipality created a window of opportunity for the project via a tender procedure. High sustainability targets were set for the new residential neighbourhood in the old harbour, which DuCoop's project could achieve (Terlou, 2022). DuCoop had to overcome several legal obstacles to realize the project. First, according to formal rules, domestic wastewater must be disposed of through the large-scale city wastewater plant. DuCoop does not comply with this rule, as it constructs local collectors and treatment technology. The rule could be circumvented if the wastewater was considered industrial wastewater by the Flemish Environmental Agency. To achieve this, DuCoop negotiated with the municipal solid waste company to get permission to collect organic food waste and add this to the black water sewage by using food grinders (Ampe et al., 2021).

Secondly, the reuse of treated wastewater in residential homes is limited (e.g., for toilet flushing). DuCoop found a different use for the treated wastewater at Christeyns, which could use it as cooling water (Terlou, 2022). Moreover, to finance the investments for the source-separated wastewater system, DuCoop had a difficult time getting a loan from financial institutions. The institutions' risk analysts were hesitant to provide a loan to such an unusual project which makes use of a novel combination of technologies (heat network and wastewater treatment). Eventually, Triodos Bank, specializing in sustainability, cautiously provided a loan with strict default conditions. Triodos used its monopoly position to preserve strict requirements for the loan (Ampe et al., 2021).

Financial structure and key developments

In the years after the establishment of DuCoop, several other financiers joined. These were social economy investors (Trividend), energy cooperative (EnerGent), impact investors Human Capital and OYA Seed, and the drinking water utility of the municipality (Ampe et al., 2021).

As it constructs local sewers and treatment technology, DuCoop does not comply with the mandatory-connection rule for domestic wastewater. To overcome this challenge the taxes for water treatment that are levied by the water utility on the water bill of the residents is transferred directly to DuCoop. The remainder of the financial means that were required for technological development was provided by Flanders, the EU, a financial institution, and impact investors. Real estate companies were mainly responsible for financing investments in the residential buildings. The European subsidies that DuCoop received were used for equipment investments and to add engineers to the team (Ampe et al., 2021).

Inhabitants at De Nieuwe Dokken receive water that has the same price as anywhere else in Ghent. The same principle goes for energy in the neighbourhood (Block & Dehaene, 2022). To prevent residents from having to make large investments in the additional costs of circular technologies, DuCoop covers all the investments that exceed standard technologies (closed water and energy cycle in De Nieuwe Dokken), based on a so called ESCO model (Energy Service Company). This makes DuCoop the owner of all installations. Residents pay DuCoop a monthly compensation for the delivered services, over which DuCoop charges a margin (Crabbé, 2017). Since 2019, residents can get shares in DuCoop, and in this way also share in the future profits made by the cooperation (Block & Dehaene, 2022). If you buy a house in De Nieuwe Dokken, you also receive a share in the company (European Commission et al., 2023), which gives you a voting right in the General Assembly.

For the central heating network, residents pay a fixed yearly fee that covers the access to the heating system and the maintenance. They also pay a monthly fee for their actual heat consumption. Finally, they pay a starting fee for connection to the heating system (Block & Dehaene, 2022).

Governance context

Conventionally, in Ghent, regional sewers and treatment plants are managed by Aquafin, the Flemish wastewater treatment company. The Flemish Environment Agency oversees the economic and environmental performance of this company. In general, municipalities are responsible for local sewers and transport of wastewater on their territory. However, in Ghent this is outsourced to Farys, a public-private drinking water utility (Ampe et al., 2021).

The Belgian wastewater system overall is characterized by end-of-pipe management, fostering a flush-and-forget culture. Criteria for treated wastewater are being tightened to address the focus on clean waterways. Additionally, there is a focus to increase the connection rate of households to wastewater infrastructure (in 2021 this was only 86% as compared to 99% in the Netherlands) (Ampe et al., 2021). With its strict sustainability criteria, DuCoop's project in De Nieuwe Dokken fits within the ambition of Ghent to achieve climate neutrality by 2050 (Ampe et al., 2021). DuCoop worked closely with the municipality of Ghent. The municipality set high sustainability targets for the building of De Nieuwe Dokken. The real estate developers got the approval of the municipality to rebuild the site and comply with the targets. The province of East-Flanders and the Flemish government supported the project financially through district heating capex subsidies. The Belgian government did not have an influential role in the project (Terlou, 2022). On a higher governmental level, the EU played an important role by providing funding for the project and monitoring it. However, the EU did not actively influence decisions within the project.

Sogent is seen as the project lead, since they started the project that led to De Nieuwe Dokken. The intentions of Sogent and DuCoop for De Nieuwe Dokken differ from each other. As a municipal company, Sogent mainly has the ambition to create a sustainable neighbourhood which is accepted on both a technical and social level. DuCoop on the other hand focuses more on technical sustainability as a goal (Block & Dehaene, 2022).

It proved to be difficult to get the approval and cooperation of other involved services and institutions, such as the wastewater utility and bank, because the project differs from the usual regulatory regimes. This took DuCoop a lot of time to set up and implement the project (Block & Dehaene, 2022). Since Sogent and the Flemish Environmental Agency were both involved from the start of the project, DuCoop was able to use these connections to gather stakeholders in a discussion group. This allowed them to improve their relations with different actors, as well as their reputation and position among

the more conventional stakeholders (Ampe et al., 2021). It is these good connections that seem to have played a crucial role in realizing De Nieuwe Dokken and successfully building DuCoop's niche.

Synthesis: Small win?

De Nieuwe Dokken can be considered a small win because it represents a concrete and implemented achievement of moderate importance: a functioning circular sanitation system serving a new urban neighbourhood. The initiative did not only introduce technological innovations such as source separation, nutrient recovery, and energy recovery, but also required the development of novel organizational and financial arrangements through the DuCoop cooperative. This reflects in-depth change, as the initiative challenged established regulatory, financial, and governance practices rather than merely introducing a new technology. Moreover, the collaboration between public authorities, private developers, utilities, and investors demonstrates how small wins can connect local achievements to broader institutional and societal change processes. However, the project struggled with delayed implementation, difficulties in securing financing, and lower-than-expected resource recovery performance. Therefore, De Nieuwe Dokken exhibits the key characteristics of a small win, but its transformative contribution remains contingent on whether the lessons generated through its innovative governance and sanitation approach can be sustained and translated to other contexts.

4.1.2. Agency and propelling mechanisms

Table 4 *Actors involved in De Nieuwe Dokken*

Actor	Role
DuCoop	Cooperation responsible for De Nieuwe Dokken
City of Ghent	Municipality
Sogent	Urban development agency Ghent
Milieudienst Gent	Environmental agency Ghent
Farys	Drinking water utility
Schipperskaai Development	Real estate developer (CAAAP & Van Roey vastgoed)
Christeyns	Neighbouring soap factory
Circular	Commercial spin-off of DuCoop

Visionaries set the bar for sustainability ambitions

The development of the ZAWENT system at De Nieuwe Dokken was facilitated by Ghent's wider ambition to become climate neutral by 2050 and the redevelopment of De Oude Dokken, a former industrial site, into a sustainable residential neighbourhood. In 2011, Sogent launched a call for proposals for this redevelopment. A representative of Schipperskaai Development stated: *"They [Sogent] actually owned this plot of land and had drawn up a set of specifications in which they set out certain conditions, reflecting their rather high ambitions in terms of sustainability."* With these specifications Sogent sought to facilitate the development of a broad sustainable neighbourhood with attention to both technical and social perspectives. The specifications set by Sogent encouraged a broad approach to sustainability, encompassing both technical and social dimensions, but did not explicitly require a source-separated wastewater system.

An important opportunity for the development of such a system emerged through the work of Milieudienst Gent which had been exploring the potential of source-separated wastewater systems and produced an inspiration paper on the topic. As one employee of the agency noted: *"If we had never produced that inspiration paper, the ZAWENT system might not have come into existence."*

Together, Sogent's sustainability requirements and the environmental agency's preparatory work helped establish the direction and conditions for DuCoop to propose the ZAWENT system. These activities illustrate the role of visionary agents of change in the conceptual phase of the initiative, translating broad sustainability ambitions into opportunities for specific technological innovations.

The municipality's sustainability assessment framework (BREEAM) further strengthened this opportunity. One interviewee explained: "*In 2017, Ghent became the first city in Flanders to use such a sustainability meter [BREEAM] as a decisive factor in project allocation. This sustainability meter evaluates various aspects, not only the technical aspects of building operation but also mobility, social diversity, and more.*" The sustainability assessment framework [BREEAM] assessed proposals across multiple dimensions, including architecture, materials, mobility, social diversity and environmental performance. Crucially, water was included as a criterion in the award process, creating a direct link between the municipality's sustainability objectives and the proposed ZAWENT system. As one interviewee observed: *"For the first time, water was included as a criterion in the awarding of a project. The developer who ultimately won the contract understood this well."* Another interviewee emphasized the understanding of DuCoop of this framework: "*An exceptionally high score was achieved [by DuCoop's proposal], one that is rarely seen in other projects."* The call for proposals thus created a window of opportunity in which the initiative's ambitions could be translated into practice, enabling an innovative water system to become part of the neighbourhood's development.

Networking and coalition building were also identified to be important during the conceptual phase, where the initial idea had to be translated into a feasible project involving multiple stakeholders. A representative from Schipperskaai Development explained: *"I think that relationship management is always important, but I believe that during the preliminary phase – the stage when everything really needs to be established, when the idea is being developed into something feasible – you need to pay a great deal of attention to the relationship. Even if it's just a matter of finalizing contractual agreements, coming up against the practical realities and then engaging in dialogue with the authorities about how we're going to tackle these issues – that's a very intensive process during the preliminary phase."* Another interviewee emphasized these insights: *"Actively bringing stakeholders together is clearly crucial in the early phase of the project. I spent three years on this before everything was fully in place to move forward with contracting. It's truly a long-term effort, which is why it's such a key part of the initial phase."* This was especially important because the initiative challenged traditional arrangements for wastewater management.

Issue linking and navigating regulatory boundaries

The initiative challenged traditional regulations and arrangements, which sometimes lead to challenges. For example, implementing the wastewater system requires legal exemptions because some parts of the project deviated from traditional wastewater regulations. The ability to obtain these exemptions was related to early phase engagement with relevant stakeholders. One interviewee explained: "*Fortunately, there was a lot of goodwill. This was partly due to the fact that, from the very first plans – long before the first shovel hit the ground – we involved all relevant stakeholders in the process. We showed them what we aimed to achieve, how the project could take shape, and why it serves as an important example of how things can be done differently. This gave us some leeway to deviate from the rules."*

Examples of such exemptions are related to the treatment of domestic wastewater. Domestic wastewater was normally required to be discharged into a centralized wastewater treatment plant, whereas DuCoop developed decentralized collection and treatment systems. One way of addressing

this barrier involved negotiating with the municipal solid waste company to obtain permission to collect organic food waste and add it to the black-water stream through kitchen grinders, enabling the wastewater to be treated under a different regulatory classification. In addition, the reuse of treated wastewater in residential buildings was restricted, leading DuCoop to develop an alternative arrangement with the nearby soap manufacturer Christeyns, which now uses treated grey water as process water.

