THE PROCESS OF URBAN SYSTEMS INTEGRATION

An integrative approach towards the institutional process of systems integration in urban area development

MSc Thesis
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November 2017

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Delft University of Technology

AMSTERDAM INSTITUTE FOR ADVANCED METROPOLITAN SOLUTIONS

INTRODUCTION

Today, more than half of the world's population lives in cities. This makes them centres of resource consumption and waste production. Sustainable development is seen as an opportunity to respond to the consequences of urbanisation and climate change. In recent years the concepts of circularity and urban symbiosis have emerged as popular strategies to develop sustainable urban areas. An example is the experimental project "Straat van de Toekomst", implementing a circular strategy based on the Greenhouse Village concept (appendix I).

This concept implements circular systems for new ways of sanitation, heat and cold storage and greenhouse-house symbiosis. Although many technological artefacts have to be developed for these sustainable solutions, integrating infrastructural systems asks for more than just technological innovation. A socio-cultural change is needed in order to reach systems integration.

The institutional part of technological transitions has been underexposed over the past few years. Besides the fact that systems integration is a relatively new concept, challenges regarding the process towards it have been mainly focussed towards the technological side. There is a lack of a clear answer on what institutional challenges and opportunities emerge during the process of systems integration, as well as a lack of knowledge on its implementation in urban area development.

Because systems integration is considered to be able to play a role in the transition towards a more sustainable society and built environment, the success of these projects should be enhanced. Consequently, this thesis explores the main research question:

What are the challenges and opportunities of systems integration in urban area development and how can these be adressed by actors?

The following subquestions are developed in order to answer the main question:

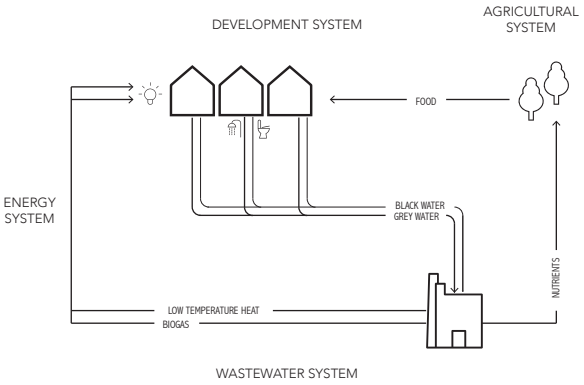
Features
1 What is systems integration and what does is mean in an urban context?
2 What are the variables that influence the process of systems integration?
3 How and in what way do these variables influence the process of systems integration?

Strategies
4 What are the existing strategies for systems integration in urban development projects?
5 How can challenges and opportunities (variables) be addressed by using a certain strategy?

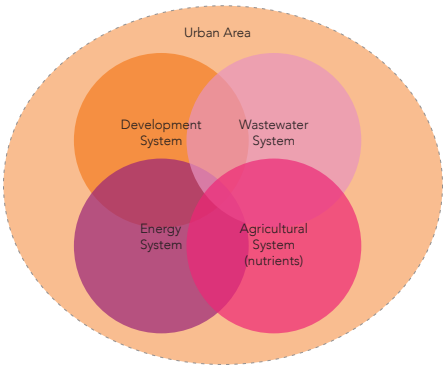
This thesis focusses on projects in urban area developments, the variables that influence the institutional process and the strategies actors can use to address challenges and opportunities. The goal is to provide insight into the institutional and spatial elements of systems integration processes.

THEORETICAL FRAMEWORK

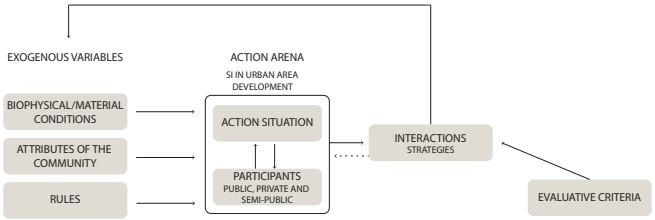
Systems integration is about connecting initially separate urban systems by which an optimal use of resources can be achieved. This is done by integrating multiple infrastructural systems and linking different technologies to each



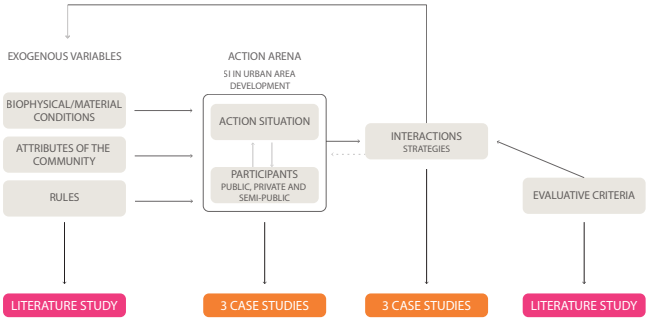
S.1 The concept of systems integration



S.2 Combining socio-technical systems



S.3 IAD framework (adjusted for this research)



S.4 Methods used for each part of the framework

other (e.g. the recovery of nutrients from wastewater for agricultural purposes) (figure S.1). Although linking different technologies is at the root of systems integration, these technologies are part of a larger whole and can be conceptualised as socio-technical systems (figure S.2). Systems integration is about combining initially separate socio-technical systems and can therefore be conceived as a transition process.

Socio-technical transitions are often described by the Multi Level Perspective, developed by Geels (2002;2004). In order for a transition to be successfull, the processes at three different levels (landscape, regime and niche) should reinforce each other. Systems integration is a relatively new concept and currently finds itself in its experimental phase. Because this research focusses on individual projects and involves local dynamics, interactions and negotiations between actors, we are mainly concerned with the niche level. The MLP provides a good overview of how these three levels interact, but remains on the surface of how processes within niches take place. We've therefore decided to use the IAD framework in order to get a better understanding of institutional processes within niches.

In order to analyse the process of systems integration in urban area development, the Institutional Analysis and Development (IAD) framework of Ostrom is used. The framework enables us to identify the influence of important variables on the decision making process. It consists of three exogenous variables (biophysical/ material conditions, attributes of the community and rules) that influence an action arena (action situation and participants) and provides handles to identify interactions and analyze these interactions through evaluative criteria (figure S.3).

METHODOLOGY

The research strategy is of qualitative nature. Because the concept of systems integration is relatively new and little research has been done into the process towards it, an explorative research is considered to be a suited approach.

A comparative case-study is performed into three cases in the Netherlands: Cityplot in Buiksloterham, Amsterdam; Waterschoon in Noorderhoek, Sneek and EVA Lanxmeer in Culemborg. These were selected on the criteria of encompassing a project integrating infrastructural systems from the "Straat van de Toekomst" and being an urban area development. Due to time considerations and availability of cases and information, the number of cases was limited to three, all taking place in The Netherlands.

The first, second and fourth subquestion are answered by a literature study. General literature on systems integration

and urban area development provide the knowledge to answer subquestion 1. The IAD framework of Ostrom adds a structure to the research and helps identifying relevant variables influencing the process (subquestion 2) and interactions between actors (strategies). In order to give meaning to these interactions, six evaluative criteria are obtained through theory on Strategic Niche Management, Niche Entrepreneurs and Policy Network Management (answering subquestion 4) (figure S.4).

The third and fifth subquestion are answered by the empirical part. Case studies show the way in which the variables (derived from the theoretical framework) manifest themselves and how actors interact with each other (figure S.4). Whether these variables influenced the process in a positive (opportunities) or negative (challenges) way and how actors addressed them is examined. Data collection took place through the analysis of relevant case documents and semi-structured interviews with stakeholders that played an important role during the process in the three cases.

CONCLUSIONS

The main findings were as follows:

1 The impact of the UAD system

Variables derived from the urban area development (UAD) system had a large impact on the studied projects. Urban development and systems integration processes are both very much bound to their location. This makes the choice to select specific actors difficult, and projects in general have to "deal" with the presence of existing actors in the area. Actors from the UAD system such as municipalities and housing associations are responsible for a certain region. Monopolists furthermore often control infrastructural systems in urban areas. Depending on the willingness of these actors to cooperate, their sense of urgency and awareness of a problem, existing actors can be either a challenge or an opportunity.

This characteristic of present actors is determined by the boundary rules. Institutional arrangements determine the number of participants, their attributes and resources, whether they can enter freely and the conditions they face for leaving. These aspects are often entirely determined by the location of the UAD project.

Long time span & tender procedures

For the few actors that can be selected, long time spans and tender procedures form a barrier to become engaged in an early phase of the process. This makes it challenging to select e.g. product suppliers, include the fertilizer industry (Dutch: kunstmestindustrie), homeowners and organic waste processors in an early stage of the systems integration process and make use of their expertise. Additionally, not engaging actors from the start can also create fewer incentives for the system and installations working in an optimal way.

Because there is little flexibility of the boundary rules and actors can hardly be selected, the activation or (de) activation of actors is difficult. The building of social networks, with the goal of expanding the resource base, has to be achieved with present actors.

The important role of the Municipality

One of the most important actors that plays a role in the UAD process is the municipality. Municipalities are an important actor due to (among other things) their power over the land-use plan and permit provision. This is especially the case in Amsterdam, where a lot of land is still in leasehold (Dutch: erfpacht). Municipalities furthermore have the power over the sewage system in most cases. Consequently, they are an essential actor to incorporate in the decision making process of integrating (wastewater) infrastructures.

Connecting a problem with a policy issue is one of the possibilities to get the municipality engaged. We found a difference between small and large organisations regarding the effects of policy. Although smaller municipalities are often said to possess less capacity or financial means to realise innovative projects, policy does have a better outreach in small organisations. Lines are short and departments seem more alligned and less extensive. In large organisations, where tasks are scattered over multiple departments accounting to different aldermen, policy seems unsufficient to achieve awareness and urgency at all levels. It became clear in BSH that although a topic is integrated in the municipal sewage plan or the water management plan, additional steps have to be taken towards creating awareness.

Concluding

Although the main focus is often on the infrastructural actors in such projects and the (new) roles they should fullfill, the actors of the UAD process seem to play a major role for realisation. Not only are they location bound and already present, actors also bring specific restrictions regarding their ways of working and regulatory framework. Besides organisational challenges (e.g. tender procedures, urban plans, municipal practices, etc.), the financial opportunities of UAD are embedded on a higher level of land prices and projects are economically and politically dependent.
For complex UAD projects, multidisciplinary projectteams within the organisation can be set up. This team integrates multiple departments, which enhances the input of expertise on every aspect of the development. Besides

putting systems integration ambitions in official documents such as the building envelope, it could be usefull to integrate people of energy, water and waste departments within this projectteam. If the urban plan (Dutch: stedenbouwkundig plan) is developed by a developer, the municipality needs to reconsider their role. Do they want to fullfill a regulating role, or a more prescriptive one? This decision is also bound to legal obligations regarding the building regulations (Dutch: Bouwbesluit). The type of role that the municipality wants to fullfill in systems integration projects is an important part for determining a course of action.

2 Physical characteristics of the systems' infrastructural requirements

Systems integration often requires new types of infrastructure, also within houses (e.g. vacuumtoilets, low temperature heating systems, etc). Because infrastructural systems comprise long-term investments, it is not always possible to integrate new installations and systems with the existing infrastructure. Newly built houses and greenfield developments (where no infrastructure is in place yet) or where there exists a replacement task provide the best opportunities. Besides the type of development, the location also plays an important role. Spatial requirements for the installations are less feasible in the inner city, where land prices are high and space is scarce.

Integrating installations in the urban plan

The amount of connections to the system is limited to the scale of the UAD. In order to find a financially feasible and sustainable scale for S.I., the amount of houses built should ideally coincide. Connecting e.g. surrounding UADs enhances risk for delay and difficulties regarding tender procedures. This is more of a challenge when upscaling towards the regime level is required. Niches are in general first protected from market mechanisms and experiments are often performed at a smaller scale due to risk considerations. Not only should the scale of UAD be taken into consideration, ideal scales for the infrastructural systems also differ. The scale for transportation, buffering or supply of different systems does not automatically coincide. However, this is perhaps more of a technical aspect that should be solved.

When additional space is required, integrating physical interventions within the urban plan has to be done at the very beginning. Involving relevant (UAD) actors with the S.I. process is therefore crucial if installations need to be integrated in the urban plan. In order to achieve this, social networks between actors with relevant resources should be built in an early stage. Making sure they interact on a frequent basis secures continuous information exchange and facilitates physical implementation of the system. This is often a challenge as little (technical) information is avaible during innovative projects in an early stage.

Concluding

The requirements for systems integration are physically depending on the UAD project. Besides the necessity for new infrastructure and interventions within the houses (opportunities therefore depending on the type of development), the necessity of physical space for installations is directly connected to the location of the development. Integrating installations in the historic centre of Amsterdam is evidently more complex than a greenfield development on agricultural land.

3 Distribution of roles and responsibilities

Keeping the organisation similar to the traditional distribution of roles and responsibilities provides opportunities. Existing knowledge from actors can be used to optimalise the product and system. Additionally, trust is established when actors perform their regular duties. However, transitions in socio-technical systems were argued to require new types of roles and institutional arrangements in the introduction of this thesis.

Taking on a new role

The case of EVA Lanxmeer showed that an infrastructural actor (a drinking water company) was able to succesfully take on another role (operating a district heating network). Challenges then arise regarding finding a place within the existing organisation, especially when the system is still operating on a niche level. Changes in the organisation (mergers, acquisitions, political direction, etc.) can lead to other ideas about roles. Because S.I. projects require long-term commitment, they will be affected when this happens. Nevertheless, combining tasks within one organisation has a positive effect as well: the amount of actors diminishes which can facilitate collaboration processes.
Whether actors should or can take on a different role or shift their responsibilities is very much depending on the ambitions and focus of the organisation. When certain roles are missing in a new type of system (e.g. the energy component of new sanitation is lacking) a specific demand is created. The ambition of taking on a different role for public or semi-public actors is driven by other incentives than those of private actors. Public actors will probably start thinking about new roles when the market is not willing to offer a certain service or product or when it is being considered as a public good.

Barriers for actors to act as urban system integrators were mentioned in theory on niche entrepreneurs. They included difficulties for public actors to be involved in activities that are market driven while private actors face difficulties in organising public activities. Questions about roles specifically arise regarding the responsibility for infrastructural systems such as energy and water.

Water has always been part of a collective system, while the energy system (more specifically energy supply) experienced a shift towards the privatised market in the '80s. However, the idea that public actors are responsible for infrastructure and more capable of making these long-term investments still exists. This means that municipalities or watercompanies/district water control boards might need to invest in energetic infrastructure in order to make systems integration a success. This may bring up difficulties, as intervening in a privatised market as a public actor causes unfair competition. The distribution of costs and benefits between public and private actors is complex when public actors finance parts of the systems and services operated by private actors.

4 Collaborating with different corporate cultures

Actors from different disciplines bring multiple corporate cultures together in systems integration projects. Challenges arose in Buiksloterham from differences in 'language', as some (UAD) actors were more projectoriented and some (infrastructural) actors rather processoriented. These different perceptions were strengthened by the creation of an official document stating circular and sustainable ambitions for the area. Although all stakeholders signed it, nothing was put into formal or binding agreements. As a result, different expectations about taking action existed. The choice rules (actions that actors can (t)/should (n't) take) were not made explicit enough.

Putting ambitions into formal agreements

The articulation of expectations or visions was mentioned as criteria to make sure that actors share similar expectations, based on experimental results. Similarities and differences in actors' perceptions should indeed be explored in order to reach goal convergence, but the importance of making ambitions formal at a certain point needs to be emphasized.

Working together in formal ways proved successfull and necessary in the studied cases during the long-term commitment that S.I. comprises. Additionally, UAD projects also have long time spans. It was not uncommon that companies merged or were acquired by others, and goals changed. Formal agreements provide clearity on roles and responsibilities during the process and afterwards.

Concluding

Difficulties exist regarding collaboration between different organisations, which increase when systems are combined. Although the articulation of expectations between actors is essential, this might not be enough to reach an actual course of action. Formal agreements can help making this more explicit, and play a role during the long time spans of UAD and S.I. The downside of formalities is that they can make processes rigid and inflexible which is not desirable in innovative projects. This is a trade-off that organisations need to make.

5 Connecting the MLP and IAD framework to the process of S.I.

Transitions as discussed by the MLP usually take place over long periods of time. The focus of this research was not on the transition process of S.I. but on the institutional process within a niche. However, regime and landscape levels were found to be important for this. Influential factors that came from the regime level were differences in 'language', ways of working together and the distribution of roles and responsibilies. More broad and external factors that are argued to be beyond the range of influence of actors (landscape level) were, among others, rules and regulations, policy, tender procedures and land prices. These influences were considered as the exogenous variables in the IAD framework.

Niches are perceived as protected spaces where innovations can be developed and have the ability to act as an incubator for regime (meso) changes in the MLP. We adjusted the IAD framework in the second chapter by adding a relation between interactions (strategies) and the exogenous variables. This connection between strategy and exogenous variable became especially apparent in the BSH case, where actors from the niche level pursued a legislative amendment (landscape level). In EVA Lanxmeer, a change in the regime was made when a drinking water company started operating a district-heating network (taking on a different role). Furthermore, the acquisition of the network by inhabitants also required changes in the set of rules (regime) of the involved actors.

Analysing spatial elements through the IAD

The IAD framework provided a possibility to analyse the influence of exogenous variables on the institutional process. This was important for this research as it focussed on projects within a specific spatial environment. The biophysical/material conditions of the urban development and the infrastructural systems turned out to have a large influence on the institutional process. The physical and economic conditions of an area largely determine the possibilities of S.I., especially due to scale restrictions. The ideal scale of urban developments and infrastructure for water transportation, treatment, energy storage and -supply does not automatically coincide. The more systems are integrated, the more important diverging scales become.

Actors from different systems in the IAD

Integrating different disciplines and sectors was a central part of the problem definition. Values that participants share or do not share, their preferences and the size and composition of the community were handles provided by

the IAD for analysis. The creation of consensus and mutual understandings did indeed provide challenges. However, creating mutual goals seemed less important for success than creating cooperative attitudes.
The institutional arrangements are particularly special in S.I. Because this is a new type of process, there are no determined rules for it yet. Nevertheless, actors bring their own ways of working and institutional arrangements with them when getting involved.

6 Continuation of experiments in niches
Finally, the question exists on what to do with niches in which the experiment does not function in an optimal way. This seems more difficult when innovations are related to a long-term investment such as infrastructural systems. When research has been performed and the niche has fullfilled one of its main goals (namely providing knowledge), outcomes are more difficult to adjust. It might be necessary for actors to think about the phase after experimentation and research, especially with infrastructure and urban developments, as these are not easy aspects to change when outcomes turn out dissappointing.

RECOMMENDATIONS

The main goal of this research was to give recommendations to the stakeholders of systems integration projects in urban area developments.

1 The location (land prices and availability of space) and the type of development (greenfield and no infrastructure in place) are important aspects for applying the concept of S.I. If installations need to be integrated in the urban plan, (infrastructural) actors should provide technical information and create social networks in an early stage of the process. The developer of the urban plan is an essential actor for this, and differs from case to case. Getting involved in the decision making process of e.g. the municipality (public actor) requires a different strategy than with a project developer (private actor). In order to create a social network, a clear overview of actors and their incentives by making an extensive actor analysis may be usefull.

2 By connecting the implementation of S.I. to a policy issue, (public) actors with important resources can become involved. Although this can indeed enhance the opportunities for creating a social network, the extensiveness of organisations should be taken into consideration. When tasks and responsibilities are spread over multiple departments (e.g. in large municipalities) it becomes more difficult to connect to a single policy issue. It is safer to get the topic of S.I. into the decision making process at a smaller scale and make it politically independent (mainstreaming). This is even more so when public actors change every four years due to the elections (Dutch: gemeenteraadsverkiezingen).

3 Actors having exactly the same goal is not considered to be necessary in order to reach a successfull process. Working towards a different goal which is obtained by realising the S.I. project creates sufficient incentives. More emphasis should instead be on the expectations about the expectations of the *process* instead of the *product.*

In order to identify differing perceptions beforehand, communication about expectations and visions in an early stage is a key element. To prevent difficulties from differences in language and expectations about action, formal agreements on ways of working can be helpfull.

4 Structuring the process of exploring perceptions and expectations on the project can be done by setting up a project organisation. Actors with essential resources (municipality, land owner, developer of the urban plan, infrastructural actors) should at least be incorporated within this team at an early stage.

A central project organisation with a joint wallet enhances incentives for all actors. Risks are then more equally distributed and standard hierarchical systems between organisations broken down.

5 Lastly, it is important that all actors think ahead about the project after the experimentation phase. Although it is unnecessary for everyone to have a similar goal initially, long term investments are required for infrastructure (and urban developments). Differing goals should have similar timelines or it should be able for actors to quit the project afterwards without negative consequences for the S.I. project.

INTRODUCTIE

Meer dan de helft van onze wereldbevolking woont in stedelijke gebieden, wat het centra maakt van consumptie en afval productie. Duurzame ontwikkeling wordt gezien als een kans om de gevolgen van verstedelijking en klimaatverandering aan te pakken. In de afgelopen jaren zijn hiervoor verschillende strategieën bedacht die voortkomen uit concepten als circulariteit en symbiose. Een voorbeeldproject hiervan is de innovatieve "Straat van de Toekomst", die wordt ontwikkeld voor de Floriade in Almere in 2022.

De Straat van de Toekomst is gebaseerd op het concept van de Greenhouse Village, waarin sanitatie, warmte- en koude opslag en kassenbouw met woningen wordt gecombineerd. Hoewel er veel technologische innovaties nodig zijn voor dit soort duurzame ontwikkelingen vraagt de integratie van infrastructuren zoals (afval)water en energie ook om een sociale en culturele omslag, waarbij partijen vanuit verschillende disciplines en sectoren wordt gevraagd samen te werken met elkaar.

De institutionele kant van technologische innovaties en transities is tot nu toe onderbelicht gebleven. Naast het feit dat systeemintegratie relatief nieuw is, worden onderzoeksvragen vaak gericht op de technische inpassing ervan. Er bestaat nog geen duidelijk antwoord op de vraag welke institutionele uitdagingen en kansen zich voordoen tijdens het proces van systeemintegratie, en er is een gebrek aan kennis over de toepassing ervan in gebiedsontwikkeling.

Omdat de integratie van infrastructurele systemen wordt gezien als een belangrijk aspect in de overgang naar een meer duurzame samenleving en gebouwde omgeving is het van belang om inzicht te verkrijgen in het (institutionele) proces. Daarom wordt in dit onderzoek de volgende hoofdvraag gesteld:

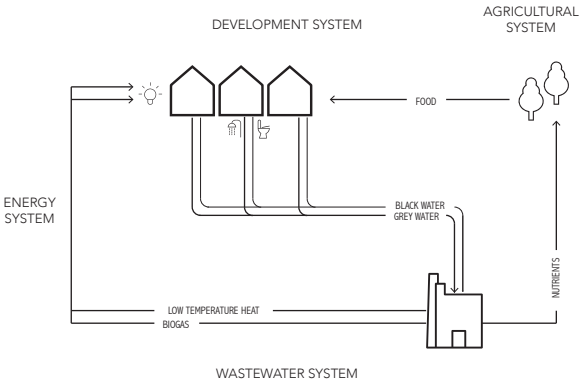
Wat zijn de uitdagingen en kansen van systeemintegratie in gebiedsontwikkeling en hoe kunnen actoren hier het best mee omgaan?

Dit onderzoek focust zich op projecten in gebiedsontwikkelingen, de variabelen die het institutionele proces beïnvloeden en de strategieën die actoren kunnen toepassen om met kansen en uitdagingen om te gaan. Het doel is om inzicht the verkrijgen in de institutionele en ruimtelijke elementen die systeemintegratie projecten beïnvloeden en aanbevelingen te doen voor de actoren binnen zo'n proces.

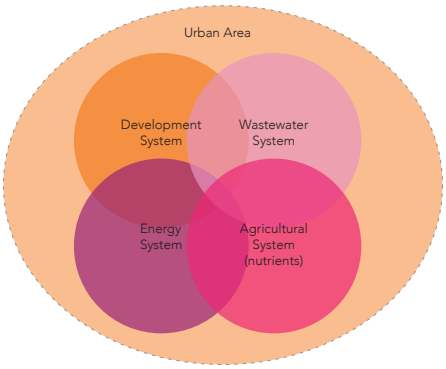
THEORETISCH KADER

Systeemintegratie betekent het combineren van aanvankelijk op zichzelf staande (infrastructurele) systemen waardoor een optimaal gebruik van grondstoffen kan worden bereikt. Door meerdere infrastructuren zoals bijvoorbeeld (afval) water en energie aan elkaar te koppelen kunnen nutriënten en warmte worden teruggewonnen (figuur S.1).

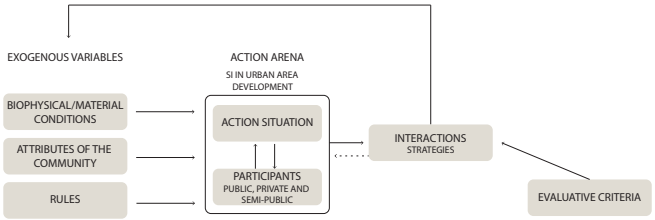
Hoewel het verbinden van verschillende technologische systemen aan de basis ligt van systeemintegratie, maken technologieën deel uit van een groter geheel en kunnen ze worden gezien als sociotechnische systemen (figuur S.2). Systeemintegratie gaat over het combineren van verschillende sociotechnische systemen en maakt daarom deel uit van een transitieproces. Transities worden vaak beschreven aan de hand van het Multi Level Perspectief, ontwikkeld door Geels (2002;2004). Om een succesvolle transitie op gang te brengen zouden processen



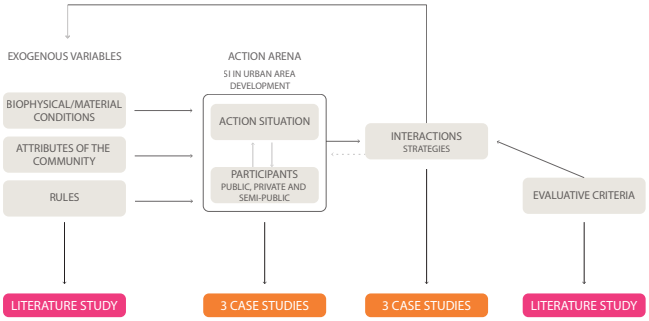
S.1 Het concept van systeemintegratie



S.2 Het combineren van sociotechnische systemen



S.3 Aangepast IAD framework



S.4 Gebruikte methodes voor elk deel van het IAD framework

elkaar op drie verschillende niveaus (niche, regime, landschap) moeten versterken. Omdat systeemintegratie een relatief nieuw concept is worden projecten nu vooral uitgevoerd in niches. Dit onderzoek focust zich op het proces in zo'n niche in plaats van op de transitie tussen de verschillende niveaus. Het MLP geeft een goed overzicht van hoe de drie niveaus met elkaar interacteren, maar biedt niet genoeg handvatten om het proces binnen een niche te analyseren. Daarom is besloten het Institutional Analysis and Development (IAD) framework van Ostrom te gebruiken om inzicht te verkrijgen in de institutionele en ruimtelijke aspecten van het proces.

Het IAD framework omvat drie exogene variabelen die het besluitvormingsproces in complexe situaties beïnvloeden. Dit zijn de biofysische omstandigheden, de gemeenschappelijke waarden/cultuur en de institutionele arrangementen/regels. Deze variabelen beïnvloeden de situatie waarin actoren met elkaar interacteren. Daarnaast bieden evaluatiecriteria uit het framework ons de mogelijkheid om die interacties te analyseren en beoordelen (figuur S.3).

METHODE

Het onderzoek is van kwalitatieve aard. Omdat systeemintegratie een relatief nieuw concept is en er nog weinig onderzoek is gedaan naar het proces ervan wordt een exploratief onderzoek als geschikte aanpak beschouwd.

Er is een vergelijkende case study gedaan tussen drie cases, namelijk Cityplot in Buiksloterham, Amsterdam; Waterschoon in Noorderhoek, Sneek; en EVA Lanxmeer in Culemborg. Deze zijn geselecteerd opdat het een systeemintegratie project betreft waarbij infrastructurele systemen uit de Straat van de Toekomst als leidraad zijn gebruikt. Daarnaast was het een vereiste dat projecten deel uitmaakten van een gebiedsontwikkeling. Vanwege tijdsrestricties en de beschikbaarheid en vergelijkbaarheid van informatie is gekozen voor drie cases in Nederland.

Algemene literatuur over systeemintegratie en gebiedsontwikkeling is gebruikt als input voor de exogene variabelen. Het IAD framework biedt hierbij de structuur voor het identificeren van relevante variabelen die het proces en de interacties tussen actoren (strategieën) beinvloeden. Om betekenis te geven aan de interacties tussen actoren zijn zes evaluatiecriteria opgesteld vanuit drie verschillende theorieen: Strategic Niche Management, Niche Entrepreneurs en Policy Network Management (figuur S.4).

Het empirisch deel bestaat uit de case-studies waarin wordt gekeken of, en zoja, op welke manier de variabelen

(uit het theoretisch kader) zich manifesteren en hoe actoren met elkaar interacteren. Er wordt onderzocht of variabelen het proces op een positieve (kansen) danwel negatieve (uitdagingen) manier beïnvloeden. Daarnaast kijken we naar hoe actoren op die uitdagingen en kansen hebben gereageerd en in welke mate dat overeenkomt met de vooraf opgestelde evaluatiecriteria. Data verzameling vind plaats door documentanalyse en semi-gestructureerde interviews.

CONCLUSIES

De belangrijkste bevindingen waren als volgt:

1 De impact van de gebiedsontwikkeling

Systeemintegratie en gebiedsontwikkeling projecten zijn beide zeer locatie gebonden. Dit maakt het lastig om bepaalde actoren te selecteren, en projecten krijgen over het algemeen te maken met de aanwezigheid van aanwezige partijen. Uit het gebiedsontwikkeling systeem zijn dat o.a. de gemeente, woningcorporaties en waterschappen. Zij zijn gebonden en verantwoordelijk voor een bepaald gebied. Infrastructurele systemen worden bovendien vaak beheerd door monopolisten. Afhankelijk van de bereidwilligheid, het gevoel van urgentie en de bewustheid van een probleem kunnen aanwezige actoren in een gebied een uitdaging of kans vormen.

Institutionele arrangementen bepalen het aantal deelnemers, hun kenmerken en middelen, of ze vrij kunnen toetreden en de voorwaarden voor het verlaten van een proces. Deze aspecten worden vaak volledig bepaald door het type en de locatie van de gebiedsontwikkeling.

Lange termijn en aanbestedingsprocedure

Voor de minderheid van actoren die wel geselecteerd kan worden vormen de lange termijn en aanbestedingsprocedures van gebiedsontwikkeling een uitdaging voor betrokkenheid in een vroeg stadium. Dit maakt het gecompliceerder om bijvoorbeeld product leveranciers, de kunstmestindustrie, toekomstige huiseigenaren en organisch afvalverwerkers te betrekken bij het systeemintegratie proces en gebruik te maken van hun expertise. Daarnaast kan betrokkenheid een stimulans zijn voor het ontwikkelen van een optimaal systeem, die dan ook ontbreekt.

Omdat er weinig flexibiliteit heerst in de 'toetredingsregels' is het lastig om actoren te activeren of juist te de-activeren. Het opbouwen van sociale netwerken met als doel het uitbreiden van hulpmiddelen moet daarom worden gedaan met de aanwezige actoren in een gebied.

De belangrijke rol van de gemeente

Een van de belangrijkste actoren bij een gebiedsontwikkeling is de gemeente, doordat die o.a. het bestemmingsplan maakt en vergunningen verlenen. Dit is met name in Amsterdam het geval doordat veel grond nog in erfpacht is. Daarnaast dragen veel gemeenten de verantwoordelijkheid voor de riolering. Zij zijn daarom vaak een essentiële partij om bij systeemintegratie projecten te betrekken.

Het relateren van een probleem aan een beleidsvraagstuk geeft de mogelijkheid om de gemeente te betrekken en urgentie te creëren. Desondanks moet het verschil tussen grote en kleine organisaties daarbij in acht worden genomen. Hoewel van kleinere gemeenten vaak gezegd wordt dat ze niet de financiële middelen of capaciteit bezitten om innovatieve projecten te realiseren, lijkt beleid sneller door te sijpelen door korte lijnen tussen personen en minder uitgebreide afdelingen. Wanneer taken verspreid zijn over veel afdelingen met verschillende verantwoordelijke wethouders, lijkt beleid onvoldoende om bewustzijn en urgentie te bereiken op elk niveau.

Conclusie

Dit alles toont het effect van het gebiedsontwikkeling systeem op systeemintegratie projecten aan. Ondanks het feit dat de focus vaak wordt gelegd op actoren uit de infrastructurele systemen en de rollen die zij (zouden moeten) vervullen, lijken actoren uit het stedelijk ontwikkelingsproces heel belangrijk. Niet alleen vanwege hun aanwezigheid, maar ook vanwege de beperkingen vanuit werkwijzen en regelgeving die zij met zich meebrengen. Naast organisatorische uitdagingen zoals bijvoorbeeld aanbestedingsprocedures en ruimtelijke plannen, worden de financiële mogelijkheden van gebiedsontwikkeling op een hoger niveau beinvloed door grondprijzen en zijn processen economisch en financieel afhankelijk.

2 Fysieke elementen van het systeem en infrastructurele ingrepen

Systeemintegratie projecten hebben vaak nieuwe infrastructuur nodig, ook binnenin huizen en gebouwen (denk aan vacuumtoiletten, vloer en/of wand verwarming, etc). Omdat infrastructurele systemen lange termijn investeringen behelsen is het niet altijd mogelijk om nieuwe installaties en systemen te integreren met bestaande infrastructuur of te vervangen. Nieuwbouwwijken en groene weide ontwikkelingen waar nog geen infrastructuur aanwezig is of waar een vervangingsopgave bestaat bieden daarom de beste kansen.

Naast het type gebiedsontwikkeling speelt de locatie ook een rol. Als installaties ruimte innemen zijn die hoogstwaarschijnlijk minder haalbaar in binnenstedelijke gebieden waar grondprijzen hoog zijn en ruimte schaars is.

Installaties integreren in het stedenbouwkundig plan

Als er extra ruimte nodig is voor installaties moet hiermee al rekening worden gehouden tijden de ontwikkeling van het stedelijk plan. Het betrekken van belangrijke actoren uit het gebiedsontwikkeling systeem is dan van cruciaal belang. Om dit te bewerkstelligen moeten sociale netwerken tussen actoren met belangrijke middelen in een vroeg stadium worden gecreëerd. Daarnaast is het belangrijk dat er continue informatie uitwisseling plaatsvindt in de fase van de ontwikkeling van het stedelijk plan en inpassing van installaties. Dat is soms lastig omdat weinig (technische)informatie beschikbaar is in het voorstadium van een innovatief project.

Ten slotte is het aantal connecties van het systeem vaak beperkt tot de schaal van de gebiedsontwikkeling (vooral wanneer fysieke interventies in huizen nodig zijn). Een financieel haalbare en meest duurzame schaal van het systeemintegratie project moet dus idealiter samenvallen met de schaal van de gebiedsontwikkeling. Het aansluiten van andere gebiedsontwikkelingen brengt veel extra risico's met zich mee (bv. vertraging en aanbestedingen). Omdat niches over het algemeen in het begin beschermd worden tegen marktmechanismen en experimenten vaak eerst of kleinere schaal worden uitgevoerd is dit vooral iets wat speelt bij de transitie naar het regime.

Concluderend

Naast de noodzaak voor nieuwe infrastructuur en interventies in huizen is de noodzaak voor fysieke ruimte voor installaties sterk afhankelijk van de locatie van de gebiedsontwikkeling.

3 Verdeling van rollen en verantwoordelijkheden

Bij behoud van een traditionele verdeling van rollen en verantwoordelijkheden worden enerzijds kansen gecreëerd. Bestaande kennis van actoren kan worden benut om het systeem te optimaliseren. Daarnaast bestaat er een gevestigd vertrouwen wanneer actoren hun eigen rol vervullen. De overgang van afzonderlijke socio-technische systemen naar integratie wordt echter gekenmerkt door het ontstaan van nieuwe rollen en instituties.

Nieuwe rollen

Infrastructurele actoren (zoals bv. het drinkwaterbedrijf in Lanxmeer) zijn in staat om succesvol een andere rol aan te nemen. De uitdaging ontstaat dan bij het vinden van een plek voor het nieuwe systeem binnen de bestaande organisatie, vooral wanneer deze nog op niche niveau opereert. Veranderingen binnen de organisatie (door bv. fusies, acquisities, politieke richting) kunnen leiden tot een verandering in de perceptie van (nieuwe) rollen. Omdat zowel systeemintegratie als gebiedsontwikkeling langdurige processen zijn kan dit van invloed zijn op het project. Desalniettemin heeft het combineren van taken binnen een organisatie ook het positieve effect dat de hoeveelheid actoren vermindert en samenwerkingsprocessen soepeler verlopen.

Of actoren een andere rol willen en kunnen aannemen hangt af van de ambities en focus binnen de organisatie. Wanneer er een gebrek is aan een bepaald soort rol ontstaat een expliciete vraag. Over het algemeen bestaat nogsteeds het idee dat publieke partijen verantwoorderlijk zijn voor de aanleg van infrastructuur. Zij worden geacht beter in staat te zijn om lange termijn investeringen te maken en te verantwoorden.

4 Samenwerking tussen verschillende bedrijfsculturen

Partijen die vanuit verschillende disciplines werken brengen ieder hun eigen bedrijfscultuur met zich mee. Uitdagingen in Buiksloterham onstonden bijvoorbeeld door verschillen in "taal". Zo waren sommige gebiedsontwikkeling actoren meer projectgericht, en systeemintegratie actoren eerder gericht op het proces. Deze verschillen in percepties van het project werden versterkt door de ondertekening van een document waarin de circulaire en duurzame ambities voor het gebied werden vastgesteld. Hoewel alle partijen deze hebben ondertekent, is niets uiteindelijk op een formele of bindende manier vastgelegt. Daardoor ontstonden verschillende verwachtingen over het ondernemen van initiatief en het overgaan op actie. De regels voor actie waren niet expliciet of bindend genoeg.

Ambities formeel maken

Het uitspreken van verwachtingen en visies was een van de evaluatiecriteria met als doel ervoor te zorgen dat actoren eenzelfde idee hebben over een experiment. Het is inderdaad van belang om de overeenkomsten en verschillen in actoren hun percepties te onderzoeken en doelen af te stemmen, maar we benadrukken het belang om ambities op een gegeven moment formeel te maken.

Samenwerkingen die formeel waren vastgelegd bleken op meerdere momenten nodig en succesvol tijdens de lange termijnprocessen van systeemintegratie en gebiedsontwikkeling projecten. Meerdere keren werden organisaties samengevoegd of overgenomen door andere/grotere bedrijven. Daarbij veranderden vaak de kerntaken of doelen. Formele afspraken bieden houvast en duidelijkheid over rollen en verantwoordelijkheden tijdens het proces maar ook erna.

Concluderend

De uitdaging ligt bij de samenwerking tussen verschillende partijen, die moet worden uitgebreid wanneer systemen

worden gecombineerd. Hoewel het uitspreken van verwachtingen en visies essentieel is, is dit niet altijd genoeg om tot actie over te gaan. De regels voor actie kunnen explicieter worden gemaakt door formele afspraken. Het nadeel van formaliteiten is dat processen minder flexibel worden, en dat is bij innovatieve experimenten in niches juist ongewenst. Dit is een afweging die actoren zullen moeten maken.

5 De verbinding tussen het Multi Level Perspective met het Institutional Analysis and Development Framework

Transities zoals besproken door het MLP gebeuren meestal over langere periodes en nemen veel tijd in beslag. De focus van dit onderzoek lag niet op de transitie van systeemintegratie van niche naar regime naar landschap, maar op het proces binnen niches. Er waren echter wel invloeden vanuit het regime- en landschapsniveau op dit niche proces. Invloedrijke factoren vanuit het regime waren bijvoorbeeld 'taal', manieren van samenwerken en de traditionele verdeling van rollen en verantwoordelijkheden. Landschapsfactoren die buiten de invloed van actoren liggen waren onder andere wet- en regelgeving, beleid, aanbestedingsprocedures en grondprijzen. Al deze factoren werden in het IAD in principe beschouwd als de exogene variabelen.

Niches worden beschouwd als beschermde omgevingen waar innovaties kunnen worden ontwikkeld en die veranderingen kunnen bewerkstelligen in het regime. We hebben het IAD kader in het tweede hoofdstuk aangepast door een extra pijl van interacties naar de exogene variabelen toe te voegen. Het verband tussen het toepassen van een strategie en de exogene variabelen werd vooral goed zichtbaar in Buiksloterham, waar een wetswijziging (landschapsniveau) werd nagestreefd. In EVA Lanxmeer vond een verandering in het regime plaats toen het drinkwaterbedrijf overging tot het opereren van een stadsverwarmingsnetwerk. Hiermee werd een nieuwe rol aangenomen. De latere overname van het netwerk door de inwoners van de wijk was bovendien ook een verandering in het regime van de betrokken actoren.

6 Vervolg van pilot projecten na realisatie

Tot slot bestaat de vraag wat het gevolg is van niches waarin het experiment niet optimaal functioneert. Dit blijkt moeilijker voor niches waarin de innovatie een ingreep in de infrastructuur behelst en langetermijn investeringen zijn gedaan. Wanneer het onderzoek is afgerond en het experiment heeft zijn belangrijkste taak vervuld (namelijk kennis verstrekken over een innovatie) is het lastiger om een niche op te heffen als het een woonwijk met infrastructuur betreft. Het is daarom van belang dat actoren nadenken over de fase na het experiment, vooral wanneer ingrijpende innovaties zoals infrastructuur worden getest.

AANBEVELINGEN

Het doel van dit onderzoek was om aanbevelingen te doen voor het proces van systeemintegratie projecten in gebiedsontwikkelingen.

1 De locatie (die verbonden is aan grondprijzen en de beschikbaarheid van grond) en het type ontwikkeling (groene weide en zonder infrastructuur) zijn belangrijke aspecten voor de toepasbaarheid van systeemintegratie. Indien installaties moeten worden geïntegreerd in het stedenbouwkundig plan is daarnaast vaak technische informatie nodig. Er is daarvoor een sociaal netwerk van actoren nodig in een vroeg stadium van het proces. De ontwikkelaar van het stedenbouwkundig plan is daarbij een essentiële actor, al kan deze per casus verschillen. Het vormen van een netwerk en betrokken raken bij het

besluitvormingsproces binnen bijvoorbeeld de gemeente vraagt om een ander soort strategie dan bij een reguliere projectontwikkelaar. Een uitgebreid en duidelijk overzicht en kennis van de drijfveren van de betrokken actoren kan nuttig zijn om een gepaste strategie te bepalen.

2 Door een (duurzaamheids)probleem te verbinden met een beleidsvraagstuk is het mogelijk om (veelal publieke) actoren met belangrijke middelen te betrekken in het proces. Dessalniettemin moet de grootte en complexiteit van organisaties daarbij niet uit het oog verloren worden. Als taken en verantwoordelijkheden verspreid zijn over meerdere afdelingen wordt het lastiger om aan te haken bij een specifiek beleidsvraagstuk. Hoewel de ene afdeling baat zal hebben bij een oplossing, kan het voor een andere afdeling enkel zorgen voor meer complexiteit en risico's. Het is dan noodzakelijk om op een lager niveau in het besluitvormingsproces betrokken te raken, en het probleem politiek onafhankelijk te maken.

3 Hoewel het doel van actoren met het project overeen zou moeten komen volgens literatuur, bleek uit dit onderzoek dat dit niet persé nodig was voor een succesvol proces. Ookal deden actoren met verschillende doelen mee, kon er nogsteeds een succesvol proces plaatsvinden. Meer nadruk zou desondanks moeten worden gelegd op de verwachtigen van het proces tussen actoren in plaats van het uiteindelijke product.

Om verschillen in "taal" en verwachtingen voor actie te voorkomen, wordt aangeraden de manier van werken op sommige punten formeel vast te leggen. Verschillende percepties over de verwachtingen en visies tussen actoren moeten hiervoor uitgebreid worden gecommuniceerd.

4 Het belang van partijen met relevante middelen betrekken aan het begin van het proces kan nog wat verder worden toegelicht. Een centrale projectorganisatie waarin actoren evenveel zeggenschap hebben en een gemeenschappelijke portemonnee kan extra stimulansen creëeren. Wanneer de risico verdeling min of meer gelijk op gaat (vaak ook gepaard met minder hierarchie) en elke partij ongeveer hetzelfde investeert is de motivatie voor het project ook in meerdere mate gelijk.

5 Tot slot is het van belang om na te denken over de fase na realisatie. Hoewel eerder werd genoemd dat niet iedereen hetzelfde doel hoeft te hebben tijdens het proces, is het voor het eindproduct wel relevant. Infrastructuur en gebiedsontwikkelingen omvatten grote en lange termijn investeringen (van soms wel 60-70 jaar). Doelen moeten ofwel in dezelfde tijdsmarge zitten, of partijen moeten voor een bepaalde periode betrokken zijn en kunnen stoppen zonder negatieve gevolgen voor het systeemintegratie project.

PREFACE

I derived my personal motivation for sustainable cities when I was following the Metropolitan Solutions course at the AMS Institute. The course was connected to the official cultural programme for the Netherlands' presidency of the European Union 2016: Europe by People. An area (FabCity) was developed at the head of Amsterdam's Java Island FabCity which offered a place for innovative pavillions, installations and prototyping. It was very inspiring to see all different kind of people and organisations working together to develop a sustainable urban area. Some people even lived over there during the whole summer. From big companies such as Waternet and Heijmans to SMEs, start ups and student projects from the Academie van Bouwkunst. After three months FabCity was closed as it was only developed as a temporary campus. It made me think about all these actors coming from different backgrounds, working towards one goal of making cities more sustainable. Combining this with my background at the faculty of Architecture in Delft, with a design-oriented bachelor and a master of Management in the Built Environment, it seemed like a logical step to write my thesis about the process of making sustainable urban developments actually happen.

A remarkable moment was when I was talking to one of my (former) teachers who mentioned the innovative 'Straat van de Toekomst' project. While discussing my graduation topic he said: "But are they really going to develop it? I'm not so sure". This made me realize even more that one could invent all types of technical solutions, but the implementation actually depends on a lot of other factors.

This thesis is the result of one year research for the Master Management in the Built Environment at the Faculty of Architecture. The graduation project is conducted in collaboration with the AMS institute and the chair of Urban Development Management at the Delft Univerisity of Technology.

I wanted to combine the governance aspects of systems integration processes with my own field of knowledge of the built environment. This was one of the main challenges to explore, as combining different disciplines has not always proved to be easy. Ironically, this was also one of the main conclusions of this research: combining disciplines and sectors is a tricky process.

Before wishing you enjoyment in reading, I would first like to thank a few people, without whoms help and support the completion of this thesis would not have been possible.

First and foremost, I would like to thank my mentors, Arie and Ellen. Arie, my sincere gratitude goes out to you, for trusting in this research and to emphasize the balance between my work and leisure time. I appreciate your positive attitude and sense of tranquility. It has shown me the importance of a weekend off (sometimes!) and often helped me to put things in perspective while pushing me to go further.
Ellen, your enthusiasm and knowledge on this topic inspired me every time. I am so thankfull that you gave me insights into a whole different aspect of urban development of which I had no clue, and made this research interesting and challenging at the same time. Your expertise has brought this research to a higher level.

From the AMS institute Kris, Lynn and Marlieke. You enabled me to discuss my work and made the Tropeninstituut my favorite place to write. I thank you for that and the (most welcome) distracting stories about something else than 'thesis stuff'.

Eva, Quita and Anna, for making this whole Delft journey so much more fun! You have become three of my best friends for life.

Many thanks go out to all of my interviewee respondents; your openness and trust has provided this research with so much more depth. I know that there must be a lot of people asking for your experiences and I therefore even more appreciate your time and patience. Hopefully this thesis helps with bringing knowledge forward to other students, practitioners and professionals in the field.

Finally, my deepest appreciation goes out to my parents Saskia en Ted and my brother Thimo, you inspire me and keep me with two feet on the ground. Thank you for your help and support over all these years of studying and showing me the relativity of it all during the hard times. You are my biggest and best example in life. And of course, Giel, thank you so much for your attention, love, positive mind and your ability to put things in perspective. I am so happy to have you in my life.

Let's make this world a more sustainable place!

Eva Ros
Amsterdam, the Netherlands
20.09.2017

CONTENT

I INTRODUCTION

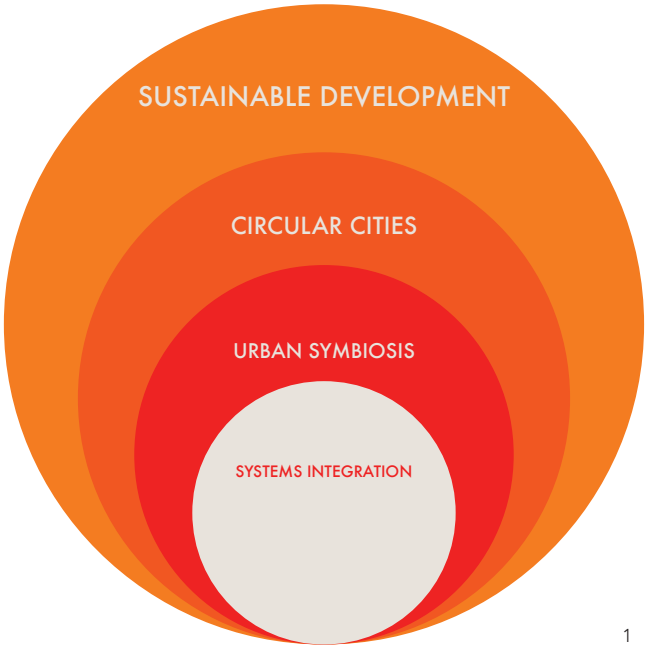
1.1 TOWARDS SUSTAINABLE DEVELOPMENT

Sustainable development responds to the challenges of urbanisation and climate change. While cities are only covering 2-3 percent of the earth's surface, they're responsible for the consumption of 75 percent of the world's energy resources and 60-80 percent of greenhouse emissions (Hollands, 2014). Around 75 percent of the European population lives in urban areas and this number is expected to increase to 80 percent in 2020 (Anderson & Galatsidas, 2014; EC, 2014). Cities are consuming huge amounts of energy, water and materials and contribute to problems such as resource depletion, pollution and climate change (Van Bueren, 2012). Although they are considered to be causing most of these sustainability issues, cities and their built environment are also able to play a crucial role in dealing with our energy supply, raw materials scarcity and waste (Gladek, Van Odijk, Theuws, & Herder, 2014; Van Bueren, 2012). Transdisciplinary research concepts (where scientists contribute with their unique expertise but work outside of their own discipline towards a common goal), policies, and technologies to help the progress towards making societies and regions greener and more sustainable are increasingly developed and promoted (Chareonpanich, Kongkachuichay, Donphai, Mungcharoen, & Huisingh, 2017). Working across disciplines poses challenges for researchers, policy-makers and other knowledge holders, as established approaches are put into a new context. This makes transdisciplinary integration a key task for sustainable development (ISOE, n.d.).

Circular economy thinking is perceived as a way to achieve sustainable development. Among others, both Girardet (1996) and Rogers (1998) argue that the city should be perceived as a circular system and that urban areas must be developed in ways that give them the characteristics of ecosystems, functioning in circular instead of linear ways. The creation of circular urban systems can also be understood as urban symbiosis (Vernay, 2013). Pandis Iveroth (2014) confirms that quite a few of sustainable urban development strategies rely on the idea of cities functioning as eco-systems, i.e. fostering urban symbiosis by integrating infrastructural systems. An eco-system approach enables us to visualize the flows going in, through and out of cities. It makes it possible to analyze part of a system such as for example the energy supply and use in a building without losing sight of the wider system context (Van Bueren, 2012). Vernay (2013) makes a distinction between stand-alone and industrial ecology types of solutions for urban development. An industrial ecology type of solution involves:

"connecting existing systems of production and consumption to each other in order to create synergy, re-use waste and optimize the environmental performance of industrial regions, cities, and production and consumption systems" (Vernay, 2013, p. 4).

This research is focussed on this industrial ecology type of solution; perceiving cities as eco-systems whilst integrating infrastructural systems. Systems integration can be conceptualised as integrating two socio-technical systems that were initially separate (Vernay, 2013), and therefore fits within the urban symbiosis approach (figure 1).



1

The integration of infrastructural systems could be for example a combination of our (waste)water with energy production from biogas. Waste products of one system (water) then become resources for another system (energy).

The industrial ecology type of solutions for sustainable urban development requires new technologies and as a result contains a lot of innovative aspects. Furthermore, viewing cities as ecosystems requires the involvement of many actors from different backgrounds such as governments, firms, users and communities, universities and research centers. Van Bueren & ten Heuvelhof (2004) confirm that actors in sustainable urban development processes address problems in multiple arenas in which actors participate from different networks with different rules of interaction. De Zeeuw et al. (2010) point out the difficulties of incorporating science and urban area development into one analytical frame. Besides the fact that it results in issues in the areas of interaction, the mindset of involved actors is often conservative on the subject of knowledge and technologies on sustainability (De Zeeuw, 2010). This makes change more complicated.

Zilberman et al. (2012) describe two processes related to change: adoption and adaptation. The response of economic agents or societies to major changes such as climate change is defined as adaptation. Adoption is defined as a change in practice or technologies and are affected by profit and risk considerations and credit and biophysical constraints (Zilberman, Zhao, & Heiman, 2012). In order to reach sustainable urban development, adoption processes of technological innovations are necessary.

Maula et al. (2006) argue that addressing ecological challenges requires not just the adoption of technological innovations, but a broader consideration of the wider context of open and systemic innovation. The energy transition is only partly a technical issue and much more of an organizational question (Agentschap NL, 2011). In order to ensure sustainable development, creating innovative technologies, policies and manufacturing processes along with socio-cultural change is needed (Pandis Iveroth, 2014). Voytenko et al. (2016) confirm that a transformation in markets, practices, policy and culture is needed In order to achieve urban sustainability.

Not only the issues of climate change itself, but reconfiguration of political authority across multiple levels and public and private sectors makes urban climate governance a complicated process (Bulkeley, 2010).

Figure 1 Research context

1.2 PROBLEM INDICATION - "STRAAT VAN DE TOEKOMST"

A particular project gave rise to the main purpose of this research: the "Straat van de Toekomst" in Almere, the Netherlands. This project illustrates the intention of making cities function in a circular and sustainable way, by aiming at largely closed energy, water and nutrient cycles and high self-sufficiency. It is an experiment for sustainable development based on the concept of the Greenhouse Village (appendix 1).

The Greenhouse Village is a concept for residential areas existing in profound synergy with agricultural greenhouses on a street level scale. It is completely based on closing the cycles of water, energy and nutrients and thereby implementing an urban symbiosis strategy. For this, agri-/horticultural greenhouses and residential units are providing a circular urban metabolism (AMS, 2016).

Although the "Straat van de Toekomst" is being developed for the Floriade that will be taking place in 2022, it is considered to be a suited concept for other projects as well (Van Hattum, 2017). Besides being a World Horticultural Expo, the Floriade will also give rise to a whole green district at the shore of the Weerwater (figure 2). With its main theme of Growing Green Cities, it will address global issues of food provision, climate change and generating new types of energy (Gemeente Almere, n.d.).

2

Some of the main sustainability-driven innovations in this project are new ways of sanitation (transportation of wastewater and interaction with rainwater), reuse of nutrients from wastewater, closed greenhouse systems, re-use of energy (e.g. Aquifer Thermal Energy Storage, using the subsurface to store cold and warm water for cooling and heating of buildings) and a Next generation Urban Harvest Approach (aiming for better urban resource management by harvesting urban resources). Additionally, green roofs, wadis and urban farming are some of the potential climate adaptation measures.

These integrated systems cut across disciplines and sectors and therefore require an extensive range of stakeholders from different backgrounds. They not only require a radical change in technological infrastructures, but also changes in the institutions developing and managing these systems (e.g. water- and energy infrastructures). The integration of systems envisioned for this project is therefore part of the complex task of combining multiple socio-technical systems.

1.3 PROBLEM STATEMENT

Cities are able to provide solutions for energy transitions at an urban scale. The need for a transition towards sustainable development is clear, but requires changes compared to the traditional ways of working. A rise in the number of actors from different backgrounds, from real estate focused towards local values and streams and bottom-up development (steering from the end-users' perspective) are just a few changes that enhance complexity (De Jong, 2013). Broman & Robért (2017) argue that the transition towards a more sustainable society is a complex process and requires extensive collaboration between disciplines and sectors. Contributing to solutions of wicked problems of sustainability requires the involvement of multiple stakeholders (Zijp, Posthuma, Wintersen, Devilee, & Swartjes, 2016).

Multiple Actors (Institutional) – Much research has focussed on the technocratic aspects of the transition towards circular systems but there exists a poor understanding of how these ideas come into being (Vernay, 2013). Tools and concepts such as Mass Flow Analysis (MFA), Energy Potential Mapping and the Urban Harvest Approach have been put forward in order to reuse resources and limit the production of waste (Vernay, 2013). However, little study has been done on how these ideas become reality (Vernay, 2013). Research is needed into the institutional aspects that affect systems integration projects. The question of how the *process* of systems integration can be facilitated is of great importance in order to reach urban symbiosis.
Bringing together actors from different sectors and disciplines lead to diverging institutional arrangements. This results in problems of interaction and collaboration.

Urban Context (Spatial) – Integrating infrastructural systems could play an important role in developing cities in a more sustainable way. For this, multiple actors from different disciplines, sectors and corporate cultures need to work together and new types of actors are necessary (Den Ouden, 2016). Implementing strategies of urban symbiosis, and thereby systems integration, has proven to be difficult (Pandis Iveroth, 2014) and attempts to create symbiotic relationships between technological systems often fail (Gibbs, Deutz, & Proctor, 2005).
Several technical, economic, organisational and institutional barriers have been identified that prohibit the introduction of symbiosis strategies (Baas & Boons, 2004; Boons & Baas, 1997). However, these studies mainly focussed on the integration of *industrial systems*. There exists a knowledge gap in the formation process of *urban* integrated infrastructural systems (Pandis Iveroth, 2014). Besides complex socio-technical systems that need to be combined, the third element of space is added when systems are integrated within an urban context.

Analyzing the insitutional and spatial challenges and opportunities encountered in systems integration processes and looking for ways to address them is important when aiming for sustainable urban development. This research explores which institutional and spatial variables influence this process and which strategies facilitate systems integration in urban development (figure 3). In particular the research focuses on the integration of infrastrucural systems as planned for the "Straat van de Toekomst".

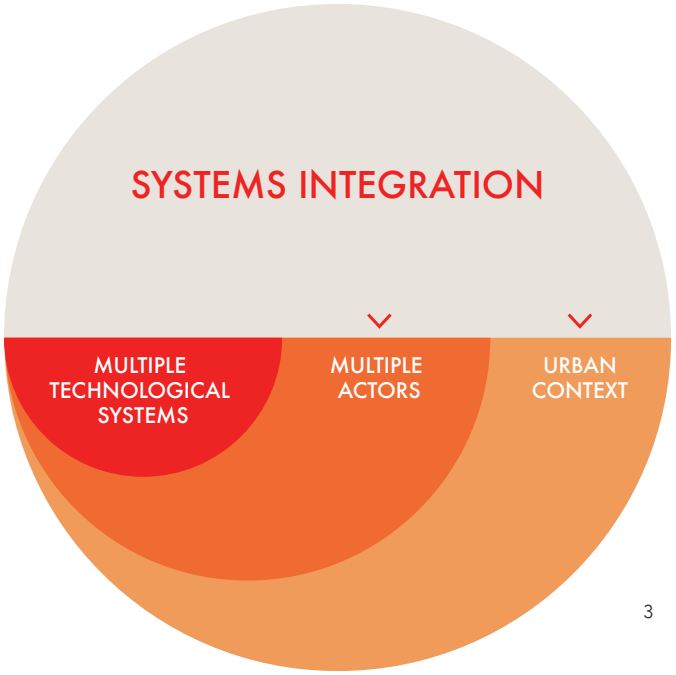


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Figure 2 Floriade 2022 (source: MVRDV)
Figure 3 Research problem

1.3.1 Research question

In order to respond to the described problem definition the following main research question has been formulated:

"What are the challenges and opportunities of systems integration in urban area development and how can these be addressed by actors?"

This main question addresses two aspects: the characteristics of systems integration processes (**features**) and the way how actors involved in these processes deal with these characteristics (**strategies**). To answer the two aspects of this main research question, the following set of subquestions is formulated:

Features

1 What is systems integration and what does it mean in the urban context?
2 What are the variables that influence the process of systems integration?
3 How and in what way do these variables influence this process?

Strategies

4 What are the existing strategies for systems integration in urban development projects?
5 How can challenges and opportunities be addressed by actors using a certain strategy?

The first part of the main question *"What are the challenges and opportunities of systems integration in urban area development [..]"* will eventually be answered by subquestion 3. The second part of the main question *"[..] and how can these be addressed by actors?"* will be answered by subquestion 5.

A more extensive overview of the methods for answering these research questions will be addressed in chapter three.

4

Figure 4 Research questions

1.3.2 Delimitations

Urban Area Development (UAD) – This research focusses on the process of systems integration within an *urban* context. Projects in an industrial- or business related context are therefore excluded.
Urban Area Development (UAD) is known in Dutch as gebiedsontwikkeling (Franzen, Hobma, De Jonge, & Wigmans, 2011). Although a wide variety of concepts such as urban planning, urban design and spatial planning exist, it is concerned with the development of a specific area. Franzen et al. (2011) add that urban area developments have an identity of their own and take place within a town or city or the expansion thereof. It is also the scale at which contracts between local authorities and developers are made (Franzen et al., 2011).
UAD projects have their own specific set of actors which will be discussed in the second chapter.

Variables – are focussed on the institutional and spatial aspects of systems integration projects, partly due to the scope of this research and partly due to time limitations. Institutions and institutional arrangements of systems integration have been mentioned in the problem statement as an underexposed topic.
The integration of multiple infrastructural systems in an urban context is relatively new. The spatial aspects were therefore also considered as an interesting element. Because research is often focussed on the technical aspects of systems integration, institutional and spatial variables could be a usefull addition to existing literature.

Strategies – are perceived as a reaction to these institutional and spatial variables. It constitutes the way in which actors respond to the challenges and opportunities and interact with each other during the process. The available strategies for this research are limited to the actors who find themselves within the action arena of systems integration. We thereby exclude strategies from external actors on a 'higher' scale, e.g. on a National State or European level.
However, the herefore discussed variables can influence the process from higher scale levels and will be taken into account.

Time – Projects have to be at least in a certain state of development. The ones that find themselves within the initiation phase are excluded.
We are specifically interested in the variables and strategies encountered during the process. This research delimits itself to systems integration projects that are currently being realized or have been developed already.

1.3.3 Goal

The context, problem statement and research questions have merged into the following goal:

To provide insight into the institutional and spatial variables that constitute challenges and opportunities during the process of systems integration in urban area development.

The goal is to analyse the way in which involved actors respond to these challenges and opportunities and provide recommendations to address them by using certain strategies. Because the "Straat van de Toekomst" partially gave rise to this research, recommendations will specifically be directed towards the actors of this project.

5

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Figure 5 Floriade 2022 (source: MVRDV)
Figure 6 Floriade 2022 (source: MVRDV)

1.4 RELEVANCE

Both societal and scientific relevant aspects are addressed in this research. It provides insight in both practice as well as in science regarding systems integration processes in urban area developments. The following paragraphs will discuss respectively the societal and scientific relevance of this research. Finally, the utilisation potential of the results will be mentioned briefly.

Societal relevance – Cities and their population are consuming huge amounts of energy resources, producing a lot of greenhouse emissions and consequently have a large impact on climate change. Besides the fact that these problems are causing high costs for society, they are also threatening humanity as a whole (Elliot, 2016; IFAD, 2016). Improving current linear systems of consumption and transitioning towards a circular system is argued to lower the impact of rising living standards and urbanisation on our planet (Pandis Iveroth, 2014). Sustainable development offers the opportunity to develop new ways to deal with our energy supply, raw materials scarcity and waste.

The societal side of this transition towards sustainable development is of great importance. Hegger et al. (2007) discuss three reasons to be critical about the current focus on technology in many innovation projects. First, technological development co-evolves with social developments such as changes in user-practices, institutions, rules and regulations. Innovations such as new ways of sanitation or the use of renewable energy sources can have great impact on the daily lives of citizens (Krantz, 2005) as well as the suppliers and service managers of new technologies (Hegger et al., 2007). An example are composting toilets, which require changes in the way the toilet is used as well as the composting process.
Second, the technological potential can only become meaningfull when it is considered in relation to the social reality in which it is expected to function. Actors that have a role to play in the desired system might often not be involved during the development of the specific system. However, this can make the difference between successfull adoption or rejection of the innovation.
And finally, although the actual technological solution might have different alternatives, the focus should be on the idea or concept that forms the basis of the experiment.

Technical innovations of systems integration projects seem to be a good way towards a circular economy. Nevertheless, societal changes for collaboration between actors and new user practices should co-evolve.

Scientific relevance – The societal context affects the introduction of technical ideas. Several sources and scholars describe the importance of studying the societal process of innovation instead of solely the technical product (Geels, 2004, 2005; Hegger et al., 2007; Krantz, 2005). Within the studies of sustainable innovation, there exist many different frameworks and concepts for innovation processes and sustainable development strategies. This thesis can contribute to the field by providing a clear approach towards the institutional process of systems integration and by giving concrete recommendations for stakeholders of similar types of projects, taking into account the specifics of an urban context. The challenges and opportunities of integrating multiple infrastructures are combined with the implications for development strategies. By applying a well established framework to the innovative concept of systems integration, new but well-funded insights are obtained.

The Urban Area Development chair of the department of Management in the Built Environment stands for a multidisciplinary approach, where aspirations, interests, disciplines and cash flows of a wide variety of actors are integrated for the renewal of urban areas. One of the four 'big' questions of SKG (a foundation that is supporting the 'practice' UAD chair) regarding sustainable area development is how to deal with this on the organisational and institutional level (Schokker, 2016). This thesis has a direct relation to this multidisciplinary approach in combination with the focus on organisations and institutions. It investigates the complex process of systems integration in several projects, but always within an urban context.

Utilisation potential – The main focus of this research will be on developing recommendations for the actors involved in systems integration projects in general, and in particular for those involved in the "Straat van de Toekomst". These recommendations will be based on the institutional challenges and opportunities found in literature and cases.
By providing not only insight into these challenges and opportunities but also in the ways that actors addressed them within the studied cases, strategies to deal with challenges and make use of opportunities are evaluated.

1.5 ORGANISATION

TUDelft – This thesis is performed at the Faculty of Architecture and the Built Environment, at the Technical University in Delft. It was executed at the department of Management in the Built Environment, and mentored by Arie Romein from the department of OTB and Ellen van Bueren from the department of Urban Area Development.

AMS – Besides the TUDelft, this thesis was partly executed at the knowledge institute for Advanced Metropolitan Solutions in Amsterdam. The institute is a collaboration between the University of Wageningen (WUR), the TUDelft and Massachussets Institute of Technology (MIT).

The time planning of this research is illustrated in figure 7.

Figure 7 Research planning


WEEK 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 1 2 3 4
MONTH SEPTEMBER 2016 OCTOBER 2016 NOVEMBER 2016 DECEMBER 2016 JANUARY 2017
TOPIC SELECTION
THEORETICAL FRAMEWORK
LITERATURE REVIEW: LIVING LABS
LITERATURE REVIEW: SYSTEMS INTEGRATION
CASE SELECTION
CASE DOCUMENTS
P1
WEEK 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 - 31
MONTH FEBRUARY 2017 MARCH 2017 APRIL 2017 MAY 2017 JUNE 2017 JULY
SUMMER RECESS
LITERATURE REVIEW: SYSTEMS INTEGRATION - STRATEGIES
SEMI-STRUCTURED INTERVIEWS
CONCLUSIONS & RECOMMENDATIONS
PROCESSING
WRITING REPORT
P2
P3
WEEK 32 33 34 35 36 37 38 39 40 41 42 43 44
MONTH AUGUST 2017 SEPTEMBER 2017 OCTOBER 2017
CONCLUSIONS & RECOMMENDATIONS
FEEDBACK ON RECOMMENDATIONS
WRITING REPORT
IMPROVEMENT REPORT
PREPARATION PRESENTATION
PRESENTATION
P4
P5
THEORETICAL FRAMEWORK
EMPIRICAL PART

1.6 READERS' GUIDE

In the introductory part of this research, the context, a problem indication and definition and the societal and scientific relevance have been discussed. The second chapter will elaborate on the general concept of systems integration and relate it to theory of socio-technical transitions. Furthermore, the IAD framework is introduced, explained and operationalised for this research.

The third chapter is the methodology chapter, in which the research strategy and design are presented. The concept of case-studies is argued to be a suitable method to answer our research question, after which the choice for specific cases is justified. Finally, the methods for data collection and usage are explained.

The empirical part of the research follows in chapter four. The three cases and the process of systems integration that took place within them are first described. After an extensive description, the challenges and opportunities that actors encountered will first be analysed in the fifth chapter. Consequently, strategies that were used by actors to address challenges and opportunities will be identified and elaborated on.

The last part of this thesis encompasses the final conclusions and recommendations. The conclusions are a result from the theoretical and empirical research. Recommendations are formulated in a more general way that makes them applicable for actors in other systems integration processes in urban area development.

The discussion will reflect on the used method and results of this research, and finally recommendations for further research will be given. We will conclude with a personal reflection on the topic of systems integration in general and its added value to a sustainable built environment.

II THEORETICAL FRAMEWORK

After having outlined the problem statement, relevance and organisation of this research, I will now elaborate on the main topic: systems integration in urban area development.

First, the concept of systems integration in general will be discussed, after which a more focussed approach is taken towards the meaning of this concept in an urban context. Technical aspects will stay on the sidelines, as our aim is to look at the institutional process of integrating multiple infrastructural systems.

This specific aim leads us to the second paragraph, where the transition theory of Geels (the Multi Level Perspective) is introduced. It is used in this research to place the process of systems integration in a broader (social) context and will particularly be used at the end of this report, reflecting on the meaning of the results.

Finally, the Institutional Analysis and Development (IAD) framework is discussed and operationalised in the last paragraph. The IAD framework provides the main structure for the rest of this research, and eventually leads to the conceptual model at the end of this chapter.

2.1 THE CONCEPT OF SYSTEMS INTEGRATION (S.I.)

The idea of circular economy thinking is that resources are used optimally by minimizing value reduction of materials and maximize reuse. This is the opposite of linear ways of thinking, where products are thrown away after use and the economic value is discarded (Kwakernaak, 2014). The circular model is proposed as a sustainable alternative to our current linear economy. As described in the introduction, creating circular urban systems can be conceived as an urban symbiosis strategy. Urban symbiosis strategies are defined as:

"The use of by products (waste) from cities (or urban areas) as alternative raw materials or energy sources for industrial operations" (Van Berkel, Fujita, Hashimoto, & Geng, 2009, p. 1545).

Systems integration relies on this idea of urban symbiosis. It implies that initially separate urban systems are connected, by which waste streams of one system are used as input for another system (Vernay, 2013). It is therefore being brought forward as a way to create circular urban systems and make cities function in more sustainable ways. By coupling systems, an optimal use of resources can be achieved. This is done by integrating multiple infrastructural systems and linking different technologies to one another, e.g. the recovery of nutrients from wastewater for agricultural purposes and the use of energy from wastewater for housing (figure 8). A section of "terminology" is added at the end of this report in order to make definitions such as circularity, urban symbiosis and systems integration more concrete.

Technological artefacts are at the heart of S.I., as it is about finding new ways to link different technologies to each other (Vernay, 2013). However, these technologies are part of a larger whole of interrelated and heterogeneous entities and can be conceptualised using a socio-technical perspective. Vernay (2013) defines the system boundary for socio-technical systems as follows:

"A socio-technical system is composed of artefacts and organisations/human actors, which 1) fulfil a given societal function when they interact; 2) whose interactions are shaped and guided by shared norms, rules and values; and 3) that are connected through their activities or due to their physical location to the geographical space where systems integration is taking place." (Vernay, 2013, p. 23)

This third element of the geographical space where S.I. is taking place adds a spatial element to the socio-technical system. S.I. is about combining initially separate socio-technical systems and is therefore resulting in a connection between the following three elements (Vernay, 2013):

1 Linking separate technical configurations, which connect previously unconnected networks of actors and the rules that guide their actions.

2 Increased interaction among actors, which leads to connecting previously separate technical configurations and the development of shared rules

3 Changing rules, which lead to the coupling of previously separate networks of actors as well as the technical configurations they create and use

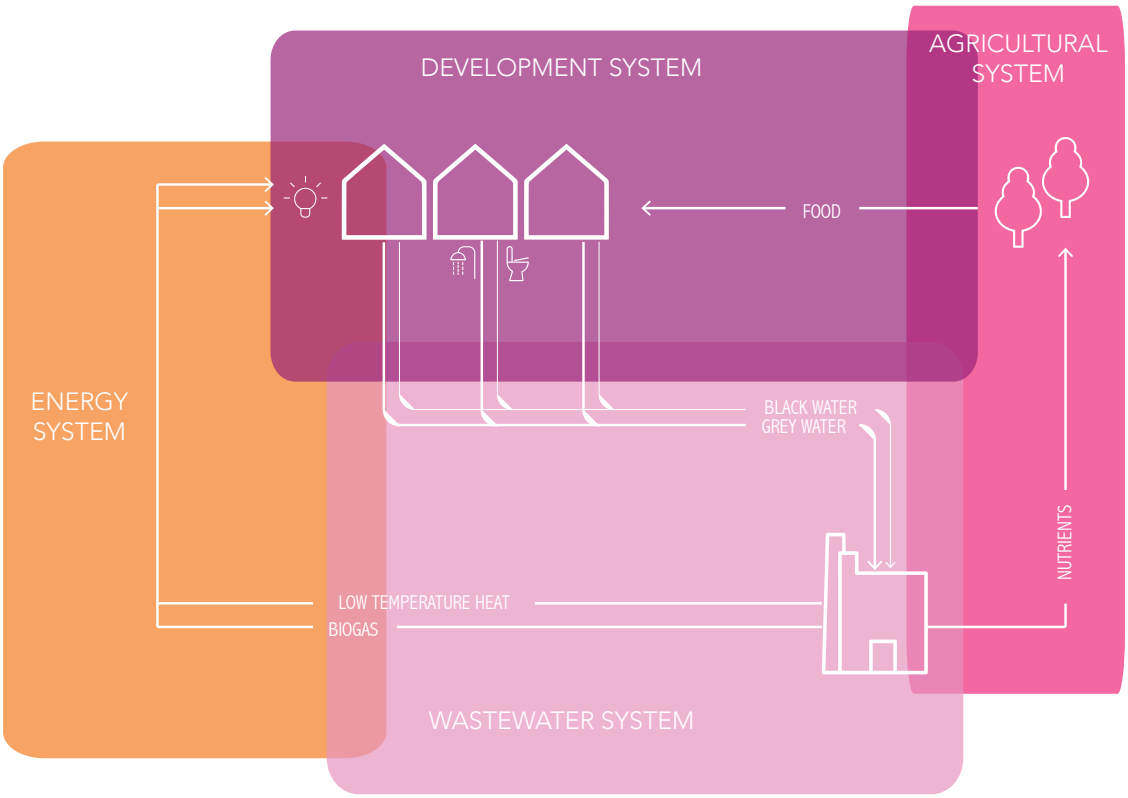
This research will focus on the connection between these elements: **connecting** previously unconnected networks of actors and their rules, the **development** of shared rules due to the connection of separate technical configurations and the **change** of rules which lead to the coupling of separate networks of actors.

Reaching for this connection can be conceived as a transitioning process: from singular socio-technical networks towards the integration of multiple socio-technical systems: S.I. can therefore be considered as a transition. This transition is defined as a:

"transformation process where the existing structure of institutions and their culture and practices is broken down and new ones are established" (Loorbach, 2007, p. 17).

The transition process of S.I. will be described in the next paragraph by using the Multi Level Perspective (MLP) of Geels.

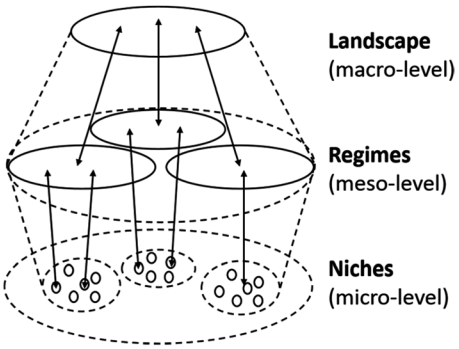
Figure 8 An example of systems integration


DEVELOPMENT SYSTEM
AGRICULTURAL SYSTEM
ENERGY SYSTEM
FOOD
BLACK WATER
GREY WATER
NUTRIENTS
LOW TEMPERATURE HEAT
BIOGAS
WASTEWATER SYSTEM

8

2.2 TRANSITION THEORY – THE MULTI LEVEL PERSPECTIVE (MLP)

The Multi Level Perspective (MLP) was first put forward by Geels (2002;2004) and intended to study how socio-technical transitions come about (Vernay, 2013). Transitions of socio-technical systems are major technological transformations in the way societal functions are fullfilled and usually take place over long periods of time (Geels, 2002). Geels (2004) describes how new technologies have to be 'tamed' in order to fit in routines and application contexts. Besides technical change, innovations have to be adjusted to the specific stakeholders, users and urban context when implemented. These socio-technical transitions are the result of interaction between processes that take place at three different levels: the micro, meso, and macro level (figure 9). In order for a transition to be successful, the processes at these three levels should reinforce each other (Geels, 2002).



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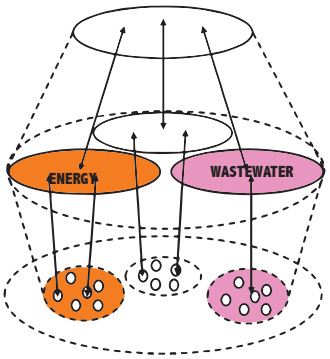
Macro level (landscape level) - include broad external factors (e.g. fuel prices and cultural beliefs) that influence both the regime and niche level (Geels, 2004). The landscape level refers to changes that are beyond the range of influence from actors of a socio-technical system (Vernay, 2013). When this analytical concept is applied to the process of S.I. in UAD, the price of recovered nutrients is a good example of a factor on the landscape level. This price affects the way actors' behave on the regime and niche level. It is an aspect on which actors have little influence because it is largely determined by the demand on a global level. Other examples include European or National State policy and rules and regulations.

Meso level (regime level) - entails a set of actors following a set of rules. The regime refers to the dominant practices, rules and technologies in socio-technical systems. This level finds itself between the landscape and the niche level. Infrastrucural systems such as wastewater, energy and drinking water can be conceived as separate regimes: a set of actors following a set of rules. Each regime has its own niche where technological innovations are developed and tested (figure 10). Regimes are influenced by the landscape level but can (for a transition to take place) also influence the landscape level. Legislative amendments e.g. might be pursued when rules and regulations are impeding regime level actors. When we apply this to S.I., the roles and responsibilities that actors fullfill in e.g. the energy or water sector find themselves on the regime level.



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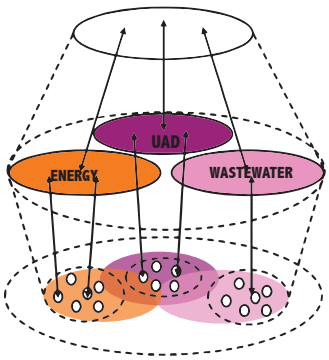
Micro level (niche level) - projects at the niche level are protected spaces where technological innovations can be developed and tested (Kemp, Schot, & Hoogma, 1998). Niches represent "incubation rooms" where innovations are able to develop and are protected from market competition (Vernay, 2013). Because it is less subject to market and regulation influences, they facilitate interactions between actors. Niches are argued to provide protected spaces that allow nurturing and experimentation with the co-evolution of technology, user-practices and regulatory structures (Schot & Geels, 2008). Although niches are more protected from external influences than regular projects, actors are still operating from a particular background and handle their own set of rules (regime).