These examples show the importance of issue linking roles to come up with creative solutions to overcome regulatory barriers. They played an important part in identifying alternative configurations that could accommodate regulatory constraints while preserving the broader ambition of resource recovery. The findings further demonstrate how issue linker, coalition builder and networker roles complemented each other in the beginning phases of the initiative. Linking the initiative to wider policy ambitions helped identify opportunities, while stakeholder engagement created relationships with public officials and other organizations that could facilitate implementation within the existing legal framework.

Committed resource brokering

Based on the interviews, one individual was recognized as a committed resource broker throughout the development of the initiative. This role was essential for stabilizing and professionalizing the initiative. In the early phases of the initiative, this individual combined a visionary role with the ability to mobilize resources and maintain a long-term perspective. The individual's professional background in renewable-energy investment provided access to financial resources and other networks that could support the initial development of the project. These resources were important because the propelling mechanisms of professionalization and stabilization require sustained investment and organizational commitment. However, the fact that this individual, together with other actors, was able to successfully mobilize the necessary resources, does not mean this was an easy task.

The financial structure of the Nieuwe Dokken illustrates the scale and diversity of resources that had to be mobilized. DuCoop brought together private developers and a range of other investors, including social-economy and impact investors, energy cooperative EnerGent and the drinking water utility Farys. Furthermore, public and European funding was mobilized to support technological development and equipment investments. The residential buildings were primarily financed by real-estate developers. In addition, the initiative introduced a service-based financial model to separate the upfront costs for the wastewater system and the residents' investments for use of that system. This way, DuCoop retained ownership of the source-separated water system and covered investments that exceeded the costs of standard technologies, while residents paid for the services they received through the system.

Nevertheless, the initiative faced substantial financing difficulties. Although a successful initiative may eventually attract interest from other actors, through logic of attraction, this mechanism initially requires activation energy in the form of funding, partnerships and demonstrated feasibility. Before the system has been implemented and its benefits demonstrated, the absence of a proven business case can make it difficult to secure financing. During the conceptual phase, the Resource Broker therefore had to mobilize funding through networking, coalition building and the alignment of stakeholder interests. The interviewee identified as a resource broker explained: *"What turned out to be challenging was the financial aspect. Our financial model relies partly on income from subsidies and partly on a bank loan. Securing that loan ultimately became the biggest financial hurdle. I spoke with all the major banks in Flanders about this project, but in the end, I was only able to secure a loan with*

Triodos, the smallest bank available and the only cooperative bank in Flanders at the time. [...] I stuck my neck out, and it worked. But [this required] reporting to the bank twice a year on progress, planning, how we address potential issues, where we need additional resources, and where those should come from."

In addition, external resource brokers can also help overcome rough financial patches, as explained by a representative of Sogent: *"It was very difficult to use vacuum toilets in social housing. And they [the social housing organisation] didn't want that [a vacuum system]; they really didn't. That was a real problem, and in the end, yes, the City of Ghent granted a one-off financial – well, a sort of subsidy – to the social housing organisation to cover the difference in cost between a standard toilet and a vacuum toilet, in order to persuade them to join the scheme after all."*

Resource brokering thus provided the initial activation energy required to overcome the absence of a proven business case and enable the initiative to reach a stage where its experience and solutions could attract further interest. The combination of private investment, public support and specialized financing helped bridge the gap between an ambitious concept and a functioning demonstration project. The case therefore illustrates that the logic of attraction does not operate automatically from the outset; it depends on agents of change creating the conditions under which an initiative can demonstrate its feasibility.

Learning-by-doing and partnering for stabilization

Learning-by-doing played an important role in the development of the initiative. De Nieuwe Dokken combines decentralized wastewater treatment, energy recovery and nutrient recovery. The black wastewater stream, consisting of excreta and organic food waste, is treated through anaerobic digestion to produce biogas and struvite, while heat is recovered from grey wastewater. Through a creative partnership, treated grey wastewater is supplied to the neighboring soap factory, Christeyns, while residual heat from Christeyns contributes to the neighborhood's heating supply. This integrated configuration meant that the experience available for future development extended beyond individual technology, and included the coordination of interconnected technical systems, organizational arrangements and relationships between different users and stakeholders.

The importance of learning-by-doing was explained by one interviewee: *"We learned a lot during the first construction phase, sometimes overdoing things a bit. You realize that you're actually in a learning process. Things don't go perfectly right away when they need to be built, and you might overspend […]. With each replication in another building, you refine things further."* Learning-by-doing therefore enabled the initiative to refine its technical and organizational arrangements while developing an organizational memory. A committed Knowledge Broker, embedded in the initiative over the long term, was important for retaining this knowledge and translating it into solutions that could be communicated to and implemented by others. As one interviewee explained, accumulated knowledge enables an organization to: "*develop feasible solutions to address the problem and convince people that these solutions exist."*

The gradual occupation of the neighbourhood illustrates why learning and evaluation require time. Until early 2022, approximately 200–300 people lived in De Nieuwe Dokken, limiting wastewater inflows and constraining the production of fertilizer and reusable water anticipated in the business model. Full capacity of the treatment plant may not be reached until 2028. One interviewee consequently emphasized the need for patience, stating: *"We have already learned a lot over the*

years. Personally, I still believe it is necessary to have enough patience to evaluate it properly only when it reaches 100% capacity."

This reinforces the importance of learning-by-doing and long-term knowledge brokering, as the system's performance cannot be assessed solely on the basis of its initial operational period. Resource brokerage and stabilization also remain relevant after construction, as the continued functioning of the initiative requires both adequate resources and the capacity to address operational problems. As one interviewee explained, *"We need to ensure that when small issues arise, they get resolved."* This also means that the contribution of resource brokers extends beyond financing the initial implementation to maintaining the conditions required for the initiative to survive, mature and eventually spread.

Spreading and commercialization of knowledge

As the initiative matured, the commercialization of developed knowledge through the spin-off company Circular became an important means of spreading both the overall ambition of the initiative and the individual elements of the integrated wastewater system. Circular was established by DuCoop to: *"to replicate what we have learned here [at De Nieuwe Dokken]".* Its creation was driven by an agent of change who had been involved in the initiative from an early stage. Initially working as a project manager with operational responsibilities, this actor developed an in-depth understanding of the initiative's technical systems, organizational arrangements and broader ambitions. This accumulated knowledge subsequently enabled the actor to combine knowledge broker and visionary roles, translating practical experience into solutions that could be offered to other initiatives.

This individual explained: *"Within the spin-off company Circular, we are constantly working on offering what we have done at [the initiative] to other parties. […] We have gained a lot of experience with the legal and financial aspects of building energy or water communities in the broadest sense of the word."* The commercialization of these lessons provided a way to disseminate knowledge while creating an economically feasible basis for further spreading. For example, the energy management system developed at De Nieuwe Dokken is also being rolled out at other sites. Through these spreading activities. Circular engages with a broad range of stakeholders, including companies, governments and project developers. The accumulated experienced was translated into a toolkit for the integrated development of decentralized water and energy management initiatives.

This process was supported by the propelling mechanism of learning-by-doing, through which practical experience increased the value of the knowledge available for subsequent projects. Rather than offering only abstract concepts, the initiative could provide solutions that had been tested in practice and could be adapted to different contexts. A committed Knowledge Broker was important for retaining this knowledge and translating it into solutions that could be communicated to and implemented by others. The findings thus suggest that knowledge accumulated in the early project phases can become a resource for spreading in later phases, particularly when Knowledge Broker and Visionary roles are combined to activate the replicating propelling mechanism.

Once the initial barriers to implementation and financing had been overcome, the logic of attraction and replicating mechanisms began to support wider spreading. The experience accumulated at De Nieuwe Dokken generated interest from other developers and initiatives, and the actors involved established international contacts through which knowledge and experience could be exchanged. One interviewee noted: *"Since we started working on this, we've noticed a kind of ripple effect. Similar initiatives began emerging in various countries. Around that time, projects were also launched in*

Germany, Sweden, and other places. We now have excellent contacts in several countries. The driving forces behind these projects are working together with us in multiple European programs. That's great to see." The initiatives also became a source of inspiration for other real estate developers, with external visitors and research institutions paying close attention to its implementation.

Synthesis

- **Conceptual phase:** *Visionaries, networkers* and *coalition builders* jointly activated *partnering* by translating Ghent's sustainability ambitions into a concrete project coalition, while *issue linkers* helped navigate regulatory barriers and *resource brokers* mobilized the funding needed for early *professionalization* and *stabilization.*
- **Development phase:** *Knowledge brokers* most strongly co-occurred with *learning-by-doing,* converting operational experience into technical and organizational improvements, while *partnering* and continued *resource brokering* helped *stabilize* the initiative and sustain its long-term implementation.
- **Impact phase:** *Knowledge brokers* and *visionaries* jointly activated the translation of accumulated experience into transferable solutions through the commercial spin-off Circular, while demonstrated feasibility and *legitimization* triggered a *logic of attraction* that increased external interest and supported the *spreading* of the concept.

4.2. Jenfelder Au, Hamburg [DE]

4.2.1. Organisation, legislation and finance

Development and background

The Jenfelder Au is a 35-hectare former barracks site in the district of Wandsbek in Hamburg, Germany. The ambition is to create a modern, climate-neutral neighbourhood with around 1,300 residential units (City of Hamburg, n.d.). The project deliberately focussed on a high-quality approach to develop an attractive neighbourhood for approximately 2,000 inhabitants, abundant with urban water and green space (Augustin et al., 2014). The implemented urban water system is developed by HAMBURG WASSER since 2007, and construction works started in 2013 (Skambraks et al., 2017).

Integrated urban water system innovation

The urban water management concept applied in Jenfelder Au is trade-registered under the label of Hamburg Water Cycle® (HWC). The concept is based on a separate collection of different water streams within the neighbourhood (Sievers et al., 2014). More specifically, black water, grey water, and stormwater are processed separately so that each fraction can be optimally processed and used for the district.

To achieve a highly concentrated supply of biomass (black water), vacuum toilets are applied in the district. These use only one-sixth (1-2 litres) of the amount of flushing water of regular toilets (6-9 litres) (Oldenburg et al., 2019). The black water fraction goes towards an anaerobic digestion plant in the district to produce biogas. In the digester, a grease water stream that is collected by truck from regional restaurants, is added as a co-substrate (Schelbert, Lüthi, & Binz, 2023). Initially, local food waste was planned as a co-substrate. However, this pathway was refused due to several, including legal, obstacles (Skambraks et al., 2017). Produced biogas is used in a combined heat and power plant to produce energy for the district. This provides up to 50 per cent of the district's energy demand (Londong & Giese, 2014). The remaining digestate potentially lends itself to nutrient recovery for

agricultural purposes. Due to inconclusive findings in previous studies as well as legal difficulties, this is not done, yet (Schelbert, Lüthi, & Binz, 2023). In particular, the economic rate of return for the recovered nutrients under current drinking water and mineral fertilizer prices was regarded as too low (Augustin et al., 2014).

It was planned to treat the grey water from showers and dish waters decentral in the neighbourhood and discharged into a small surface water body in the neighbourhood that has recreational functions but also functions as a buffer for climate-related water stress. However, necessary quality requirements could not be achieved, yet (Schelbert, Lüthi, & Binz, 2023). Currently, the grey water is therefore discharged into the main sewer, while experimental treatment plans explore suitable treatment methods (Schelbert, Lüthi, & Binz, 2023). An alternative route that has been investigated is to use the grey water's energy for domestic heat provision (Sievers et al., 2014). This study concluded that the heat recovery potential of a central grey water heat recovery is higher than domestic systems, albeit losses occur during the transport between buildings and the central system's location. However, simple, local shower tray heat recovery systems match the central system in terms of primary energy saving potential, while being limited to the shower stream only.

Stormwater is buffered in a retention pond that is part of the neighbourhood water system, where the water can infiltrate and evaporate (Londong & Giese, 2014). In addition, the pond forms part of the neighbourhood's green structure.

Legal structures and key developments

The city owns the residential plots, which enables the project to include a compulsory clause in contracts to connect to the HWC system (Schelbert, Lüthi, & Binz, 2023). Consequently, residents do not face any legal obstacles in connecting to the alternative water system. Quite on the contrary, residents cannot connect to the central system.

The introduction of the HWC required a legislative change. This is because a separate collection of water streams was not allowed in Hamburg, which is a basic concept of HWC. Actors that are engaged in the project lobbied for an amendment to the state's[6] (Freie und Hansestadt Hamburg) wastewater treatment law (HmbAbwG), which was finally realized and enabled the separate collection of different water streams (Schelbert, Lüthi, & Binz, 2023).

Above the level of state legislation, a 'regulative patchwork' for decentral, innovative water treatment systems results from the German federalist system (Schelbert, Lüthi, & Binz, 2023, p. 5). Missing industry standards and a limited range of suppliers for vacuum-based sanitation systems hindered the establishment of the pilot, by challenging the vetting process carried out by authorities (Schelbert, Lüthi, & Binz, 2023), thus slowing down the process.

Financial structures and key developments

The costs of the HWC system are approximately 30% higher than conventional systems. These additional costs could be covered by EU and national funds (Schelbert, Lüthi, & Binz, 2023). For instance, the project received an EU LIFE+ subsidy (2011-2019) under no. LIFE10 ENV / DE / 158 (total

[6] Germany is divided into 16 federal states, each with their own governments. The city of Hamburg is governed by the citystate Freie und Hansestadt Hamburg.

budget: EUR 12,546,000; EU share: EUR 2,819,000). HAMBURG WASSER carried inter alia research and development costs (Augustin et al., 2014).

Governance context

A previous study identified the strong lead of HAMBURG WASSER and stable political support as key conditions underlying the successful implementation of the pilot (Schelbert, Lüthi, & Binz, 2023). An open attitude towards learning-by-doing and from other cases, as well as related capabilities, contributed to this success. Another study also identified the governance context as most important driver towards the adoption of the more circular urban water system, in particular, local area goals, financial support, and national goals (Skambraks et al., 2017). Pressure from outside actors, such as media of environmental associations, was regarded as less important (Skambraks et al., 2017).

However, several project goals could not be achieved, leading to a partial redirection of the project's ambition. For example, "[i]t became apparent that the minor role played by the waste company, not being involved as a stakeholder due to organizational differences and legal obstacles, led to the fact that the planned food waste collection via food grinders could not be realized" (Skambraks et al., 2017, p. 294).

Synthesis: Small win?

Jenfelder Au can be considered a small win because it represents a concrete and operational achievement of moderate importance: a functioning source-separating water system that has moved beyond experimentation into practice. The project generated in-depth change by challenging conventional wastewater management through separate blackwater collection, energy recovery, and decentralized treatment concepts. It also illustrates how small wins can trigger broader institutional change, as the project successfully overcame regulatory barriers and contributed to a legislative amendment allowing separate wastewater streams. Furthermore, the collaboration between Hamburg Wasser, regulators, researchers, and public authorities linked technological innovation to wider governance processes. However, several original ambitions, including local greywater reuse and nutrient recovery, have not been fully realized. In addition, the system has become increasingly embedded in routine operations resulting. Therefore, Jenfelder Au exhibits the key characteristics of a small win, but its transformative potential ultimately depends on whether the lessons and innovations developed there continue to inspire adaptation and replication elsewhere.

4.2.2. Agency and propelling mechanisms

Table 5 *Actors involved in Jenfelder Au*

Actor	Role
Hamburg Wasser	Water and wastewater utility
Hamburg Wasser Cycle	Innovation project of Hamburg Wasser
BUKEA	Environmental regulatory agency

Embedding and transformative momentum

In the implementation and impact phases, the Jenfelder Au project became strongly embedded into the mainstream operations of Hamburg Wasser. This was facilitated by knowledge brokers who, in this case, were primarily the technical operators shaping daily operations and implementations. This is explained by an operator: *"The project is no longer an innovation project; it was transferred to*

regular operation about two years ago. Since then, it is more of a side activity". The transfer to regular operation on the one hand helps to keep the project running as part of Hamburg Wasser's everyday activities, but on the other hand also creates the risk of losing the transformative momentum and special attention that the Jenfelder Au project was previously associated with.

The need for and lack of special treatment is seen when looking at the original ambition of the Hamburg Water Cycle, and the ultimate implementation of the wastewater system that was realized. Originally, the ambition of the Hamburg Water Cycle was broader than what has been implemented. Several elements that were planned, were not realized, such as the local use of food waste as a co-substrate and the decentralized treatment and reuse of greywater. Some of these elements did not move beyond experimentation, while others were redirected into more conventional infrastructure. After implementation, the innovative characteristics of the wastewater system posed challenges for operators, and it proved hard to motivate other colleagues to engage with the system and learn how it works. This is highlighted by an operator: *"It's hard to motivate colleagues because the system is unique. Many only visit the area once a year as part of on-call duty and don't know what to do. Some prefer not to go at all."*

The lack of special treatment is also reflected in the perception of Hamburg Wasser's management of the Jenfelder Au project: *"Management often says it's just another pumping station like any other in Hamburg. Nothing special is done, no additional staff provided."* This means it is difficult to support activities connected to innovation, for example within research projects. The same operator said: "*[The lack of special action] makes it difficult, especially when I get tasks as part of the ANCHOR project, such as providing data or images, while my department doesn't really support the project."* In general, interviewees emphasized the importance of continued management support and resources for maintaining the moment of transformative projects: "*[A transformative project] needs support from management to continue. Often, a project starts with a lot of attention but ends quietly. Then it disappears from awareness. Without support and resources, it's hard to continue working across departments."*

Partnering and learning-by-doing through knowledge generation

During the implementation phase, partnering and professionalization were further developed through knowledge brokers who not only disseminated knowledge but also generated it though the project and invited other actors to contribute to knowledge generation. This contributed to process optimizations and relationship building with new partners. For example, recurring operational problems such as blockages and incrustations resulted in collaboration with a property management company and a new research project to investigate these problems more systematically in the Jenfelder Au project. As part of this research, they also want to create training material on how to deal with these issues, showing an important aspect of learning-by-doing.

Another moment where learning-by-doing was actively pursued was through a research project on the technological configuration of the wastewater system, as explained by a Hamburg Wasser project leader: "*We had a major research project with five universities and five practice partners. Technologies were tested with artificial greywater, which isn't really comparable to real wastewater. We're glad we didn't immediately build the large plant because we later changed the technology."* The experience from this research ultimately resulted in the installation of a fixed-bed bioreactor with membrane technology, after the previously considered lamella separator proved unsuitable.

Coalition building and regulatory embedding

Coalition building played an important role in navigating regulatory challenges. One example concerns the treatment and infiltration of greywater, for which no regulatory framework existed. Hamburg Wasser and the environmental regulatory agency BUKEA worked together to establish a list of quality parameters that treated greywater had to mee before infiltration. Rather than relying on a formal permit, the actors established a bilateral agreement specifying the required parameters. As a BUKEA employee explained: "*We bilaterally set the parameters that must be met before the water is reintroduced. So, there is no formal permit, but rather a cooperation agreement with an agreed catalogue of quality parameters.*"

The involvement of actors from both sides was important for developing this solution and enabled the innovative system to be incorporated into the existing legal and permitting context. BUKEA also emphasized that the intention was to not prevent innovation, while still maintaining environmental safeguards: "*We don't want to block innovation. We support everything that works. But we focus on groundwater and environmental protection. Quality requirements must be met, at least at the same level as in municipal treatment plants.*"

Learning-by-doing and transfer to other initiatives

The Jenfelder Au project illustrates how learning-by-doing can be an especially powerful mechanism when operational knowledge is shared with other initiatives and knowledge brokers are empowered to do so. For example, the exchange of knowledge within external research networks made Hamburg Wasser aware of challenges that it would have otherwise encountered later. This is explained by an operator: "*My department isn't always aware of these challenges, even though we'll face them in the coming years. In the ANCHOR project, we've seen older systems that now have problems – problems we could avoid if we learn from them.*" In this case, learning-by-doing extended beyond the experiences within the Jenfelder Au project, and included experiences of similar initiatives.

This is further emphasized by the lessons learned on through the ANCHOR network and the new research set up as a result: "*We had problems with oils overheating quickly because the pumps aren't water-cooled. We share these experiences. In the Anchor project, we jointly decide to carry out the same monitoring measures and compare results. This creates synergies.*"

Synthesis

- **Conceptual phase:** *Visionaries*, *coalition builders* and *knowledge brokers* activated *partnering* by aligning Hamburg Wasser, the municipality and regulators around the Hamburg Water Cycle vision and creating support for regulatory change.
- **Development phase:** *Knowledge brokers* most strongly co-occurred with *learning-by-doing,* generating and applying knowledge through pilot operations, research projects and university collaborations to refine the system.
- **Impact phase:** *Knowledge brokers* and *legitimizers* co-occurred with *embedding* and *stabilization*, integrating the system into regular operations, while continued knowledge exchange supported *spreading* to other initiatives and networks.

4.3. Oceanhamnen, Helsingborg [SE]

4.3.1. Organisation, legislation and finance

Development and background

In the Swedish city of Helsingborg, a sustainable city development project named H+ has started by developing the Oceanhamnen district. This district consists of around 320 apartments and several office buildings, which amount to approximately 2500 people equivalent. The project has converted a former industrial area into a green and modern living space. The building period of the project began in 2015 and is expected to be completed by 2025 (Lima et al., 2023; Run4Life, 2019). Oceanhamnen is served by a source-separation and resource-recovery system which includes water, wastewater, and food waste, called 'Tre-Rör-Ut' (Three-Pipes-Out) (Schelbert, Lüthi, Binz, et al., 2023). This system aims for maximum resource recovery (Rey-Martínez et al., 2024). The construction of the system started in 2017, with the first residents moving in during 2020. The planning and implementation of the wastewater system was managed by public water utility NSVA (Lennartsson et al., 2019). The local treatment plant 'RecoLab' handles and recycles all wastewater and food waste from the district and officially opened in June 2021 (Schelbert, Lüthi, Binz, et al., 2023).