Hegger (2007) argues that small scale experiments in niches have the ability to act as a stepping stone towards regime-changes. However, a major observation is that these are considered experiments with technologies instead of experiments with forms of social organisation (Hegger et al., 2007).

When niches start to experiment with combining technological innovations and thereby integrating infrastructural systems, regimes start to overlap (figure 11). This means that different sets of rules have to be combined. Actors from multiple regimes have their own dominant practices that don't automatically coincide. The transition towards these new institutional arrangements is at the root of this research.



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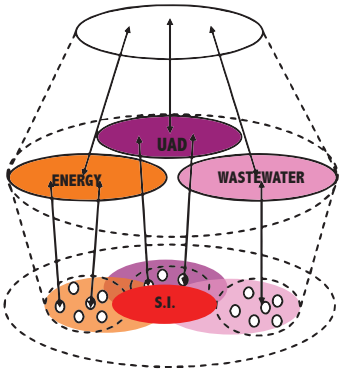
Besides infrastructural systems such as wastewater and energy, another "system" is involved in this research: the urban area development (UAD) system. UAD processes are considered to take place at the regime level with many influences from the landscape level (e.g. land prices, European or State level policy and rules and regulations) and can be perceived as the context in which S.I. projects take place. However, they also have their own actors, background, cultural beliefs and sets of rules. Considering them as a separate system enables us to identify the specific characteristics of S.I. in UAD (figure 12).

Landscape, Regime and Niches

Because this research focusses on individual projects and involves local dynamics, interactions and negotiations between actors we are mainly concerned with the niche level. The cases that are used for the empirical part of this research are taking place in niches. Landscape and regime levels can have a large impact on the processes within these niches. It is therefore important to take them into consideration when identifying challenges and opportunities (variables). Although challenges and opportunities that originate from the regime and landscape will be identified, the strategies that actors use to address them delimits itself to the niche level.



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"*The formation of a niche entails the struggle for support of institutionally embedded actors by deploying strategies to align discursive, material, and institutional resources and the continuous willingness to make trade-offs between conflicting demands.*" (Pesch, Vernay, Pandis Iveroth, & van Bueren, 2017).

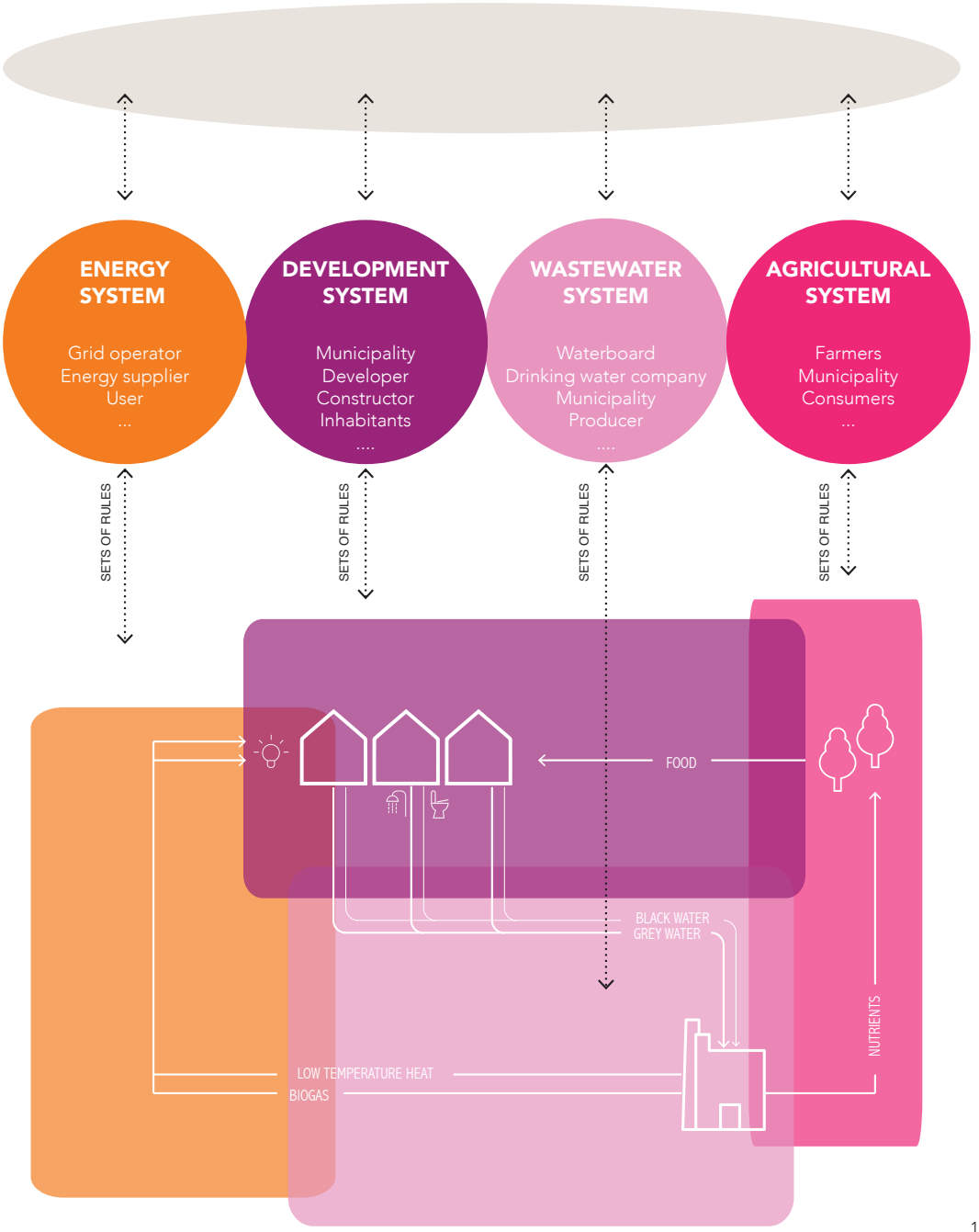
The regime level represents these institutionally embedded actors, where a certain set of rules is followed. Strategies are applied to change the regime level, and might even address issues on a landscape level. The MLP stays quite general regarding the ways in which processes *within* niches take place. It is especially focussed on the transition between the different levels that take place over long periods of time. Because this research wants to study the process within a niche, while keeping in mind the influences from the regime and landscape level as a context (figure 13), the Institutional Analysis and Development framework will be used. This framework will be further elaborated in the next paragraph.

Figure 9 The Multi Level Perspective (source: Geels, 2002)
Figure 10 MLP in a regular situation
Figure 11 MLP during systems integration
Figure 12 Systems integration process in the MLP

LANDSCAPE

REGIME

NICHE



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2.3 INSTITUTIONAL ANALYSIS AND DEVELOPMENT (IAD) FRAMEWORK

S.I. projects have been described as a transition process, connecting initially separate socio-technical systems. This research focusses on the institutional part of this transition within an urban context. The Institutional Analysis and Development (IAD) framework by Elinor Ostrom functions as a general framework and provides a clear structure for this research.

"*The development and use of a general 'framework' helps to identify the elements (and the relationships among these elements) that one needs to consider for institutional analysis. They provide the most general set of variables that should be used to analyze all types of settings relevant for the framework*" (Ostrom, 2009).

The IAD framework was developed in 1982 during a workshop of 'Political Theory and Policy Anaysis' at the University of Indiana (USA). It is the result of several collaborations between researchers from different countries, interested in understanding how individuals behave in collective action arrangements and in the institutional fundamentals that characterize these arrangements (Brouwer, 2014). The IAD thereby covers the influence of institutions on drivers and barriers that individuals experience and their proceeding behaviour (Polski & Ostrom, 1999).

The framework focusses on (the relations between) institutions within a complex social situation (Beskers, 2011) and allows researchers to inquire how institutional rules affect an action situation (Lammers & Heldeweg, 2016); in this research the process of S.I. in UAD. More specifically, the IAD framework illustrates how the *action arena* is influenced by three *exogenous variables* (biophysical/material conditions, attributes of community and rules). It enables us to look at the *interactions* between actors and at *outcomes* that originate from the action arena and evaluate them on the basis of *evaluative criteria*. It can therefore be used to set up new institutional arrangements in order to realise sustainable solutions.

Figure 13 Connecting socio-technical systems from multiple regimes

2.3.1 Elements of the IAD Framework

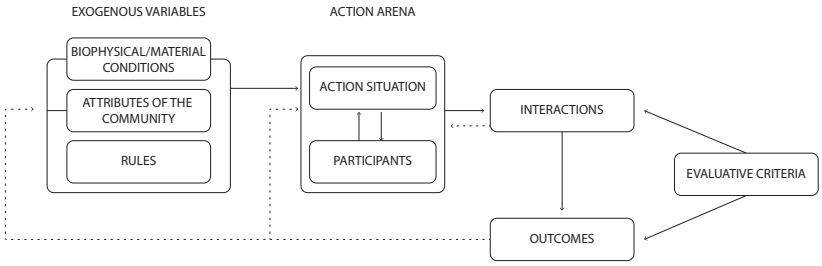
The IAD framework consists of an **action arena** where decision-making processes take place and comprises an **action situation** and its **participants**. The action situation encompasses the complex process while the participants represent the involved actors. According to the framework, each action situation and its participants results in patterns of **interactions** and eventually in certain **outcomes**. Because actors collaborate in different ways, patterns of interaction influence these outcomes. The action arena is influenced by three exogenous variables: **the biophysical/material conditions, the attributes of the community and the rules (also called institutional arrangements).**

Evaluative criteria in order to assess the interactions and outcomes are also part of the framework. The way in which these different elements are traditionally configured is shown in figure 14a.

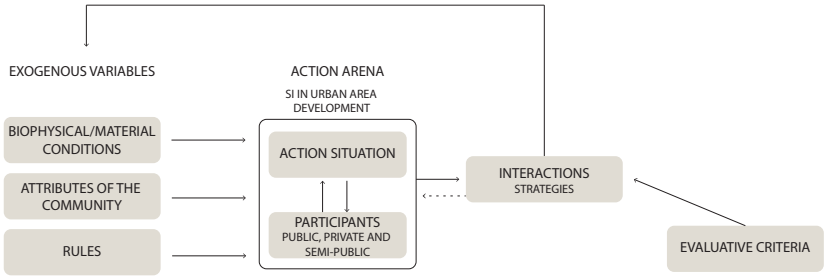
Due to the scope of this research, only a part of the framework is used. We want to know the variables that influence the process of S.I. in UAD and how actors respond to these. The exogenous variables of the IAD Framework constitute these variables, and will be classified as challenges and opportunities. Besides these variables, the strategies that are or can be used by actors are also part of this research. Strategies for addressing challenges and opportunities can be perceived as the interactions between actors. These interactions will be assessed through the evaluative criteria. Because we are interested in the institutional process of S.I., the focus is on the action arena instead of the outcomes. The IAD framework has been adjusted for this research in figure 14b.

The exogenous variables that play an important role during the process of S.I. are operationalised according to literature. The empirical part of this research studies the action arena and the interactions between actors in three selected case studies (figure 14c). Variables are classified as having a positive (opportunity) respectively a negative (challenge) influence on the process. This constitutes the way in which variables influence the action arena and the interactions between actors. Evaluative criteria from literature are used to determine to what extent actors' strategies influenced the process.
As discussed before, the studied cases take place in niches. Niches represent protected spaces for experimentation. In order to reach a transition, changes on the regime and landscape level might be needed. The exogenous variables are often determined by these two upper levels. Actors from niches might be able to change these variables in order to achieve adoption of an innovation.This means that another adjustment is needed for the framework to be suited for this research: an additional connection is made between the interactions (strategies) and the exogenous variables.

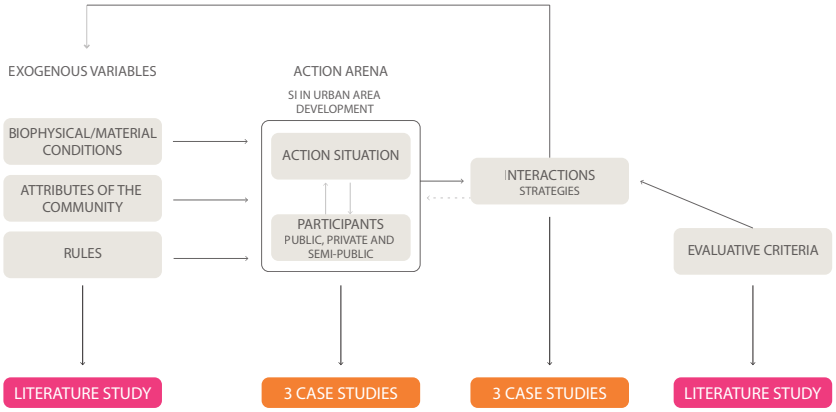
Figure 14a IAD framework (source: Ostrom (2010, p.616))
Figure 14b Modified IAD framework for this research
Figure 14c Method of research


EXOGENOUS VARIABLES
ACTION ARENA
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
INTERACTIONS
EVALUATIVE CRITERIA
OUTCOMES

14a


EXOGENOUS VARIABLES
ACTION ARENA
SI IN URBAN AREA DEVELOPMENT
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA

14b


EXOGENOUS VARIABLES
ACTION ARENA
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BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA
LITERATURE STUDY
3 CASE STUDIES
3 CASE STUDIES
LITERATURE STUDY

14c

2.3.2 The action arena

The action arena plays a central role in the IAD framework. The first step in analysing a situation is the identification of this arena: we search to understand and analyse the institutional process of S.I. in UAD.

"Arenas are places where specific groups of actors interact on an issue and make choices on specific aspects of the issue" (van Bueren, Klijn, & Koppenjan, 2003).

An arena consists of a set of actors and the decision making situation in which they interact. Traditionally, the action arena exists of an action situation and its participants/actors (figure 15a).

"Action situations are the social spaces where individuals interact, exchange goods and services, solve problems, dominate one another, or fight (among the many things that individuals do in action situations)" (Ostrom, 2011, p. 11).

For this research, the S.I. project is considered to be the action arena.

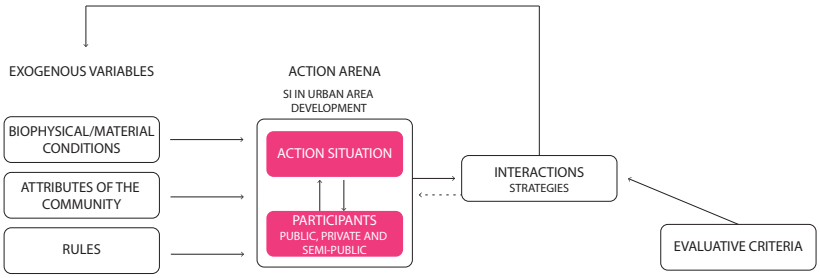
The action situation

The first element of the action arena is the action situation, which can be described by the set of variables defined as the "rules". These rules are the institutional arrangements between actors and also form one of the exogenous variables in the framework. The exogenous variable "rules" therefore defines the structure of the action situation. They determine:

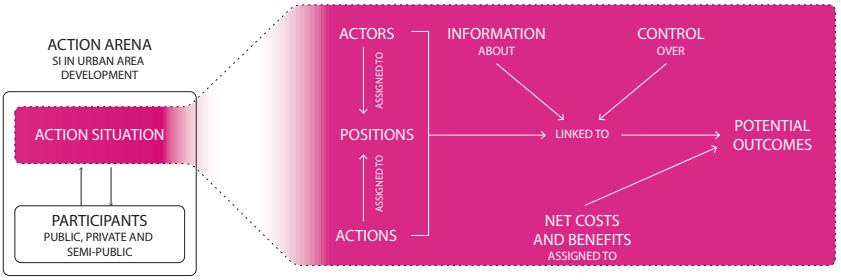
1. the set of actors
2. the specific positions to be filled by participants
3. the set of allowable actions and their linkage to outcomes
4. the potential outcomes that are linked to individual sequences of actions
5. the level of control each participant has over choice
6. the information available to participants about the structure of the action situation
7. the costs and benefits (which serve as incentives and deterrents) assigned to actions and outcomes (Ostrom, 2011, p. 11).

Elements of this internal structure are related to each other as follows (figure 15b):
Actors (1) and actions (3) are assigned to positions (2). Actors, positions and actions are linked to potential outcomes (4). Information (6) is available about action-outcome linkages. Control (5) can be executed over action-outcome linkages. Net costs and benefits (7) are assigned to potential outcomes.

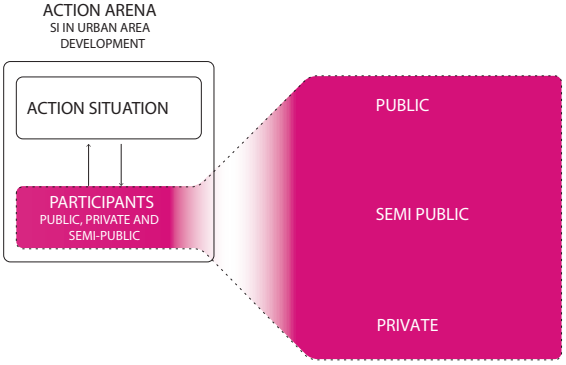
Figure 15a The action arena
Figure 15b The internal structure of an action situation (modified from: Ostrom (2011, p. 10))
Figure 15c Participants of the action arena


EXOGENOUS VARIABLES
ACTION ARENA
SI IN URBAN AREA DEVELOPMENT
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA

15a


ACTION ARENA
SI IN URBAN AREA DEVELOPMENT
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
ACTORS
ASSIGNED TO
POSITIONS
ASSIGNED TO
ACTIONS
INFORMATION
ABOUT
CONTROL
OVER
LINKED TO
POTENTIAL OUTCOMES
NET COSTS AND BENEFITS
ASSIGNED TO

15b


ACTION ARENA
SI IN URBAN AREA DEVELOPMENT
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
PUBLIC
SEMI PUBLIC
PRIVATE

15c

Participants

The second element of the action arena is the set of participants, also referred to as the actors (figure 15c).

"*The actor in a situation can be thought of as a single individual or as a group functioning as a corporate actor*" (Ostrom, 2011, p. 12).

In this research the participants are represented by the actors in the S.I. project. Because we are specifically focussing on the institutional process of S.I. in UAD, some background information on the actors in these systems will be given. Actors are divided into the three categories of public, semi-public and private actors. The main actors of the researched systems' regimes will now be discussed.

Public actors - represent all governmental organisations and entail authorities such as the Dutch national government, provinces and municipalities.

The municipality is at the bottom layer of the political governance structure in the Netherlands, below province- and national government levels. Due to decentralisation, municipalities relatively have more freedom to conduct their own policies and, important for this research, an increasing amount of influence in urban area developments (KEI, 2010).Municipalities can fullfill several roles in UAD. Although they initially had a rather dominant role, this emerged to an admittedly central and equal party in the broad network of other involved (private) actors. Besides taking up a steering role by formulating visions and arrangements for development, municipalities also have a regulating role through permit provision. One of the most present and influential documents that is developed and regulated by the municipality is the land-use plan (Dutch: bestemmingsplan). The land-use plan defines where one can build, specifying heights, depth and functions. This will later on prove to be an important document in the studied cases.

Another type of organisation that falls within the category of public actors are the District Water Control Boards (Dutch: Waterschappen). They are regional government bodies that manage water barriers, waterways, levels quality and the sewage treatment system within their region. There are 11 of these DWCB's in total in the Netherlands. Because they control the sewage treatment systems, they are an important player when is comes down to the wastewater system.

Public actors are often responsible for development and maintanance of the non-lucrative parts of UAD such as green, infrastructure and water. These elements partly determine market prices for the more profitable parts of UAD which are mostly developed by private actors. On the other hand, public actors are often dependent on land positions, goodwill and expertise from these private actors. There exists a mutual dependency of public and private actors in UAD.

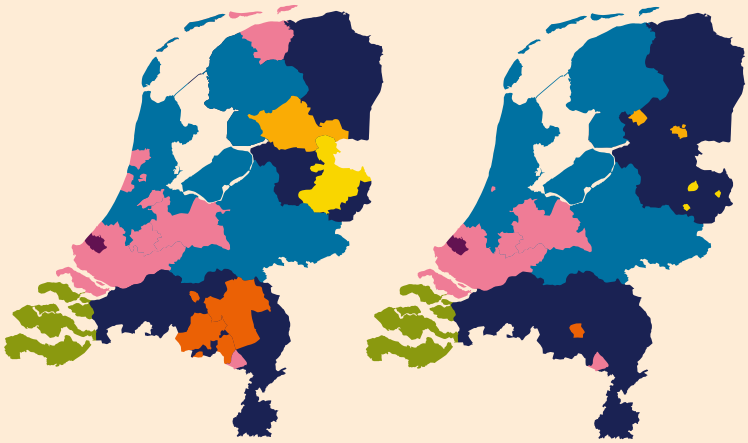
Figure 16 DNO's in the Netherlands (source: Energie Trends 2016)

Semi-public actors - are social entrerprises without a commercial interest but function as private organisations.

An important actor in UAD processes and for this research is the housing association, often regarded as semi-public actor. Its main task is to provide affordable housing to groups with low income or specific housing requirements. A large part (around 30%*) of our housing supply in the Netherlands is in ownership of housing associations and they are often involved in large scale developments. Although innovation is not one of their core tasks, they were involved in two out of the three studied cases in this research.

Another semi-public actor that plays an important role is the energy infrastructure owner and grid operator, also called distribution network operator (DNO). The DNO takes care of electricity and gas connections and the transportation of energy. There are around eight grid operators in the Netherlands (figure 16). Because DNO's are monopolists and one doesn't have a free choice for a certain operator, tariffs are regulated by the government.

Netbeheerdersgebieden van Nederland



Netbeheerder	Aansluitingen Gas	Aansluitingen Elektriciteit
Cogas Infra en Beheer B.V.	138.989	52.930
Enduris B.V.	189.423	211.262
Edinet*	399.927	108.591
Enexis B.V.	2.074.234	2.647.300
Liander N.V.	2.243.915	2.938.787
Rendo Netbeheer B.V.	103.341	31.974
Stedin B.V.	1.947.767	2.055.520
Westland Infra Netbeheer B.V.	52.930	55.745
TenneT TSO B.V.**		
Gasunie Transport Services***	1.100	
Totaal	7.151.626	8.102.109

* Per 1 januari 2017 geïntegreerd in Enexis B.V.

** Landelijk netbeheerder elektriciteit

*** Landelijk netbeheerder gas

16

* based on a prognoses for 2015 (Ministerie van BZK, 2016)

Private actors - are all entities that take part in economic traffic from a commercial or profit point of view. Private actors are often also called commercial- or market parties. An important characteristic is that they produce and trade for their own risk and account.

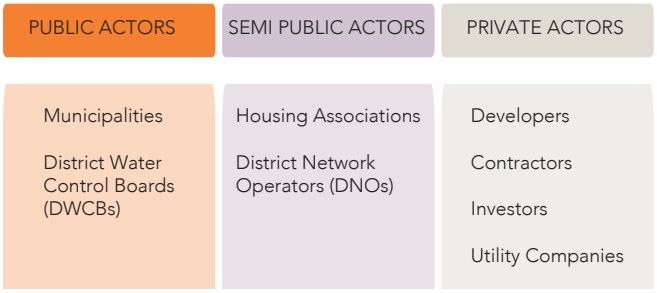
Differences exist between private actors that are involved in the UAD process. The categorisation that was developed by Steen (2016) (based on Heurkens (2012) and KEI (2010)) will be leading for this research. This typification of private actors consists of developers, investors and contractors.

The role of a private actor depends entirely on its position. They especially take on different roles due to their involvement in certain phases of the development process. Developers are present during the several phases of initiation through execution and exploitation. Consequently, developers in general have a large influence on the UAD process. A contractor is mainly involved during the execution phase, which limits his influence on the content of the development (Steen, 2016). Investors take risk and responsibility during development, realisation and operation of the project (Putman, 2010). However, their participating role is argued to remain quite passive (Heurkens, 2012).

Developers were not directly involved with the UAD processes of the studied cases. Developments were mostly initiated and executed by municipalities and housing associations. This had to do with the ownership of the land; either owned by housing associations (Noorderhoek and Buiksloterham) or the municipality (Lanxmeer).

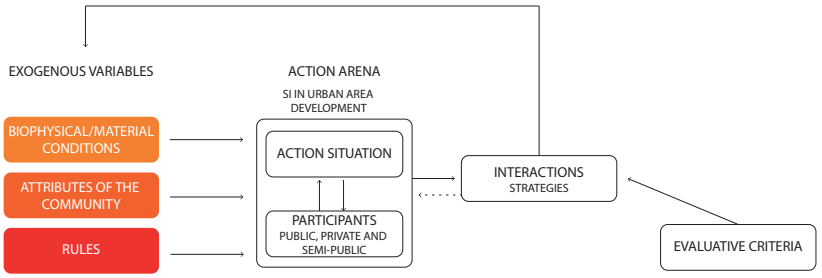
Important private actors of infrastructural systems include the utility companies. The provision of electricity, gas and drinking water are part of these utilities. Utility companies were established in the 19th and 20th century by the Dutch government to protect the provision of these services. However, markets in the EU have opened-up for competition since the '80s. The energy market in the Netherlands was completely privatised in 2004. A division between production and supply of energy and the distribution or transport was made. Consequently, customers can now choose their energy supplier regardless of where they live. Some big energy suppliers in the Netherlands include Nuon, Essent, Eneco, Greenchoice and Nederlandse Energie Maatschappij. There are however also lots of small and sustainable suppliers emerging such as e.g. Van de Bron and Energy Service Companies (ESCo's).

Overview



17

2.3.3 Exogenous Variables



18a

According to the IAD framework, the action arena is influenced by three exogenous variables (figure 17):

1 Biophysical/Material conditions
2 Attributes of the Community
3 Rules (also called institutional arrangements)

"*Underlying the way analysts conceptualize action situations are assumptions about the rules individuals use to order their relationships, about attributes of states of the world and their transformations, and about the attributes of the community within which the situation occurs*"(Ostrom, 2011, p. 17).

The attributes of states of the world constitute the first variable: the biophysical/material conditions. The attributes of community constitute the second exogenous variable, which is also often associated with 'culture'. The third variable is represented by the rules or institutional arrangements that actors use. These three exogenous variables will now be described into more detail, after which they will be operationalised for this research.

Figure 17 Overview of relevant actors
Figure 18a The exogenous variables

Biophysical/Material conditions

The biophysical and material conditions is the first exogenous set of variables of the framework that influences the action arena. It is being defined as follows:

"*What actions are physically possible, what outcomes can be produced, how [inter] actions are linked to outcomes and what is contained in the actors' information sets are all affected by the world being acted upon in a situation*" (Ostrom, 2009, p. 22).

Examples of such variables are the economic and financial conditions of an area or other means or capacities that are necessary (in this research) to integrate infrastructural systems within an urban context. Polski and Ostrom (1999) mention the following questions as relevant when researching this set of variables:

1 What is the economic nature of the activity?
2 How is this good or service provided?
3 How is it produced?
4 What physical and human resources are required?
5 What technologies and processes?
6 What are storage requirements and distribution channels?
7 What is the scale and scope of provision and production activity?

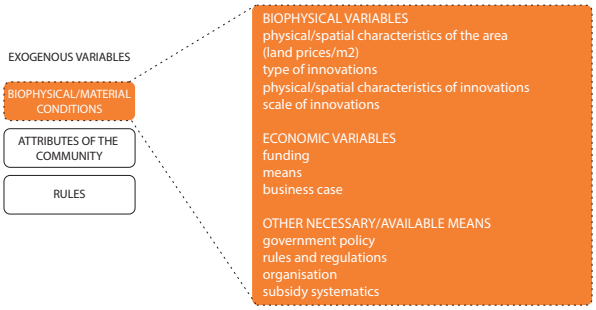
Operationalisation – S.I. and UAD projects are both very context specific. This context is partly determined by the biophysical and material conditions.

Beskers (2011) and Brouwer (2014) performed research into the variables of the IAD framework that proved to be important in UAD. These variables include the physical/spatial characteristics of the area, economic characteristics and the scale of the project. Although these studies focussed on a different arena within urban development, some of the variables are still found relevant for this research (figure 18b).

Topsector Energie (2016) identified a number of institutional variables that proved to be important for innovations in the energy sector, and in particular the integration of multiple energy innovations. The following variables were mentioned to often form a barrier: subsidy systematics, government policy, rules and regulations, taxes, permit provision and normalization. Kemp et al. (1998) argue that barriers for the use of new technologies include technological factors (e.g. ill development in terms of user needs, expensive due to low scale production), government policy and the regulatory framework (e.g. no clear view for the future, cumbersome adaptations of legislation), infrastructure and maintanance (e.g. required scale to make infrastructure profitable, responsibilities for development of infrastructure, sunk investments in existing infrastructure and maintanance of new technologies).

Additionally, two very elaborated case studies performed by Vernay (2013) which both integrated several infrastructural systems in an urban area provided variables that proved to play an important role during the process.

Based on these literature sources the following variables are identified as relevant for this research:



18b

Attributes of the Community

The second set of exogenous variables that influences the action arena covers the Attributes of the Community.

"*The attributes of a community that are important in affecting action arenas include: the values of understanding that potential participants share (or do not share) about the structure of particular types of action arenas; the extent of homogeneity in the preferences of those living in a community; the size and composition of the relevant community; and the extent of inequality of basic assets among those affected*" (Ostrom, 2009).

Examples are general corporate values and the sense of consensus across actors. Polski and Ostrom (1999) mention the following questions in order to research this set of variables:

1 What is the size of the community and who is in it?
2 What knowledge and information do members have?
3 What are member' values and preferences?
4 What are members' beliefs?
5 What are members' beliefs about other participants' strategy preferences and outcomes?
6 How homogeneous is the community?

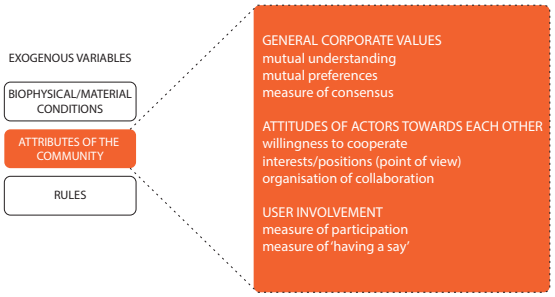
Operationalisation – S.I. is considered to be a complex process due to, among other things, the many actors that are involved. These actors come from different backgrounds and regimes and have to collaborate across sectors and disciplines. A wide variety of corporate cultures are part of the complexity when integrating infrastructural systems.

According to Beskers (2011) and Brouwer (2014), the following variables were found to be relevant in UAD: general corporate values, attitudes between actors and organizational capacity. Kemp et al (1998) discuss the barriers for new technologies related to cultural and psychological factors (e.g. status and identity).

The Hammarby Sjostad and Lille Metropole cases discussed by Vernay (2013) mention the additional variable of user involvement as influential factor for S.I. in UAD. Besides literature and case documents, a third source was used to further elaborate the importance of user involvement. An unstructured interview with a professional in the field* provided the additional context and consequences of involving future users during the process.

* Unstructured interview: Vivian van Nassou (Waternet)

Variables from literature, the aforementioned case studies and the unstructured interview led to the following operationalisation of variables:



18c

Figure 18b Operationalisation of biophysical/material conditions
Figure 18c Operationalisation of attributes of the community

Rules

The rules, often described as the institutional arrangements, are the third and last set of exogenous variables in the IAD framework. Institutional arrangements are defined as the written and unwritten institutions that structure a decision making process.

"*Institutional arrangements are the rules used by individuals for determining who and what are included in decision situations, how information is structured, what actions can be taken and in what sequence, and how individual actions will be aggregated into collective decisions*" (Kiser & Ostrom, 2000).

Institutions and institutional arrangements are, hence, at the root of challenges and opportunities of S.I. in UAD.

"*Rules are shared understandings among those involved that refer to enforced prescriptions about what actions (or states of the world) are required, prohibited, or permitted*" (Ostrom, 2009).

They structure the process of the action arena and ensure that actors know where they stand. Furthermore, it lets them know how to influence the process. Institutional arrangements become clearer when the exogenous variable is further divided into the different kind of rules that structure the process:

1 **Boundary rules** (enter or leave - participants) – are the enter- and exit rules for the process. "*Boundary rules affect the number of participants, their attributes and resources, whether they can enter freely, and the conditions they face for leaving*" (Ostrom, 2007, p. 19).

2 **Position rules** (be - positions) – determine the roles and positions of the participating actors (Polski & Ostrom, 1999).

3 **Scope rules** (occur - outcomes) – determine the goals, which outcomes are desirable and which are not. "*Scope rules delimit the potential outcomes that can be affected and, working backward, the actions linked to specific outcomes*" (Ostrom, 2007, p. 38).

4 **Choice rules/ Authority rules** (do - actions) – determine the actions that actors can(t) and should(n't) perform (Ostrom, 2007).

5 **Aggregation rules** (jointly effect - control) – are the rules that determine how certain actions are performed.

6 **Information rules** (send or receive - information) – determine availability and transparancy of information. "*Information rules affect the amount and type of information available to participants in an action arena*" (Polski & Ostrom, 1999, p. 17).

7 **Payoff rules** (pay or receive - costs/benefits) – payoff rules determine what the obliged or forbidden costs and benefits are. "*Payoff rules affect the benefits and costs that will be assigned to particular combinations of actions and outcomes, and they establish the incentives and deterrents for action*" (Ostrom, 2011, p. 20).

Operationalisation – S.I. is regarded as a complex process and requires actors with different roles and responsibilities. There are no existing rules within this action arena yet because it is a new concept. Actors are in search of new institutional arrangements that lead to success. The influence of the "rules of the game" on the decision making process will be different from traditional decision making processes. The variables that are connected to these rules and relevant for the process of S.I. are derived from literature (Kickert, Klijn, & Koppenjan, 1997; Ostrom, 2009) and case documents (Vernay, 2013; Vernay, Pandis Iveroth, Baldiri Salcedo Rahola, Mulder, & Brandt, 2011).

Figure 18d shows the operationalised variables for each rule.

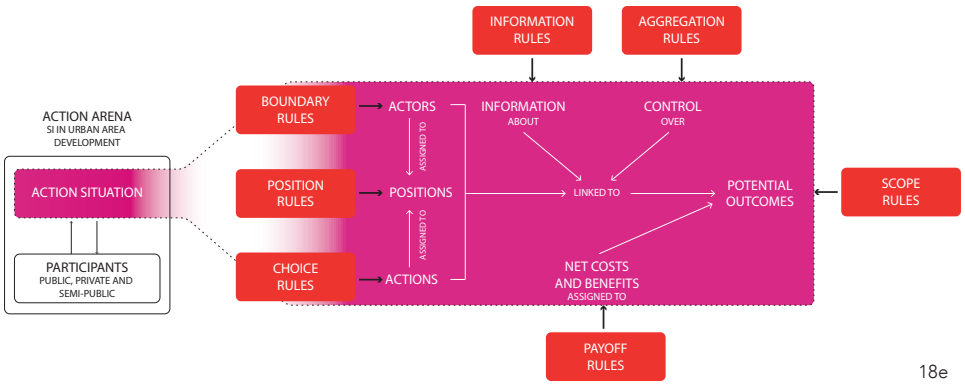
At the same time, the rules are the analysis framework for the action situation (stated in paragraph 2.3.2). By using the rules, one can explain what fundamentals caused a certain decision of an actor. The "rules in use" have been configured in a way that the effect of changing a rule depends on other rules (Ostrom, 2011). The ways in which these rules influence the action situation is shown in figure 18e.

The framework provides the ability to analyse perceptions and interactions between actors by giving a set of variables that can be linked to actions, interactions and outcomes. Consequently, it provides insight into the driving forces actors experience and creates conditions for possible collaborations.

Figure 18d Operationalisation of the rules
Figure 18e Rules influencing the action situation


EXOGENOUS VARIABLES
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
BOUNDARY RULES
number of actors
contributions and means
free access to the process
exit conditions
POSITION RULES
roles
changing/improving positions
number of actors with the same position
SCOPE RULES
results
functional and geological boundaries
CHOICE RULES
actions of specific actors
AGGREGATION RULES
control of positions
permission of other actors
INFORMATION RULES
degree of available information
transparency
PAYOFF RULES
costs and benefits
sanctions

18d


INFORMATION RULES
AGGREGATION RULES
ACTION ARENA
SI IN URBAN AREA DEVELOPMENT
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
BOUNDARY RULES
POSITION RULES
CHOICE RULES
ACTORS
POSITIONS
ACTIONS
ASSIGNED TO
ASSIGNED TO
INFORMATION
ABOUT
CONTROL
OVER
LINKED TO
POTENTIAL OUTCOMES
SCOPE RULES
NET COSTS AND BENEFITS
ASSIGNED TO
PAYOFF RULES

18e

Exogenous vs Endogenous Variables

An additional comment should be made regarding the exogenous variables. Traditionally, the exogenous variables are independent variables from outside the action arena, often considered as something that is given. For the S.I. process in UAD, this might be a bit different.

The terms exogenous and endogenous variables originate from the studies of economy and econometrics.

Exogenous variables are defined as the variables that are not affected by the model, and its qualitative characteristics and method of generation are not specified by the model builder. It is used for setting the external conditions.

Endogenous variables are defined as the dependent variables that are generated within the model, and constitute the variable whose value changes. Values change by the functional relationships within the model.

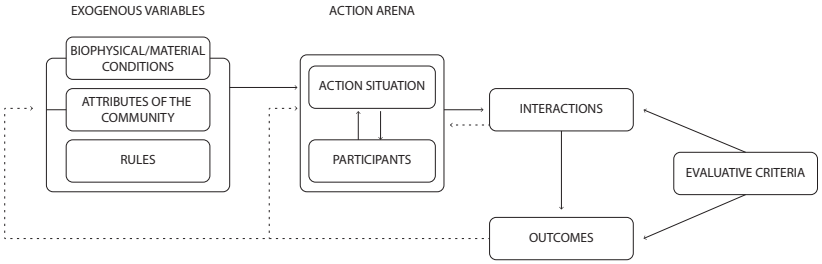
We initially start with the exogenous variables as the external conditions in the IAD framework, based on literature sources. However, the framework provides the opportunity of rearranging these external conditions. Looking at the traditional framework, an arrow from outcomes to exogenous variables shows that for new institutional arrangements the outcomes may affect the exogenous variables (figure 19).

In this research, not the outcomes but the interactions might lead to an adjustment of the exogenous variables. This could be especially true for niches, as they foster experiments and innovations. New institutional arrangements ask for adjustments of the exogenous variables and are probably crucial for upscaling.

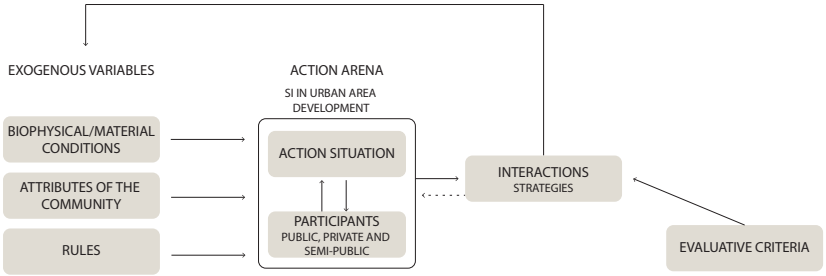
To provide an example of such an adjustment the variable 'rules and regulations' is used. Whenever a new product is being developed within a niche, the regulatory framework might hamper the introduction of the new product on a regime or landscape level. Applying certain strategies in that niche could lead to opportunities for changing the regulatory framework.

The connection between using a certain strategy (interactions) and changing the exogenous variables is illustrated by an additional arrow in the original framework (figure 20).

Figure 19 IAD framework (source: Ostrom (2010, p.616))
Figure 20 Modified IAD framework for this research


EXOGENOUS VARIABLES
ACTION ARENA
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
INTERACTIONS
EVALUATIVE CRITERIA
OUTCOMES

19


EXOGENOUS VARIABLES
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BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA

20

2.3.4 Interactions

The characteristics of an action situation and the behavior of participants which result in a certain structure are referred to as the patterns of interaction (Polski & Ostrom, 1999). These patterns of interaction can be seen as the strategies that actors use to achieve their goals (figure 21).