Integrated urban water system innovation

The apartment buildings and offices in Oceanhamnen make use of vacuum toilets. Approximately one litre of water is required per flush, which reduces water use and creates a blackwater flow which is highly concentrated. Moreover, the kitchens are equipped with food grinders. These are connected to separate low-pressure pipes. Finally, greywater (shower, laundry, sink) is collected in a separate pipe as well. This three-piping system is led to RecoLab (Rey-Martínez et al., 2024).

For the transport of blackwater and food waste, vacuum pipes are used. These lead to two Upflow Anaerobic Sludge Blanket (UASB) reactors, in which liquid effluent is separated from produced biogas. From the liquid effluent, struvite and ammonium sulphate are recovered by struvite precipitation and ammonium stripping and can serve as fertilizers. The biogas is upgraded to fuel for city buses. Sludge from the reactors is used for agricultural applications. Greywater is treated in an activated sludge process and by using nanofiltration and ozonation. This results in water of high quality (Lima et al., 2023). Currently, possibilities for the reuse of this greywater are being explored. One option for reusing could be for the municipal indoor swimming pool (Run4Life, 2019; Schelbert, Lüthi, Binz, et al., 2023)

Legal structure and key developments

Legal aspects, such as connection points, areas of operations cost/tariffs have made it difficult to delineate responsibilities among different actors working at H+, such as NSVA and Helsingborg Municipality (Schelbert, Lüthi, Binz, et al., 2023).

The Swedish legal framework neither encourages nor prohibits the implementation of decentralized urban water treatment and reuse systems. At the same time, the regulative framework for wastewater treatment and resource recovery is considered progressive when compared internationally. Since 1999, the Swedish Environmental Code has the objective to create closed loops. The Swedish Environmental Agency (SEPA) reacted by prioritizing nutrient recycling for onsite sanitation systems. In 2008, Swedish municipalities were urged by the SEPA to look for possibilities to recover resources from wastewater and to deal with different wastewater fractions (Schelbert, Lüthi, Binz, et al., 2023).

At Oceanhamnen, sludge from both food waste and blackwater can be used to produce NPK fertilizers together with the extracted struvite and ammonium sulphate. This process is enabled by existing Swedish national fertilizer certifications for sludge-based products and fits into the EU end-of-waste process. Furthermore, since July 2022, the recently introduced EU Fertilizer Regulation (2019/1009) allows the selling of struvite across the EU. This creates market opportunities for the struvite that is produced from the liquid blackwater and food waste effluent (Schelbert, Lüthi, Binz, et al., 2023).

Currently, NSVA only have an environmental permit to treat wastewater, and not for reusing treated wastewater from the district for drinking water purposes. After treatment, the collected greywater meets potable water standards. 20% of the treated greywater and blackwater is currently discharged into the ocean. The remaining 80% could be reused.

Financial structure and key developments

Little information can be found on the exact costs of the project. It is estimated that the three-piping system costs the municipality approximately 2000 SEK/capita/year (≈€180). This number is similar to the costs of a conventional wastewater system (Schelbert, Lüthi, Binz, et al., 2023). Costs were saved because the treatment plant is near the buildings in Oceanhamnen (Drangert & Kjerstadius, 2023). NSVA is responsible for managing the Tre-Rör-Ut system and the RecoLab. NSVA thus invoices NSR and Öresundskraft for parts of operational and maintenance costs. Tariffs are the same for conventional city customers.

Capital expenditures for installations within public spaces that are owned by the city of Helsingborg were covered by taxes. For costs within private spaces, the costs are covered by the owners of the building. As the municipality owns the public water utility NSVA, it was responsible for many of the infrastructural costs of the three-piping system, such as costs for the vacuum sewer network. The establishment of the local treatment plant RecoLab was paid for by municipal funds and national and international research funds that were acquired by the team. These funds were used for capital expenditures (Schelbert, Lüthi, Binz, et al., 2023).

Governance context

In 2007, development of the H+ masterplan started as part of the vision-shaping 'Imagine Helsingborg' competition. In 2011, the management of H+ initiated the EVAA-project (Swedish abbreviation for Energy-Water-Wastewater-Waste). This project aims to create synergies between the different sectors to maximize sustainability. In the subsequent two years, EVAA started the detailed planning of an integrated system of energy, water, wastewater, and waste. In this stage, the water and wastewater (NSVA), waste (NSR) and energy (Öresundskraft) utilities were involved.

Once the plan started taking more shape, the objective of H+ shifted from being energy-focused to (waste)water-focused and the Öresundskraft became less involved. From 2012 to 2013, several technical options were explored. These formed the conditions for the current implementation of the project. At the same time becoming a sustainable city became more important in Helsingborg's municipal vision. Thus, the city of Helsingborg itself finally commissioned public water utility NSVA and waste utility NSR to drive the planning and implementation of the source separating system (Schelbert, Lüthi, Binz, et al., 2023). Because the city owned the area in which the Oceanhamnen district would be realized, they were able to mandate that all new developments had to be connected to the Tre-Rör-Ut within contracts signed during the selling of the plots in the area.

Several important agreements were made regarding management, ownership, and responsibilities within H+. An operational group consisting of representatives of NSVA, NSR and a strategic steering group was established. This included relevant city departments and CEOs. RecoLab, the water treatment facility, was agreed to be jointly operated by the City of Helsingborg, NSVA and NSR. In 2016, a new agreement, valid for five years, established NSVA as the managing entity. In this agreement it was defined that the city and NSR would remain owners of the Tre-Rör-Ut system (Schelbert, Lüthi, Binz, et al., 2023).

Reflecting on the project, several key factors can be identified that have contributed to the success: political support, a common vision between the city and (waste)water utilities, collaboration and cooperation between the different utilities and the municipality, and strong leadership (Lennartsson et al., 2019; Schelbert, Lüthi, Binz, et al., 2023). The project did not encounter serious technical problems. However, there were some organizational issues and problems caused by insufficient detailed knowledge among the different stakeholders involved on how they should or should not use the technical systems (Drangert & Kjerstadius, 2023).

Synthesis: Small win?

Oceanhamnen can be considered a small win because it represents a concrete and operational achievement of moderate importance: a functioning source-separating wastewater system that recovers energy, nutrients, and potentially reusable water. The project also reflects in-depth change by challenging conventional centralized wastewater management through the implementation of the Tre-Rör-Ut system and RecoLab. Furthermore, it connects technological innovation to broader societal and institutional change by fostering collaboration between the municipality, utilities, researchers, and other stakeholders, supported by a favourable regulatory environment. However, some ambitions, such as large-scale water reuse, have not yet been fully realized, and the initiative remains partly dependent on a relatively small group of committed actors. Therefore, Oceanhamnen exhibits the key characteristics of a small win but its contribution to system-wide transformative change will depend on the extent to which its innovations become institutionalized and adopted beyond the local context.

4.3.2. Agency and propelling mechanisms

Table 6 *Actors involved in Oceanhamnen*

Actor	Role
City of Helsingborg	Municipality
NSVA	Water and wastewater utility
NSR	Solid waste utility
Öresundkraft	Energy utility
RecoLab	Development facility for the wastewater system

Visioning and coalition building in the conceptual phase

In the conceptual phase, the municipality of Helsingborg and the utilities – NSVA, NSR and Öresundskraft – were in a strong leading position to realise the circular water initiative Oceanhamnen, located within the H+ development. This leadership position was embedded in the broader governance structure that was developed as the H+ project moved from vision-setting towards implementation. The H+ masterplan originated in the “Imagine Helsingborg” vision-shaping process, while the EVAA project was initiated in 2011 to create synergies between energy, water, wastewater

and waste. An operational group consisting of representatives from NSVA and NSR was established alongside a visionary steering group that included engineers, the CEOs of the utilities, and a project leader from the city's urban development department. The latter group represented the agents of change roles of visionaries, coalition builders and knowledge brokers. A former CEO of NSVA explained: *"All major decisions went through this [strategic steering] group. The H+ project manager would bring our proposals to the city's steering committee, and they always said yes".* The importance of a dedicated strategy team for translating the vision of the H+ project to politicians and to secure financial approval was also emphasized. It was also mentioned that the institutional position of the municipality played an important role in the initial collaboration as explained by a NSR employee: *"[The municipality] own[s] the utility companies and could direct us to participate".* This steering capacity of the municipality was reinforced by their ownership of the H+ development, in which Oceanhamnen was to be realized, which allowed them to require new developments to connect to the Tre-Rör-Ut system through the contracts used when selling plots. This meant the municipality was in a position where they had both political and direct institutional means to shape the implementation of the H+ project.

The leadership of the strategic visioning group involved more than articulating a vision. The actors emphasized the importance of ensuring that the project was feasible, and not just a "*crazy idea*", which according to a former municipality employee required *"ongoing discussion with the conventional parts of the municipal organization, like the safety planning office and engineers from NSVA and NSR".* Close personal relationships were also important during this phase, with interviewees emphasizing that these connections helped actors solve problems quickly.

The collaborative structure of the H+ project provided a basis for exploring different innovations through the joint EVAA-project and creating new knowledge. As a former CEO of NSVA described *"Between 2009 and 2011 we conducted a lot of studies. It was a joint project between NSVA, NSR, Öresundkraft, and the city".* Over time the focus shifted from an initially broader orientation towards a water and wastewater approach, reducing the role of Öresundkraft in the project while NSVA and NSR became more central to the planning and implementation of the source-separating system. The development of the source-separating wastewater system was driven by several actors within NSVA, including the research chief who promoted the idea and an engineer who worked on its' development. One interviewee mentioned that the research chief *"really had the idea about source-separating wastewater, and she really pushed this idea".* To gain knowledge on what type of source-separating wastewater system would work, they went on many study trips across Europe. Several technical options were explored, before the current Tre-Rör-Ut system was decided upon.

The initial coalition was formalized over time through agreements concerning ownership, management and operation of the wastewater system. RecoLab was initially agreed to be jointly operated by the City of Helsingborg, NSVA and NSR, but a 2016 agreement established NSVA as the managing entity while retaining ownership of the Tre-Rör-Ut system to the municipality and NSR.

From experimentation to operational learning

As the H+ project moved into the development phase, learning-by-doing became increasingly professionalized, particularly through knowledge brokers and problem brokers at RecoLab, as explained by a former NSVA CEO: *"We made a clear plan: test new technologies in RecoLab's testing facility, try them in the development facility, and then scale them to our regular plants. That allowed us to stay at the forefront of innovation".*

Business-development and product-development staff were also identified to act as knowledge broker, for example though coordinating studies and developments, while also ensuring that new knowledge reached the right audience. One NSVA employee described this role as follows: *"I work as a business developer [at NSVA]. In my daily work that means I handle all the studies and contacts: it can be politicians, municipal representatives, different kind of companies".* Over time, RecoLab became part of a broader network of comparable initiatives, through which knowledge could be exchanged and shared. The interviewees also illustrate the importance of connecting visitors and external knowledge to the right actors within this network, extending the role of knowledge brokers into that of a connector of sorts. A NSVA employee gave an example of this extension: *"Sometimes we have really interesting visitors, but I can feel they should meet another part of the network. I'm not the right person. We have study visits, we talk about RecoLab and what we do, but many people who come here are very professional and they bring very good knowledge that could really help another part of the network. How do we get the right contacts together at the right time?".*

Parts of the learning-by-doing were also unintentional, and occurred through unexpected operational problems, as explained by a former NSVA CEO: *"Honestly, the biggest challenge came after construction. The system was harder to maintain than expected. Our maintenance team had to learn how to operate it efficiently. We addressed those issues later, and now it works well."* This is further emphasized by a current NSVA employee, who states that operating the system is an ongoing process of learning and developing: *"I think it's very important to not just launch a system. You have to keep developing the existing one too. Even though it's not so old, we're not done with the maintenance: how to take care of it. We need more information and communication about it too."*

Embedding through legitimization

In the development and impact phase of the project, the role of the legitimizer became increasingly important. Engineers and other actors at RecoLab continuously worked to ensure that the pioneering system works. This included maintaining the technical system, solving operational problems and maintaining dialogue with residents. Such activities were important for end-user acceptance and consolidation and spreading of the source-separation wastewater system. A former municipal employee described this legitimizer role as *"… safeguarding and making sure the project remains sustainable and long-lasting"*, while a NSVA employee emphasized that *"it has become a very important role to have the dialogue with the people who live here".*

The legitimizers played an important role in informing residents about how to use the vacuum toilets and kitchen grinders, while also addressing problems arising from how residents used the system. The latter highlights the importance of the RecoLab employees, who, as a former NSVA CEO stated *"… are central. They prove the systems work and maintain credibility".* Residents themselves also became familiar with the facilities and processes through guided visits and other interactions with RecoLab. One resident explained: *"In our building, we have a board, and when we have our board meetings, we use RecoLab's facilities. We go there once a month for board meetings. I've also been there for guided visits, to learn how the system works and how they manage the different waste fractions, how they make fertilizer, and so on."*

Aside from the RecoLab employees, the residents themselves also took on the role of legitimizer. Some residents actively communicated the environmental benefits of the source-separation wastewater system to others and described themselves as positive ambassadors for the concept. One resident explained that the environmental concept was *"one of the main drivers"* for moving to Oceanhamnen and that they had *"been positive […] and spoken to people about it because I believe in this direct,*

sustainable way of living and handling waste". Another resident described how they discuss the system when meeting people outside of Oceanhamnen: *"When we meet people, we often mention it. People who live in traditional housing often see this as the future. […] Visitors are impressed."*

Residents also contribute to the practical reproduction of the system, by helping newcomers learn how to use the source-separated wastewater system. One resident explained: *"What we've learned is that when new people move in, we need to spend about half an hour visiting them in their apartment to train them on how to use the toilet system and the food waste grinder. We do this regularly now. It's important because it's a new system, and there's a learning curve."*

Dependency on a small group of motivated individuals

Much of the competences and many of the contacts relating to Oceanhamnen were concentrated in a small number of involved individuals. This creates bottlenecks now that the project is maturing, as explained by a NSVA employee: *"There are a lot of bottlenecks to solve. For example, [an NSVA engineer] has all the competence and contacts in Oceanhamnen for different kinds of problems. But since we have been up and running since 2021, more people should be involved. It should be part of the daily work for more people than just [that engineer] solving the problems."* To address this, interviewees emphasize the need for further professionalization, including more staff that is able to manage the systems as well as communicate their technical content and support the spreading of the concept of the Tre-Rör-Ut system. This is explained by the same NSVA employee: *"I think we are at the stage now where we have to be much more organized and maybe hire more people so we can have a very stable organization in the long run. [...] We need more people who can actually handle the systems. We need more people who can tell the story and communicate, both the technical depth and spreading the word."*

Boundary spanning and issue linking

NSR acted as a boundary spanner by connecting different environmental issues and organizational domains. However, the interviews indicate that this role was not always easy to take on. One NSR employee mentioned: *"I often talk with [an engineer at NSVA], and we try to process ideas, but within my own company, very few people are familiar enough with the project for it to be a productive collaboration."* Highlighting how spanning boundaries between different issues and domains can be challenging for the individuals involved.

In a broader sense, boundary spanning activities are seen throughout the project, as the source-separate wastewater system, cuts across organizational and regulatory boundaries, between water, wastewater and waste. This not only required broad knowledge on how to connect these sectors, but also concerned close collaboration between the municipality, NSVA and NSR regarding ownership, tariffs, environmental permits and resource recovery. In addition, the possibilities for reuse of treated greywater and the regulatory status of products recovered from this water (such as fertilizers) created challenges that extended beyond the technical operation of RecoLab. This highlights the importance of boundary spanners, as during innovations issues arise that cannot be addressed within a single organization or sector.

So, while boundary spanning at times was challenging, the collaboration enabled actors to identify connections between different environmental and regulatory issues, with certain individuals acting as issue linkers. For instance, questions concerning the end-of-waste status of the fertilizer products and whether food waste and black water should be collected separately or treated together. One NSR employee described their wish to move beyond mere issue linking towards problem brokering: "*In the*

future, I'd like to be a problem broker, someone who connects solutions with policy and funding. But I'd need more support and legitimacy to take on that role fully."

Signs of spreading

The interviews indicate that the initiative is spreading. The experience from Oceanhamnen and RecoLab has generated interest from other municipalities, particularly those where source separation could provide an alternative to costly conventional infrastructure. A former NSVA CEO explained: *"It's particularly relevant for small villages with long, single-pipe sewage lines. If you build new areas with separated systems, you avoid building costly new infrastructure. That drew interest from other municipalities."* This can be further explained by the estimated cost of the Tre-Rör-Ut system that is comparable to that conventional wastewater system when building a new development, while the three-pipe system is able to recover resources such as biogas and struvite, that a conventional system is not. The experience of the project thus offers a reference point for municipalities facing comparable infrastructural conditions. Östra Ramlösa is one example of such a municipality exploring whether they can implement as similar source-separated wastewater system.

Synthesis

- **Conceptual phase:** The strongest co-occurrence was between *coalition builders, visionaries* and *knowledge brokers* and the *partnering* mechanism. Through the H+ vision, EVAA collaboration and strategic steering group, these actors aligned the municipality, utilities and other stakeholders around a shared ambition, creating the institutional coalition needed to move source-separating sanitation from concept to implementation.
- **Development phase:** *Knowledge brokers* most strongly co-occurred with *learning-by-doing* and *professionalization*. Through RecoLab, research projects and operational experimentation, actors continuously generated, shared and applied knowledge to refine technologies, solve operational problems and build organizational capacity. *Partnering* further reinforced this process by connecting utilities, researchers and external networks.
- **Impact phase:** *Legitimizers* and *knowledge brokers* most strongly co-occurred with *embedding, stabilization* and *spreading.* Operational staff, RecoLab employees and even residents demonstrated the feasibility of the system, built user acceptance and maintained credibility, while knowledge exchange with external initiatives and municipalities enabled the transfer of lessons learned and supported the gradual replication of the concept in new contexts.

4.4. Superlocal, Kerkrade [NL]

4.4.1. Organisation, legislation and finance

Development and background

Until recently, the neighbourhood of Bleijerheide in Kerkrade, a city in the south-east of the Netherlands, was home to four high-rise flats that were built in the 1960s, a period of high housing shortage (SUPERLOCAL, n.d.). Nowadays, the high-rise flats in Bleijerheide no longer meet the wishes and requirements of our time. To prevent vacancy in light of demographic projections, it was decided to demolish one flat in 2012 (SUPERLOCAL, n.d.). This opened up a window of opportunity to redevelop the whole area. The project initiators for this redevelopment were housing cooperation HEEMwonen and the municipality of Kerkrade. The project's ambition is to be a frontrunner in future-proof and circular construction (Gemeente Kerkrade, 2023). The existing materials of the demolished

high-rise flats were reused to construct approximately 130 new apartments (Gemeente Kerkrade, 2023). These apartments, owned by HEEMwonen, became home to both former and new residents. Besides the construction of new homes, the project aimed to create an attractive public space, while maintaining social relationships in the neighbourhood. Moreover, the water cycle in the neighbourhood is (nearly) closed by means of a Collective Adaptive Water Management (CAWM) system (van Duuren et al., 2019).

Integrated urban water system innovation

Although circular construction principles lie at the core of SUPERLOCAL's transformative ambition, the project also has an innovative urban water system, consisting of a separate collection and digestion of black water, a reuse of grey water, decentral drinking water production, and the collection of storm water. The black water stream consists of water from vacuum toilets, which use very little potable water to flush, combined with food waste from food grinders. The black water is led to an anaerobic digestion unit that is located on the premises (van Duuren, 2020). Initially, it was planned to place a food waste grinder on every floor of the apartment buildings. However, due to financial and sustainability reasons, it was decided to place larger, central grinders on the ground floor of the apartment buildings. The individual houses have their own food grinders. Nutrient recovery, for instance in the form of struvite, is currently explored (van Duuren, 2020). This fertilizer shall be used on community scale for agro-forestry purposes (van Duuren, 2020). SUPERLOCAL has the ambition to treat grey water locally in a vertical aerated helophyte filter and reuse it for shared laundry and car wash services, if the quality of the water allows it (van Duuren, 2020). Moreover, recirculation showers will be placed in three dwellings for experimental purposes (van Duuren, 2020).

Another ambition of the project is to collect and treat storm water from roofs and paved surfaces for drinking water purposes in the neighbourhood (van Duuren, 2020). The overflow should be infiltrated locally. This would cover the supply of approximately 90% of the community's drinking water demand. The remaining supply would stem from the central system that feeds from German surface water sources (van Duuren, 2020). However, this part of the water system is not realized, yet. Currently, drinking water company WML performs research on how storm water treatment could be realized to conform with standing drinking water quality standards in this case. The required piping infrastructure is already present at SUPERLOCAL, but not currently in use.

Legal structure and key developments

Urban Innovative Actions, who provided the largest subsidy for the project, set as a requirement that all the knowledge and experience gained from the project should be widespread across Europe as much as possible (IBA Parkstad, n.d.).

SUPERLOCAL's ambition to produce drinking water from rainwater harvesting in a decentralized system is difficult to realize. The drinking water monitoring program would have to be approved by the Environment and Transport Inspectorate (ILT). Approval of rainwater harvesting for potable reuse is difficult, as the National Institute for Public Health and the Environment (RIVM) does not yet acknowledge rainwater as a suitable source for potable water (Ministerie van Infrastructuur en Waterstaat, 2022; van Driezum et al., 2020).

Financial structure and key developments

Additional costs that arise from applying circularity principles in construction are currently not adequately reflected in real estate calculation models (Urban Innovative Actions, 2021). This is why subsidies were key in realizing the transformative ambition of this project. SUPERLOCAL received 2

different subsidies. In October 2017, Urban Innovative Actions provided the first subsidy of EUR 4.7 million. In October 2018, the project received the second subsidy of EUR 2.5 million from the European Life+ programme for the development of the closed-loop urban water system (IBA Parkstad, n.d.; SUPERLOCAL, n.d.). This EU project funding allowed the testing of novel water service approaches and for the reuse of materials (Dühr et al., 2023).