Whenever action situations are tightly constrained and there exists little to no uncertainty, participants have a limited range of strategies. However, in most policy analysis situations there are no such unambiguous patterns of interaction (Polski & Ostrom, 1999). Individuals make decisions within the context of community norms or meet with other stakeholders to solve problems. Product innovations or new institutions and organizations may be designed which results in a broad range of available strategies (Polski & Ostrom, 1999).

Whenever such a more open and less constrained situation is analysed, weaker inferences about patterns of interactions can be made. However, these can still provide important information and may narrow the range of predictions by excluding patterns which will not emerge (Polski & Ostrom, 1999).

The action situation of an S.I. process is not tightly constrained and a lot of uncertainties exist. We've mentioned the characteristics of involving multiple actors from different backgrounds and sectors, handling different sets of rules. Van Bueren et al. (2003) mention the strategic uncertainty of wicked problems due to the involvement of many stakeholders. Strategies are based on one's own perceptions of problem and solution, which results in conflicting and diverging strategies when multiple actors are involved (van Bueren et al., 2003). In order to understand the process of breaking down existing structures and establishing new ones, interactions between actors play an important role.

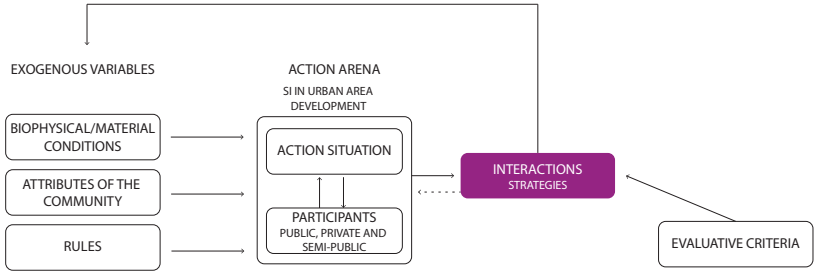
For this research, we will analyse the patterns of interaction from an evaluative point of view. Evaluative criteria derived from theory will be compared to the patterns of interaction that took place during the S.I. process in the three studied cases.

2.3.5 Evaluative criteria for the Interactions

Interactions are the strategies that actors used during the S.I. project in this research. Evaluative criteria will be used to evaluate these strategies (figure 22).

Multiple theories exist about strategies that actors may use in complex networks or to create successfull niches. Three existing theories will provide input for the evaluative criteria in this research. First, Strategic Niche Management (SNM) is discussed from which the main criteria are extracted. These are supplemented with strategic elements from the concept of Niche Entrepreneurs and theory of Policy Network Management (PNM).

Figure 21 Interactions in the IAD framework
Figure 22 Evaluative criteria


EXOGENOUS VARIABLES
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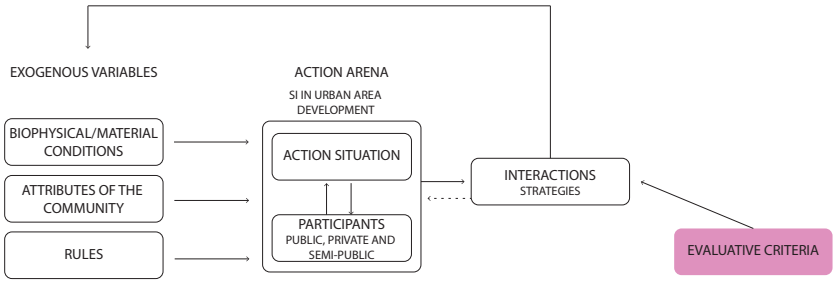
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA

21


EXOGENOUS VARIABLES
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BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
PUBLIC, PRIVATE AND SEMI-PUBLIC
INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA

22

Strategic Niche Management (SNM)

SNM is considered to be valuable for actors who want to push new sustainable technologies on to the market (Kemp et al., 1998). Niches were introduced in one of the previous paragraphs (2.2) as protected spaces where innovations are developed.

"Strategic Niche Management is the creation, development and controlled phase out of protected spaces for the development and use of promising new technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the further development and the rate of application of the new technology." (Schot et al., 1994)

In short:

"the controlled development and breakdown of protected spaces for new technical applications aiming at market introduction" (Schot, Hoogma, & Elzen, 1994, p. 1073).

Systems integration can be partly understood as a technological transition, as multiple technical innovations are introduced in these projects. Entrepreneurs (sometimes also called systems builders) and niches are suggested to play an important role in this transition process (Kemp et al., 1998). Kemp et al. (1998) argue that niches not only demonstrate viability of new technologies and provide financial means, but also set in motion interactive learning processes and institutional adaptations. The SNM approach argues that both technical as well as institutional innovations can be facilitated by niches.

SNM is characterized by three core processes:

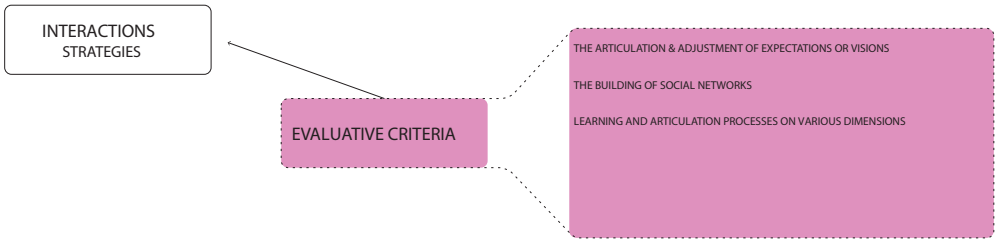
1 The articulation and adjustment of expectations or visions - these provide guidance for innovation processes and aim to attract attention and funding from external actors. It is about making sure that all of the involved actors share similar expectations and that they are based on experimental results (Vernay, 2013).

2 The building of social networks - the enrollment of more actors, which expand the resource base of niche innovations. The aim here is to gather actors from different fields around the innovation and make sure they interact on a frequent basis (Vernay, 2013).

3 Learning and articulation processes on various dimensions - e.g. technical design, market demand and user preferences, infrastructure requirements, organisational issues, business models, policy instruments, and symbolic meanings. This allows identifying and implementing necessary technological adjustments (Schot & Geels, 2008).

The success or failure of a niche project can be assessed on these three interacting internal processes. These core processes will be used as the basic evaluative criteria for the strategies that were used by actors in the studied cases (figure 23).

Figure 23 Evaluative criteria from SNM


INTERACTIONS
STRATEGIES
EVALUATIVE CRITERIA
THE ARTICULATION & ADJUSTMENT OF EXPECTATIONS OR VISIONS
THE BUILDING OF SOCIAL NETWORKS
LEARNING AND ARTICULATION PROCESSES ON VARIOUS DIMENSIONS

23

Niche Entrepreneurs (NE)

Pesch et al. (2017) have done research into the role of individuals in niche formations. The "niche entrepreneur" is brought forward as an actor who:

"[..]successfully connects the elements that are needed to develop a successful niche that allows learning for sustainability transitions" (Pesch et al., 2017, p. 1).

The niche entrepreneur employs strategies for the creation of coalitions between actors. By doing this, they connect the elements in order to create a successfull niche. It is argued that the formation of a niche resembles the process of setting a particular issue on the agenda (Pesch et al., 2017).

According to Kingdon's model (1984), three streams should be simultaneously occur in order to achieve a transition i.e. the problem stream, the solutions stream and the politics stream. When these streams coincide, a 'window of opportunity' emerges. In general, these streams are independent and they follow different social patterns (Pesch et al., 2017). However, entrepreneurs may have the ability to allign these streams (Pesch et al., 2017).

Strategies of niche entrepreneurs are based on the strategies of policy entrepreneurs. The key strategies of policy entrepreneurs are characterized as follows:

1 Drawing attention to an issue

2 Creating and maintaining a coalition of actors that disposes over relevant values or resources

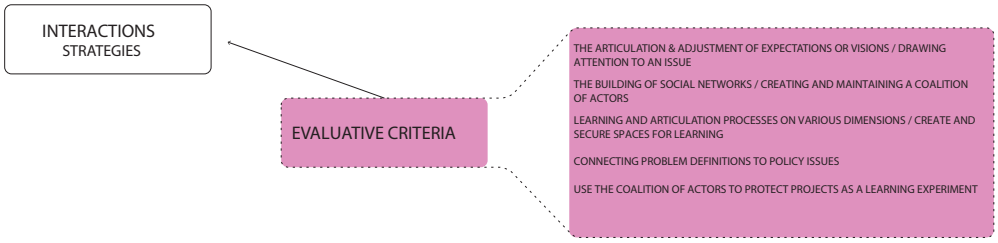
3 Connecting problem definitions to policy issues given the existing political and institutional context.

Niche entrepreneurs use these strategies with a specific emphasis on the creation of coalitions. Two additional strategies of niche entrepreneurs according to Pesch et al. (2017) are:

4 Create and secure spaces for learning

5 Use the coalition of actors to protect projects as a learning experiment

The creation of "bridges" between urban systems is considered to be crucial for the success of their integration (Vernay & Mulder, 2016). Urban system integrators, actors who are dedicated to the integration of systems instead of representing the interests of one system, are able to facilitate the creation of these bridges (Vernay & Mulder, 2016). The niche entrepreneur, aiming at the formation of coalitions, might be able to create these bridges in order to achieve a successfull S.I. project.



24

Vernay & Mulder (2016) mention four barriers for actors to act as urban system integrators:

1 Public organisations, such as local authorities, cannot be involved in activities that are considered to be market driven.

2 On the other hand, private parties face difficulties in organising public activities.

3 Some of the activities of an organisation could be negatively affected by the systems integration

4 The scale of the urban systems integration projects might make it of minor significance to the partner organizations.

The concept of niche entrepreneurs emerged from the theory of SNM. Therefore, the strategies of drawing attention to an issue (1), creating and maintaining a coalition of actors (2) and the creation of spaces for learning (4) correspond with the three core processes of SNM.

The strategy of connecting a problem definition to a policy issue (3) and using the coalition of actors to protect the project as a learning experiment (5) form valuable additions to the evaluative criteria of this research (figure 24). The connection of problem definitions to policy issues is also known as issue linking: entrepreneurs adjust their preferred problem definition and ideas for policy change to the interests and expectations of other actors (S. Brouwer & Biermann, 2011). Using the coalition of actors to protect projects as a learning experiment is related to the creation of spaces for learning. Besides their creation, projects should also be protected as a learning experiment.

Figure 24 Additional evaluative criteria from NE

Policy Network Management (PNM)

Besides the fact that S.I. projects are currently taking place in niches, the insitutional process of S.I. in UAD can be conceived as a complex network. More specifically, it can be seen as a complex policy network, where public, semi-public and private actors participate on a certain policy field: the integration of several infrastructural systems.

The concept of a policy network combines insights from policy science with ideas from political science and organization theory about the distribution of power and dependencies, organizational features, and interorganizational relations (Kickert et al., 1997). It analyses the policy process as a complex interaction, where many actors participate and processes are ambiguous due to the multiple goals and strategies of actors and uncertainty about information and outcome (Kickert et al., 1997). Actors in these networks are interdependent, as goals cannot be attained by themselves but resources of other actors are needed. This coincides with the characteristics of S.I., where resources of one infrastructural system serve as input for another system. Theory on managing complex policy networks is therefore considered as usefull additional input for evaluating the strategies that actors used in this research.

Network management is aimed at:

"coordinating strategies of actors with different goals and preferences with regard to a certain problem or policy measure within an existing network of interorganizational relations" (Kickert et al., 1997, p. 10).

Network management can be seen as a way of coordinating the interactions from the IAD framework. Interactions can therefore be evaluated with strategies for network management.

Network management can be divided into game management and network constitution (Kickert et al., 1997). Games, arenas and networks are the central concepts in network management theory (van Bueren et al., 2003). A game is conceived as the interactions that take place between actors, arenas as the places where groups of actors interact and a network as a collection of stable relations among mutually dependent actors (van Bueren et al., 2003). Within the process of S.I., interactions (games) cut through different networks which results in a lack of a common frame of reference, methods and values. This inhibits a common approach (van Bueren et al., 2003).

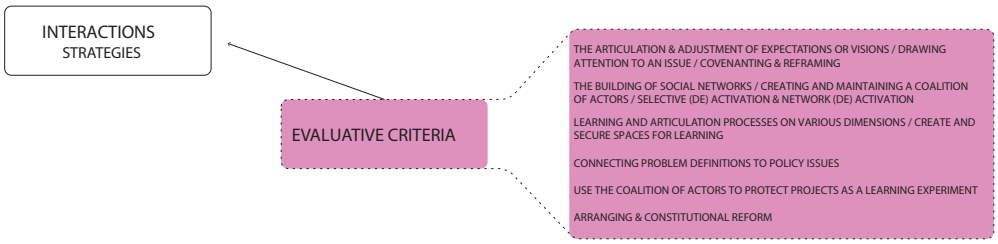
The strategies for game management are as follows:

1 Covenanting - meaning that similarities and differences in actors' perceptions are explored and opportunities for goal convergence are studied.

2 Selective (de)activation - selecting and (de)activating certain actors that possess the resources to block a game, or selecting and activating actors that possess the resources to continue/start the game.

3 Arranging - on the institutional level, ad hoc provisions which suit groups of interactions have to be created, sustained and changed.

Figure 25 Additional evaluative criteria from PNM



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Strategies for network constitution are:

4 **Reframing** - changing the way in which actors perceive the network.

5 **Network (de)activation** - changing the configuration of the network by bringing in new actors or changing the positions of existing actors

6 **Constitutional reform** - on the institutional level, changing the rules and resources in the entire network or changing the ecology of games in a fundamental game.

Some strategies discussed in PNM theory can be added to the evaluative criteria, while others (partly) overlap with the strategies discussed in SNM and Niche Entrepreneurs.

Covenanting (1) can be compared to the first core process of SNM: making sure that all of the involved actors share similar expectations. In order to do this, similarities and differences in actors perceptions need to be studied. Reframing (4), which is also based on actors' perceptions, falls within the first core process of SNM as well. Adjustments of expectations or visions requires a change of actors' perceptions on the network.

Selective (de)activation (2) can be compared to the second core process of SNM: the building of social networks. Gathering actors from different fields is argued to be important to achieve a successfull niche. PNM adds an important aspect: the *de*activation of certain actors that posess resources to block the game. Network (de)activation (5) approaches this on the level of networks, where new actors need to be brought in or existing actors need to change their position.

Arranging and constitutional reform address management at an institutional level. It does not coincide with any of the three core processes of SNM and is considered a valuable addition to the evaluative criteria (figure 25).

It appears that some of these criteria complement the 'rules' from the IAD framework that were discussed in paragraph 2.3.3. Strategies such as (de)activation show a certain connection with the boundary rules and position rules. The variables that influence niches have been argued to be less clearly exogenous or endogenous as institutions have to be reconfigured and actors are searching for new positions and roles. Interactions might be able to address the exogenous variables of the IAD framework. It is possible for these exogenous variables to change under the influence of certain strategies.

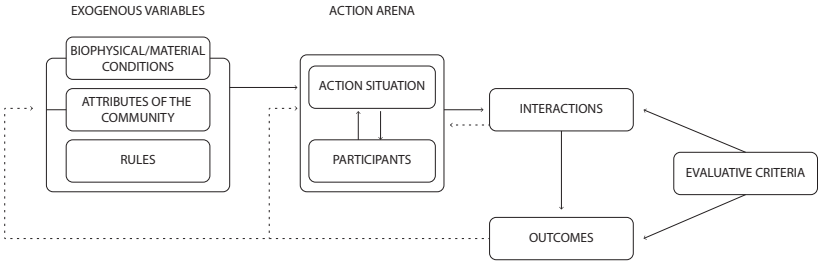
2.2.6 Evaluative criteria for outcomes

The outcomes are the actual performance of a policy system. Although there are many, Polski & Ostrom (1999) mention six common evaluative criteria for outcomes:

1 Economic efficiency
2 Fiscal equivalence
3 Distribution equity
4 Accountability
5 Conformance to general morality
6 Adaptability

In this research, the outcomes of the SI process will not be evaluated as such. As was mentioned in the introduction, the exogenous variables that caused challenges and opportunities during the process will be researched and the way in which actors responded to those. The fact whether the outcomes were successfull or not are in that sense not relevant. However, the three studied cases were succesfull in a sense that SI projects are currently being or have been realised.

Outcomes are excluded from this research for the following reason. Assessing whether an outcome is succesfull or not requires evaluative criteria such as these six mentioned above. Attributing a value to a certain outcome in S.I. projects does not fall within the scope of this research. Besides time limitations, it seems more difficult to attribute value to e.g. economic or fiscal efficiency in projects aiming at sustainable solutions. Besides the fact that niches are often still protected from market competition, desirable outcomes differ for all actors. It would be impossible to consider the projects successfull or unsuccessfull from the basis of an independent scientific perspective.


EXOGENOUS VARIABLES
ACTION ARENA
BIOPHYSICAL/MATERIAL CONDITIONS
ATTRIBUTES OF THE COMMUNITY
RULES
ACTION SITUATION
PARTICIPANTS
INTERACTIONS
OUTCOMES
EVALUATIVE CRITERIA

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2.4 CONCEPTUAL MODEL

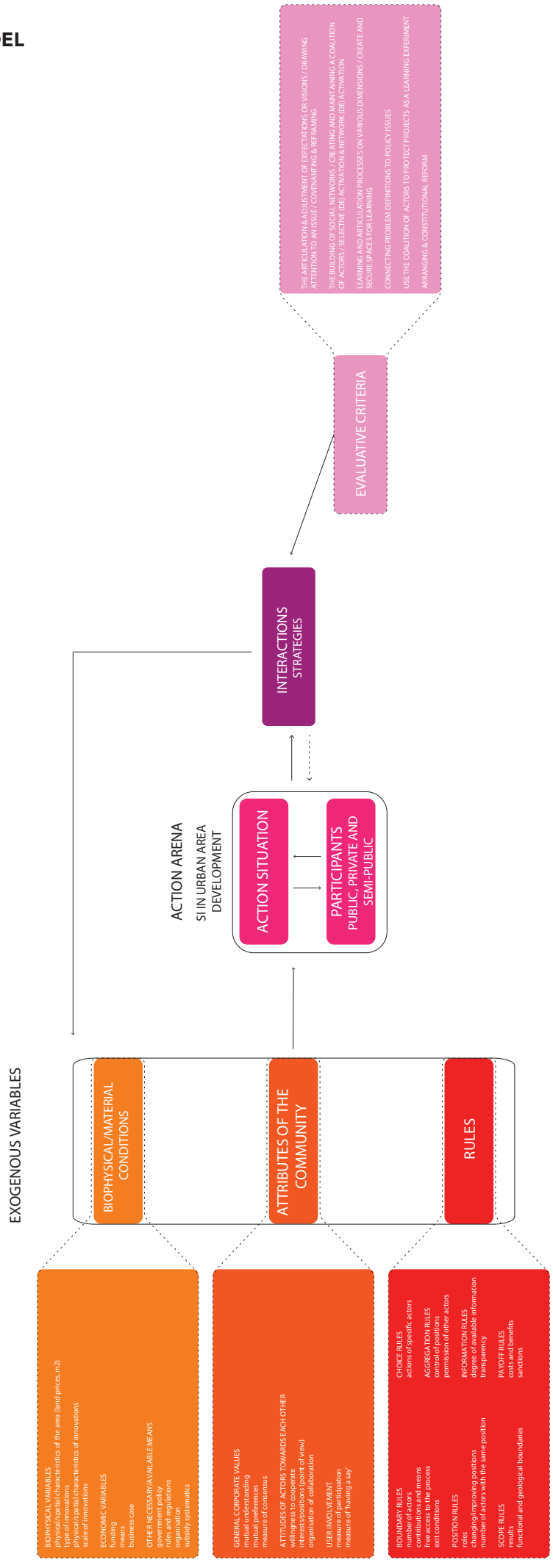


Figure 27

III METHODOLOGY

3.1 RESEARCH STRATEGY AND DESIGN

The strategy for this research is of qualitative nature. It focusses on the determination of relevant variables and strategies to address them during the process of systems integration in urban area development. Finding a relationship between the variable and a positive respectively negative influence on the process is aimed for. This research additionally focusses on the strategies that actors use to address influential variables. Outcomes will be based on theoretical and empirical evidence from respectively literature and case studies.

The research will be mainly based on explorations. One of the advantages of explorative research is that it is flexible and open to new ideas. Because the concept of systems integration is relatively new and little research has been done into the process towards it, exploring is considered to be a suited approach. A descriptive research into the concept of systems integration itself, the implementation in an urban context and existing theory on transitions in order to outline the characteristics of these phenomena was performed in the previous chapter.

Case studies - Numerous possibilities for performing research exist. The question which one should be used depends on three conditions.

"The three conditions consist of (a) the type of research question posed, (b) the extent of control an investigator has over actual behavioral events, and (c) the degree of focus on contemporary as opposed to historical events" (Yin, 2009, p. 8).

The first condition is the type of research question posed. This research addresses the way in which certain variables influence the process of systems integration and how interactions between actors take place. This resulted in an explanatory research question. There are three ways of doing research into explanatory questions.

"Explanatory questions are likely to lead to use of case studies, histories, and experiments as the preferred research methods" (Yin, 2009, p. 9).

This brings us to the second condition to determine the appropriate research method: the extent of control an investigator has over actual behavioral events. In an experiment (also called the laboratory approach) the investigator has complete control over the situation. In this research, the researcher does not have any control over the events taking place. Therefore, using the experiment as a method is not a suitable approach. This leaves us with a choice between case studies or histories. Because this research focusses on contemporary events instead of historical ones, the case study method is chosen.

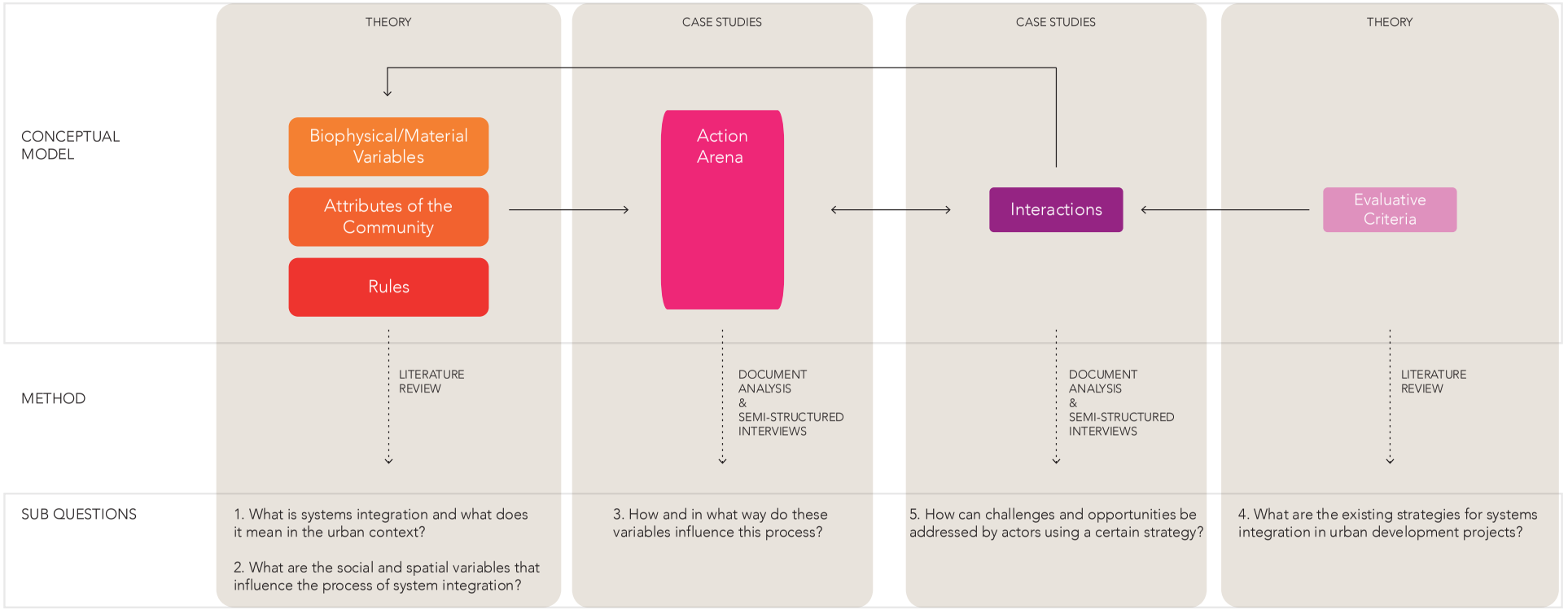
Descriptive case study - The design for this research is a descriptive case study. The descriptive design aims to observe and describe the variables influencing the process of systems integration and the way in which actors respond to these variables. In order to get an in-depth view of the process and the interactions taking place, three case studies are conducted. Lynn & Lynn (2015) argue that case studies are in-depth studies that provide understanding of complex issues through a detailed analysis of a limited number of conditions and their relationships. Ostrom (2009) confirms that case studies are an important technique for analyzing the structure of complex action situations.

IAD framework - The IAD framework that was discussed in the previous chapter is used to distinguish and analyse the variables during the process and the way in which these are addressed by actors. Because the concept of systems integration is relatively new, an extensive and frequently used research framework has been chosen. This provides the researcher with the handles that are necessary to analyse such a complex and new type of process.

While the framework proves to be usefull in determining the exogenous variables and how actors deal with these through interacting, it also provides the point of departure for achieving desired outcomes (recommendations). The design of this framework is universal, but asks for local specifics in order to be applied. It forms the theoretical framework for this research.

The research strategy and design are visualised on the following page (figure 28).

Figure 28 Research strategy & design



MAIN RESEARCH QUESTION

What are the challenges and opportunities of systems integration in urban development and how can these be addressed by actors?

3.2 CASE STUDIES

The empirical component forms an important part of this research. It studies the integration of several infrastructural systems in practice through document analysis and semi-structured interviewing. In order to do so, three descriptive case studies of the following projects in the Netherlands are performed:

1 Cityplot Buiksloterham, Amsterdam
2 Waterschoon Noorderhoek, Sneek
3 EVA Lanxmeer, Culemborg

The way in which these cases were selected will now be discussed.

3.2.1 Case Selection

Whether cases were suitable for this research was determined by the following selection criteria:

Systems Integration projects - The first requirement was that the cases integrate different infrastructural systems. This research focusses specifically on the process of systems integration projects. Whether this process was succesfull was not a requirement as both challenges as well as opportunities are part of this research. Outcomes are not inherently connected to those. If the process was considered unsuccessfull, the variables that caused a failure can still provide usefull information. Likewise, unsuccessfull projects can identify opportunities that facilitated the process in a positive way.

Infrastructural systems - The type of systems that are integrated were also a selection criteria. The 'Straat van de Toekomst' project initially gave rise to this research. The systems that are to be integrated in this project are leading for the selection of cases for this research:

1 The integration of wastewater & energy infrastructures: A decentralised sanitation system will recover energy from black and grey water streams. This energy can be used in a district heating system and for greenhouses.

2 Reuse of nutrients from wastewater infrastructure: By recovering the nutrients from black water streams, phosphate and sulphates can serve as a fertilizer for agricultural purposes.

Urban development projects - The research question focusses specifically on systems integration within an urban context. Therefore, cases need to take place in an urban area development project. Systems integration projects on a single building scale or industrial plants are therefore excluded from this research.

Number of cases - Due to the innovative character of this type of projects, there exists a limited choice for cases. Integrating multiple infrastructural systems in urban development is relatively new. Although a lot of initiatives and ideas exist, almost none of them have been realized yet. Because this research focusses on the execution phase of systems integration and not on the initiation phase, it was an important criteria that projects were already realized or currently being realized. Considering the time-span of this research and the balance between workload and generalizability, the number of cases for this research was limited to three.

Context - Because the external context (e.g. the policy and regulatory system) is also studied it is considered best if projects are under a similar system of governance. The researcher has therefore chosen to select cases from The Netherlands only.

Availability of information - Additionally, selecting projects in The Netherlands enhances the availability of information. Semi-structured interviews are considered to be better performed 'face-to-face', as some of the answers to the questions can entail sensitive information. However, only limited cases exist in which systems integration has taken place within urban area development. Some foreign cases have therefore been used in the literature study to identify relevant variables that influence the process.

3.2.2 Cases: Cityplot, Waterschoon and EVA Lanxmeer

Given the described selection criteria, three urban area developments integrating multiple infrastructural systems were chosen.

Systems Integration - The cases integrate the following infrastructural systems:

1 Cityplot, Buiksloterham: integration of wastewater and energy infrastructures and the recovery of nutrients.

2 Waterschoon, Noorderhoek: integration of wastewater and energy infrastructures and the recovery of nutrients.

3 EVA Lanxmeer, Culemborg: integration of drinking water extraction infrastructure and a district heating network (energetic infrastructure).

Infrastructural systems - Both projects in Buiksloterham and Noorderhoek integrate similar types of systems: a (decentralised) wastewater system and an energy system.

This combines the infrastructures of sewage and energy, which corresponds with the circular wastewater and energy streams in the 'Straat van de Toekomst'. Outcomes of these two cases are therefore considered to deliver usefull input. The reuse of nutrients adds to the suitability of the selected cases.

The project in Lanxmeer integrates two other systems. Drinking water (12 celsius) is extracted within the area, which is used for the district heating network of the neighbourhood. This is a very specific type of systems integration, as it can only be done because there is a drinking water extraction plant available. This is not the case in the 'Straat van de Toekomst'. However, this case is still considered relevant for giving a good example of best practice of systems integration. Lanxmeer has been operating for already 20 years, and can provide relevant insights about the different stages of such a long term process. Furthermore, energy from water is used which coincides with aims of the 'Straat van de Toekomst'.

Urban Area Development - All three selected cases are part of an urban area development project. Buiksloterham is located in the inner-city of Amsterdam, Noorderhoek in the city of Sneek and EVA Lanxmeer in Culemborg. The nature of the developments differs.

Cityplot in Buiksloterham is a transformation of existing urban fabric. It is located at the northern river banks of Amsterdam and currently being developed from industrial area towards as a mixed-use neighbourhood.

Waterschoon originates from a restructuring task of an old social rental neighbourhood in Noorderhoek. It is an inner-city location where a care facility for elderly and social housing is built from scratch.

EVA Lanxmeer was built on a greenfield location. The idea for this neighbourhood derived from the EVA concept, in which the inhabitants played a major role.

These three different developments provide a varied image of the diverging context of urban area development projects.

3.3 METHODS

The research methods used for this research are a literature review, semi-structured interviews and document analysis.

3.3.1 Literature Review

Research questions one, two and four can be answered through an explorative literature review (figure 28).

'The point of departure in an explorative research is usually a set of notions or assumptions. The aim is to create insights: to identify, define and illustrate relevant phenomena, to explain specific characteristics and effects and (inter) relationships. The aim of such an approach is generally to formulate hypotheses, leading to more focused, empirical research' (Breen, 2002, p. 138).

Insight into the concept of systems integration and the process towards it in an urban context is obtained. The specific characteristics of systems integration are explained and effects and relationships between the concept and the process identified. The results are assumptions about the challenges and opportunities (variables) of systems integration in urban area development, and the relationship with strategies on how to deal with those variables.

Answers to the first two subquestions provide input for answering the third subquestion. The fourth subquestion contributes by providing criteria for the fifth subquestion.

Systems integration in urban area development - First, reliable sources were found that describe the concept of systems integration into more detail in order to give an overview of the characteristics and the meaning of integrating multiple infrastructures. These sources were used to place systems integration within the context of the transition towards a circular economy. A specific theory on how transitions come about and how they emerge is the Multi Level Perspective (MLP).

The MLP is most extensively described by Geels (2002; 2004). It is often used to describe how transitions take place at different levels: the landscape, regime and niche level. Within the MLP theory, the subtheory of Strategic Niche Management was found. Kemp et al. (1998) and Schot et al. (1994) argue that niches are a way of achieving transitions for sustainable innovations, and that these should be managed in certain ways to become successful.

Looking at MLP transition theory and the concept of systems integration, two researchers stand out when combined in an urban context: Vernay (2011; 2013; 2016; 2017) and Pandis Iveroth (2011; 2014; 2017). Both have performed a lot of research into three cases of *urban systems symbioses*. Most of their research is based on the three cases of Hammarsby Sjostad, Lille Metropole and EVA Lanxmeer. It is striking that these cases keep coming back over the years as an example for analysis. It appears as if not many new *urban systems symbioses* projects are developed.

Lastly, a part of literature on the general idea of urban area development was explored. In order to understand the particularities of the case studies, some background information was found relevant for placing the concept of systems integration in the urban context, mostly written by Franzen et al. (2011). Important aspects are the different actors involved and their roles, which were distilled from specific publications of Heurkens (2012) and the publications of the KEI (2010) knowledge centre. Heurkens and Hobma provided some specific insights into the legal aspects and tendering rules and restrictions for urban area development (personal communication).

IAD Framework - Focussing on the institutional process of systems integration, a general framework was used to provide a structure for this research. The IAD framework is considered to be suited to analyse complex action arenas and their external influences. Literature sources on the IAD framework are mainly written by the developers of the framework: Elinor and Vincent Ostrom (2007, 2009, 2011). Polski and Ostrom (1999) provided extensive literature on the explanation and usage of the framework.

Challenges and opportunities (exogenous variables) - The IAD framework is operationalised for this research and the specifics of the action arena that we want to analyse: the systems integration process. Therefore, several sources were used to identify relevant exogenous variables that play a role during the processes of urban area development and systems integration.

Interactions (evaluative criteria) - Last but not least, evaluative criteria for the interactions between actors had to be found. None to very little literature has been written on specific strategies during the process of systems integration. However, systems integration was argued to take place in niches. Within innovation literature, strategic niche management (SNM) and niche entrepreneurs are positioned within the theory of the MLP. Kickert et al. (1997) and Van Bueren et al. (2003) wrote some very elaborate literature on strategies for managing complex networks. Pesch et al. (2017) recently wrote a more specific theory on the strategies for systems integration taking place in niches. An important addition for this research, as it provides a more focussed approach on the research topic.

3.3.2 Interviews

Besides a literature review, interviews are a second method of research. A list of interviewees can be found in appendix III.
Whenever a phenomenon is new and when the investigator seeks to answer 'how' and 'why' questions, qualitative methodology such as interviewing is used for data collection and analysis (Yazan & De Vasconcelos, 2016). For this research, "what if" questions are also considered relevant as they seek to identify relevant information on how actors should or could act in order to achieve desired outcomes.

Interviews can be (roughly) divided in three ways: stuctured, semi-structured and unstructured. While a structured interview has a rigorous set of questions, unstructured interviews are completely open. The semi-structured interview is best described as 'flexible' (Bryman, 2012). The advantages of this type of interviewing are that it enables us to talk to people about more sensitive issues, allowing the conversation to flow while still having a clear structure. Because this research addresses several sensitive subjects such as collaboration issues and difficulties, assuring confidentiality is considered an important aspect. Structured interviewing is regarded unsuited as the interviewer might come across as 'cold' and uninterested in the context of the situation of the interviewee. Unstructured interviewing does qualify for gaining a better understanding of the context of this research as it is often used for general research about a topic or idea. Some unstructured interviews are held in order to extend the theoretical framework (appendix X).

This research clearly focusses on the specifics during a process and the variables influencing this process. Therefore semi-structured interviewing is used for the empirical part of this research.

Unstructured interviews – A small amount of unstructured interviews are performed with stakeholders and non-stakeholders in order to get a better understanding about the topic. Unstructured interviews are used when the understanding of the interviewer is still evolving and no structured questions can be asked. These interviews are conducted to extent the contextual knowledge of the researcher in the field of systems integration in urban area development.

Semi-structured interviews – Semi-structured interviews are conducted for the empirical part of the case studies. These interviews are held with the participating actors in the systems integration process and concern the endogenous and exogenous factors influencing the collaboration process. The framework for these interviews is based on the IAD framework of Ostrom.

3.3.3 Document Analysis

For both the theoretical as well as the empirical part of this research, document analysis is used as a research method. All formal documents about collaboration agreements are

analysed on the division of responsibilities between actors and funding. Informal decision making documents will also be taken into account when available.

3.3.4 Processing

The gathered information through these different research methods is processed in order to be analysed in the following ways:

Literature review – Different academic theories on the researched topic are summarised, analysed and compared. Consequently a conclusion can be drawn on the state of the art existing literature of the research topic.

Unstructured interviews – are held before and during the empirical part of this research in order to gain a better understanding of the topic and the context. They were not recorded but summarised according to the notes of the researcher. Relevant information was used to validate results from the semi-structured interviews, the researchers ideas originating from literature and sometimes brought up new questions which were then integrated into semi-structured interviews during the process.

Semi-structured interviews – are held with an interview schedule in which themes with specific questions were asked. This mainly served as a guideline, and interesting deviations were encouraged. Interviews were recorded and transcribed afterwards.

IV CASE DESCRIPTION

I CITYPLOT BUIKSLOTERHAM, AMSTERDAM

Cityplot is an urban area development in Amsterdam. It forms part of the bigger development of Buiksloterham, an old harbour district in the northern part of the city. Circular ambitions for this area are high, which resulted in coupling energy and wastewater infrastructures in Cityplot.

Figure 29 Map of the Netherlands: Amsterdam

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31

The Buiksloterham (BSH) area is an old harbour district located on the northern banks of the IJ in Amsterdam. It used to be full of industrial plants but is currently being redeveloped into a mixed-use neighbourhood, resulting in a combination of the functions working and living (Gemeente Amsterdam, 2016). There are approximately 1.500 houses being developed and, in the following 10 years, more than 3.000 to be built in the BSH (Gemeente Amsterdam, 2016). Due to its complexity, the area has become a playground for experimenting with innovative solutions, temporary use, self-builders, collective private commissioning projects (CPOs) and developers that are aware of the need for differentiated housing environments (Gladek et al., 2014). Although this is very unique for the city of Amsterdam (Daems, 2017), the development has a lot of similarities with (waterfront) areas around the world. An inner-city, former industrial area with a transformation task towards a sustainable mixed-use neighbourhood.

An important contextual event that occurred during the development of the BSH was the worldwide financial crisis, starting in the summer of 2007, reaching its peak in the fall of 2008 and ending during the course of 2011. This caused a lot of developments in the Netherlands to be stalled and had a large impact on the entire building sector. Some developments in Amsterdam were not able to absorb the consequences of the crisis. For example a new part of the city district IJburg, Centrumeiland*, was entirely put on hold. Due to the relatively flexible land-use plan of BSH it was easier to gradually continue with the transformation process. Furthermore, it provided the opportunity for many bottom-up initiatives to emerge (Daems, 2017).

The transformative character of the BSH has some specific consequences. Development of this location is made possible by an extraordinary law: the Crisis and Recovery law (Dutch: Crisis en Herstel wet). This law was initiated to speed up large building projects in the area of sustainability, energy and innovation and give an impulse to the building sector during the financial crisis. It enables, among other things, housing development at places near industrial sites. The fact that BSH is a gradual transformation of an industrial area where a lot of factories are still operating makes it a challenging case. Difficulties exist regarding the amount of pollution and noise that some of the industrial plants produce in order to reach a mixed-use environment. The existing factories often have environmental outlines, which don't relate to the concept of a lively housing neighbourhood. The Municipality of Amsterdam handled an active acquisition policy for the locations where this was the case (Daems, 2017). Companies with less extensive environmental outlines were offered the opportunity to stay (Daems, 2017). Making use of the Crisis and Recovery law provided opportunities, but resulted in challenges regarding objections from surrounding companies at the same time. Making adjustments in the land-use plan brings additional risks for transformations as many neighbouring companies fear for their future and business activities.

Another special characteristic of this development is the "Manifest Circulair Buiksloterham", which is a sustainability statement that was signed by all of the involved stakeholders. Among others Waternet, Alliander, De Alliantie, Eigen Haard, Metabolic, AMS, De Ceuvel, Westpoort Warmte and the Municipality of Amsterdam (and many more) made a statement (Manifest Circulair Buiksloterham, 2015), which entails that more than 20 organisations are collaborating in different projects and have set the ambition to make BSH an example for circular development. Cityplot is one of these developments.

*** Centrumeiland** comprises, together with Middeneiland, Strandeiland and Buiteneiland, the second phase of UAD IJburg. Around 1.300 houses will be built, of which 70% by self-builders, 20% social housing and 10% by developers. The construction process starts in 2018, and everything is newly built. Centrumeiland differs a lot from the development approach in BSH. The land-use plan is much more of a blueprint, and little to no room for experimentation exists. Initiatives for new ways of sanitation were started too late during the process. Because the development of Middeneiland is still in its very beginning, opportunities exist for implementing a decentralised sanitation system. A thematic study is organised in order to get the subject into the process at an early stage.