Governance context

SUPERLOCAL functions as the key innovative project for the transformation of the region towards a more sustainable and circular system. The project is deeply intertwined with the local administration, for instance as part of the municipality's transformative ambition (Urban Innovative Actions, 2021). This transformative ambition consists of a set of agreements between the municipality and housing corporations regarding housing in the area. This is led by HEEMwonen. The municipality is a central partner of the project. Moreover, community engagement lies at the heart of the project, being a key motivator for design decisions as well as a key driver for success (Dühr et al., 2023). However, project insiders uttered that the project must stand up against deep-rooted expectations of politicians, civil servants, and the broader public of how urban development projects should be planned and realised, leading to a time-intensive process (Dühr et al., 2023). Furthermore, adopted circular solutions are more costly and might be challenging to scale up (Dühr et al., 2023).

Synthesis: Small win?

Superlocal can be considered a small win because it represents a concrete and implemented achievement of moderate importance, rather than a large-scale systemic breakthrough. The project introduced in-depth change by combining circular urban redevelopment with an innovative circular water system, demonstrating how alternative water management practices can be integrated into neighbourhood regeneration. By reusing local resources and experimenting with decentralized water solutions, Superlocal challenged conventional approaches to both housing redevelopment and urban water management. Furthermore, the project connected technical innovation with broader social and institutional change through collaboration between the municipality, housing association, water actors, and residents. However, many of these achievements were closely linked to the specific conditions of the project in Kerkrade, including the availability of suitable housing stock, committed local partners, and a supportive experimental environment. Consequently, while Superlocal exhibits the key characteristics of a small its contribution to broader sustainability transitions will depend on whether the lessons from its circular water system and redevelopment approach can be successfully adapted and applied in other contexts.

4.4.2. Agency and propelling mechanisms

Table 7 *Actors involved in Superlocal*

Actor	Role
Waterschap Limburg	Waterboard
Waterschapsbedrijf Limburg (WBL)	Former wastewater treatment company, now merged with Waterschap Limburg
Gemeente Kerkrade	Municipality
HEEMwonen	Social housing organisation
WML	Water utility
Inspectie Leefomgeving en Transport	Inspectorate of the Human Environment and Transport
RIVM	National Institute for Public Health and the Environment

Coalition building and a radical shared vision

The development of Superlocal was facilitated by existing professional relationships and the emergence of new ideas about circular construction and water management. The project emerged from the redevelopment of Bleijerheide in Kerkrade, where four high-rise apartment buildings constructed in the 1960s no longer met contemporary housing needs. The decision to demolish one of these buildings in 2012 created a window of opportunity to rethink the development of the neighbourhood. HEEMwonen and the municipality of Kerkrade used this opportunity to pursue a transformative ambition: to become frontrunner in future-proof and circular constructions while maintaining social relationships and improving the neighbourhood's public space.

Existing professional relationships helped activate this opportunity and bring relevant actors together. One interviewee described how their involvement began through a colleague at WBL, whom they knew from a previous collaboration: *"They told me that something interesting was happening in Kerkrade and that there might be opportunities for a local circular water cycle."* This led to discussions between WML, WBL, the municipality of Kerkrade and HEEMwonen.

This illustrates the importance of networkers in activating existing relationships and connecting actors who might otherwise not have collaborated. In the initial phase, networking was closely connected to the coalition builder role, as the emerging network needed to be transformed into a coordinated collaboration. As the same one interviewee explained: *"I was primarily responsible for forming the coalition and building networks, as I started by establishing a network and shaping the collaboration between the four parties mentioned, and then went on to organise the project."*

Coalition building provided the organizational foundation for moving from an initial opportunity towards a concrete project. However, the collaboration was not limited to coordinating established interests; it also created space to explore more radical ideas. Superlocal was driven by an ambition to reuse materials from demolished buildings and incorporate them into the redevelopment of the area. One interviewee described this as a particularly radical idea originating from the municipality and housing association: *"We'll put a fence round that area, and everything that's demolished there will be reused, and we'll use that to create a new [neigbourhood]."* Although the original vision was not fully implemented, it was realized to a considerable extent. The reuse of materials from demolished buildings to construct approximately 130 new apartments demonstrates that this circular ambition was translated into tangible changes to the built environment. The visionary role was thus important in articulating an ambitious direction that challenged conventional approaches, even when not every element proved feasible. The value of the vision did not depend on complete implementation. Rather, it established a reference point for experimentation and helped actors explore how far circularity could be integrated into the redevelopment process.

The vision was developed collaboratively rather than imposed by a single actor. One interviewee explained that the project began with relationship-building and the development of concepts, including a session involving, amongst others, colleagues from KWR to explore what might be possible: *"We encouraged those ideas to emerge; it's not as though we came up with them entirely on our own."* The development of the vision was therefore supported by the interaction between knowledge brokers, visionaries, networkers and coalition builders. Existing relationships brought actors together, while new collaborations enabled them to combine their knowledge and explore opportunities for circular water management.

Connecting with organizations beyond the immediate project network was also considered valuable. As one interviewee explained: *"In any case, I find it interesting to establish links outside the WL with other water authorities and research institutes and the like; I find that really interesting. And also to compare what we're doing with what they're doing and see how we can align our efforts."*

Nevertheless, the project had to contend with established expectations among politicians, civil servants and the wider public about how urban development should be planned and delivered. Project insiders reported that these expectations contributed to a time-intensive process, despite support from the municipality and HEEMwonen. The initial phase therefore involved more than forming a coalition around a shared vision, it also required maintaining that ambition while negotiating established ways of working.

Mobilizing resources and boundary spanning for experimentation

Turning the Superlocal vision into a funded project required the ambition to be translated into terms that could be recognized by funding organizations. As one interviewee summarized: *"We had to rephrase it into something that was eligible for funding."* This illustrates the relationship between the resource broker and issue linker roles. The mobilization of resources depended on identifying funding opportunities, while issue linking involved connecting the project's circular ambitions to objectives and categories recognized by funding programmes. Issue linkers thus aligned the ambitious, experimental initiative with existing funding arrangements without necessarily changing the underlying ambition.

The financial context helps explain why this was important. Applying circular construction principles generated additional costs that were not adequately reflected in conventional real-estate calculation models, making subsidies critical to realizing the project's transformative ambition. Superlocal received €4.7 million from Urban Innovative Actions in October 2017 and a further €2.5 million from the European LIFE+ programme in October 2018 to support development of the closed-loop urban water system. This funding enabled the project to test novel water-service approaches alongside the reuse of construction materials.

The funding arrangements also connected resource mobilization to the project's longer-term knowledge ambitions. Urban Innovative Actions required the knowledge and experience generated through the project to be disseminated as widely as possible across Europe. Knowledge sharing was thus an explicit expectation attached to the project's funding.

Boundary spanning by drinking water company

Superlocal challenges established organizational boundaries, particularly through the involvement of WML, a drinking-water company. Traditionally, wastewater treatment in the Netherlands falls within the responsibilities of regional water authorities, such as Waterschap Limburg. WML's involvement in Superlocal therefore demonstrated an interest in circularity and water conservation beyond the company's conventional remit. One interviewee from WML stated: *"The fact that we, as a drinking water company, are involved in this sort of activity unequivocally demonstrates that we were actively engaged with the themes of circularity and water conservation."*

This involvement illustrates boundary spanning, as an organization extended its activities into a field that was not traditionally central to its core responsibilities. WML's participation enabled it to engage with new approaches to water reuse and contribute to the wider exploration of circular water systems. Its involvement also had a legitimizing function, demonstrating that the drinking-water sector was

proactively exploring these issues rather than responding only to external pressure. The same interviewee from WML explained that Superlocal served as a national example of the drinking-water sector's engagement with circularity. The purpose was not simply to showcase activity, but to demonstrate that the sector was "*actively engaged in this on the drinking water sector's own initiative*."

Knowledge development and legitimization

Knowledge development and sharing were explicit goals of Superlocal. The initiative was not only intended to implement circular solutions, but also to generate lessons that could inform future initiatives. As one interviewee explained: *"What I think is important is that the lessons learnt from Superlocal are shared and put into practice. Or not, if they turn out to be bad lessons."*

The development of this knowledge was closely connected to learning-by-doing. As the project progressed, the actors developed a more critical understanding of what was technically and practically feasible. One interviewee described this shift: *"Now we're going to become increasingly critical about what is actually feasible and what isn't."* The experience gained through implementation helped refine the project's ambitions and establish a more evidence-based understanding of the possibilities and limitations of circular water management.

This process was particularly important because some proposed applications required regulatory approval. At the beginning of the project, the team had considered reusing water for washing dishes, washing machines and washing cars. However, the Dutch Inspectie Leefomgeving en Transport (ILenT) required evidence of safety before allowing these applications to proceed. As one interviewee explained, the project team was told that it needed to *"provide clear evidence and collect sufficient data so that we [ILenT] can decide whether this is responsible"* and that supply could only proceed after a decision had been made.

The ambition to produce drinking water from harvested rainwater faced additional institutional barriers. Approval of the drinking-water monitoring programme was required, while RIVM did not yet recognize rainwater as a suitable source for potable reuse. Consequently, the ambition to cover approximately 90% of the neighbourhood's drinking-water demand through locally treated stormwater remained unrealized, despite the presence of the required piping infrastructure.

During these developments, the knowledge broker and legitimizer roles were closely connected. Knowledge development provided the evidence needed to demonstrate feasibility, while legitimization involved making that evidence meaningful to organizations responsible for assessing and approving new practices.

A similar dynamic emerged around the intended use of recovered fertilizer. Although the use of the fertilizer was not yet permitted, the project aimed to document its composition and demonstrate its added value. As one interviewee explained": *"if we document the composition properly and can demonstrate the added value of that fertiliser, we can then create a movement that will enable that fertiliser to be sold safely."*

This illustrates how knowledge development could be directed towards changing the conditions under which a circular product might eventually be accepted. Documenting the composition of the fertilizer and demonstrating its value were not merely technical activities; they were also intended to create a basis for regulatory acceptance and future implementation. Learning-by-doing could thus support institutional change indirectly by producing the evidence required to reconsider existing restrictions.

Sharing lessons learned

As Superlocal attracted attention from other organizations, the challenge shifted from generating knowledge within the initiative to deciding how that knowledge should be communicated and used elsewhere. Local authorities and other organizations visited the project because they were interested in implementing similar approaches. However, the actors recognized that the lessons from Superlocal could not simply be transferred without considering what other initiatives actually needed.

One interviewee described how visitors often expressed an interest in creating *"something like that too"*, but that the Superlocal actors questioned what this meant in practice: *"What exactly is 'something like that'?"*. The interviewee explained that the team was beginning to develop a shared view of what advice it should provide and which information it felt comfortable communicating. This reflects the evolving role of the knowledge broker. Rather than presenting Superlocal as a model that could be copied wholesale, the actors needed to critically assess which lessons were transferable, which were context-dependent and which approaches they could confidently recommend. Knowledge brokerage therefore involved selecting, interpreting and communicating experience, rather than simply disseminating information.

The funding requirement to disseminate lessons across Europe reinforced this responsibility. At the same time, the different stages of implementation made critical knowledge sharing particularly important: circular construction was substantially realized, whereas several water-system ambitions still required further technical development, evidence or regulatory acceptance. A useful account of the initiative's lessons therefore needed to distinguish between approaches that had been implemented and those that remained experimental or aspirational.