Figure 30 Historical image Buiksloterham (beeldbank.amsterdam.nl)
Figure 31 Historical image Buiksloterham (beeldbank.amsterdam.nl)

Cityplot's location used to be inhabited by the factory of Air Products, a supplier of chemicals and gases. Because their environmental outline fell within legal boundaries, Air Products was allowed to keep operating according to the land-use plan. However, they decided not to due to uncertainty of intensification and development options for the future (Daems, 2017). A 'triangle' trade was made with housing corporation De Alliantie; the Municipality of Amsterdam offered a location near Schiphol to Air Products, while De Alliantie bought the property rights of the factory's former location from the Municipality. Air Products left the BSH area in March 2014. Due to the financial crisis, the MoA was unable to buy the property themselves, although they would have wanted to (Daems, 2017).

De Alliantie did already buy the property rights of the neighbouring Nedcoat location in 2011, and it was a logical step for them to expand their ownership on this location. More importantly, it was almost crucial to acquire the Air Products location to make development of both locations financially feasible (Daems, 2017) (figure 32 & 33). The development of Cityplot was very much initiated by De Alliantie. Being the owner of the property rights and the developer of the urban plan, they were the frontrunner of this project (Daems, 2017).

Cityplot will contain around 550 houses and 4000 m2 of working units and food service industry, for which housingcorporation De Alliantie, STUDIONINEDOTS architects and DELVA landscape architects developed the masterplan. The future users of Cityplot will be social renters (30%) from De Alliantie, market- and buy (45%, including free sector rent), self-builders/CPO's (11%) and businesses/horeca (14%) (Cityplot Buiksloterham, n.d.; Hillecamp, 2017).

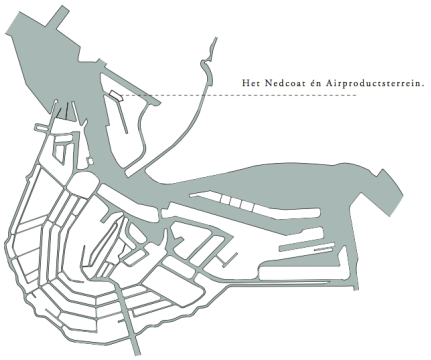

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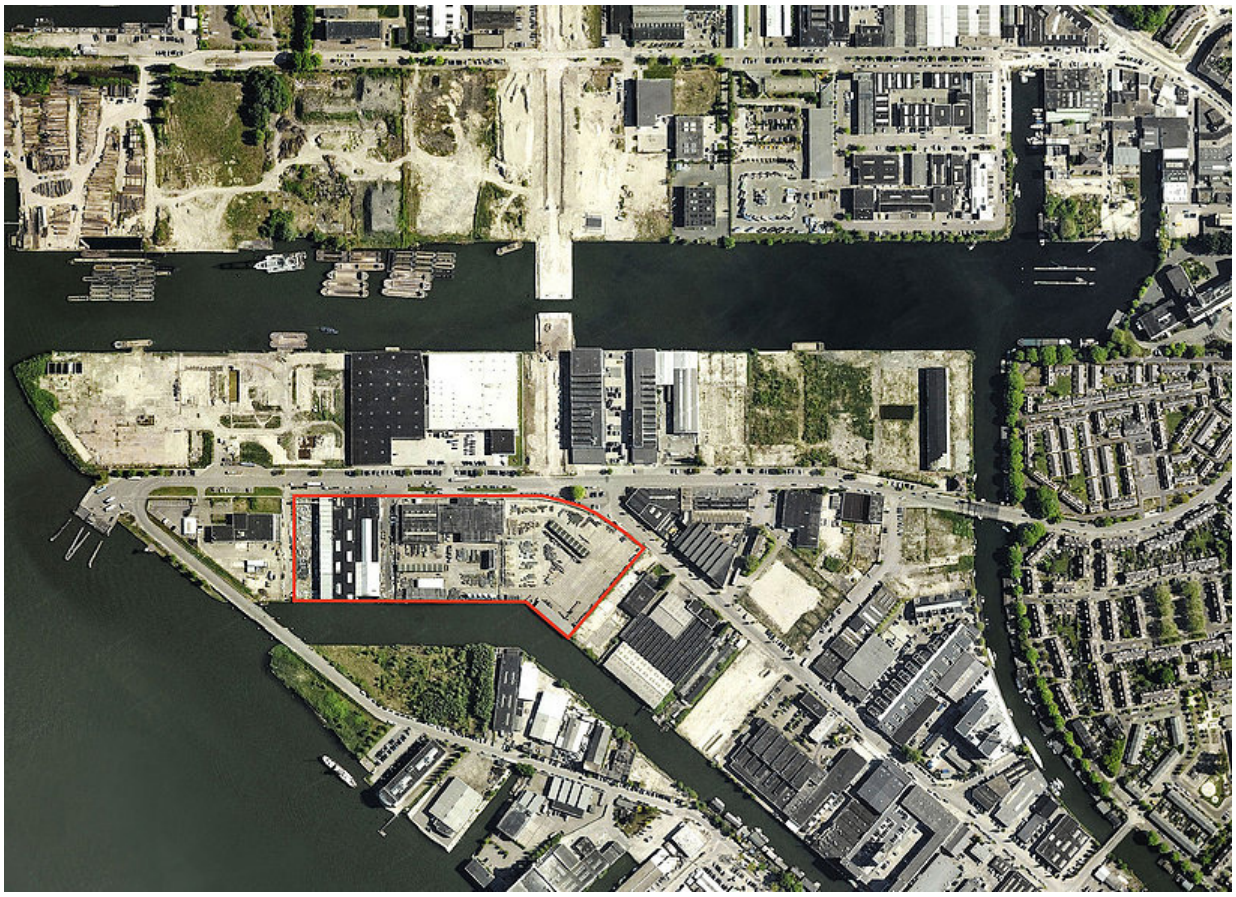
Figure 32 Airproducts & Nedcoat location (source: Studioninedots, 2016)
Figure 33 Airproducts & Nedcoat location (source: Cityplot-Buiksloterham.nl)



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The following actors were particularly important for Cityplot: housing association De Alliantie, watercompany Waternet, the Municipality of Amsterdam and CPO Schoonschip. Furthermore, the district water control board Waterschap AGV provides one of the main financial streams and is therefore also considered to play an important role. Another relevant actor is district heating supplier Westpoort Warmte. Although they did not participate in the S.I. project, they had a large impact on the project.

1 **De Alliantie** is a housing association with 53.000 dwellings within the regions of Amsterdam, Almere, Amersfoort and the Gooi & Vechtstreek. More than 90% of their stock consists of social rent. Being a housing association, they represent a semi-public actor that provides affordable rental houses to people with lower incomes. Besides being the owner of the property rights and the developer of Cityplot, De Alliantie is responsible for the collection of wastewater untill parcel boundaries.

2 **Waternet** is the only watercompany in the Netherlands that is responsible for the complete watercycle: from the production of drinking water to the sanitation of wastewater (Aartsma, 2017). Additionally, they keep surface water on accurate heights, look after the firmness of the dikes and keep the canals clean (Waternet, n.d.). The company was established in 2006 by the Municipality of Amsterdam and Waterschap Amstel, Gooi en Vecht (AGV). The Municipality had its 'Service of Water Management' and 'Sewage and the Waterworks Company of Amsterdam' merge into Waternet. AGV placed its executive organisation under Waternet.

Waternet performs tasks for the provision of drinking water, the management of ground water and the sewage system for the Municipality. For AGV they perform tasks for wastewater sanitation, maintanance of dikes and the management of surface water (Unie van Waterschappen, n.d.) (figure 34). The Municipality and AGV are the administrative commissioners of Waternet. They provide the financial streams and therefore have a say in the decision making process (Ververs, 2017). Consequently, Waternet needs AGV for certain decisions and the Municipality for others (Daems, 2017). Waternet provides all technical knowledge and is the main investor of the raw materials station (indirectly financed by AGV).

3 **The Municipality of Amsterdam (MOA)** is located in the province of North Holland. It has around 838.338 inhabitants and a surface of 219 km^2. The organisation of the MoA contains four clusters, a Governance and Organisation department and seven city districts. The four clusters are: Space and Economy, Social, Service and Information and Management. The three most important departments that are involved in the Cityplot development are Land & Development (Dutch: Grond en Ontwikkeling: G&O), the department of Space & Sustainability (Dutch: Ruimte en Duurzaamheid: R&D) and the Project Management Bureau (Dutch: PMB). All three are part of the cluster Space and Economy.

- **Land & Development (G&O)** prepares land for construction and issues ground leases, performs the maintanance of real estate and financial-economic guidance and the management of spatial projects (Gemeente Amsterdam, n.d.-a). In urban development, it works towards balancing costs, revenues, phasing and quality. Different roles can be played by the department of G&O: advisor, negotiator, empoyer, fund manager and often the one of land-owner (Gemeente Amsterdam, n.d.-a).

- **Project Management Bureau (PMB)** is the specific department for project development. They assemble multidisciplinary projectteams within the MoA and provide the projectmanagers. Besides urban area development, PMB also takes on other projects such as the development of public buildings and public space.

- **Space & Sustainability (R&D)** Unlike the department of G&O, R&D works on every scale level ("from porch to metropole") in order to develop a sustainable vision for the city of Amsterdam, developing concrete proposals and making developments possible (Gemeente Amsterdam, n.d.-b). On the one hand, R&D is responsible for policy making and framing spatial planning, urban planning and sustainability. On the other, they are also commissioned by the city district and large urban planning projects to provide knowledge about city planning, design, urban planning and sustainability.

4 **Waterschap Amstel, Gooi and Vecht (AGV)** is the district water control board of the Amstel, Gooi and Vechtstreek. There are 22 of these water boards in total in the Netherlands. Their main tasks are protecting the areas under sea level, guarding the quality of drinking water, swimming water and water for agricultural purposes. They control the water levels and recover energy and resources from wastewater. As discussed before, AGV's executive tasks in Amsterdam have been accommodated under the organisation of Waternet.

5 **Westpoort Warmte (WPW)** is a district heating company in Amsterdam. It is a collaboration (50% - 50% ownership) between energy company Nuon and the MoA. Their core business is storage, distribution and supply of heating produced by the Waste Energy Company (Dutch: Afval Energie Bedrijf: AEB). WPW makes use of residual heat from the waste recovery installation in order to limit

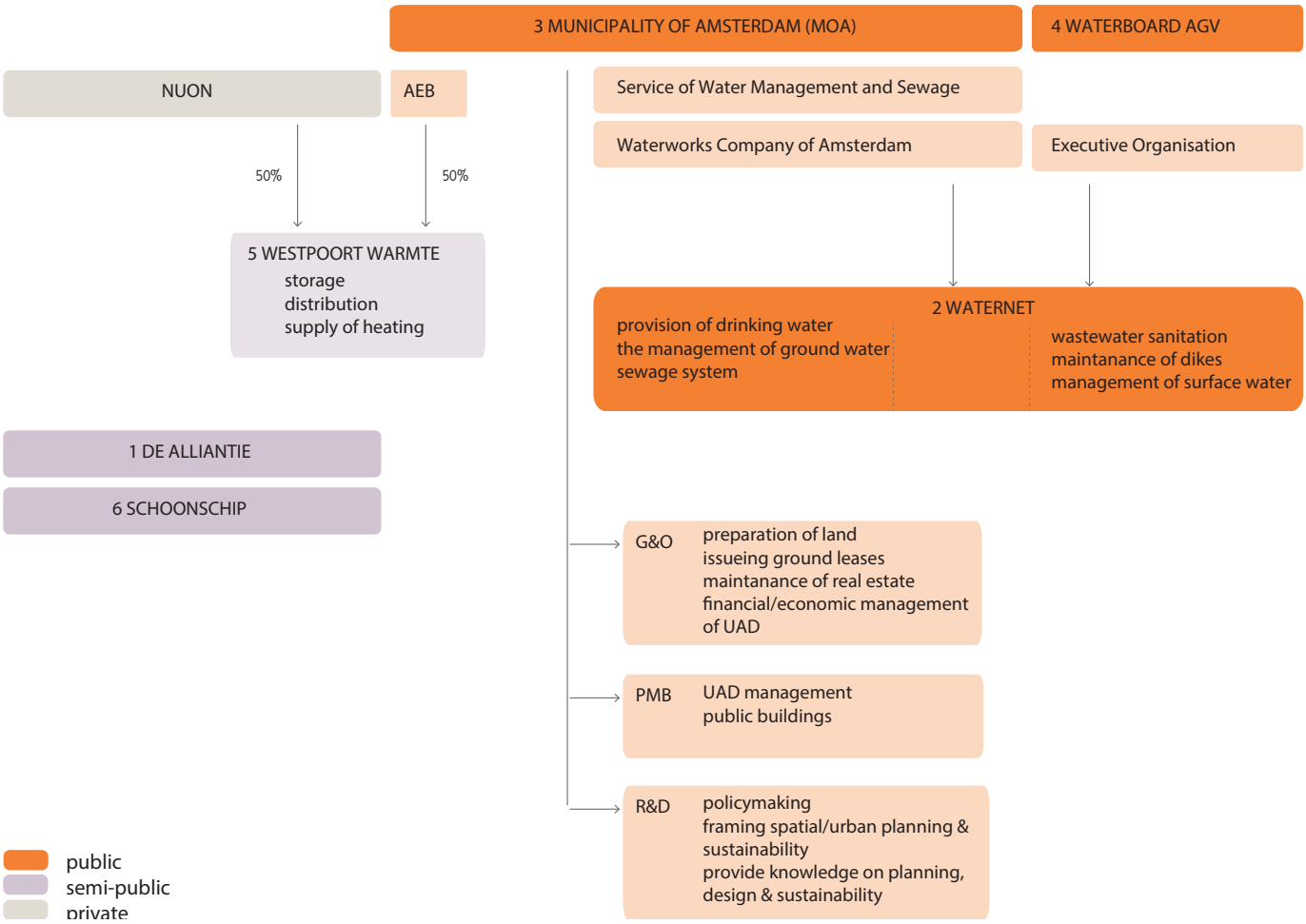


Figure 34 Organisation of S.I. actors in Cityplot

CO2 emissions (Amsterdam Smart City, n.d.). Large parts of Amsterdam have a district heating concession, which means that new developments are obliged to connect to the heating system of WPW. Cityplot is such a development.

6 Besides the Cityplot development, another small scale development will be connected to the decentralised sanitation system: **CPO Schoonschip**. This floating development is located in the Johan van Hasselt Channel (in BSH) and exists of 47 housing boats. Around 105 inhabitants will start living there between 2017 and 2019 (Schoonschip, 2016). It is completely initiated and organised by the future inhabitants.

The system integration project of Cityplot constitutes a decentralised sanitation system, combining the two infrastructures of wastewater and energy. Black- and grey water will be collected separately through vacuum pipes of 50mm (black) and traditional drains and sewers (grey) and transported towards a "raw materials station" (Dutch: grondstoffenstation) (figure 35). Due to the industrial past of the area, a traditional system was already in place to which the grey water stream will be connected. Piping for the grey water stream is overdimensioned, which provides an alternative in case the vacuumsystem fails. If the system does not work, Waternet will take full responsibility for re-installing the traditional system. They have made sure that there is a back-up plan and will also bear the costs for this (Wets, 2017). Kitchen shredders can be placed optionally within the houses, discharging biodegradable waste to the black water stream. Unfortunately, it is prohibited to combine biodegradable waste and wastewater as it entails combining two different environmental compartments (Ververs, 2017). Possibilities for an exception were found in the Cityplot project, although it did cost additional effort and persistance (Ververs, 2017). Another possibility for getting the biodegradable waste to the raw materials station could be separate collection and transportation by e.g. electric trucks (Heppener, 2017; Ververs, 2017).

Black water - Toilet water and biodegradable waste are transported to the raw materials station. From these two waste streams, biogas is produced. The gas is converted into heat and electricity within a CHP plant. There are two potential options for usage: heat might be led back into the district heating system or electricity could be used for e.g. charging electric boats. The raw materials station itself needs electricity to function as well and it is yet unknown how much will be left for these alternative usages. Besides the electricity produced through biogas, the station will be covered with PV cells (Ververs, 2017).

Struvite (phosphate) is a usefull by-product of black water and biodegradable waste streams and can be sold on the market as a sustainable type of fertilizer (Ververs, 2017; Wets, 2017). However, this aspect of nutrient recovery ran into regulatory complications as well. The production (more specifically the selling) of phosphate is prohibited as it is considered to be a waste product. Waternet is already recovering a lot of phosphate in the western area of Amsterdam, and has a relatively large sales market. Most recently, they did an attempt to achieve a legislative amendment which makes it possible to sell the product as fertilizer on the market (Wets, 2017). Although it is currently tolerated, there is no official termination of its waste status.

Grey water - From shower, laundry and dishwasher water, energy (low temperature heat) is recovered. This heat (around 20 degrees celsius) can be stored underground in a thermal storage system (Dutch: Warmte Koude Opslag: WKO). Low temperate heat can only be offered to houses in combination with a floor heating system. The Cityplot development will not make use of this recovered heat from grey water due to the choice of De Alliantie to connect to the district heating system of WPW.

Organisation - The distribution of responsibilities of all these elements is comparable with the traditional sewage system. De Alliantie pays for the collection of wastewater, which is the vacuum toilets and piping untill plot boundaries. Waternet is responsible for the transportation and treatment of wastewater in Amsterdam and therefore pays for the pipes and the raw materials station. Indirectly, financial means of Waternet come from AGV (treatment of wastewater) (Ververs, 2017). Looking at the supply of heating, a role discussion appears. In an optimal decentralised sanitation concept, heating is extracted from grey water and redistributed to the neighbourhood. None of these tasks are conventional for any

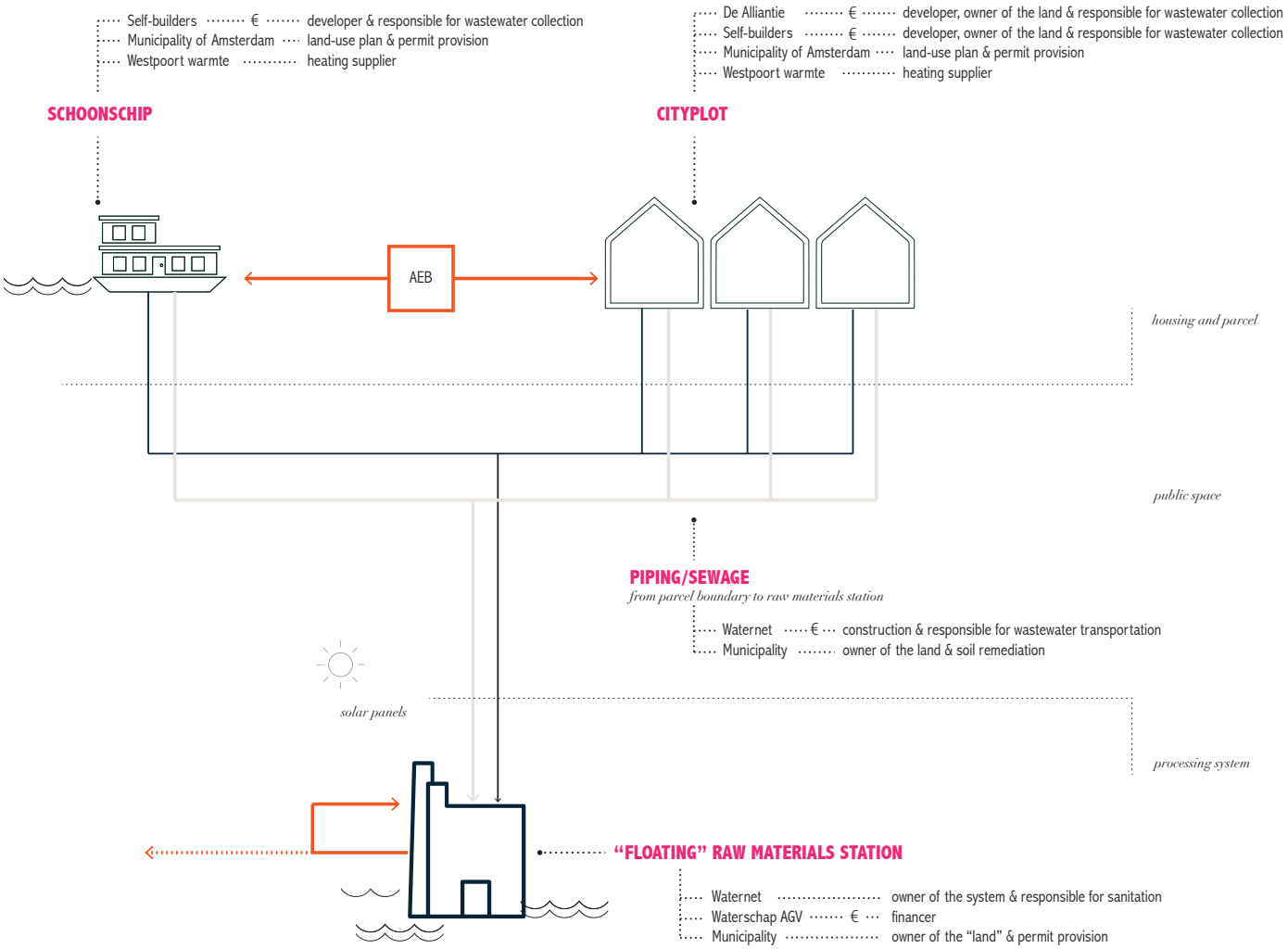


Figure 35 S.I. project and its actors

of the involved actors. Whenever wastewater passes the plot boundary, Waternet becomes the owner. Anything that happens afterwards requires a contractual relationship with a third actor. An option for Waternet is to perform these tasks themselves (Wets, 2017). However, it's neither core business of the MoA nor from Waternet. In order to take over the energy component they would need an assignment from mother companies AGV or the MoA (Wets, 2017). Alternatively, collaborations with a distributor could be entered (e.g. Alliander).

In Cityplot, De Alliantie would also have to be involved as a client base is needed and bills have to be sent. Waternet performs these tasks for drinking water, but not for energy (Wets, 2017). Another possibility is the establishment of an ESCo, a collaboration model in which roles also have to be redetermined (Wets, 2017). Waternet considers taking over the energy component of new sanitation, partly because there's a specific demand for such a company and no to little private actors are willing to invest. This could have to do with the relatively long businesscases related to infrastructural investments. Private actors prefer a shorter businesscase with a maximum payback time of 3-4 years. Investments in pipes and infrastructure are still considered to be a task of the government (Wets, 2017).

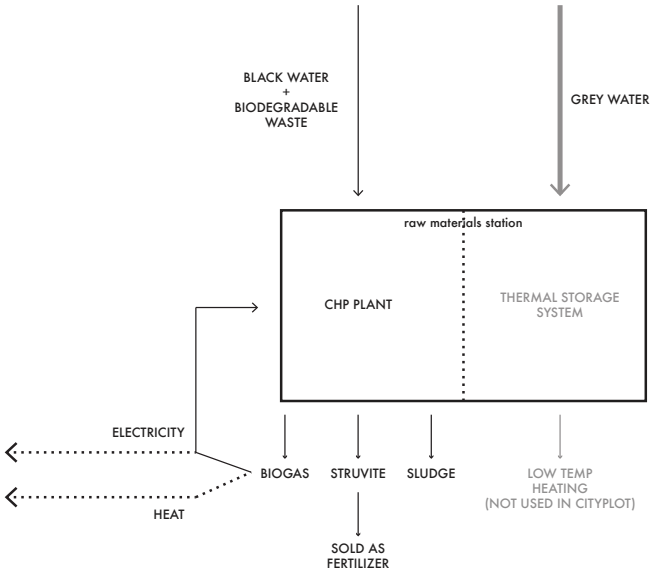
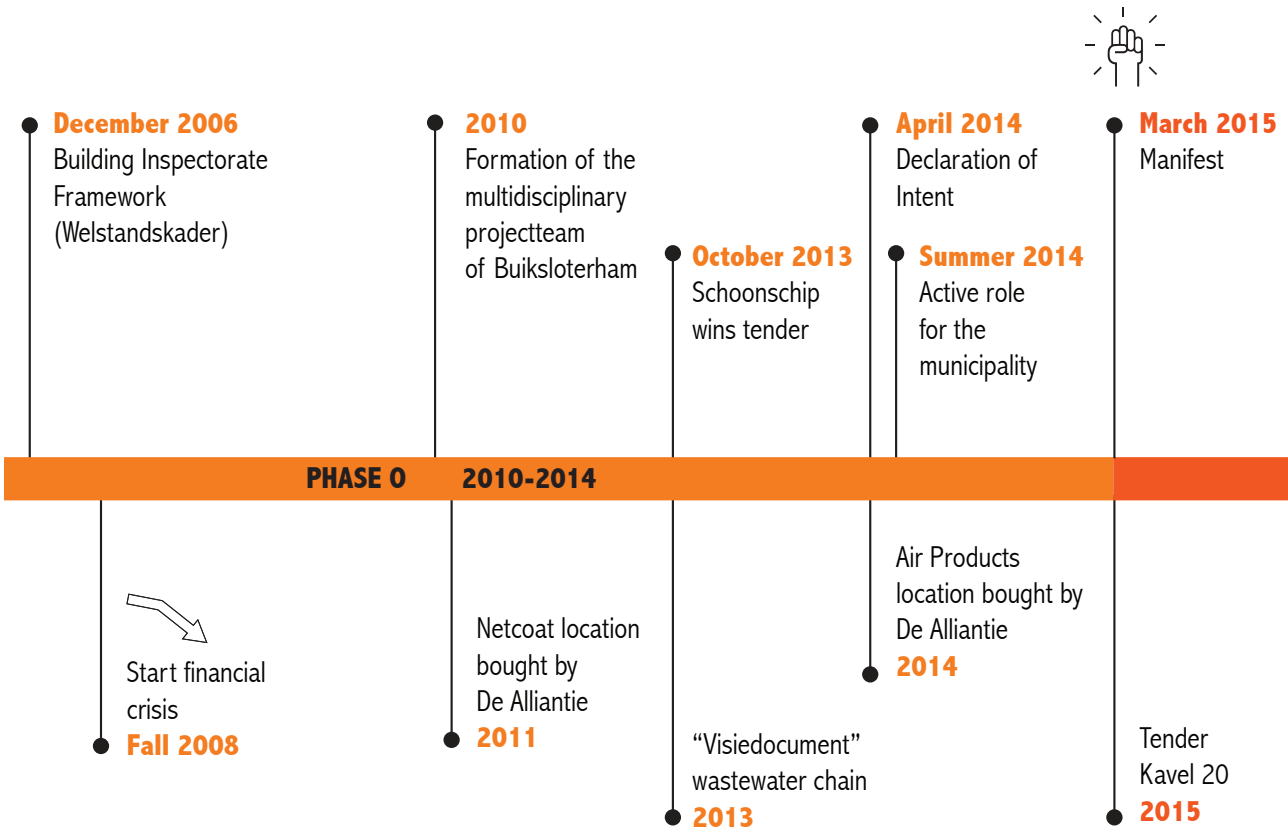


Figure 36 Technicalities of the system



PHASE 0 2010-2014

In 2010, the PMB established a multidisciplinary projectteam responsible for the overall development of BSH. Multiple municipal departments were integrated within this team that was led by projectmanager Els Daems (Daems, 2017). Projectteams such as these are in general responsible for decontaminating the land, the urban plan and ground-level design and eventually putting a building envelope on the market. The MoA can exert influence through "plot passports" (Dutch: kavelpaspoorten) and these building envelopes. For the area of Cityplot, tasks were partly performed by De Alliantie because they are the owner of the property rights on this location. This made Cityplot an extraordinary case. The municipal projectteam could only influence the development through consultation and goodwill of De Alliantie and through the land-use plan and permit provision. It formed an additional challenge to find the right distribution of tasks and responsibilities within this new configuration (Daems, 2017).

As a consequence of this new distribution of tasks, actors ran into some difficulties on the maintanance aspects of the urban plan. The municipality is responsible for the maintenance of the public space after development. Traditionally, the Department of Maintanance is incorporated with the projectteam during the development of an urban plan (Heppener, 2017). Because De Alliantie was responsible for this they were initially not involved, causing a lack of input from the Department of Maintanance during the design phase. Certain ideas related to the Rainproof* concept could therefore not be implemented. All kinds of other practicalities such as too narrow streets were encountered. This might be caused due to miscommunication and late involvement of this department (Heppener, 2017). On the other hand, the Department of Maintanance has a very strict policy (Puccini method) from which they rather not deviate (Hillecamp, 2017; Ververs, 2017). This complicated the implementation of innovative aspects in Cityplot.

*** Rainproof** is a concept that was initiated by Waternet in order to make the city more resistant for heavy rainfall and floods. Besides technically innovative, it is a new way of organising such projects. Actors from different backgrounds are working together from a separate organisation.

Around that same time, the implementation of a decentralised sanitation system in Cityplot was put forward by Waternet (Daems, 2017; Heppener, 2017; Ververs, 2017). New ways of sanitation are mentioned in the municipal sewage plan and in the water management plan of AGV as a focus point (Ververs, 2017). The MoA was mostly unaware of this focus point (Heppener, 2017). Very few people know of its existence, and it has untill now not been included in any of the building envelopes of new developments (Heppener, 2017).

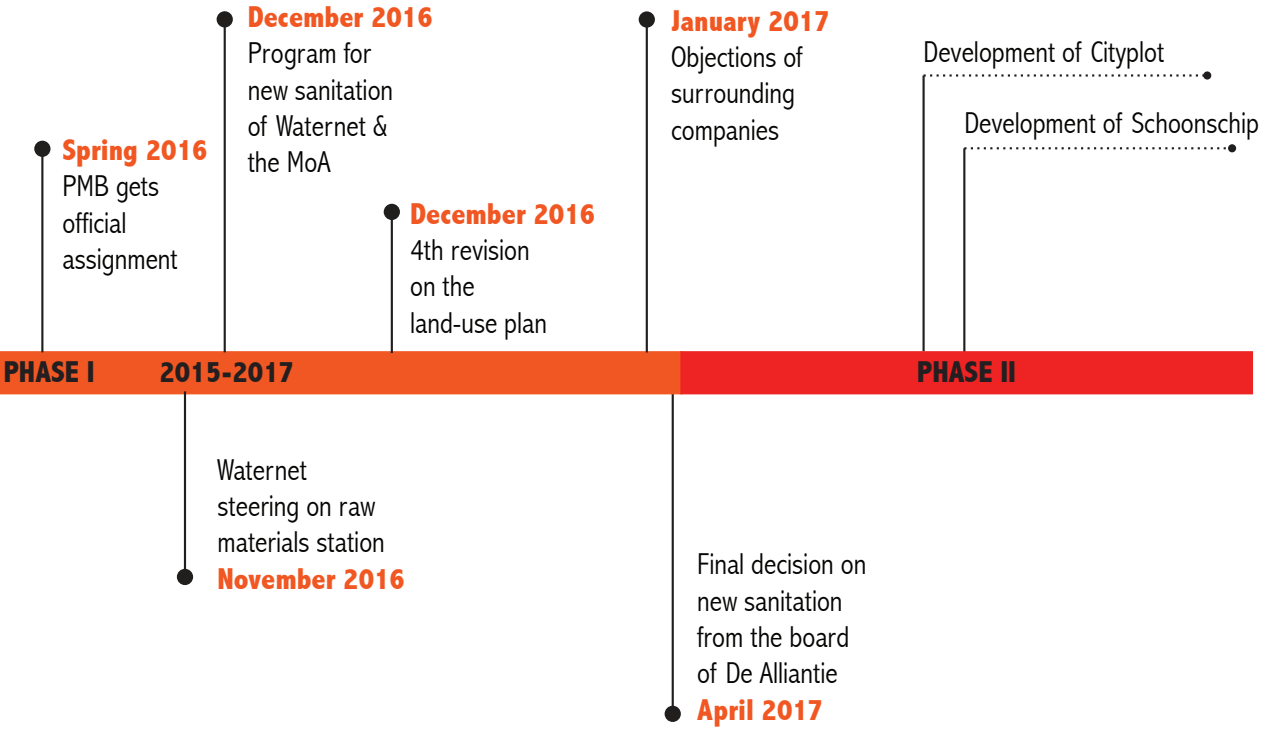


Figure 37 Timeline of the Cityplot development process

Waternet considers the current sewage system partly as a suboptimal system and there exists awareness of new develoments in the area of new sanitation (Ververs, 2017). Furthermore, the organisation has a large replacement task coming up (Ververs, 2017; Wets, 2017): the traditional system has a lifespan of around 50-60 years and most sewage has been installed in the 60s. It is important to make a well-funded choice between replacing the current system in a traditional way or with something else as sewage infrastructure constitutes a long-term decision. In order to make this decision, there is a need for experimenting and gaining experience on a substantial scale (Ververs, 2017; Wets, 2017). The Cityplot development provided a good opportunity to gain new insights and experience that can be used in other projects. Koers 2025* stresses the importance of looking at the opportunities of connecting developments to new ways of sanitation (Wets, 2017). The goal from Waternet of putting new sanitation on the map (within and outside the organisation) and getting it into the planning phase at an early stage is a more recent one. This emerged from earlier problems of being "too late" within the process (Centrumeiland). In collaboration with the departments G&O and R&D, Waternet has developed a thematic study for new ways of sanitation.

De Alliantie has other tasks than being very innovative and progressive in terms of technology (Hillecamp, 2017): developing innovative projects is not its core task. The main goal as an association is to provide sufficient social rent housing. All projects and initiatives are tested against the three policy pillars of availability, affordability and quality (Hillecamp, 2017). It therefore took some additional effort to convince the board to implement a decentralised sanitation system in the Cityplot development (Hillecamp, 2017). However, dwellings should be affordable and quality is indirectly connected to this. Sustainability aspects fall within this third category of quality. A trade-off between the three aspects was made, which eventually resulted in an opportunity for the decentralised sanitation system. Besides small savings on water use, De Alliantie reaps no real benefits from the system (Hillecamp, 2017). New sanitation was a way to fill in the expectations of the manifest (Hillecamp, 2017).

*** Koers 2025** is a policy plan from the MoA to built 50.000 houses in the city of Amsterdam before the year of 2025. In order to make the best decisions for these developments on all aspects, thematic studies are being done in the area of sustainability. New ways of sanitation are a part of this and should be helpfull in implementing the topic into the decisionmaking process at an early stage.

A lot of meetings and the provision of exemplary cases were needed for Waternet to convince the MoA of the project (Ververs, 2017). It was unclear what the concept of new sanitation entailed and how it had to be integrated (Daems, 2017; Heppener, 2017). R&D was initially more

enthusiastic on the topic than G&O (Ververs, 2017). This had to do with differences of tasks and responsibilities between departments (Heppener, 2017).

Benefits from new ways of sanitation can be found in the collection of biodegradable waste. It becomes beneficial for the municipality when this waste is collected separately or through a vacuumsystem, as it forms a significant and heavy (because wet) part of waste in the city of Amsterdam. Whenever biodegradable waste is filtered from the residual waste it could become a feasible business case for the MoA, as savings can be made on regular waste transportation and processing (Heppener, 2017). Unfortunately, the biodegradable waste shredders have been eliminated from the Cityplot development. De Alliantie did not have the financial means for any additional costs compared to the traditional system (Hillecamp, 2017). A European innovation subsidy covers 50% of the total S.I. costs. It covered the additional costs of the system for De Alliantie, and parts of the installation for Waternet (Ververs, 2017). AGV was willing to make an additional investment in the raw materials station.

There were two main problems raised by the MoA (Ververs, 2017):

1 The decentralised sanitation system brought more risks, especially for the (time)planning of the project.
2 The raw materials station had the negative image of a polluting factory.

Opinions between the MoA and Waternet differed due to the unfamiliarity of the concept of decentralised sanitation. All water treatment and sanitation installations were moved outside of the city a few years ago. Decentralised sanitation is based on the idea of bringing them back into urban areas. The image of decentralised sanitation within the MoA entails a polluting factory (Ververs, 2017). This is confirmed by their fear for bad smell and negative personal experiences with treatment plants (Daems, 2017). That image was very difficult to change (Ververs, 2017).

Difficulties in convincing actors about the need for new ways of sanitation might have had to do with the specific theme of wastewater treatment as well (Ververs, 2017). Actors need to be ensured that the system doesn't lead to less comfort, less hygiene or more risks (Ververs, 2017). This is always the case with innovative products, but sanitation and sewage systems seem to be more of a 'taboo topic' and can have a large impact on public health (Ververs, 2017).

The raw materials station would initially be placed within the Cityplot area in order to make inhabitants aware of its existence (Daems, 2017; Wets, 2017). Despite differing opinions, the MoA and Waternet agreed on this location. By the time this was decided the urban plan had already been made. It had already been optimalised and adjusted to agreements with the municipality several times (Hillecamp, 2017). De Alliantie did not want to revise it again. Furthermore, finding a place for a relatively large building is difficult and expensive within the inner-city of Amsterdam (Hillecamp, 2017). There existed unclearity about the environmental outlines of the station, taking up even more (scarce) space. Also, placing the raw materials station within the neighbourhood would cause certain risks (smell, incovenience) for future inhabitants (Daems, 2017).

Another location for the raw materials station had to be found. This resulted in a tense situation, as the station now had to be placed on property of the MoA (Daems, 2017). Because a clear plan of approach that stated the environmental outlines was lacking, it was unclear what the consequences of such a station would

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be (Heppener, 2017). In general, there existed a lot of uncertainties as integrating infrastructures of sanitation and energy is a very new and innovative concept. This lack of information caused uncertainties that were especially a problem for the PMB, as their goal and responsibility is to mitigate risks. Waternet proposed several locations and the municipality eventually decided on implementing a 'floating' station in the Johan van Hasselt channel (figure 36). It is considered not to be the best option and the MoA feels like they should have paid better attention and set stricter requirements for De Alliantie regarding this aspect (Daems, 2017).

There were some other CPO projects in BSH that were interested in connecting to the decentralised sanitation system, among others Kavel 20. This idea to connect other developments came forth from a consultation between CPO's and Waternet. Problems arose when this was not communicated correctly with the municipal department of Land and Development (G&O). They had already performed a tender procedure in October 2015 for these CPO projects (Gemeente Amsterdam, 2015). Aspects such as a decentralised sanitation system could not be added to these developments (Daems, 2017). It was legally impossible to add important aspects when a tender has been performed. This limited the scale of the S.I. project.

In the run-up to the Manifest, a declaration of intent was signed on the 15th of April 2014 by involved actors, stating the ambition to make BSH a 'living lab' : an innovative urban laboratory for small scale pioneering concepts in a partnership that takes responsibility for the whole area (Cityplot Buiksloterham, 2014).

Figure 38 Map of the northern part of Amsterdam (beeldbank.amsterdam.nl)

The manifest 'Circulair Buiksloterham' was signed in 2015, resulting from the declaration of intent. It was an initiative from Waternet and De Alliantie and supported by specific persons that valued sustainability within their own organisation (Daems, 2017). The MoA initially played a small role in this. Due to the crisis, they were not allowed to participate in projects that didn't lead to direct revenues and the manifest was not considered to be profitable in that sense (Daems, 2017). This resulted in unspecific goals with the new sanitation project and an awaiting role at the start of the Cityplot development. The expectations of the manifest were initially higher than untill now has been realised (Hillecamp, 2017). Signers of the manifest had hoped for a more collaborative attitude from all actors during innovative developments in general (Heppener, 2017; Hillecamp, 2017; Ververs, 2017). At the start, the manifest was a driver for all actors to collaborate and come up with innovative ideas. Initiatives were expected from other actors after signing, which resulted in awaiting roles from all sides. This caused dissatisfaction for everybody (Ververs, 2017).

In 2016 the PMB got commissioned by the City Council of Amsterdam to turn Cityplot and the decentralised sanitation system into a success. From the moment that the department of G&O got this specific assignment to actively develop BSH, the balance between actors had to be reconsidered. This was not easy as the initiative had come from bottom-up parties over the years, while the MoA considers urban development as one of their core responsibilities. Concerns existed about actors being 'in the way' as roles were not clear from the start (Daems, 2017).

The assignment from the City Council stated that BSH would only be perceived as a 'living lab' untill certain heights. The development of Cityplot and the decentralised sanitation system had to be balanced according to this task. This resulted in other actors (especially Waternet) having to adjust their expectations. G&O wanted to deliver a high quality neighbourhood for which they had a clear planning and deadline. In order to achieve this, risks needed to be managed and mitigated (Daems, 2017; Ververs, 2017). Innovations such as required for the decentralised sanitation system always introduce process-based risks (Ververs, 2017). These risks did not stroke with the G&O approach. The MoA facilitated the new sanitation project as long as it didn't hamper regular development (Daems, 2017). When Waternet failed to deliver a plan of approach within time they had to intervene (Daems, 2017). It was a field with different influences, also within the organisation of the MoA (Daems, 2017).

Although the MoA signed the manifest too, diverging ideas about the development of BSH emerged at the time they got this assignment. Different 'languages' between organisations became an issue: a process- versus a project oriented language. The people working on the project from Waternet were mostly process oriented, which is about creating support and developing step by step. The department of G&O and the PMB took a project approach (Daems, 2017), which entailed a concrete and systematic process. These differences caused tensions between the organisation of Waternet and the municipal departments (Daems, 2017). The process oriented approach of Waternet was related to the perception of BSH as a living lab. While Waternet approached the Cityplot development very much from this perspective, the MoA did not see it as such (Ververs, 2017). G&O had a task of developing the entire urban area of Buiksloterham, dealing with an overall land-use plan.

A list of agreements was made between actors that stated the ways of communication; e.g. regular meetings to coordinate (Wets, 2017). This was not a formal contract. An example is the temporariness of the location of the raw

materials station, and that it should be evaluated within a certain time. Proposals and decisions about the location of the station were first an informal process of mutual consultations, but were eventually recorded in contracts and letters.

Decentralised sanitation is optimally integrated with the energetic infrastructure: using residual heat from grey water to heat houses with a low temperature heating system. BSH and the Northern part of Amsterdam have a district heating concession from Westpoort Warmte. This concession made that optimal solution for decentralised sanitation difficult (Wets, 2017). Nevertheless, there are possibilities for exceptions when developments implement similar or more sustainable solutions for heating (Daems, 2017; Heppener, 2017). De Alliantie had the possibility to request an exception on the district heating concession. They performed a lot of research for connecting a heat or cold storage (Dutch: WKO) in combination with the sanitation system. Comparing the investment, management costs, management of the installations, and especially the reliability of the installations, it was a (financially) unfeasible option (Hillecamp, 2017). De Alliantie therefore chose to connect to the district heating system of WPW. Meetings were set up regularly between organisations in order to discuss, compare and improve costs and calculations (Hillecamp, 2017). This helped making the project feasible, as decisions were eventually always made on the basis of finances (Hillecamp, 2017).

From a purely financial perspective, the businesscase for decentralised sanitation in BSH is negative (Wets, 2017). In order to get a financially feasible businesscase for new sanitation, heat from grey water needs to be recovered and reused. Whenever this thermic heat is extracted it can be stored and delivered to the neighbourhood, for which a rate can be charged. This means that investments flow back. A scale of at least 1000-1200 houses is required for this (Wets, 2017). The amount of energy production from biogas and the recovery of phosphate of the current scale is non-sufficient for making a businesscase in Cityplot (Heppener, 2017).

Future inhabitants

Besides 350 rental units, Cityplot consists of private property and plots for self-builders. Neither Waternet nor the MoA has legal authority to impose the decentralised sanitation system on inhabitants. Potential future inhabitants were recently informed by De Alliantie about the decentralised sanitation system (Hillecamp, 2017). Whenever buyers are known, Waternet and De Alliantie are planning a course of action and will have to work together on the education of future inhabitants (Hillecamp, 2017). This is especially relevant for the vacuum toilets and sewage.

The new system will require some adjustments of behaviour. First of all the perception of a vacuum toilet, but secondly the cleaning products that people use and stuff they throw in. This is also related to the target group; it is expected that social renters are more difficult to reach than motivated self-builders from e.g. Schoonschip (Wets, 2017). On the other hand, self-builders are probably more specific on their wishes (Van Nassou, 2017). They will determine what their house looks like, how it is designed and therefore might also be more demanding about the interior of their bathroom. Vacuum toilets don't come in a lot of different designs and form a certain restriction. For social rent dwellings, the housing association decides on the design and the sanitary. Because De Alliantie stays owner of the rental units, and therefore play an important role in the implementation of the system.

Future inhabitants did not participate or have a say in the project. There have been 'tables' on several aspects of the development in general (energy-table, water-table, mobility-table) where different actors from different backgrounds were involved, also current and future inhabitants of BSH. At these tables actors had the opportunity to pitch ideas and bring in their expertise.

The individual plots and self-builders also have to connect to the new sanitation system. De Alliantie and Waternet are trying to incorporate this obligation into the sale contracts (Wets, 2017). While public parties such as the MoA are bound to the Building Order (Dutch: bouwbesluit) when making the requirements for issueing land, private parties are not. The Building Order sets the minimum requirements for housing regarding multiple aspects. Public parties cannot require more than these requirements from developers. The fact that the development of Cityplot falls under the Crisis and Recovery law is an advantage when additional sustainability measures are desirable. Public parties are allowed to issue better performance from developers for projects that fall under this law. The condition of connecting to the decentralised sanitation system within contracts is considered as a very important part of the process (Wets, 2017). If people are able to decide for themselves whether to connect or not, the whole system will be affected.

Third parties

Technical suppliers of the system have not been involved during the process. Although a developer of vacuum toilets (Quavak) thinks along with how the system should be developed, this is only on the basis of an assignment (Ververs, 2017). During the design- and construction phase they are invited to think along about e.g. certain

optimalisations such as entering biodegradable waste on a local spot within the neighbourhood instead of using shredders. However, this forms part of their product-design and is only interesting for them during the execution phase of the development.

The eventual decision of suppliers of the toilets, pipes and system will be done through a European tender procedure, performed by Waternet. Definite suppliers are therefore yet unknown.

Since last year, a multidisciplinary team is working on the New Sanitation Program, which enhances support within the organisation and was commissioned by the direction of Waternet (Wets, 2017). This should result in putting new sanitation on the map at Waternet and the MoA, but also provides possibilities for gaining experience on the short-term (Wets, 2017). New sanitation untill now has focussed on incidental cases.

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When Cityplot is finished (figure 39), Waternet and De Alliantie will enter a maintanance and exploitation agreement. This agreement is currently in the making, and states that Waternet is responsible for the maintanance and exploitation of the sanitation system in the public space, while De Alliantie is responsible for the collection of wastewater within the houses and transportation untill parcel boundaries. The responsibilities of De Alliantie rely on ownership (social housing and free sector rent).

Because there are some market plots and self-builders involved in this project, formal agreements have to be made about maintanance of the system within dwellings. Maintanance for the in-house system will be recorded in these contracts, combined with certain rules of behaviour. Besides using certain products for cleaning and not throwing any solid substances in the toilet, a specific contractor will be assigned to maintain the system. Users will be restricted to this contractor, who is specialised in the specifics of a vacuum system (Wets, 2017). This same contractor will be used by De Alliantie for social rental houses (Wets, 2017).

Both the MoA and Waternet stress the difference between greenfield and brownfield locations when implementing new ways of sanitation (Daems, 2017; Ververs, 2017; Wets, 2017). The municipal sewage plan (made by Waternet) states that greenfield locations will in general be connected to new sanitation systems while brownfield developments (of non-substantial scale) will not. This has to do with the new infrastructure that is needed, which cannot be connected to the traditional infrastructural system; when you do, all benefits of separate collection are lost. Vacuumpipes can not be included in the old sewage system. Furthermore, new ways of sanitation are often related to decentralisation. Decentralised sanitation entails treating wastewater on a local scale. The possibilities for local wastewater treatment for inner-city developments are small, as space is scarce and land prices are high which results in a less feasible businesscase and groundexploitation (Dutch: grondexploitatie or GREX) (Wets, 2017).

Figure 39 Cityplot (source: Delva Landscape Architects)

II WATERSCHOON NOORDERHOEK, SNEEK

The second case that was studied for this research is the Waterschoon project in Noorderhoek. The idea of implementing a decentralised sanitation system in this neighbourhood arose from an earlier performed pilot project. The restructuring task for Noorderhoek provided the perfect opportunity to implement the Waterschoon system on a larger scale.

Figure 40 Map of the Netherlands: Sneek

NOORDERHOEK - URBAN AREA DEVELOPMENT

Noorderhoek is a residential area in Sneek, the second biggest city of the Dutch northern province of Friesland. The development was part of a restructuring task, where 282 dwellings from the 50s were demolished and 200 houses rebuilt during a period of 8 years (2008-2016). Just as the previous case of BSH, the financial crisis in 2008 had its influence on the development of Noorderhoek. The area was developed in two different phases because less houses than planned could initially be rebuilt. The first phase was realised between 2008 and 2011. It comprised an appartment building of 62 dwellings, housing 79 elderly people. In the second phase, realised between 2015 and 2016, an additional 170 regular houses were constructed (Waterschoon, n.d.). Both phases were developed by housingcorporation De Wieren and Elkien and consist entirely of social housing.

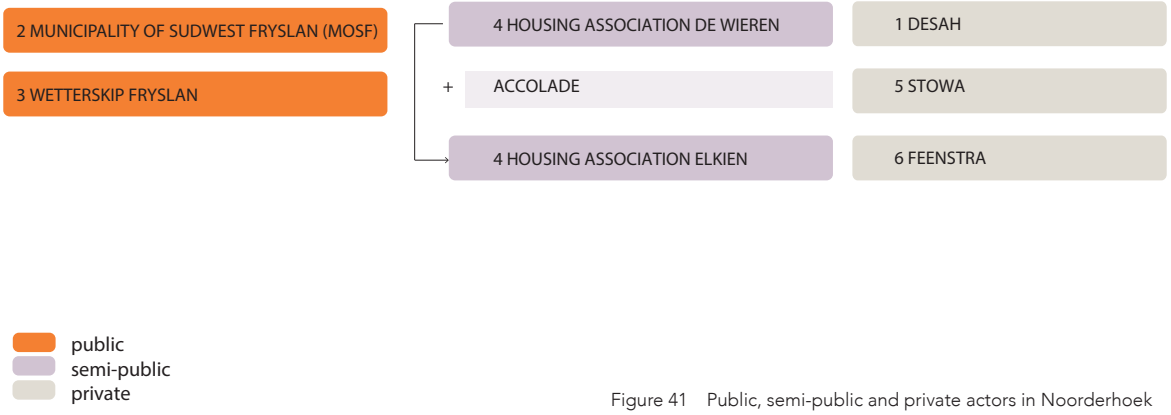

Figure 41 Public, semi-public and private actors in Noorderhoek

The main actors of the Waterschoon project in Noorderhoek are DeSaH, the Municipality of Súdwest-Fryslân, Wetterskip Fryslân and housing corporation De Wieren/Elkien (Waterschoon, n.d.). There were, however, some additional important actors involved. The STOWA, a knowledge institute for regional water management, performs research into the system. Another important actor is Feenstra, who was contracted by Elkien to develop the heating system. Both STOWA and Feenstra were not involved during the development process but after the Waterschoon system had been implemented.

1 **DeSaH** designed the Waterschoon system for the Noorderhoek development. They specialize in innovative solutions within the waterchain, taking care of feasibility studies, design, supply, construction, maintanance and management of installations, with a specific focus on decentralised sanitation systems for the treatment of wastewater and biodegradable waste (DeSah, n.d.). They are a private actor with a commercial interest in the project.

2 **The Municipality of Súdwest-Fryslân (MoSF)** is located in the region of the south-western part of the province of Friesland. It contains 82.284 inhabitants and has a surface of 841 km2, of which almost half consists of water (380 km2). The organisation of the MoSF comprises 31 teams and the registry (Gemeente Sudwest-Fryslan, n.d.). The Municipality of Sneek merged with 4 other municipalities into the Municipality of Súdwest-Fryslân in 2011.

The MoSF was partly the initiator of the Waterschoon project. Besides investing money and knowledge, it provided the opportunity to make exceptions on rules and regulations and granting the permits (Van Scheltinga, 2017). This gave a powerfull position within the project. Municipalities are traditionally responsible for the sewage system until parcel boundaries and therefore provided substantial technical input on this part (Van Scheltinga, 2017).

The two main departments that were involved during the Waterschoon project were:

- **Realisation and Development** is the department within the municipality taking care of project development. This department was involved during the entire design and development phase.

- **Public Works** took over the maintanance part of the vacuumsystem after development. They were also involved during design and development of the system.

3 **Wetterskip Fryslân** is the district water control board of the province of Friesland. Just as AGV in Buiksloterham, they take care of the quality of the dikes and are responsible for the quantitative and qualitative management of the surface water within their province.

The organisation is subdivided in 14 clusters with 24 teams, a management board and a works council (Wetterskip Fryslan, n.d.).

Responsibilities for water sanitation traditionally lie with the Wetterskip. In the Waterschoon project they've outsourced this task to DeSaH. DeSaH was responsible for the installation, maintanance and partly for the performed research. Wetterskip invested €300.000 from innovation-money and provided knowledge on water treatment processes (Gerbens, 2017).

4 **De Wieren** used to be a small housing corporation but merged with the bigger corporation **Elkien** in January 2015. Elkien currently owns around 20.000 rental houses in Friesland, spread accross eight different municipalities (Elkien, n.d.). The first phase of Noorderhoek was developed by De Wieren and the second phase by Elkien. De Wieren was the owner of the existing housing stock in Noorderhoek and was planning on restructuring the neighbourhood. They provided the land and made a financial investment. De Wieren financed the development of the houses and the Waterschoon system untill parcel boundaries (Meulman, 2017; STOWA, 2014), partly themselves and partly from a joint wallet. Elkien is currently also the owner of the entire heating network.

5 **STOWA** is a knowledge centre for regional water management in the Netherlands. They develop, gather and distribute knowledge in order for water managers to complete their duties (STOWA, n.d.). They work on a demand-oriented basis, with the initiative often coming from district water control boards. For the Waterschoon system STOWA performed an independent research by sampling and monitoring in order to form a basis for an extensive evaluation of the concept (STOWA, 2014).

6 **Feenstra** is the heating company that developed the district heating system for Noorderhoek. They were commissioned by Elkien during the construction phase.

All newly built houses in Noorderhoek are connected to the Waterschoon system, which was designed in 2008 for around 500 users (STOWA, 2014). Waterschoon is a decentralised sanitation system, where wastewater and biodegradable waste is treated and energy and nutrients are recovered. The two infrastructures of wastewater and energy are thereby integrated.

All installations are located within the neighboorhood, in a 'NUTS' building that has the size of a single family home (figure 42 & 43). Due to the large windows, the sanitation process becomes visible for the inhabitants of the neighbourhood, while signs on the outside provide additional information.
The fact that Noorderhoek was a restructuring project was one of the main conditions to implement this system, as it offered the opportunity to start from scratch with toilets and piping within the houses (Meulman, 2017). Because Noorderhoek is an inner-city area, the system and the amount of connections were bound to the scale of the development. Furthermore, land prices determined the type of sanitation system that was chosen (Meulman, 2017). The NUTS building was considered to take up a relatively small amount of space compared to e.g. constructed wetlands (Dutch: helofytenfilters).

The Waterschoon system and its installations were developed during the first phase of the Noorderhoek development. There existed an underload because the area was developed in two phases due to the crisis and the system was initially designed to treat the wastewater of 500 households. However, actors agreed that there was no option of backing out (Gerbens, 2017). Part of the research that STOWA performed was done with only 62 connected households. The aspect that suffered most from this underload was the process of phosphate recovery (Gerbens, 2017). However, an advantage of the two phases was that research performed in the first phase can now be tested. Extrapolations were performed in the first phase for 200 houses. Because there are currently 232 dwellings connected, these tests can now be verified (Gerbens, 2017).

Waterschoon works similarly to the decentralised sanitation system of Buiksloterham. This is no coincidence as Cityplot has made use of Sneek as an example to design their own system.

Biodegradable waste and black water is first collected through a vacuumsystem to keep the wastewater stream as concentrated as possible (Meulman, 2017). Grey water is collected separately through the regular sewage system (Meulman, 2017). Black- and grey water streams are treated in a NUTS-building and subsequently discharged to the traditional sewage system (Kloet, 2017). The initial idea was to discharge purified water on the surface water, but this was impossible due to prohibiting regulations (Kloet, 2017). Black water and biodegradable waste streams are converted into biogas, resulting in energy for heating and hot water. From grey water, low temperature heat is recovered and used as heating for housing (figure 44). Due to the experimental character, the system and its wastewater streams are also connected to the regular sewage system, in case discharge requirements can not be met (Gerbens, 2017; STOWA, 2014).

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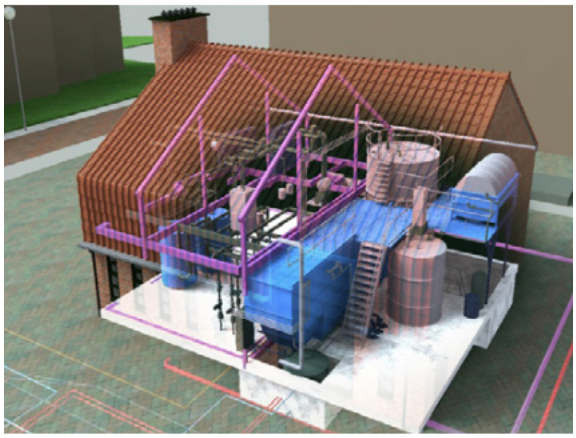

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Figure 42 NUTS building in Noorderhoek (source: stowa.nl)
Figure 43 NUTS building (source: groenblauwenetwerken.com)

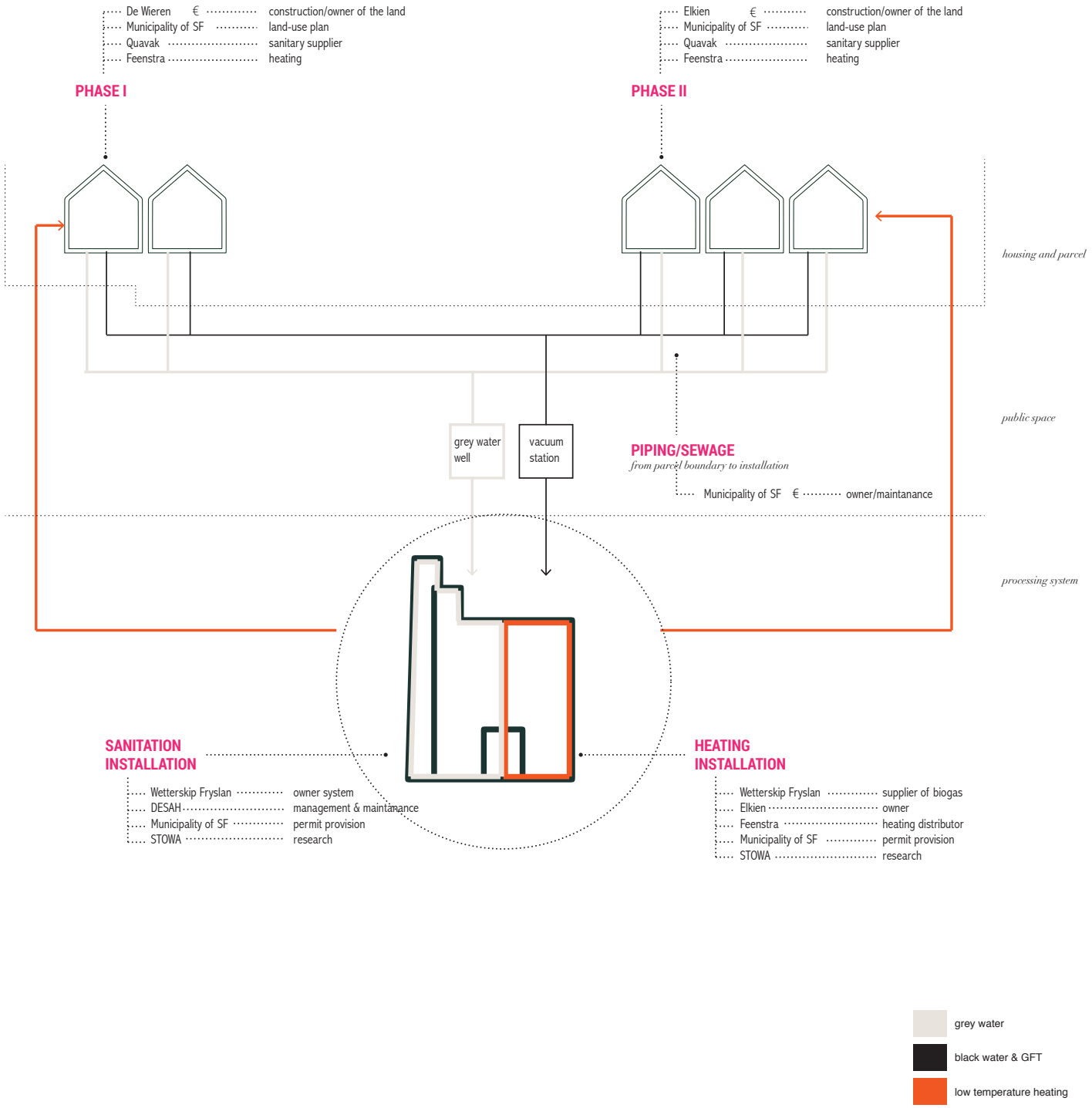
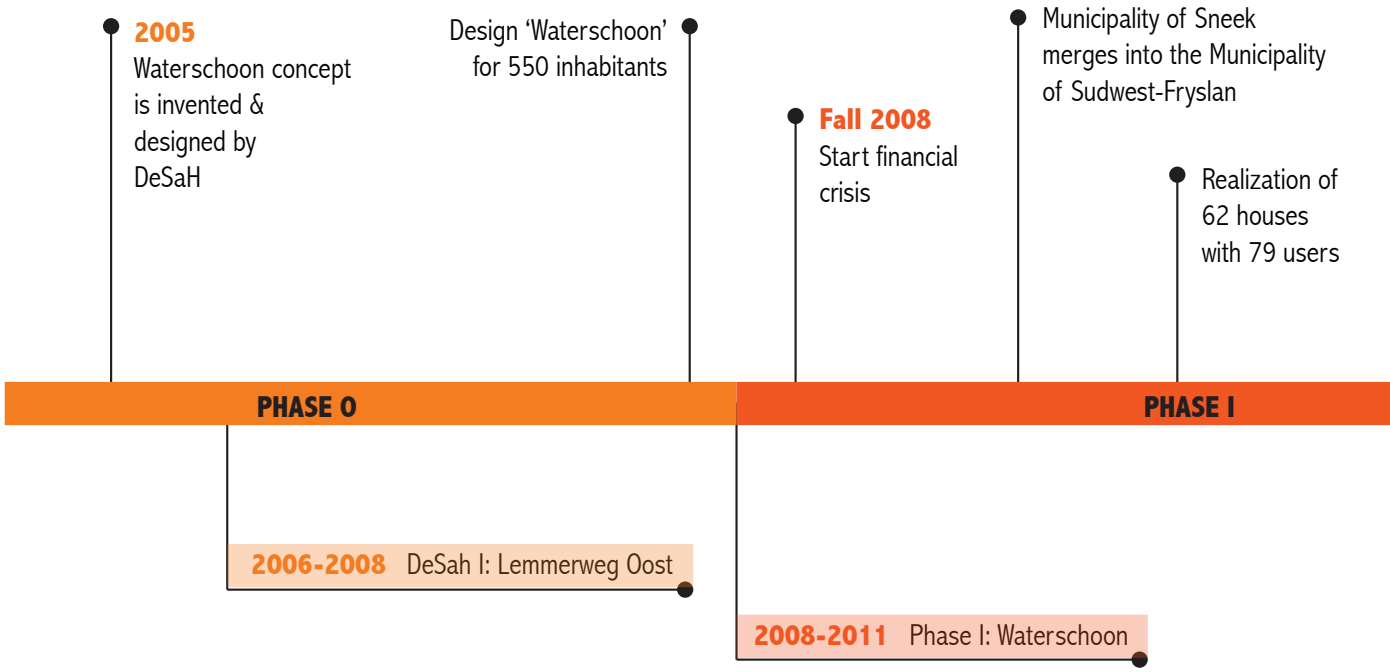


Figure 44 SI project and its actors



PHASE 0 2005 - 2008

There were two main elements that stimulated the implementation of a decentralised sanitation system in Noorderhoek. First, the provincial capital of Friesland (Leeuwarden) hosts the Water Campus and is regarded by many corporates and start-ups as the European Water Technology Hub (Startup Delta, n.d.). Sneek, the second biggest city of Friesland, wants to accommodate innovation and entrepreneurship by providing space for water-related experiments (Meulman, 2017). Secondly, the Waterschoon project emerged from an earlier project at the Lemmerweg Oost in Sneek: DeSah 1. This pilot project of 32 houses was developed between 2006 and 2008. It was the result of a collaboration between the Municipality of Súdwest-Fryslân, DeSaH and housingcorporations De Wieren and Accolade. Because it was successfull on a small scale, stakeholders decided to integrate the system in Noorderhoek (Kloet, 2017; "Nieuwe sanitatie in Sneek," n.d.; Van Scheltinga, 2017). The MoSF played an important role in connecting the different actors from the pilot project (Van Scheltinga, 2017). This resulted in an easier connection between the actors of Noorderhoek, as they already knew each other (Van Scheltinga, 2017).
This pilot project in combination with the ambition of becoming a watertechnology hub resulted in combining the Waterschoon concept with the Noorderhoek development.

DeSaH had been researching and promoting the Waterschoon concept since 2005, with the eventual goal of commercialisation (Meulman, 2017). Although the concept is not dependent on any location, the Noorderhoek area brought a specific advantage. It was the perfect opportunity for DeSaH to scale-up the pilot project and show the functionality of the system at a more demonstrative scale to potential buyers (Meulman, 2017). The main goal for DeSaH was to sell their product (decentralised sanitation systems). Noorderhoek provided the additional advantage of demonstration, as it is close to their headquarters in Sneek. The main reason to invest in this project was based on their commercial interest as a private actor.

Implementing the Waterschoon concept in Noorderhoek was initially an idea of housing association De Wieren and the MoSF (Meulman, 2017; Van Scheltinga, 2017). With Leeuwarden functioning as a watertechnology hub, the MoSF wanted to facilitate these (small) businesses by providing space for research demonstrations and start-ups (Meulman, 2017; Van Scheltinga, 2017). They wanted to become a 'living lab' for watertechnology (Van Scheltinga, 2017). There existed a very clear goal with new ways of sanitation: providing a space for watertechnology related companies and attracting higher educated people. This caused the internal organisation to be quickly convinced (Van Scheltinga, 2017).

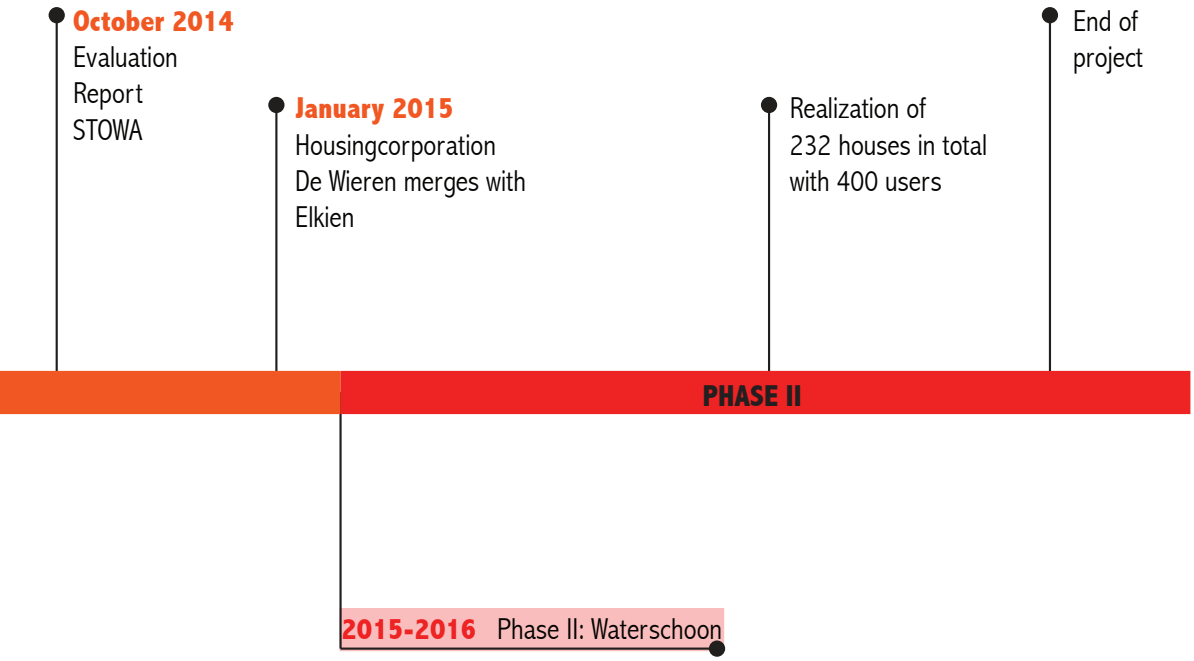


Figure 45 Timeline of the Noorderhoek development process

De Wieren's main motivation for engaging in the project was to develop Noorderhoek in a sustainable way and to provide opportunities for innovation (Kloet, 2017). There existed awareness within the organisation that sewage- and heating systems represent long term decisions. The board from the corporation felt the need to start experimenting with new and more sustainable ways for these systems and infrastructure, before making any new long term commitments (Kloet, 2017).

Similarly, the Wetterskip's motivation was also to kickstart innovation (Gerbens, 2017). Results of the research would lead to knowledge production for all waterboards regarding new ways of sanitation and help answer the question whether it is a good alternative for the tradtitional sewage system. The urgency for this knowledge production came forth from questions that were asked by several municipalities (Gerbens, 2017). In order to make a well-funded choice between ways of sanitation, it was important to gain experience.

The board of the Wetterskip needed some convincing before getting engaged with the Waterschoon concept. The main concerns were related to the innovation budget: it was untill then unclear what projects would qualify and what criteria were applicable to make use of this budget (Gerbens, 2017). An innovation note was made within the organisation that determined a robust course. At that time, Sybren Gerbens (Wetterskip) introduced the Waterschoon project, which was immediately conceived as a great opportunity. There was a lot of confidence in this project and eventually few persuasiveness was needed to convince the board of Wetterskip (Gerbens, 2017). Because some specific people were motivated and really believed in the project, they succeeded in getting everybody enthousiastic (Gerbens, 2017).

PHASE I 2008 - 2015

After the internal boards were convinced, a projectgroup and steeringgroup were set up. All actors were represented in both groups and equal in hierarchie with everyone having one vote in the steeringgroup (figure 46). Depending on the position within one's own organisation, one could be within the steering- or projectgroup or in both. Unanimous decisions were necessary for big decisions such as termination of the project, while most actions could be executed with a majority of votes (Meulman, 2017).
It proved to be important whom from which organisation was the respresentative within which group. This had to do with the internal structure of each actors' organisation (Gerbens, 2017; Kloet, 2017). Some representatives had more authority for decision-making than others. Consequently, the length of time of the decision-making processes differed. The process was influenced by the

composition of actors in the steering- and projectgroup.

During the first phase, Brendo Meulman (DeSaH) was assigned as the projectmanager of the Noorderhoek development. DeSaH coordinated the different roles and connected all aspects into one system (Gerbens, 2017). This didn't mean anything for the hierarchie or amount of influence from DeSaH, it did not make them more powerfull. Because DeSaH also had a commercial interest in the project, it was important to act independently during the process. This required working in a very transparant way (Meulman, 2017).

A collaboration model was set up which entailed a formal contract; an implementation agreement that was signed by all actors. Although everybody tried to work together as informal as possible (Meulman, 2017), the contract was considered to be crucial (Gerbens, 2017). It entails a very extensive document on which actors fell back quite often during the process. A lot of time and effort was put into developing this contract beforehand, as it required a lot of consultation to come to a mutual agreement (Gerbens, 2017). Nevertheless, the importance of such an extensive and detailed contract was emphasized (Gerbens, 2017; Meulman, 2017).

Another contractual relationship was the budget plan, which stated the items, whom bears what costs and gains what benefits and who has a say in what. This prevented al lot of discussion during the process (Gerbens, 2017; Meulman, 2017). The budget plan was guaranteed through the previously discussed implementation agreement. Because urban developments are often long-term trajectories and compositions of organisations change, it proved to be especially important to have a formal agreement (Gerbens, 2017; Meulman, 2017). An example is the merger between housingassociations De Wieren and Elkien in 2015. The arrangements about hierarchie and the division of responsibilities proved to be very helpfull during this period of change within the organisation of the corporation (Meulman, 2017).

A partnership with a joint wallet was established. Each actor, or sometimes multiple actors, could make expenses from certain compartments. This distribution was made in order to keep the process organised and clear (Meulman, 2017). Financial contributions are relatively similar to a traditional distribution. The MoSF financed the sewage system in the public domain. DeSaH maintains and manages the installations, which are partly financed by the Wetterskip. Both Elkien and the MoSF have outsourced their tasks to third parties. However, the financial streams are provided by them. Everyone ran a certain risk and whenever the project would fail all actors would be affected.

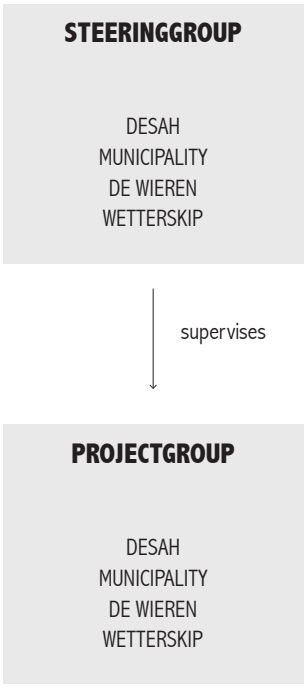


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Figure 46 Configuration of the project- and steeringgroup

An independent financial advisor was hired during the project. This advisor mainly focussed on the financial aspects, as this was also where most difficulties were found. Most hassle was experienced when additional costs had to be made, which again costed a lot of time (Gerbens, 2017). This independent advisor was considered to be very helpfull during (financial) disagreements.

The fact that the sewage system had a replacement task and that the vacuum piping didn't result in a lot of extra costs had a positive effect on the financial feasibility. Actors further made use of subsidies to finance the project: SNN (EU and the EFRO program) and UKR (a subsidy program from the central government). The consultant of the SNN subsidy changed a few times which made it more difficult and time consuming. A change of people working on such a project always requires additional time and explanations, which sometimes resulted in frustrations (Meulman, 2017).

Difficulties of collaboration were found in the details. Whenever a problem with the system occured, it had to be clear who was responsible. The inhabitants e.g. suffered from a couple of failures with the vacuum system. This needed to get fixed quickly, otherwise the system would lose support from the inhabitants. It is important to be clear on every level from the very beginning where responsibilities lie. In the case of the disturbance with the vacuum system it was also important to know its cause. It costed a lot of time to get together every time in order to discuss what went well and what went wrong after such events. Each of these gatherings were recorded in reports (Gerbens, 2017).

Because the MoSF was one of the initiators, they acted in a very cooperative manner and exceptions could be made more easily (Meulman, 2017). An example are the biodegradable waste shredders; it is officially prohibited to discharge food waste on the sewage system (Meulman, 2017; Van Scheltinga, 2017). The MoSF made an exception by providing an environmental permit.

"There are a lot of rules, but even more exceptions on these rules exist" (Meulman, 2017).

Possibilities for exceptions had a lot to do with the people that were involved. Waterschoon was co-initiatiated by the MoSF, which resulted in motivated civil servants (Meulman, 2017; Van Scheltinga, 2017).

The users of the decentralised sanitation system in Noorderhoek from the first phase are elderly of a small scale residential care facility (figure 47).

PHASE II 2015 - 2016

The second phase of Noorderhoek's development started in 2015 and was completed in 2016. Besides developing an additional amount of houses, some adjustments to the system were made. The second phase particularly resulted in an additional amount of connections for the system, and was technically uncomplicated (Kloet, 2017).

Housing association Elkien encountered some trouble with the heating network. This was especially regarding the biogas (black water) due to a kettel that wasn't functioning well (Gerbens, 2017). The recovery of heat from the grey water caused less trouble. Elkien hired Feenstra to take care of the energysystem after the project was developed. This was their responsibility, and other actors were not involved during the selection process. The energysystem was not a primary goal in the project (Gerbens, 2017) as it wasn't a crucial part of the Waterschoon concept. However, it will become a very important aspect when the system is implemented on a larger scale (Gerbens, 2017).

Some actors argue that engaging other actors in the process can be easily done afterwards while others might have preferred them more at the front of the process. The advantage of involving third parties beforehand is that they are more engaged, running similar risks and are therefore more motivated to make the system work as efficient as possible.

Inhabitants were not involved during the development in Noorderhoek. Although no big changes of behaviour are necessary for the system to function, there are some differences with the traditional system. Vacuum toilets make a specific noise, and waste shredders are a new way of dealing with waste. Furthermore, disposing additional water in the toilet should be prevented (Meulman, 2017). Some of the first inhabitants of the restructured neighbourhood (the care facility for elderly) indicate that there were some problems with the new apartments. There were issues with the floor heating and the ventilation system. Nevertheless, first impressions of the new sanitation system were very positive as it enables users to go back from 75 m2 to 50 m2 of water usage a year (Hondebrink, Lebbink, van Nassou, & Smeenge, 2017; STOWA, 2014).

There seemed to be a disallignment about the satisfaction of the system between professionals and users. Research indicates that inhabitants experience inconvenience due to the noise of the vacuum toilets (STOWA, 2014). Furthermore, elderly from the care facility are not fond of using the waste shredders as some problems did occur earlier (Hondebrink et al., 2017). However, they were the first group of people using them (phase I) and shredders have been adjusted and finetuned for phase II. Attention was paid to the complaints of the first inhabitants (Hondebrink et al., 2017). One of the problems that remains is the smell of the installation when temperatures rise (Hondebrink et al., 2017).

The transparancy of the installation in the middle of the neighbourhood had a positive influence on the inhabitants (Meulman, 2017). It enables them to see what happens with their wastewater and biodegradable waste. This makes it comprehensible and creates awareness (Meulman, 2017). The feeling of responsibility and ownership is confirmed by one of the inhabitants of the neighbourhood (Hondebrink et al., 2017). The decentralised sanitation system gives inhabitants a feeling of pride (Hondebrink et al., 2017).

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TOWARDS THE FUTURE

Noorderhoek currently exists of 232 houses, which are all connected to the Waterschoon system. The system treats wastewater and biodegradable waste of around 400 users (STOWA, 2014). This scale has proven to be too small for a financially feasible businesscase. Housing units should be at least doubled (400-500) in order to close the businesscase (Meulman, 2017). Furthermore, it should be compared to a case where investments in a new sewage system would have to be made anyway (Meulman, 2017). This is argued to be one of the problems when implementing new ways of sanitation in the Netherlands. A lot of sewage treatment plants (Dutch: RWZI) exist that have enough capacity for new developments to connect without additional costs. It is difficult to deviate from the traditional infrastructure, as it is cheaper to connect a neighbourhood to an existing treatment plant with an additional pipe. This causes new sanitation systems to be more expensive (Gerbens, 2017).

Untill now, all costs have been covered through the project budget. Benefits from redistributing heat and electricity costs for recovering heat were calculated and everything, including subsidies, was equally distributed across actors (Gerbens, 2017). However, when the project is finished at the end of this year, actors will have to make new agreements about this. Wetterskip Fryslân is the official owner of the installation and will therefore bear the costs while Elkien reaps the benefits from heat supply. Furthermore, maintanance of the installation should be incorporated within the costs. The financial benefits from heat recovery on this scale are low (an estimated few thousand euros). This indicates that a larger scale would be more beneficial, as construction costs for the installation stay more or less the same while much more heat and biogas could be recovered. Furthermore, savings can be made on centralized wastewater treatment plants (Gerbens, 2017).