The findings suggest that learning-by-doing supports the potential for replication while also helping establish the limits of what should be replicated. The knowledge generated through the project can inform other initiatives, provided it is adapted to their circumstances and accompanied by a realistic understanding of technical, regulatory and organizational constraints.

Organizational commitment and stabilization

Despite the importance attached to knowledge development and sharing, the interviews reveal organizational challenges that may limit the continuity of these activities. Research and experimentation had to compete with the core operational responsibilities of the organizations involved, particularly the operation of wastewater treatment infrastructure.

One interviewee explained that operational staff were deployed across multiple tasks and that the organization's primary responsibility remained the operation of its treatment locations. Although the interviewee had tried to promote Superlocal as an *"18th treatment location",* not everyone regarded the research being conducted there as a priority. From an operational perspective, research was not always viewed positively, and commitment depended heavily on individual managers and their appreciation of the initiative's value.

This illustrates the tension between the knowledge broker role and established organizational priorities. Generating new knowledge requires time, staff and organizational support, but these resources may be difficult to secure when operational performance remains the principal responsibility. The continuity of learning can therefore depend on whether relevant individuals and managers recognize its value and are willing to support activities that do not directly contribute to immediate operational tasks.

The problem is compounded by the long-time horizons involved in developing and validating circular solutions. As one interviewee explained: *"a project like this takes a very long time, so you need to ensure that there are people who remain involved in the project for a very long time, or who are very closely monitored."*

If individuals leave or attention shifts to other priorities, the knowledge and relationships developed through the initiative may be difficult to maintain. The findings therefore suggest that the continuity of knowledge brokering activities depends not only on individual commitment, but also on organizational arrangements that preserve knowledge, sustain engagement and recognize experimentation as a legitimate part of operational work. These constraints are important to understand the potential for spreading. Although Superlocal attracts visitors and generates interest, turning its experience into transferable knowledge requires sustained investment in evaluating results, documenting lessons and determining which solutions can responsibly be recommended. Without such continuity, the initiative risks being treated primarily as a showcase rather than as a long-term source of applied knowledge.

Synthesis

- **Conceptual phase:** *Networkers, coalition builders* and *visionaries* activated *partnering* by bringing together HEEMwonen, the municipality, WBL and WML around a shared vision for circular construction and water management.
- **Development phase:** *Resource brokers* and *boundary spanners* co-occurred with *professionalization* and *partnering*, securing EU funding and connecting the project to actors, sectors and policy agendas beyond traditional water-management boundaries.
- **Impact phase:** *Knowledge brokers* and *legitimizers* most strongly co-occurred with *learning-by-doing, stabilization* and *spreading*, generating evidence on circular solutions, addressing regulatory barriers and translating lessons learned into knowledge that could inform other initiatives.

4.5. Cross-case insights

The findings suggest that agents of change can be understood as the human drivers through which propelling mechanisms are activated. While propelling mechanisms explain on a system level how small wins accumulate and gain momentum, agents of change help explain what individual actions by whom contribute to activating and sustaining these mechanisms. A recurring finding across the four case studies is that specific agent-of-change roles consistently co-occur with particular propelling mechanisms. We propose that these recurring findings constitute patterns that are suitable and promising for structural empirical validation. While our research design does not allow causal relationships to be established, the repeated occurrence of these combinations across cases suggests that certain forms of agency are particularly important in enabling small wins to emerge, persist and spread.

Most notably, knowledge brokers were consistently associated with learning-by-doing. Across all cases, individuals responsible for generating, translating and retaining knowledge played a central role in converting practical experience into organizational learning. This finding suggests that learning-by-doing is not merely an emergent characteristic of innovative projects, but depends on actors who actively capture lessons, disseminate insights and maintain organizational memory over time. Knowledge brokers therefore appear to be particularly important for the deepening of initiatives, as they continuously refine both technological and organizational practices. This indicates the need for personal continuity in this role over time.

A second recurring pattern concerns the relationship between coalition builders and networkers and the mechanism of partnering. Across cases, partnering did not emerge spontaneously from a shared interest in circular water management. Rather, it was actively constructed by actors who connected organizations, aligned interests and mobilized support around a common ambition. This finding highlights the social and relational foundations of small wins. Before technological experimentation can take place, actors need to establish the collaborative arrangements that enable innovation. For projects this signifies the need to actively equip their coalition builders or networkers with the resources and capacities needed to achieve partnering. This avoids that innovative projects remain at the sidelines but rather contribute to broader transformative change.

The findings further indicate that visionaries frequently operated in close conjunction with coalition builders and networkers. Visionary actors were important for articulating transformative ambitions and creating direction, but their influence was greatest when these ambitions became embedded within broader coalitions. This suggests, in light of financial, legal and organizational barriers, that transformative visions alone are insufficient to generate change. Their practical relevance depends on the ability to translate aspirations into collaborative action and institutional commitment.

Furthermore, resource brokers were repeatedly associated with professionalization and stabilization. In all cases, access to financial resources, political support and organizational capacity proved essential for moving beyond the experimental stage. This finding suggests that many circular water initiatives experience a critical transition from conceptual ambition to operational reality, during which resource mobilization becomes a prerequisite for continuity. Resource brokers therefore play an important role in sustaining initiatives long enough for other propelling mechanisms to emerge.

In the more mature stages of development, legitimizers frequently co-occurred with stabilization and embedding. Their contribution extended beyond demonstrating technical feasibility to maintaining credibility among users, regulators and partner organizations. This finding is particularly relevant in light of the embedding paradox discussed 4.2.2. Although embedding contributes to the continuity of an initiative, it may simultaneously reduce the visibility and transformative momentum that characterized the earlier phases. Legitimizers therefore appear to play a crucial role in balancing institutional acceptance with the continued recognition of the initiative's transformative character.

Finally, the later stages of development reveal a recurring association between knowledge brokers and visionaries and the mechanisms of replicating and spreading. Across cases, the diffusion of ideas, practices and technologies depended not only on successful implementation but also on actors capable of translating local experiences into transferable knowledge and broader narratives. This finding suggests that spreading is not an automatic consequence of successful experimentation. Instead, replication requires deliberate efforts to codify lessons learned, communicate their relevance and connect them to wider transformative ambitions.

Taken together, these findings point towards a recurring developmental pattern in which:

- Visionaries, networkers and coalition builders are particularly important during conceptualization;
- Resource brokers and knowledge brokers become more prominent during development and stabilization;

- Knowledge brokers, legitimizers and visionaries gain importance during embedding and spreading.

This pattern suggests that the contribution of agents of change evolves throughout the lifecycle of a small win. Consequently, understanding transformative change requires attention not only to which roles are present, but also to when particular forms of agency become most important in activating and sustaining propelling mechanisms.

5. Discussion

5.1. Dynamics of roles of agents of change

The findings of this research emphasize the conclusion of Van Aalderen & van Dooren (2024) that the roles of agents of change are not fixed or mutually exclusive, but rather overlapping and dynamic forms of agency that can change across projects and contexts. The same actor may perform several roles depending on the situation, while different actors may contribute to the same role at different points in the innovation process. For example, knowledge brokers may also act as problem brokers or legitimizers when knowledge is used to address operational challenges and embed an innovation. Similarly, coalition builders may shape their coalitions around linking certain issues to potential solutions, thus also acting as issue linkers. Focusing on fixed roles thus risks overlooking how actors shift between forms of agency as project needs and context change. Future research could further explore agents of change not only through the roles they assume, but also through the strategies they employ to address specific challenges. Such a perspective would make it possible to examine how forms of agency differ when actors address technical, regulatory, financial or organizational barriers and how these strategies evolve over time. Rather than treating roles as stable identities, roles could be understood as constellations of strategies that enable actors to navigate different contexts and challenges. This may provide a more dynamic understanding of how agency contributes to transformative change. For example, the strategies of agents of change may be employed in certain configurations, in which the combination and sequencing of the strategies should be tailored to the context. This is highlighted by recent research of Breviglieri & Yamahaki (2024), who show that not all strategies are always applied to realize change, and that different configurations of strategies can lead to similar outcomes under different conditions.

5.2. Paradox of embedding

A finding across multiple cases is that embedding innovation into regular structures can have a paradoxical effect. On one hand, embedding can provide stability for an initiative and enables innovations to persist beyond the initial pilot phase. On the other hand, becoming a part of routine operations and structures (“mainstreaming”) can reduce the attention and resources that initially supported experimentation and change (Lasseur et al., 2026).

From an agent of change perspective, this creates a tension between the stabilization associated with embedding and continued transformative efforts. Knowledge brokers and legitimizers contribute to embedding by maintaining technical systems, solving operational problems and transferring knowledge into regular practice. However, once they are successful and the innovations and their operation become part of the regular routine, continued learning-by-doing and transformative momentum require renewed agency and organizational support. The Jenfelder Au case study showed that operators continued to create learning opportunities through new projects, knowledge exchange with similar initiatives, and new collaborations, but this required more effort than when the project was still seen as a transformative pilot. Embedding is thus simultaneously seen as a successful indicator of innovation but also creates challenges when it comes to preserving transformative momentum.

5.3. Dependency on a small group of agents of change

The research identified a potential dependency on relatively small groups of individuals in all four cases. These individuals hold critical knowledge, maintain relationships, and have gained great

experience in relation to the initiatives. The fact that this group was often relatively small, can create vulnerabilities for the further development of the initiatives. When these capacities are concentrated in a few individuals, their absence or changing roles (formal, not agents of change) may create bottlenecks and make it more difficult to maintain transformative momentum. Broadening and institutionalizing the group can reduce this dependency and strengthen continuity, but may also alter power dynamics, slow decision-making and constrain the flexibility that enabled the initiative to progress. Successful innovation therefore requires a balance: retaining the commitment and agility of core agents of change while distributing knowledge and responsibilities across a wider group through clear procedures and allocation of responsibilities. Professionalization may support this process by creating organizational structures and routines that reduce dependence on individual actors without unnecessarily undermining responsiveness.

5.4. Co-occurrence and inferring causality: limitation of this study

A limitation of this research concerns the extent to which the observed relationships between roles of agents of change, mechanisms, and outcomes can be interpreted as causal. The qualitative material gathered in a small-n comparative study provides evidence that certain roles and mechanisms co-occur in the analysed cases. For example, knowledge brokers are repeatedly associated with learning-by-doing and professionalization, while coalition builders are associated with partnering and resolution of regulatory and organizational challenges. However, the research design does not allow us to establish that the actions of a particular role of agents of change caused the observed mechanism or outcome, which was also not the goal of this study. Consequently, the findings of this research should be primarily understood as identifying patterns of co-occurrence and plausible process relationships, rather than testing causal effects of specific agents of change roles. It thus contributes to explaining how change processes may unfold but cannot infer causality between the occurrence of agents of change roles and mechanism.