Some actors argue that it is cheaper to switch the whole installation off. Keeping the installations running costs about €40.000 a year. When all research has been carried out at the end of this year, actors could decide that due to monitoring, management, maintanance and additional costs for chemical dosage, it is better to stop the project. The neighbourhood would then be reconnected to the traditional sewage system of Sneek (Gerbens, 2017). In order to keep the installation operational, expenses have to be made. It is yet unclear who and if actors want to pay for this.

Wetterskip Fryslân does not see the potential in the *decentralised* part of the system. However, they are interested in new ways of sanitation where wastewater is separated at the source, within the houses. The lack of trust in decentralised systems has to do with the trend of minimising the number of sewage treatment plants. Merging is cheaper and often more sustainable (Gerbens, 2017). Research from the Waterschoon project also indicates that a larger scale is needed in order to make it financially feasible and more sustainable than the traditional system. The final goal for Wetterskip is to implement this type of system for the entire city of Sneek. They want to scale up the technology that is now being tested in Noorderhoek to the level of traditional sanitation (Gerbens, 2017).

Figure 47 Residential care facility for elderly in Noorderhoek (source: sijperda-hardy.nl)
Figure 48 Single family homes during construction second phase (source: sneekernieuwsblad.nl)

III E.V.A. LANXMEER , CULEMBORG

EVA Lanxmeer is an urban district of 24-hectare in the Municipality of Culemborg, located in the province of Gelderland. The area used to be a protected zone for drinking water extraction (Vernay, 2013). When the operating watercompany enlarged its extraction depth from 40 meters to 80 meters underground, the land was released for the construction of housing (VOEW, 2008). The EVA concept was developed in the 90s by Marleen Kaptein and a group of experts from several disciplines, who wanted to create an example for sustainable urban development. The Municipality of Culemborg was willing to cooperate in realising these ambitions (Vernay & Mulder, 2016), which included among others sustainable water- and resource management and the participation of future inhabitants (Vernay & Mulder, 2016). The EVA Lanxmeer district is now home to about 800 people, office buildings, schools and an urban farm (Pesch et al., 2017; Vernay, 2013).

Figure 49 Map of the Netherlands: Culemborg

50

The urban area development of Lanxmeer was initiated by Marleen Kaptein, who was inspired by the momentum for sustainable development (Kaptein, 2017). After creating the EVA foundation, a workshop was organized with experts in the fields of architecture, landscape architecture, water management, energy and permaculture (Kaptein, 2017; Pesch et al., 2017). This resulted in the EVA concept; a vision for sustainable urban development where experiments with decentralised energy production and sanitation could be performed. After a period of searching for the right location, the Municipality of Culemborg offered a space for the development and the foundation got permission to built houses in the Lanxmeer area.
Several urban systems were integrated within the neighbourhood, such as district heating, drinking water, wastewater treatment and construction. Furthermore, a lot of effort was put into creating a social infrastructure (Pesch et al., 2017).

Wastewater treatment and energetic infrastructures were eventually not realised. The integration process of the district heating and drinking water infrastructure was more successfull and will therefore be analysed for this research.

District heating was not a very popular technology in the Netherlands at the time that the idea for system integration (S.I.) was put forward. One of the main reasons for this were the high investments for infrastructure. Furthermore, it would be the first time that extracted drinking water would be used for district heating in the Netherlands (Vernay, 2013). Drinking water companies were mainly local (or at most regional) companies at that time (Vernay, 2013). Since the 1980s the number of drinking water providers in the Netherlands has diminished from 100 to 11 due to mergers and acquisitions. We will see the effects of this during the S.I. process in EVA Lanxmeer.

Figure 50 EVA Lanxmeer and the watertower (source: eva-lanxmeer.nl)

Actors of the S.I. project in EVA Lanxmeer have changed over the years. Thermo Bello and Vitens are currently the main actors of the district heating and drinking water system. Because of the long and interesting history and a recent shift in ownership, important actors from the past will also be introduced in this paragraph.

1 **The Municipality of Culemborg (MoC)** is located in the province of Gelderland, in the middle of the Netherlands. It consists of a city council and a board of mayor and aldermen. Culemborg has around 27.600 inhabitants and a surface of 31.23 km2. The MoC was especially involved during the construction of dwellings and offices in EVA Lanxmeer, as it fullfilled the developers role in the project. It was both owner of the land as well as the commissioner of the development (Kaptein, 2017; Vernay, 2013). A current important role for the MoC is the provision of permits. Environmental permits are required whenever physical interventions are wished for. Whenever new infrastructures are built, additional fees can be added. Support from the MoC for the SI project has differed a lot over the years, depending on the composition of the board and the people involved. This was a dynamic process, as some left and some people entered the project over time (Verschuur, 2017).

2 **Waterbedrijf Gelderland (WG)** was the initiator of the district heating network and the first owner of the installations of the SI project in EVA Lanxmeer. WG extracted drinking water in the middle of the area and developed, in collaboration with an energy-expert, the idea to incorporate the heating network. After a merger with Nuon Water and Wateleidingsmaatschappij Overijssel they became the company **Vitens** in 2002 (Vernay, 2013).

3 With 4 million customers, **Vitens** is currently the largest drinking water supply company in the Netherlands (Vitens, n.d.). Their core business entails drinking water extraction, treatment and supply. When the small scale company of WG was acquired, the district heating project had to find a new place in the much larger company of Vitens (Vernay, 2013). This went well for a few years, after which they sold the system to Thermo Bello.

4 **Thermo Bello (TB)** is the current district heating company of EVA Lanxmeer and owned by the inhabitants of the neighbourhood. Thermo Bello was established in November 2008 and now supplies heat to almost all inhabitants of the neighbourhood and some companies.

5 **The BEL (EVA Lanxmeer Residents' Association)** is organised by the residents of EVA Lanxmeer. All inhabitants automatically become a member when they live in the area. It organises meetings and has a newsletter that informs the inhabitants about events, developments and on-going issues in the district (Vernay & Mulder, 2016). The BEL exists of different working groups. The **'Energy and Equipment' working group** was especially important for the SI project. It emerged because there was a need for people that could help solve the problems with the equipment in the homes (Vernay, 2013). The energy and equipment working group works together with Thermo Bello.

6 **The VOEW** was established in October 2007 in order to fullfill the following demands: completing a business plan for the district heating takeover within a short period of time, transparent and reliable figures about the performance of the district heating should be completed and there was a need to raise more social support (Vernay, 2013). The VOEW exists of 80 members.

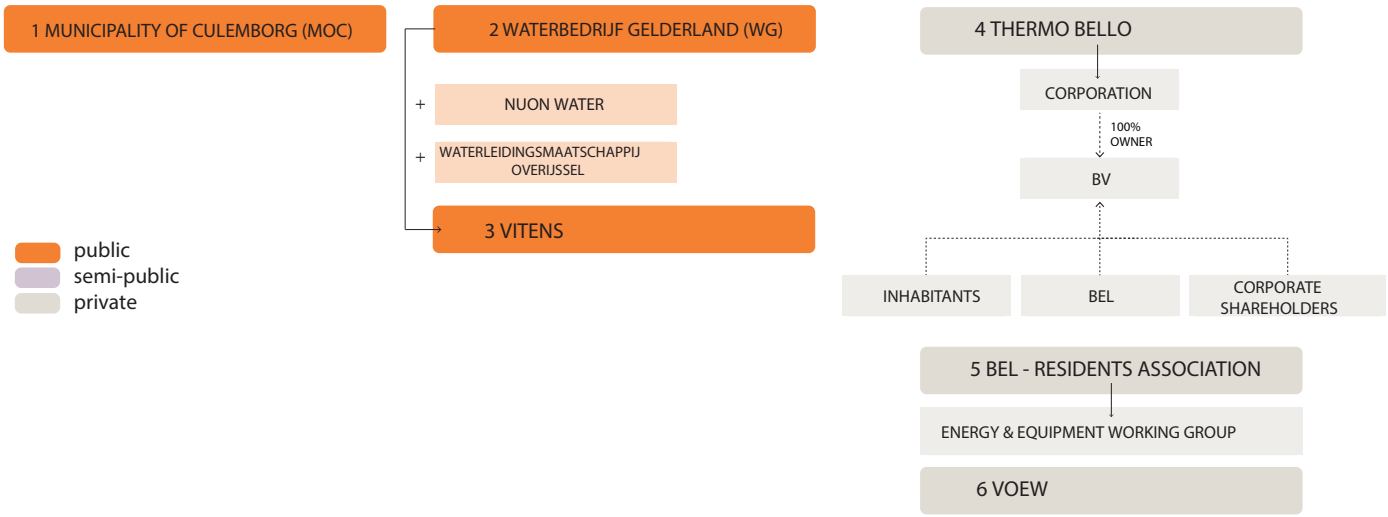


Figure 51 Public, semi-public and private actors in Lanxmeer

E.V.A LANXMEER - SYSTEM INTEGRATION

In the middle of the EVA Lanxmeer district, drinking water from 80m underground is extracted that reaches the surface at a constant temperature of 12 degrees celsius (VOEW, 2008). By using a heat pump, the extracted drinking water forms an ideal heat source for wall- and floor heating (VOEW, 2008). The infrastructure for the supply of drinking water is thereby integrated with the district heating system. Thermo Bello upgrades and supplies the heat to around 220 customers in the neighbourhood. From these, 210 are houses and 10 are railway- or office buildings (Verschuur, 2017). Hot water is brought to the houses and returned cooled through pipes to the heatingstation (Thermo Bello BV, n.d.). Within the station, water is reheated by using a heating pump. Besides the cooling of drinking water, there's an additional gas boiler in case this is insufficient. However, Thermo Bello is currently steering on the use of electricity instead of gas.

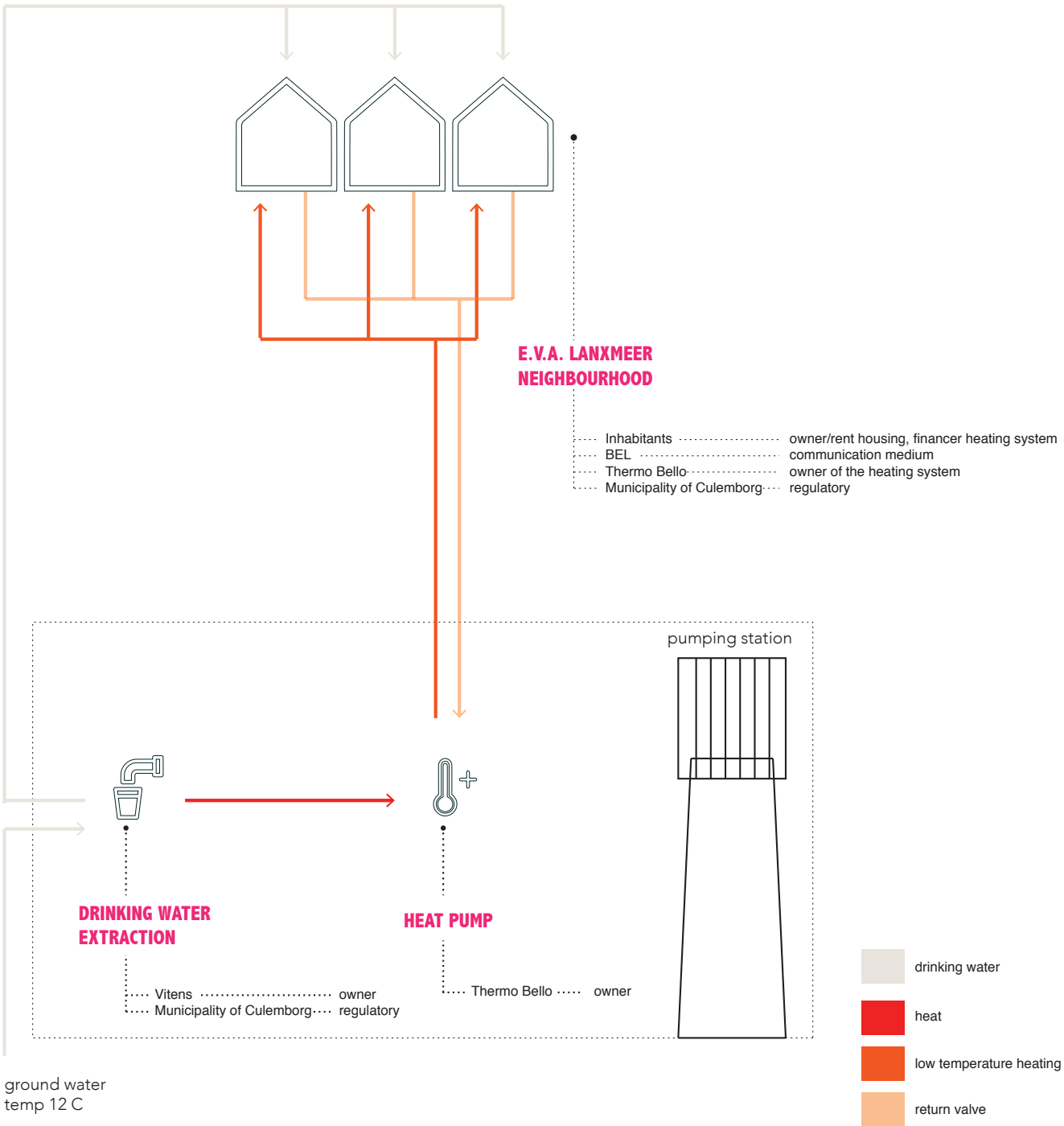
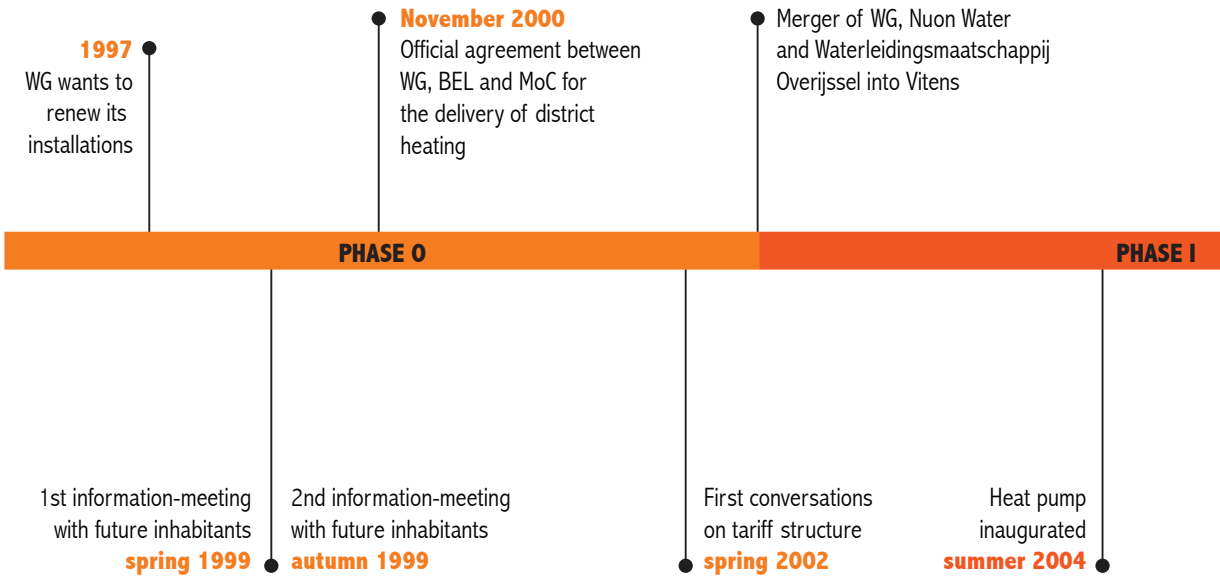


Figure 52 SI project and its actors



PHASE 0 1997 - 2002

In 1997, the energy expert of the EVA foundation discovered that WG wanted to renew its installations (Vernay, 2013). He identified this as a great opportunity and proposed to extract heat from the drinking water by installing a heat pump and use it for a heating system in the district (Vernay & Mulder, 2016). The head of WG was attracted to this idea rather quickly and consensus was reached between the energy expert of EVA and WG (Vernay, 2013). The attitude of WG towards the plans for implementing the district heating system was very positive. WG performed both operational parts of the system itself: drinking water extraction and district heating distribution. Consequently there was no need for collaboration agreements with external stakeholders.

Despite their enthusiasm, WG had one condition to integrate the heat pump with their installations: the initiative needed full support of the future inhabitants (Vernay & Mulder, 2016). Future users had to be enrolled in order to secure organisational relations within the system for district heating (Vernay, 2013). During the first information gathering in 1999, a lot of critique was expressed by future inhabitants on the system. As a reaction, the board of the BEL handled the energetic balance and accrual of costs in a very transparent way (VOEW, 2008). Meetings were organized in order to gain support (Vernay, 2013), which was captured through repeated conversations between the MoC, inhabitants and WG (Gelderland, 2000). By the time the second information gathering took place, inhabitants had given their consent.

An official contract was signed in November 2000 between WG, the MoC (as commissioner of the development) and the BEL. The contract stated the delivery of district heating based on drinking water extraction for the second phase of the area's development (Gelderland, 2000). Several meetings took place between the MoC, WG and the BEL to decide what the financial contribution of the inhabitants for the heating system should be (Vernay, 2013). It was decided that the "not more than usual principle" would be used to calculate heat prices. The principle states that consumers of district heating shouldn't pay more than those using natural gas and boilers (Vernay, 2013). A contract was signed based on these agreements between the three stakeholders (Vernay, 2013).

The BEL and WG continued investigating other possibilties for partnerships, resulting in a joint venture. Each inhabitant provided a financial contribution that was equal to what they would have invested if a standard heating system was implemented (Vernay, 2013). In return for this, a representative of the BEL could meet once a year with WG to discuss issues and future plans

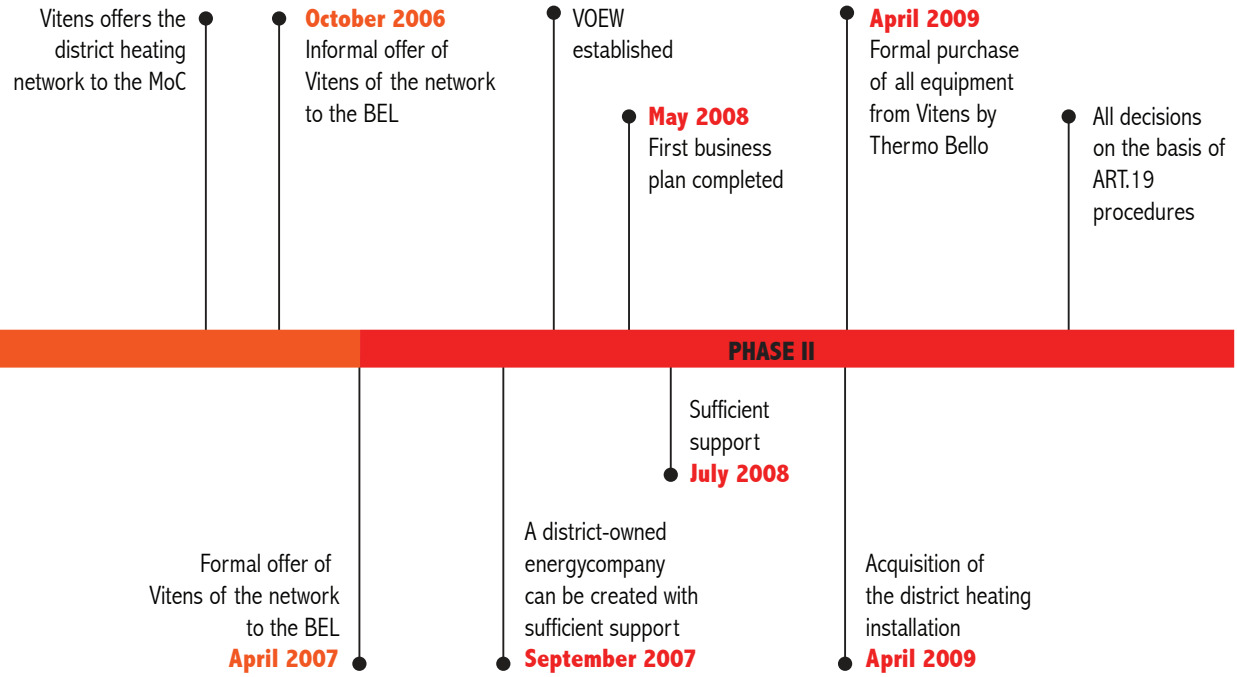


Figure 53 Timeline of the EVA Lanxmeer development process

for the system (Vernay, 2013). Finally, economic feasibility depended on the possibility of obtaining subsidies from Novem (Vernay, 2013).

The role of the MoC as a developer was an uncommon aspect in EVA Lanxmeer. It gave the municipality a lot more power and authority than they had traditionally when giving out plots to developers. As the commissioner of the project they had the authority that was required to enforce decisions and preferences during the implementation phase (Vernay, 2013). This resulted in an apparent lack of resistance from the construction company to implement the district heating network (Vernay, 2013). However, construction of the district heating could only be done in a specific phase of the process or it would be very costly. The first apartments were therefore not connected (Vernay, 2013). An obligation to connect to the district heating network has been recorded in the plot contracts, which upgraded the financial feasibility of the system.
Similarly, the fact that a drinking water company developed and operated a district heating network was also something completely new. The goal of WG to engage in the project was mainly to diversify business activities and enter the energy market (Vernay, 2013). They owned multiple pumping stations and wanted to be a part of the game of renewables (Vernay & Mulder, 2016). If it would work at this location they might be able to use it in other places as well.

PHASE I 2002 - 2007

However, this changed in 2002 when WG merged with Nuon water and Waterleidingsmaatschappij Overijssel into Vitens. Within this bigger organisation district heating lost its place as a strategic element of the company's business future (Vernay, 2013), but Vitens was still willing to cooporate so that it could continue its course. This was mostly from the perspective of corporate social responsibility and sustainable business activities (Vernay, 2013). However, after a few years Vitens specifically started focussing on their core business: the supply of drinking water. The district heating network in Culemborg "of all places" did not fit in this vision (Verschuur, 2017). After the MoC had indicated that they weren't interested in taking over the network, the BEL was approached. Although the board of the BEL itself was not interested either, there was an active Energy and Equipment working group within the BEL who saw the acquirement of the district heating network as a great opportunity. They were interested in starting entrepreneurial activities, being able to steer developments, gaining better control over heat prices and steering the transition towards sustainable energy in the district (Vernay, 2013).

PHASE II 2007 - now

When the district heating network was officially offered to the inhabitants of the neighbourhood, a financial-, technical-, and organisational feasibility study was needed. However, the installations did not have a place within the organisational structure of Vitens (Vernay, 2013) and the division of responsibilities for the installations within the organisation was unclear (Vernay, 2013; Verschuur, 2017). Little information was available and no clear overview existed describing the activities and performance of the heating installations. This information was essential to determine a market price for the equipment. Vitens and the E&E working group spent a lot of energy and time in making new calculations and creating a complete overview (Vernay, 2013).

Trust and goodwill was achieved between Vitens and the E&E working group during this acquisition period. Although they comprise very different organisations (Vitens as the largest water company in the Netherlands and TB as a small energycompany set up by the inhabitants of a neighbourhood) and corporate values differed, Vitens was considered to be TB's 'best friend' (Vernay et al., 2011; Verschuur, 2017). Besides the thought that selling the district heating to this small group of inhabitants might provide them with good publicity, the regional director of Vitens also enjoyed the collaboration (Vernay, 2013). Consensus was enabled by transparant communication about the processes that took place within the neighbourhood and the flexible attitude of Vitens by giving TB time to gain support from the inhabitants.

Legitimacy for the acquisition within the neighbourhood was pursued by engaging inhabitants with the process and planning. This resulted in the establishment of a development-association: the VOEW, existing of around 80 members. The VOEW performed a viability study and made a businessplan for the acquisition. The first businessplan was completed in May 2008 and inhabitants were asked for their opinion. The businessplan was put forward to the general assembly and the BEL and got approved. People from the neighbourhood were mostly participating out of idealism (Verschuur, 2017). There were five important drivers for the establishment of TB (Verschuur, 2010):

1 Environmental background - an optimized system leads to a reduction in emissions, which is better for the environment.

2 Mutual entrepreneurship - owning an energy network was considered to be a challenging step for the neighbourhood.

3 Affordability - inhabitants worried about rising energy prices whenever the system would be sold to a commercial company such as Nuon, Essent or Eneco. Vitens kept their rates low.

4 **Autonomy** - individual control is an important value in the neighbourhood. Being the owner and having the responsibility of an energy network fitted within this vision.

5 **Local economy** - although small, local employment plays a part in this project as all employees of TB are inhabitants of the neighbourhood.

TB consists of two legal entities: a corporation and a BV. The corporation is 100% owner of the BV. Stocks are divided over 3 membercategories: inhabitants who invested a minimum of € 250, the BEL and some corporate shareholders (figure X). The three membercategories control the BV (Verschuur, 2017), wherein each of them has one vote. New ideas are presented to these three categories that need to give their permission or consent. Ideas are mostly communicated through the 'BELnieuws' (the BEL newspaper) or a meeting is organised.

Because all three member categories were involved during the acquisition process and a lot of support within the neighbourhood was created beforehand, corporate values are very much alligned within the organisation. A lot of effort was put into convincing the neighbourhood by giving regular presentations and the provision of transparant information. In practice, all inhabitants are invited for the general assembly where TB lets them approve of the relevant documents. This is in general always a unanimous decision, but statutory it has to be a majority of votes (Verschuur, 2017). No decisions have been made unless all categories agreed untill now.
The building where the district heating installations are located is rented from Vitens. When TB officially took over the network in 2009 a collaboration agreement was set up, which states that TB cannot perform independent activities on this terrain. Because there is only one electricity connection, TB gets a bill from Vitens for their electricity use once a year. TB is thus an official tenant and subcontractor of electricity from Vitens. It is an advantage that they can make use of the cheap and ensured electricity supply contracts of Vitens.

Usage of extracted drinkingwater for the district heating is free. Decisions without physical consequences are taken within TB, but for physical interventions they need consent from Vitens (Verschuur, 2017). An example is the cleaning process of the heat exchanger. This is done with hydrochloric acid and critical to be done correctly for the drinking water extraction process. Because the manager of TB is the same as the former manager of Vitens, trust was created. A new manager who had no knowledge of drinkingwater extraction would've created more resistance (Verschuur, 2017).

The neighbourhood as a collective has been in front of the Council of State three times due to differing opinions with the MoC over the past few years. The power of the neighbourhood had grown over the years and actors had differing perceptions on authority. The BEL perceived the neighbourhood as an equal parner of the MoC (Verschuur, 2017). Misunderstandings arose because the MoC bears most of the financial responsibilities. Since they've started an improvement plan, issues have been cleared up and responsibilities and amounts of influence were clarified. However, this didn't influence the process of the district-heating network. It just functions as an indication where the division of authority clashed.

The way in which the MoC behaves oneself towards the EVA Lanxmeer neighbourhood corresponds with how inhabitants feel (Verschuur, 2017). The MoC facilitated this development and in a certain way they are now connected with very involved inhabitants. Sometimes this causes difficulties, but everybody at the MoC is willing to talk about new ideas. An important aspect in Culemborg are the short lines between actors. Just as was mentioned in Sneek: short lines make things easier.

The ambition for a decentralised sanitation system with the biogas installation provides a good example. It was at first perceived as a great idea within the neighbourhood. The idea was to integrate a biogasinstallation in an educational centre, the EVA centre, which would use the produced energy. After cancelation of the EVA centre due to financial reasons, calculations were performed for an independent biogas installation. These turned out to be non feasible at this scale. The aspects that caused financial difficulties were the system itself that needed space and land had to be bought (m2). Energy revenues constitute around 10% of the necessary financial means in order to keep the installation running. By taking over wastewater treatment costs of the local water board was estimated to cover 40% of the costs. Additionally agreements could be made with waste collector Avri, but this was still unsufficient for a feasible business case (Kaptein, 2017; Verschuur, 2017). The second problem that occurred was regarding the biogas. Whenever gas is being brought back to the regular gas network, it needs to be upgraded to a certain level. This proved to be unaffordable on such as small production scale (Kaptein, 2017; Verschuur, 2017).

TOWARDS THE FUTURE

At this moment, Thermo Bello is considering several options to deal with the shared electricity with Vitens. Soon, gas will no longer be used and the gas boiler will have to be replaced. The system needs to be transformed to be future proof. Additionally, whenever the shares of sustainable energy rise, prices will become more volatile which results in risks. In order to keep the heating rates balanced, TB needs to anticipate on this. Sustainable energy leads to more peaks and dips in the net. One of the solutions for this could be a thermic buffer, own energy production, etc. TB has thought of 10 possible variants and has asked Vitens which of these are negotiable for them. Because the property is owned by Vitens it has to be discussed with them.

Figure 54 EVA Lanxmeer: houses (source: groenblauwenetwerken.com)

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V CASE ANALYSIS

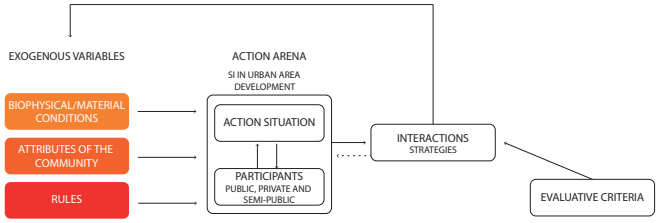
Now that we've described the S.I. process of the three cases in detail, this chapter continues with the analysis. In the second chapter of this research, a literature study was performed into the institutional process of S.I. in urban area development. The IAD framework of Ostrom was used to structure this process and identify the most important variables that influence it (the exogenous variables) and existing strategies to address them (the evaluative criteria). The third subquestion, *how and in what way do these variables influence this process?* and the fifth subquestion, *how can challenges and opportunities be addressed by actors using a certain strategy?* will be answered in this chapter. It should be emphasized that this analysis is purely based on the three studied cases. Results can therefore only be generalised to a certain limit.

First, challenges and opportunities that were found in the cases will be classified according to the three exogenous variables from the IAD framework. They will be shortly described and a comparison between the most striking ones will be made (5.1). Second, strategies that were used to address these challenges and opportunities are elaborated and compared to the evaluative criteria from theory on Strategic Niche Management, Niche Entrepreneurs and Network Policy Management (5.2). We will conclude with the main findings of this research (5.3).

Figure 55 "Our dog already knows for a long time that toilets contain drinking water" (source: Loesje.nl)

5.1 CHALLENGES & OPPORTUNITIES

Not all variables that were identified by literature have been found relevant within the cases. Additionally, some variables proved to be more important than others. A selection was made regarding their presence within the three studied cases. This paragraph first presents a table where challenges and opportunities from the cases are classified per variable. Second, a short description of each variable is given, after which challenges and opportunities between cases are compared to each other. Finally, we will reflect on the found variables in practice and theory and elaborate on any differences.



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Whether an influential factor should be classified as an opportunity or a strategy was sometimes difficult to determine. This can be best illustrated by giving the example of the variable 'policy'. Sometimes governmental policies opened up new opportunities for the S.I. project, in which case it could be ranked as an opportunity. It could also be seen as a deliberate way to stimulate S.I. projects: a strategy. Consequently, opportunities and strategies have been classified according to their time of occurence. Whenever a certain policy already existed, it is classified as an opportunity. When it was deliberately implemented in order to stimulate the S.I. project, it is classified as a strategy.

This resulted in the following analysis of challenges and opportunities of S.I. in the three studied cases.

Figure 56 Exogenous variables

TABLE I CHALLENGES & OPPORTUNITIES

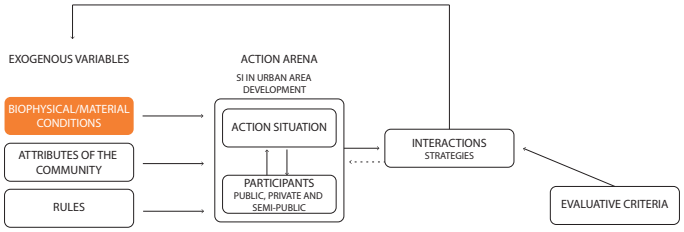
C challenge
O opportunity

		CITYPLOT BUIKSLOTERHAM	WATERSCHOON SNEEK	E.V.A. LANXMEER
BIOPHYSICAL / MATERIAL CONDITIONS				
BIOPHYSICAL CONDITIONS				
LOCATION/TYPE OF DEVELOPMENT	physical/spatial characteristics of the area (land prices, m2) and the type of urban area development	C objections from surrounding factories result in additional risks (transformative character of the development) O flexible land-use plan provides opportunity for experiments	C restricted scale C phased development O starting from scratch with infrastructure within houses	O no infrastructure for heating (piping etc.) in place yet O existing drinkingwater company and infrastructure
INSTALLATIONS	physical/spatial characteristics of the installations (scale, m2)	C expensive and scarce space required		O no additional space needed for installations
ECONOMIC CONDITIONS				
FUNDING	subidy systematics & financial means and possibilies for a business case	O subsidy	O subsidy O similar distribution of costs as the traditional system O replacement task coming up for existing infrastructure O benefits of recovered energy	O subsidy O inhabitants invested (the amount that they would've invested anyway) O the system pays itself back through low energy prices
OTHER NECESSARY/ AVAILABLE MEANS				
POLICY	governmental policies, documents, ambitions	C lack of urgency, knowledge and awareness at the municipality O awareness and urgency at waternet	O watertechnology HUB	O momentum for sustainable solutions (brundtland report)
RULES & REGULATIONS	regulatory framework	C no waste shredders allowed C no selling of phosphates allowed	C no waste shredders allowed C no selling of phosphates allowed C no discharge of purified water on surface water allowed	
ORGANISATION	way in which actors organised themselves during the project	C unconventional role and rask division C lack of involvement from municipal departments C late with integrating raw materials station in urban plan	C involvement of people from own organisation in steeringgroup	C no place for SI within the organisational structure and unclear division of responsibilities
ATTRIBUTES OF THE COMMUNITY				
GENERAL CORPORATE VALUES				
CORPORATE VALUES WITHIN THE ORGANIZATION	mutual understanding and preferences inside one's own organisation	C different departments of the municipality working on UAD		O common goals and support from the neighbourhood
CORPORATE VALUES BETWEEN ORGANIZATIONS	mutual understanding and preferences outside one's own organisation	C project vs process oriented language	O working with the right people & short lines between actors	C differing perceptions on level of participation O short lines between actors O good relationships between actors
MEASURE OF CONSENSUS	mutual understanding and preferences between actors in the S.I. project	O creation of consensus through manifest: innovative intentions and living lab approach C creation of expectations	O clear overall goal	O trust in actors operating the district heating installations
ATTITUDES OF ACTORS				
INTERESTS/POSITIONS	point of view and willingness to cooperate	C lack of specific goals for SI at De Alliantie C lack of specific goals for SI at the municipality	O all actors had specific incentives with the project	O both infrastructures were owned by the same organisation C goals changed when vitens acquired waterbedrijf gelderland
ORGANISATION OF COLLABORATION	the way in which actors organise themselves in collaboration models		C different organisation of risks & responsibilities	

C challenge
O opportunity

		CITYPLOT BUIKSLOTERHAM	WATERSCHOON SNEEK	E.V.A. LANXMEER
USER INVOLVEMENT				
MEASURE OF PARTICIPATION	the extent to which users were involved during the S.I. project and the means they had for participating/exerting influence	C different target groups	C gaining user support	O important role for inhabitants due to joint venture
MEASURE OF HAVING A SAY		C self-builders O sustainability "tables"	O users from first phase gave feedback to improve second phase	C support from the neighbourhood as a demand from drinkingwater company C support from the neighbourhood required to acquire district heating system
RULES				
BOUNDARY RULES	the number of participants, their attributes and resources, whether they can enter freely and the conditions they face for leaving (Ostrom, 2007)	C less motivated actors C district heating concession C no involvement of suppliers: long time span and tender obligations	O early involvement municipality & waterboard O single developer C no involvement of heating supplier during the process C changing people handling subsidies	C gaining support of the inhabitants as a condition
POSITION RULES	the roles and positions of the participating actors (Polski & Ostrom, 1999)	C changing role of the municipality during the process C unconventional role distribution C waternet having two commissioners	O DeSaH incorporating knowledge from the municipality and the waterboard	
SCOPE RULES	delimit the potential outcomes that can be affected and, working backward, the actions linked to specific outcomes (Ostrom, 2007)	C limited scale due to risk considerations and tender procedures C district heating concession limited full system implementation	C limited scale regarded as non-ideal	C limited scale for district-heating due to performed tenders
INFORMATION RULES	affect the amount and type of information available to participants in the action arena (Polski & Ostrom, 1999)	C lack of information of the system and technicalities at the PMB O transparency between Waternet and De Alliantie and WPW and De Alliantie	O pilot project provided technical information and certainty O transparency between project and steeringgroup	C little availability of information on the installations required additional time and effort to determine a market price O consent for acquiring the district heating network was obtained by extensive information sharing
CHOICE RULES	determine the actions that actors can(t) or should(n't) perform (Ostrom, 2007)	C differing perceptions of authority	O all actors were equally represented and equal in hierarchie	O enforcement of implementation and connection to the system
AGGREGATION RULES	determine how certain actions are performed	C De Alliantie making the decision for district-heating	O all actors with the same amount of influence in the project and steeringgroup	C installations are located on property of the drinking water company
PAYOFF RULES	affect the benefits and costs that will be assigned to particular combinations of actions and outcomes, as they establish the incentives and deterrents for action (Ostrom, 2011)		C new distribution of costs and benefits required at the end of this year C keeping the installations running requires additional costs	O financially and technically feasible businesscase

5.1.1 FIRST EXOGENOUS VARIABLE - BIOPHYSICAL / MATERIAL CONDITIONS



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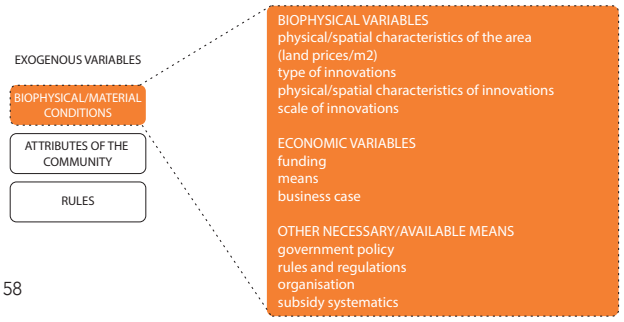

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BIOPHYSICAL CONDITIONS

physical and spatial characteristics of the area and the installations and the type of urban area development

Location / Type of development

The transformative character of **Buiksloterham** gave rise to objections from surrounding companies, resulting in additional risk for delays in the Cityplot project. On the other hand, the transformation required a flexible land-use plan and phased development, which provided the opportunity for experiments and bottom-up initiatives to emerge.

In the north of the country, the **Waterschoon project** was also influenced by its location and type of development. Because Noorderhoek had an inner city restructuring task, only a certain amount of houses was rebuilt. This resulted in a restriction of scale of the S.I. project (the amount of connections). While this had a negative impact on the financial feasibility, a complete restructuring of the area was also argued to provide an opportunity for the decentralised sanitation system: everything was built from scratch and infrastructure could be renewed within the houses.

A similar advantage emerged in **EVA Lanxmeer**. As a greenfield development, no infrastructure for heating (gaspiping etc.) was in place yet. This provided the opportunity for a district heating network: all houses were built anew and investments for infrastructure had to be made in any case.

Besides the specific types of development, there was one element that proved to be important in all three cases: houses were built from scratch, which provided the opportunity for a new infrastructure.

The locations Buiksloterham and Noorderhoek restricted the amount of connections to the S.I. project. A larger scale would have enhanced financial feasibility. Besides the scale of the development, there was another reason for this in Cityplot: an already performed tender procedure prohibited additional connections. However, it should be noted that experiments are often tested in small scale projects due to risk considerations. A smaller scale was therefore also mentioned by the actors of Cityplot as a deliberate consideration.

Installations

Decentralised sanitation systems and accompanying installations require a certain amount of space. Implementation within the inner-city of Amsterdam proved to be expensive due to the scarce space that the city has to offer. This increased difficulties to find a place for the station in the **Cityplot** development. Furthermore, disagreements emerged regarding the location of the station. The installations could not be integrated within the urban plan as actors were involved too late. Because space is scarce and expensive within the city, it was difficult to incorporate the installations within the urban plan and diminished the possibilities for a feasible ground-exploitation (Dutch: GREX).