5.5. Recommendations for future research

Based on the findings of this research, several recommendations for future research can be made. In this section, we will highlight three of those recommendations:

- First, future research could work towards further illuminating the relationship between roles of agents of change, mechanisms and transformative outcomes. The current study identifies recurring associations between particular roles and mechanisms, but the empirical data does not allow causal relationships to be inferred. Longitudinal studies and process tracing could investigate how specific forms of agency contribute to mechanism and how these mechanisms subsequently influence innovation outcomes.
- Second, future research should examine the conditions that enable agents of change to perform their roles effectively. The findings suggest that agency is influenced not only by individual capacities, but also by organizational and institutional conditions such as management support, available resources, political backing, regulatory flexibility and access to networks. Research could therefore investigate under which conditions particular agents of change roles can emerge, be sustained and supported.
- Third, future research could further shift attention from how agents of change realize singular projects, to how they realize the spreading, broadening and deepening of these initiatives. While singular projects provide opportunities for experimentation and learning, their transformative potential depends on whether lessons and technologies can be transferred, replicated or expanded beyond the initial project. Studying how agents of change navigate the

transition from a small win to a broader systemic change, across and beyond individual innovation projects could help clarify how agency contributes to spreading, broadening and deepening of small wins.

6. Conclusion

This report examined how agents of change contribute to the realization of decentralized circular water initiatives and to the propelling mechanisms that enable these initiatives to spread, deepen and broaden. By combining the Small Wins framework with the Agents of Change framework, the study addressed a gap in the literature on transformative change. Whereas existing small wins research has primarily focused on systemic mechanisms, this study explored the role of individual actors in activating and sustaining these mechanisms.

Across the four ANCHOR case studies, decentralized circular water initiatives were shown to function as small wins: concrete and implemented projects that challenge dominant approaches to water management and create opportunities for wider transformation. The findings demonstrate that the development of these initiatives depends not only on technological innovation and supportive institutional conditions, but also on the actions of individuals who perform different roles throughout the lifecycle of an initiative.

The analysis identified recurring patterns in the co-occurrence of agent-of-change roles and propelling mechanisms. In the conceptual phase, visionaries, networkers and coalition builders frequently co-occurred with partnering, creating the coalitions and shared ambitions needed to initiate transformative projects. During the development phase, knowledge brokers and resource brokers played a central role in learning-by-doing, professionalization and stabilization by generating knowledge, overcoming barriers and mobilizing resources. In later phases, legitimizers and knowledge brokers were particularly important for embedding innovations within organizations and communities, while knowledge brokers and visionaries contributed to replication and spreading by translating local experiences into transferable knowledge and broader narratives.

These findings suggest that transformative change is not driven by a single type of actor or mechanism. Rather, different forms of agency become important at different stages of development. The realization and continuation of small wins therefore depend on the presence of complementary roles that collectively support experimentation, learning, legitimacy, and diffusion.

At the same time, the cases reveal important challenges. The knowledge, networks and commitment required to sustain transformative initiatives were often concentrated in a relatively small number of individuals. Furthermore, successful embedding into routine organizational structures sometimes reduced the attention and resources previously dedicated to experimentation and innovation. The findings therefore highlight a central paradox: the institutionalization of innovations is necessary for their long-term survival, yet it may simultaneously weaken the transformative momentum that enabled their emergence.

Overall, this study demonstrates that propelling mechanisms do not operate independently from human agency. Agents of change play a crucial role in activating, sustaining and amplifying the processes through which small wins contribute to wider transformation. The transformative potential of decentralized circular water initiatives therefore lies not only in their technological performance, but also in the capacity of actors to build coalitions, mobilize resources, facilitate learning, create legitimacy and translate local successes into broader societal change. Ultimately, transformative change in urban water management appears to depend on the continuous interaction between

ambitious visions, supportive partnerships, iterative learning processes and the individuals who connect them.

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ANNEX I: Schoonschip, Amsterdam [NL]

Development and background

Schoonschip is a sustainable, floating neighbourhood in Amsterdam in which 46 households with approximately 100 inhabitants live on 30 boats in a canal in the urban development area of Buiksloterham (Schoonschip, n.d.). This community of boats is created by citizens who had the ambition to develop and realise 'the most sustainable floating neighbourhood of Europe' (Rompa, 2021). The project started in 2008 in search of an answer to the question of instigator Marjan de Blok 'How can I live as ecological and social as possible?'. Schoonschip can be considered a bottom-up development in which a group of citizens was able to find a pathway to realise the dream of a sustainable living community.

Integrated urban water system innovation

The urban water management concept applied in Schoonschip consists of different techniques in which water is collected separately and used in a circular way (Schoonschip, n.d.; van Duuren et al., 2026). The most important source of water for the neighbourhood is drinking water that is distributed by drinking water company Waternet. However, several techniques are applied to keep water usage low. This is for example done by the installation of recirculation showers and vacuum toilets. Both techniques aim to limit the use of drinking water. The recirculation shower makes use of potable water from Waternet, but also reuses this shower water and heats it by using solar boilers. The main water source for the vacuum toilet is rainwater. Furthermore, regular heat pumps rely heavily on the use of water for central heating. In Schoonschip, however, surface water is extracted from the canal to limit the demand and usage of drinking water. This is an innovative heat system that is applied on a neighbourhood/community scale (Greenprint, n.d.; Leclercq & Smit, 2021).

Wastewater in Schoonschip is minimized and separated into two streams of grey water and black water. Black water consists of water coming from the vacuum toilets and is collected with food waste from an installed food grinder. This stream is treated in a black water treatment UASB-reactor, which produces both biogas that can be used for local heating and struvite that can be used as a fertilizer for food production. Both these recovered products can be used on a community scale (Greenprint, n.d.; Leclercq & Smit, 2021).

Legal structure and key developments

The initiators of Schoonschip organised and institutionalised themselves in the 'Schoonschip corporation' which was founded in 2010 by future residents and in a collective private commissioning (or CPO, Collectief Particulier Opdrachtgeverschap) (Greenprint, n.d.). The structure of a CPO ensured enough collectiveness, but also individual freedom in the development of a collective housing project. In the search for a location for the project, the initiators decided to take part in a tender procedure that the municipality of Amsterdam had set out for 'the market' to come up with plans for this specific area in Amsterdam. The initiators invited urban design agency Space & Matter to develop the urban design plan. The tender had set high demands relating to different sustainability criteria (Leclercq & Smit, 2021).

The municipality had a constructive relationship with the project and supported it. The demands of the municipality, however, differed from the vision of the corporation on the number of households in Schoonschip. The demand was that there should be 30 households, but this would mean large homes, which would be too expensive and not conform with the sustainability objectives of the project. The corporation developed a plan for 46 households, which had legal consequences as it was not allowed yet to develop two houses in movable property (Greenprint, n.d.). The so-called 'twee-onder-één-kap' homes only existed in real estate.

In 2016, the Coop was founded in addition to the corporation. The corporation remained responsible for preparation tasks, whilst the Coop took on collective aspects of the execution of the project and represented all members of Schoonschip. However, over time it became apparent that the Coop had a lack of legal prevalence. This resulted in foundation of the Owners Association (Greenprint, n.d.). This organisation is owner of the local energy infrastructure. At first, it was not legally possible to have ownership on such an energy collective in the form of a smart grid, but Schoonschip was able to get an exemption under the energy law (Leclercq & Smit, 2021).

Financial structure and key developments

The participants, or future residents of Schoonschip, had to take a considerable financial risk by investing in the project when it was still unsure whether it would succeed. Besides the costs of their own houseboat, the participants had to contribute to the collective budget, which consisted of constructing jetties, an electricity and plumbing network, project costs, permits, etc. This together with unforeseen costs caused by delays and legal issues resulted in a total of €70.000 for collective costs per household (Greenprint website, n.d.).

Almost all participants of Schoonschip were dependent on a mortgage to finance the houseboats. However, because houseboats cannot be classified as real estate but rather as moving property, very few banks were willing to make the investment. Moreover, a mortgage was also necessary to cover the collective costs. Finally, with the help and advice of lawyers and notaries, Triodos bank agreed to a construction that would allow the granting of mortgages for Schoonschip (Greenprint, n.d.).

Governance context

From different reports about the development of Schoonschip (Leclercq & Smit, 2021; Rompa, 2021; Schoonschip, n.d.), it can be concluded that the persistence of the citizens group and the support of the local government made the realisation of the neighbourhood happen. In Leclercq & Smit (2021), it is stated that 'the pilot project was so new, that a lot of consultation and attuning between different local officials, the water utility company, engineers, installers and citizens (group) was necessary to make the development happen'. 'It was a technical and organizational challenging project in which new financial and juridical pathways had to be found, which was time consuming and costly', according to the association.

The project took over 11 years to develop due to bureaucracy at the municipality, officials that were changing jobs, juridical hurdles and financial and technical challenges. Not all initial demands could be met, such as the ambitions for local food production. However, during the development new insights led to improvements and new ideas, like the collective space that is now realised (Leclercq & Smit, 2021). Furthermore, the demand related to the number of houses and 'twee-onder-een-kap' homes caused a lot of juridical hurdles. This is still not legally solved until this day. There were also challenges for the municipality related to the novelty of the systems; there were no regulations yet and officials had to figure out who could say something related to questions that were arising. Also, due to the

transfers of co-workers, the process was delayed and in a lot of situations the group had to start over with informing the new official about the project (Rompa, 2021).

Important contributors to the project plan were urban design agency Space & Matter and consultancy agency Metabolic together with Spectral, who oversaw the sustainability research for the development and translated ambitions into concrete solutions that were financially and technically feasible (Leclercq & Smit, 2021). All residents of Schoonschip were allowed to choose their own architect and contractor, which appeared to be highly complex organisationally. This required more communication and costs (Rompa, 2021).

ANNEX II: Interview Guide

Interview guide ANCHOR WP3.2

Note: Semi-structured interview; regard questions as prompts to arrive at in-depth, qualitative and rich descriptions of experiences.

1. What is the main goal of the initiative?
2. What is the vision of the initiative?
3. To what extent has this vision changed over time?
4. To what extent is the initiative a symptom/pioneer of a larger transformation?
5. How have you, in your role at [organization], contributed to other initiatives adopting your vision? To what extent are you engaged in this in your daily work?
6. How can your initiative do even more towards circularity and sustainability? To what extent are you involved with this 'deepening' of your vision in your daily work?
7. To what extent do you find it important that your vision is adopted in other sectors? How do you contribute to this personally?
8. [Show and briefly explain the Agents of Change framework]
9. Which role do you identify with the most?
10. What legal barriers have you encountered in the project and how have you personally dealt with them?
11. What financial barriers have you encountered in the project and how have you personally dealt with them?

ANNEX III: Overview of interviews

Nieuwe Dokken, Ghent

Organisation	Date
Farys	17 December 2024
CAAAP	17 December 2024
DuCoop	17 December 2024
DuCoop	17 December 2024
Stad Gent	17 December 2024
Stadsontwikkeling Gent	17 December 2024

Jenfelder Au, Hamburg

Organisation	Date
Hamburg Wasser	11 June 2025
Hamburg Wasser	16 October 2025
BUKEA	12 November 2025

Oceanhamnen, Helsingborg

Organisation	Date
NSR	10 June 2025
NSVA	16 June 2025
NSVA (former)	23 June 2025
NSVA (former)	13 August 2025
City of Helsingborg (former)	16 June 2025
City of Helsingborg	25 August 2025
Svenkst Vatten	23 June 2025
Resident	24 June 2025

Superlocal, Kerkrade

Organisation	Date
Waterschap Limburg (formerly WBL)	27 August 2025
WML (former)	9 July 2025