Although the requirement of m2 was a disadvantage for the decentralised sanitation system in Amsterdam, land prices and available space provided possibilities vice-versa for new ways of sanitation in **Sneek**. The decentralised sanitation system for Noorderhoek was selected because of its small space intake, opposed to for example

Figure 57 First exogenous variable - biophysical/material conditions
Figure 58 Operationalisation of the first exogenous variable based on literature

constructed wetlands (Dutch: helofytenfilters).

Unlike these two cases, no additional space was needed in order to implement the district heating installations in Culemborg. Opportunities in **EVA Lanxmeer** emerged due to the existing infrastructure of the drinking water extraction plant. Installations were integrated within the existing buildings of the watercompany, which enhanced financial feasibility.

The requirement of space for installations were an important element and especially proved to be a challenge in the expensive inner city of Amsterdam. Early integration within the urban plan was essential but not achieved.

ECONOMIC CONDITIONS

subsidy systematics, financial means and possibilities for a businesscase

Funding, means & business case

The S.I. project was partially made possible by subsidies in all three cases. Although some actors in **Noorderhoek** experienced a problem of changing people providing these subsidies (requiring time to convince new people and let them catch up with the current state of affairs) subsidy was indispensible for all projects.

The fact that the existing sewage system in **Noorderhoek and Buiksloterham** had a replacement task provided opportunities for an experiment. Investments for a new infrastructure were due within a foreseeable amount of time. Similarly, the non-existence of heating infrastructure in **EVA Lanxmeer** was at the root of the SI project. Investments had to be made anyway, which enhanced financial feasibility. An additional advantage in Lanxmeer was the businesscase: the system eventually pays itself back to the inhabitants through low energy prices.

Although existing infrastructure in Cityplot and Waterschoon was in a way competitive (representing the cheapest option to connect), it also provided a back-up for the S.I. projects with an experimental character in case the system would fail.

Financial opportunities for S.I. arise when infrastructure is not in place yet (EVA), or whenever a replacement task exists (BSH & Sneek). Financial benefits of decentralised sanitation can be found at the possibility for heat recovery and supply. Waterschoon uses this recovered energy from wastewater for heat distribution within the neighbourhood. However, the scale limits the financial benefits.

OTHER NECESSARY / AVAILABLE MEANS

governmental policies, documents and ambitions; regulatory framework and the way in which actors (organisations) are organised

Policy

The unawareness about new ways of sanitation at the Municipality of Amsterdam represented a challenge for S.I. in **Cityplot**. Even though it is mentioned in the municipal sewage plan, there was no sense of urgency to include it in the building envelopes and getting it into the decision-making process at an early stage.

On the contrary, policies from the Municipality of Sudwest Fryslan for facilitating water related experiments stimulated the S.I. project in **Noorderhoek**. Because Sneek wants to participate in the program of the province of Friesland and the city of Leeuwarden in becoming a European watertechnology HUB, it was of interest to the Municipality to provide the means for the Waterschoon project.

The different effects of governmental policies may be explained by the size of the involved municipality. Amsterdam is a big municipality with a lot of different departments. Tasks are scattered and policy in one department might not be of interest to another department. When lines are shorter such as in Sneek, tasks of UAD are less divided and executed by a smaller amount of people/departments.

Rules & regulations

Rules and regulations prevented the implementation of a decentralised sanitation system in its most complete form in **Cityplot and Noorderhoek.**

Biodegradable waste shredders are not allowed to connect to the sewage system because they represent two different waste compartments. However, both Cityplot and Waterschoon got an exception to this rule.

The second obstructing regulation prohibited recovered phosphates to be sold on the market as it is considered to be a waste product.

Lastly, purified water could not be discharged on the surface water in Noorderhoek due to rules and regulations. Exceptions on the rules were made in both cases, although it did cost a lot of additional time and effort.

Organisation

There was a different role division than in traditional UAD in **Cityplot**, which created a challenge for the Municipality of Amsterdam and housingcorporation De Alliantie. The fact that Waternet has two administrative commissioners complicated the decision-making process, as some financial decisions are taken by AGV and some by the Municipality of Amsterdam.

The **Noorderhoek** development was organised differently. A projectgroup and steeringgroup provided clearity, but also resulted in some difficulties. The people in the steeringgroup were held accountable towards their own organisation. Some representatives in the steeringgroup needed more time to get approval within their own organisation than others. Because all organisations were organised differently, this resulted in a challenge during the project.

Differences between departments in **EVA Lanxmeer** were considered an issue during the acquisition period, as there was no suitable place in the organisational structure of Vitens for the district heating network. Different employees from different departments fullfilled tasks concerning the district heating system and there was no clear division of responsibilities. This complicated the acquisition as there was no information to determine a market price.

BIOPHYSICAL VARIABLES

Most of the biophysical variables derived from the studied literature on UAD. Characteristics of the area such as land prices, available square meters and the scale of the development had an effect on the S.I. project.

The scale of the UAD proved to be important as it determined the amount of possible connections to the S.I. project. The UAD scale is not always the ideal scale for a feasible businesscase for S.I. This is more of a challenge when upscaling towards the regime level is aimed at. Niche projects are often smaller scale experiments due to risk considerations and a don't have a feasible businesscase as the main goal.

Second, the location of the development influenced the choice for type of installations. The requirement of physical space is more complicated when land prices are high and space is scarce. The characteristics of the installations and its space intake are therefore an important element.

Comparing these two elements of scale and location leads us to the consideration between the optimal scale for S.I compared to the space intake and the amount of possible connections.

Finally, the location and type of development determine the possibilities to start an S.I. project. Houses that are built from scratch provide opportunities for implementing new infrastructure. This can be a restructuring task, a transformation or a complete greenfield development.

Most influences from UAD are a good example of processes taking place on the regime and landscape level. They are part of a system that is difficult to change. The characteristics of an inner city location can not easily be adjusted. Similarly, land prices are determined through a long history and complex market system. S.I. projects that take place in niches will initially have to adjust to these variables, as changes are difficult to achieve and imply longer time spans.

From this we can conclude that S.I. in UAD has to be tailored towards the specifics of the area, and solutions should be customized for each project. The choice for applying S.I. in the future depends on the possibilities of location and type of development.

ECONOMIC VARIABLES

As already identified at the previous variable, the scale of UAD and the scale of the S.I. are interrelated. Niche projects are in general often dependent on subsidies, as experiments and innovations need investment before they become financially self-sufficient.

A feasible businesscase depends on the scale and the possibility to distribute recovered resources over a specific amount of houses. Furthermore, financial feasibility depends on existing infrastructure, monopolists in the area and whether e.g. RWZI's are full or can take up additional connections. These are aspects that become more important when upscaling towards the regime level is needed.

OTHER NECESSARY / AVAILABLE MEANS

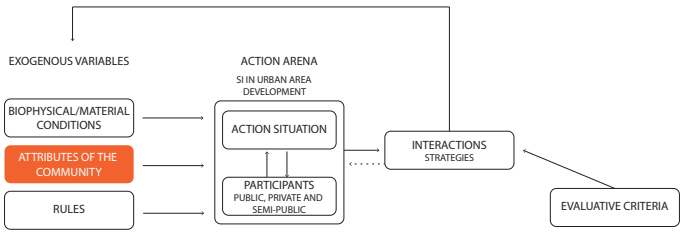
Government policy, rules and regulations, established organisation structures and subsidy systematics were all identified as potential barriers in the studied literature.

Policy was more often a stimulating aspect than an impeding variable. Especially in Noorderhoek, the ambition of becoming a water technology HUB stimulated the S.I. project. Although policies were not identified as a challenge, they could become one when implementation in traditional processes or upscaling of innovations is required. The niches in which the experiments take place are argued to be protected from external influences. When upscaling is required and existing regimes have to be changed, existing policy may become more challenging.
Second, the extensiveness of the organisations was a factor in the amount of influence that (stimulating) policy can exert. The more departments are involved, the more convincing and incentives on multiple levels are necessary. Short lines in small municipalities makes the process easier and the effect of policy more direct.

Rules and regulations proved to be a challenge in all three cases. Exceptions were made on these rules but did cost additional time. The existing legislative framework is located on the landscape level and considered difficult to change.

Subsidy systematics were mentioned in literature to form barriers for innovation. However, in the three studied cases they were essential for the financial feasibility of the project. It may be possible that subsidies provide opportunities for niches untill a certain stadium and become a barrier for the regime level. Furthermore, the long time spans of UAD have a negative impact on the subsidy process. Subsidy can be a challenge when research results need to be delivered within a certain time and might hamper the "living lab" approach.

5.1.2 SECOND EXOGENOUS VARIABLE - ATTRIBUTES OF THE COMMUNITY



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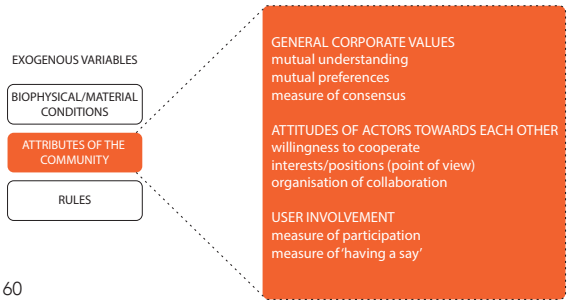

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GENERAL CORPORATE VALUES – WITHIN AND BETWEEN ORGANIZATIONS & CONSENSUS

mutual understanding and preferences inside and outside one's own organisation

Corporate values within the organisation

There were multiple departments within the municipality involved with the **Cityplot** project. Interdisciplinary projectteams are normally set up in order to integrate different values and preferences from these departments. Because De Alliantie was in this case developing the urban plan, this did not happen. This resulted in a lack of involvement from the department of Maintanance, which caused challenges for the urban plan.

In the **EVA Lanxmeer** case, sharing mutual values within the organisation proved to be very important. The organisation of Thermo Bello consists of three membercategories that are very well alligned. All actors are shareholders of the BV, which gives them a common goal.

Values within the organisation in **Noorderhoek** were not identified as a challenge or opportunity. Although sometimes people within the organisation of Wetterskip needed some convincing, this was not seen as an obstructing factor.

Corporate values between organisations

Corporate values between organisations were more often challenging. In order to implement a decentralised sanitation system in **Cityplot**, the Municipality of Amsterdam needed a lot of convincing. This was partly due to the specific tasks and responsibilities of the different departments within the municipality and partly because of the sanitation topic.

All of the involved actors in the **Cityplot** development signed the "Manifest Buiksloterham", which initially created consensus about future developments in the BSH. Although it had a positive influence on actors in the run up, initiatives disappeared after the manifest was signed.

Conflicts appeared mostly due to a difference in "language": project-oriented versus process-oriented. These different approaches became especially apparent between Waternet and the municipal department of Land and Development/PMB. The manifest played an important role in the creation of these different perceptions. It stimulated a living lab approach on the one hand while on the other hand nothing was officially stated. There was no clear statement of responsibilities and it was a non-binding document.

Actors of the **Waterschoon** project emphasized the importance of working with the right people. Enthusiastic stakeholders were a result from the pilot project and resulted in a good basis for collaboration. Most actors knew each other beforehand and the system in general had proved to be technically successfull. Finally, 'short lines' between actors were mentioned to enable collaboration as well.

Corporate values in the **EVA Lanxmeer** case proved to be a challenge between the Municipality of Culemborg and the BEL. Different ideas on the level of participation existed because there were initially no clear agreements on this. Short lines between organisations are mentioned Culemborg as well to be an advantage when working together.

Figure 59 Second exogenous variable - attributes of the community
Figure 60 Operationalisation second exogenous variable based on literature

ATTITUDES OF ACTORS

point of view and willingness to cooperate and the way in which actors organised themselves during the project

Interests / positions

Actors in the **Cityplot** development had different goals and interests. De Alliantie and the Municipality of Amsterdam did not have a specific sense of urgency for S.I., while Waternet had a very specific interest in experimenting with decentralised sanitation. This was a challenge as a lack of incentives leads to other priorities.

This was different in the **Waterschoon** development, where all parties had very clear project goals. Although these goals differed, everyone had a particular interest with the S.I. project.

In **EVA Lanxmeer,** goals and benefits for all actors were also found. However, when the incentive for the drinking water company changed after a merger, the project lost its strategic position and was sold to the inhabitants of the area. The users of the system have a direct benefit with owning the system as influence can be exerted.

Organisation of collaboration

An extensive contract between actors in **Noorderhoek** proved to be crucial and provided opportunities to fall back on during the process. The creation of such an extensive document costed a lot of time and consultation in the beginning, but saved time along the way due to clearity of responsibilities on every level.

An official contract was also signed between actors in **EVA Lanxmeer**, which secured the delivery of district heating based on drinking water extraction. Furthermore, a joint venture was created with inhabitants for which in return a representative of the BEL could meet once a year with the watercompany. Inhabitants got an important role due to the creation of this joint venture. Another collaboration agreement was set up between Vitens and Thermo Bello when they took over the network.

USER INVOLVEMENT

the extent to which users were involved during the S.I. project and the means they had for participating/exerting influence

Measure of having a say

Cityplot has a specific future user which proved to be a challenge: self-builders. New types of contractual relationships are needed to oblige multiple 'developers' to connect to the infrastructural system and stay connected on the long term. Future inhabitants prove to be an important consideration in general: (social) renters are in general involved after development and have little influence on interior and sanitation. Self-builders and house owners are involved in an earlier process and may have more specific ideas on their interior (and type of bathroom, sanitary, etc).

Due to the different development phases in **Noorderhoek**, users from the first phase were able to give feedback on the system in order to make improvements in the second phase. Consequently, some technical difficulties with the system (especially the waste shredders) were solved.

In **EVA Lanxmeer**, users played a very important role. Social involvement was one of the main pillars of the entire development and was therefore also an essential aspect of the S.I. project. Support came as a demand from the drinking water company to implement the district heating system. This was mainly because of the financial feasibility. A joint venture could be created in which inhabitants paid for a part of the system. Second, support was required for the acquisition of the system in a later stage. It provided the opportunity to establish Thermo Bello, the neighbourhood's local energy company.

Because they had such an important role, inhabitants ran into some difficulties regarding their roles and responsibilities. Different perceptions of participation existed between inhabitants and the municipality which resulted in multiple cases in court.

GENERAL CORPORATE VALUES

General corporate values were described as the mutual understanding and preferences and the measure of consensus between actors. The influence of this variable on the S.I. project in the cases will now be compared to the literature sources.

S.I. projects are complex projects, especially due to the many actors that are involved. Different corporate cultures (regimes) are combined during these projects. Corporate values did indeed sometimes lead to difficulties in the studied cases. Differences within one's own organisation were specifically encountered at the Municipality of Amsterdam and its many departments.

Because Amsterdam is a big municipality, tasks and responsibilities are divided over multiple departments, supervised by different aldermen. Traditionally, departments are integrated into a multidisciplinary projectteam during UAD. In order to get something new such as S.I. into the process, multiple departments need convincing. Combining a well established UAD process with the experimental characteristics of S.I. does not always match. Elements for achieving a successfull UAD are different from the elements that an experimental niche project needs.

In the other two cases (EVA Lanxmeer and Noorderhoek) short lines between actors provided opportunities for S.I. When one department is responsible for the entire building cycle, goal convergence becomes easier. The more extensive the organisation and the more departments are involved, the more different corporate values exist.

ATTITUDES OF ACTORS

However, having exactly the same preferences was unnecessary to achieve a successfull niche experiment in Noorderhoek. There existed different goals (commercial, experimental, demonstration, image) but all actors had an incentive for collaboration.

When a project is considered to be an experiment and research is done for a limited amount of time, it is important to look at the phase after results are attained. When the goal of experimentation loses its purpose, new incentives are needed if the project needs to continue. This is a deliberate consideration.

USER INVOLVEMENT

User involvement was mentioned as an influential factor for S.I. projects by multiple literature sources. Future users sometimes had a positive influence, but can also provide difficulties.

Infrastructural interventions within houses demand cooperation from the inhabitants. These expectations can be organised formally, but also depend on the type of developer and development (social housing, sell, rent). Whenever houses are sold, it is important to have a contract that states the obligation to stay connected to the S.I. project.

Developing an area in several phases provided opportunities for users to give feedback on the system. Especially with technical innovations that accompany S.I., this can be a valuable addition to the learning process.

5.1.3 THIRD EXOGENOUS VARIABLE - RULES

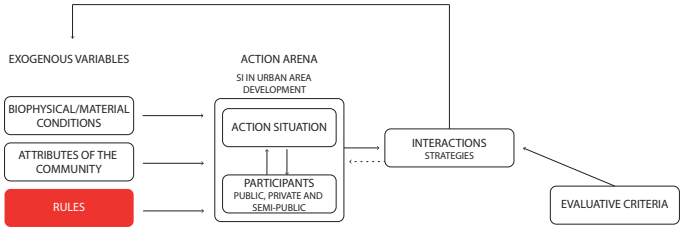

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Figure 61 Third exogenous variable - rules
Figure 60 Operationalisation third exogenous variable based on literature

BOUNDARY RULES

affect the number of participants, their attributes and resources, whether they can enter freely and the conditions they face for leaving.

S.I. projects and their actors are very much bound to a specific location. Resources are recovered and re used at the place that originates from the availability and necessity of these resources. Actors in UAD are also location bound. Urban developments are connected to the actors that are working in that area. Consequently, the majority of actors are present and determined by the location and little or no selection takes place.

The presence of certain actors caused a challenge in **Cityplot**, as some key players (e.g. the municipality) were less motivated for the S.I. project than others (e.g. Waternet). Location bound actors even proved to be an actual disadvantage for the sanitation system: implementation in its most complete form failed due to the existing monopolist for district heating Westpoort Warmte. On the other hand, the presence of actors within an area can also provide opportunities for S.I. This can best be illustrated by the **EVA Lanxmeer** case where S.I. emerged from the presence of a drinking water supply company.

Engaging non-location specific actors seems to be a challenge in UAD due to their long time span. Because it takes a long time in general before construction actually starts, it is difficult to engage (technical) suppliers from the beginning. There was therefore no heating company involved during the process of **Waterschoon**. When third parties are not engaged or running any risk during the process, there are less incentives for the system to be working as efficient as possible.

Besides difficulties for early engagement due to long time spans, suppliers of the sanitation system in e.g. **Cityplot** have to be selected with a European tender procedure and are therefore yet unknown. The Cityplot development experienced another tender related challenge: tendering procedures of surrounding plots delimited the scope and scale of the S.I.

Actors in **EVA Lanxmeer** also encountered the consequences of a performed tender. The district heating could only be integrated from the second phase onwards, as the first phase had been tendered and final dates to make changes passed.

S.I. projects are location bound and have to deal with actors that are already present within the area. Because the majority of involved actors is not selected, stimulating participation and motivation can be a challenge. Monopolists can form a barrier when the existing infrastructure cannot be integrated with the new system. Public actors are obliged to perform tender procedures. These make the experimental character less flexible and difficult to involve suppliers beforehand.

Roles and positions of participating actors in the studied S.I. projects changed over time. This could be a direct consequence from the long time span of UAD and S.I. projects.

POSITION RULES

determine the roles and positions of the participating actors.

During the **Cityplot** development, the role of the municipality changed from a facilitating position in the background to an important project-oriented actor. This was mostly due to a new impulse for the building sector and new assignments after a period of crisis. The unconventional role distribution between the De Alliantie and the Municipality required a new division of responsibilities. It was a challenge to find this new distribution which was mostly reflected during the development of the urban plan.

The municipality had a limited role in the decision-making process of **Cityplot** because the developer owned the propertyrights. De Alliantie had the right of choosing between the existing district heating or develop and maintain their own heating installations. By making the choice for district heating, the S.I. project was influenced.

Actors of the **Waterschoon** project kept their traditional role distribution which resulted in a clear division of responsibilities and organisational structure. Also, trust was created because everybody could integrate their own expertise in the project.

Because S.I. projects are in general long term projects and actors are involved over long periods of time, there's a good possibility for mergers and acquisitions between companies. This occured when housingcorporations De Wieren and Elkien merged during the Noorderhoek development. Due to clear and formal agreements on roles and responsibilities this did not result in any problems for the S.I. project.

The fact that a drinking water company operated a district heating system in **EVA Lanxmeer** was a completely new and unknown role. When a focus on core business was determined after WG merged into the bigger company of Vitens, the district heating network had to be sold. This caused a challenge for the inhabitants of the neighbourhood, but eventually resulted in the opportunity for acquiring the network. Inhabitants got an important role due to the establishment of a local energycompany (TB).

UAD and S.I. projects have a long time span where actors enter long term relationships. Unconventional distribution of responsibilities can form both challenges as well as opportunities.
The scope of the projects was largely determined by the location and type of development.

SCOPE RULES

delimit the potential outcomes that can be affected and, working backward, the actions linked to specific outcomes.

Due to tender procedures and risk considerations, the scale of the S.I. project in **Cityplot** was limited. Connecting more urban developments to the system was physically possible, but partly discarded because tender procedures had already taken place. Risk considerations from Waternet and the Municipality further determined that this was a feasible scale for such an experimental project. Adding connections from other developments would enhance risk as each of these projects run their own risk for delay or going over-budget. The system of decentralised sanitation and energy recovery was additionally narrowed down due to the concession of district heating.

The scale of the S.I. project in **Noorderhoek** is not regarded as ideal. However, initial goals have been achieved regarding the experiment. A challenge will be the evaluation and potential termination of the project. Wetterskip had an experimental goal with the installations, while DeSaH wants to keep using it as a demonstration project for its clients. When the research is completed, Waterschoon loses its experimental character. Economic and financial feasibility will then become more important.

In **EVA Lanxmeer**, the goal of experimentation was initially present at the drinking water company WG. They wanted to find out whether this could be an option for their other water extraction plants. After the merger with Vitens it lost its experimental position and was sold to Thermo Bello. When they acquired the network, economic and financial feasibility became the main scope rules.

INFORMATION RULES

affect the amount and type of information available to participants in the action arena.

There were uncertainties about the physical and technical parts of the system (environmental boundaries, smell, etc.) in **Cityplot**. A lack of information might be common for innovative projects such as these, but clashed with the ways of working at some municipal departments. The PMB encountered difficulties in managing the urban development process because unsufficient information was available about the system and its installations.

Information between De Alliantie, Westpoort Warmte and Waternet was treated in a transparant way which helped making the project financially feasible. Unfortunately, this did not lead to any advantage for complete integration of systems. Heat from Westpoort Warmte was the cheapest and safest option for De Alliantie. A deliberate choice was made for district heating instead of using the recovered energy from the decentralised sanitation system.

The pilot project that preceded the **Waterschoon** project provided technical information about the system. During the process of Noorderhoek information was treated in a very transparent way between project- and steering group.

In **EVA Lanxmeer**, little information was available about the installations. This was caused by the unclear position of the system and organisation at Vitens. It took a lot of time and effort to get a clear overview in order for acquisition.

There is currently no exchange of information between Vitens and TB, which is also regarded as unnecessary. There is however communication about the aspects that affect the district heating installation such as the emergency generators. Because TB is still operating on their property, all actions have to be performed in consultation.
The sharing and transparency of informaton played a very important role between Thermo Bello and the inhabitants.

CHOICE RULES

determine the actions that actors can(t) or should(n't) perform.

Consent for taking over the network was obtained through extensive information sharing.
The manifest was an important document that influenced the **Cityplot** development. It indicated a certain direction and expectations were raised that a collaborative approach would be followed. It proved to be a challenge to manage these different perceptions about authority. The municipality used its authority during development, and not always in favor of the S.I. project.

Actors were equal in hierarchie in **Noorderhoek**. There existed a difference between the project- and the steering group but actors were equally represented within both groups. All actors were entitled to the same actions.

In **EVA Lanxmeer**, the Municipality functioned as the commissioner and the district heating network could therefore easily be implemented by enforcing its preferences. Furthermore, the support of the inhabitants was relevant during the first phase (condition of WG) but even more during the second phase of acquisition. A challenge occured regarding the amount of influence and participation of these inhabitants in general, but was solved by making agreements on levels of participation. Municipality and inhabitants agreed that the amount of influence now depends on the amount of risk that an actor takes.

AGGREGATION RULES

determine how certain actions are performed.

Aggregation rules refer to decision-making procedures, and specifically to the actor's contribution to a decision. This includes the arrangements to include actors' expertise into the S.I. project and in particular the decision practices within the project organisation.

Actions in **Cityplot** were distributed over multiple actors. Waternet is responsible for the watersystem, the Municipality fullfilled the task for finding a place for the raw materials station and de developer performed actions for the heating system and infrastructure within the houses. Because there was no project organisation, it was unclear how certain actions were performed. Decisions were often taken within one's own organisation.

The **Waterschoon** project was more organised and decisions were in general taken within the project group. When decisions had to be made for going over budget (>10.000), approval from the steering group was required. The steering group consisted of representatives from their own organisation. They sometimes needed permission from their board, and it differed how much authority the representatives had in the steeringgroup. Although actors kept their traditional responsibilities for part of the system, the communal budget and central project organisation resulted in mutual decisions. There was one exception: the developer was solely responsible for the decision-making process of the heating system.

Choices on the heating part of the system were made by the developers (De Alliantie and Elkien). This resulted in challenges regarding the choice of supplier (Cityplot) and less incentives for the system to function in an optimal way, as the heating supplier was not involved during the decision-making process (Waterschoon).

In **EVA Lanxmeer** decisions are taken in the BV of the district heating company: Thermo Bello. Officially, decisions have to be unanimous among the three shareholders, which also represent all the inhabitants of the area. TB has not yet experienced that there was unanimity during a decision-making process.

PAYOFF RULES

affect the benefits and costs that will be assigned to particular combinations of actions and outcomes, as they establish the incentives and deterrents for action.

Payoff rules refer to the incentives and disincentives in terms of resources that are available to actors for exercising their authority.

The available resources in **Cityplot** differed for each actor. Results of the S.I. experiment were seen as the most important outcome for Waternet and they were therefore prepared to make additional investments. The Municipality was focussed on the UAD process and developing a high quality neighbourhood, and had less incentives to invest in the S.I. project. Because the development is executed by a housingcorporation, less (financial) resources were available for innovations. Payoff rules caused De Alliantie choosing for district heating instead of using the energy from the S.I. project. Additional costs were not part of the possibilities for the corporation.

This was different in the **Waterschoon** project in Noorderhoek, where goals were more alligned and the experiment was seen as a priority by all actors. However, a challenge that resurrects when the project term is finished at the end of this year is the distribution of costs and benefits. Costs for the installations are currently paid by Wetterskip and benefits of heating reaped by Elkien. In order to keep the installation operating additional expenses have to be made. The goal of experimentation dissappears resulting in less incentives (for some actors) to continue.

The district heating project in **EVA Lanxmeer** needed a financially and technically feasible businesscase. This was partly made possible buy the inhabitants who invested in the system and created a joint venture with the water company.

BOUNDARY RULES

The boundary rules that influenced the S.I. project especially derived from the UAD regime. One of the elements that influences the number of actors are the obliged tender procedures for public actors. Tender procedures are performed to maintain a fair market in which everyone can compete for (building) assignments of the public sector. They are often done at the very beginning of an UAD process. A lot of legal rules come along with tendering, among others that no changes can be made afterwards. Incorporating the idea for S.I. at the very beginning is therefore essential. Most municipalities perform these tendering procedures. Therefore extensive collaboration between them and the infrastructural actors is needed for S.I.

Besides the obliged tender procedures, there's another difficulty in engaging (product) suppliers in an early stage of the process. Suppliers are conceived as the actors delivering e.g. new sorts of sanitary products, pipes and systems. By getting them into the decision-making process at an early stage, products can be optimalized and improved during the process. The short term characteristics of product innovation doesn't seem to match long term UAD projects.

The way in which boundary rules are described by the IAD framework (the entering and exit rules for the process) were not exactly found as such in the studied S.I. projects. Most actors are already present within the area: municipalities, monopolists for water or energy systems, district water control boards and housing corporations are very much bound to their location. They are not selected, and no rules exist to enter the process. However, boundary rules did appear regarding the involvement of third parties. Product suppliers and future users were difficult to engage in an early phase due to tendering procedures and missing incentives.

Most of these actors are indispensible for the project and cooperation is a necessity. The fact that actors are already present and are not selected makes it more difficult to create enthusiasm about the project sometimes. More effort is necessary to convince all important and existing stakeholders in the area.

POSITION RULES

New roles and institutional arrangements were found as an important pillar of socio-technical transitions in literature. However, positions and roles of actors did not change compared to the traditional division in two of the studied cases (Buiksloterham & Sneek). Because actors kept their responsibilities, all were staying in their own field of expertise. In Culemborg there was a shift in role when the watercompany took over the energy component. However, this role was discarded and lost its strategic position in the organisation after a merger.

The composition of organisations did change over time in two cases (Sneek & Culemborg), and a shift of tasks appeared in Buiksloterham. A changing context and external influences from the regime level are at the root of this. Mergers and acquisitions were a result from the centralisation trend. The number of waterboards and housingcorporations have been brought back to a few big companies over the years. The fact that this influenced two projects came forth from the long term commitment of actors in S.I.
The economical crisis initially caused an untraditional role division between the municipality and developer. Due to the recovering economy, roles had to be reconsidered during the process. This is a result from the long time span of UAD.

SCOPE RULES

The rules that delimited the potential outcomes and the actions that affected the outcomes were dependent on the goals of the participating actors. Because there existed other goals next to the S.I. project, or other goals with the S.I. project, the scope was influenced.

The scope rules included a delimitation of the system in Buiksloterham, as one of the actors made the choice for district heating. Another delimitation was the physical scale due to risk considerations (Buiksloterham) and type of development (Sneek).

The experimental character of the project was often leading, especially in the beginning. Elements such as financial or economic feasibility are less important when the main goal is to obtain results from an experiment. This is also one of the main characteristics of a niche project.

After the results of the research have been obtained, the project loses its most important goal: the experiment. The scope of the project then changes and provides the perfect illustration of an innovation that is tested (niche) and a decision has to be made if upscaling (regime) is desired.

INFORMATION RULES

Innovative and experimental projects often have little information available beforehand. This results in

uncertainties about the technical performance and physical interventions that are needed. Challenges emerge when innovations in a system (e.g. wastewater) have to be implemented in another system that is working from a regime level (e.g. UAD). Uncertainties in general enhance the risk for delay and can hamper regular development when not managed in the right way.

A pilot project on a smaller scale can provide technical information and enhance trust between actors, especially when most actors were also involved during the pilot.

CHOICE RULES

The manifest in Buiksloterham stated the ambitions for the area and inexplicitly raised expectations about action actors should take. When intentions for action are not formally binding, expectations can lead to dissapointment and awaiting roles from all sides.

Actions in Sneek were all in consultation and controlled by a central projectorganisation.

AGGREGATION RULES

Making decisions within a central project organisation such as in Sneek enhances collaboration and regular consultation between actors. Although actors in the Waterschoon project kept their traditional responsibilities, decisions were made together on all aspects. Besides giving everyone a chance to contribute their knowledge, it also resulted in actors meeting regularly.

Although complete unanimity was required in two cases for decisions to be taken (Sneek & Culemborg), this was never considered to be a challenge. When the scope of the project and the main goals are clear for all actors, decision-making processes seem to become easier.

PAYOFF RULES

Payoff rules are different in niches because they are protected from external influences and the market.

The costs and benefits can be related to the goals of the different actors that were discussed at the scope rules.

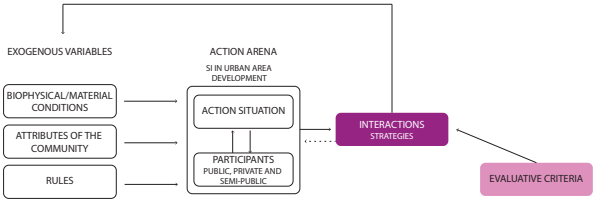
When the main goal was the experiment, no businesscase was initially needed and actors were willing to make additional investments. This is a typical characteristic for niche experiments, where products are first tested and protected from market mechanisms. When the main goal was different (e.g. successfull UAD) and the experiment was not leading for some actors, financial feasibility and a businesscase became more important.

The rules for costs and benefits become more financially focussed when projects need upscaling towards the regime level. In niches, incentives for actors are in general geared towards the outcomes of the experiment.

5.2 STRATEGIES & EVALUATIVE CRITERIA

The most important challenges and opportunities for S.I. in UAD have been identified in the previous paragraph. The strategies that actors used to address them will now be analysed. According to the IAD framework, interactions (strategies) between actors come forth from the action arena. Because the action arena is influenced by the exogenous variables, we can now look at how actors respond to these influences.

The last part of the theoretical framework identified six evaluative criteria from literature. These criteria are now applied to evaluate the strategies that actors used in the studied cases (figure 61).



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Not all previously discussed challenges and opportunities were addressed by a strategy or this has remained unknown to the researcher. A division was made which resulted in the following tables:

1 challenges and opportunities that were addressed by a certain strategy in the cases (table II)

2 challenges and opportunities that were not addressed by a certain strategy in the cases but could have been addressed by a strategy from literature (evaluative criteria)

3 challenges and opportunities that were not addressed by a certain strategy in the cases and for which no strategy from literature could be found

The following page presents the first table: challenges and opportunities that were addressed by a strategy within the cases. It provides an immediate comparison with the six evaluative criteria from literature.

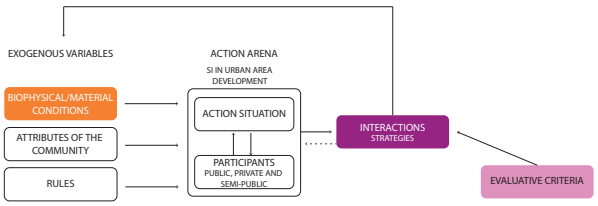
Compared to the table of challenges and opportunities in the previous paragraph, the table of strategies has been tilted. This was done because we are less interested in the type of strategies that was used in a particular case, but rather want to look at the strategies that were applied per exogenous variable. Furthermore, the subdivision from the three exogenous variables was left out in order to keep a clear overview.

Figure 63 Strategies & Evaluative criteria

TABLE II STRATEGIES

BIOPHYSICAL MATERIAL CONDITIONS	CHALLENGES & OPPORTUNITIES FROM CASES	STRATEGIES FROM CASES	STRATEGIES FROM LITERATURE (EVALUATIVE CRITERIA)
CITYPLOT	C transformative character of the development O flexible land-use plan	trade off between risk & scale	x
	C lack of urgency, knowledge and awareness at the municipality (policy)	program "New Sanitation"	the articulation and adjustment of expectations or visions the building of social networks
	C prohibiting rules	change of rules & regulations	constitutional reform
WATERSCHOON	O watertechnology HUB		connecting a problem definition to a policy issue
	C phased development	user feedback, extrapolation of research results	using the coalition to protect projects as learning experiment
EVA LANXMEER	O no existing infrastructure	financial contribution by inhabitants	the building of social networks
ATTRIBUTES OF THE COMMUNITY			
CITYPLOT	O creation of consensus & C creation of expectations	manifest	the articulation and adjustment of expectations or visions
	C self-builders	contractual obligation	the building of social networks using the coalition to protect projects as learning experiment
WATERSCHOON	O incentives for all actors	one project organisation & joint wallet	the building of social networks
	C different organisation of risk & responsibilities	extensive formal collaboration agreements	the building of social networks
	C gaining user support	visibility of the installations & information	x
EVA LANXMEER	C differing perceptions on levels of authority	creation of an improvement plan	learning and articulation processes
	C important role for inhabitants	joint venture	the building of social networks
	C required support from the neighbourhood (reluctancy on development and acquisition of the network)	BEL: meetings, information provision	the building of social networks
RULES			
CITYPLOT	C lack of information and technicalities of the system at PMB	program "New Sanitation"	the building of social networks
WATERSCHOON	O pilot project	use the availability of technical information to form a coalition of actors	using the coalition to protect projects as learning experiment
EVA LANXMEER	O enforcement of implementation and connection to the system	municipality as commissioner of the project	the building of social networks
	C installations on property of the drinkingwater company	contractual agreements creation of trust	the building of social networks

5.2.1 BIOPHYSICAL / MATERIAL CONDITIONS



Trade off between risk & scale - The transformative character of Cityplot provided opportunities. A flexible land-use plan resulted in multiple bottom-up initiatives to emerge. These initiatives gave rise to the idea of Buiksloterham as a 'living lab'; where innovations such as the integration of water and energy infrastructure became a possibility. The land-use plan stimulated the experimental character of the area. In order to cope with the uncertainties and additional risks, a trade-off between risk and scale was made. Although multiple other urban developments were interested in connecting to the system, the scale was limited due to higher risks. These risks originated mostly from objections from surrounding companies which caused delays. This was also a result from the transformation task of the area.

The transformative character and accompanying land-use plan provided opportunities for experimenting and the S.I. project. It was on the other hand also a challenge due to higher risks, which was strategically solved by limiting the scale of the project.

Program of "New Sanitation" - The absence of urgency and awareness for new ways of sanitation at the Municipality of Amsterdam was recently a kickstarter for the program "New Sanitation" (Dutch: Programma Nieuwe Sanitatie). This program has been set up by Waternet and the Municipality in order to get the topic of sanitation into the decision-making process at an early stage.

The Municipality is an important actor during S.I. projects, as they hold essential resources (e.g. permit provision, land-use plan). It is essential to enroll them in an early stage and make sure that similar expectations of the project are shared. This is one of the goals of the program. These goals correspond with the first and second strategy of Strategic Niche Management: "the building of social networks" and "the articulation and adjustment of expectations or visions". Unfortunately this strategy came forth from the problems that were encountered in Cityplot, and its effectiveness can only be evaluated in a later stadium.

Making use of policy documents proved to be an important strategy for the actors of Noorderhoek as well. The ambitions of the province of Friesland and the city of Leeuwarden to become a watertechnology HUB stimulated the Municipality of Sneek to facilitate water related businesses. As a result, they wanted to be involved and had clear goals with the decentralised sanitation project Waterschoon.

Figure 64 Strategies to address the first exogenous variable

Connecting problem definitions to policy issues is one of the strategies that was discussed by theory on Niche Entrepreneurs. The policy issue in the Municipality of Sneek was the need to connect their ambitions of participating in the watertechnology HUB to actual projects. The Noorderhoek development provided a perfect opportunity for this, which addressed the problem definition of the need for experimenting with new ways of sanitation.

Change of rules and regulations - All projects experienced prohibithing rules and regulations regarding the technicalities of the system. Besides getting exceptions on these rules, Waternet followed an additional path in Cityplot. They decided to go through the process of getting a legislative amendment (Dutch: wetswijziging) for the selling of phosphate on the market. Besides having a positive effect on the S.I. project in Cityplot, it was also done because Waternet is already recovering a lot of phosphate in other parts of Amsterdam. It was therefore worth it to go through this time consuming process.

Legislative amendments can be understood as changing the rules and resources of an entire network, as it takes place on the regime or even the landscape level. Changing rules and resources of the entire network was mentioned in PNM as constitutional reform. Although this strategy was successfully applied by one of the actors in an S.I. project, a certain scale was necessary before this actor initiated a process of constitutional reform. It was connected to a bigger project operated by the same actor.

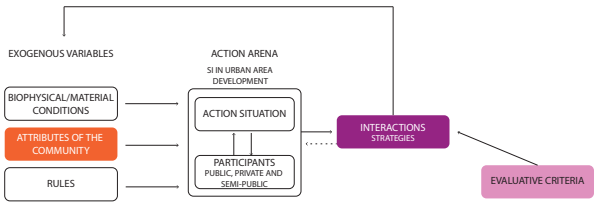
User feedback - Noorderhoek was developed in two phases. This provided the opportunity of integrating feedback from users from the first phase before constructing the second phase. The chance to learn from mistakes was used to enhance the system. Although this strategy was unintended (the phasing came forth from the financial crisis), building in phases might provide a good opportunity for learning processes. The niche was used to learn on the technical aspects as well as user preferences.

The project was in the first phase protected as a learning experiment. Due to the financial crisis it could not be developed according to plan, but actors decided to continue anyway.

Financial contribution by inhabitants - Because there was no existing infratructure in place and houses were built from scratch, the future inhabitants of EVA Lanxmeer financed a part of the S.I. project. A heating network had to be installed anyway and the 'not more than usual' principle was applied. By establishing a joint venture the inhabitants got a more prominent role within the network and enhanced the financial feasibility of the system.

The three theories of SNM, niche entrepreneurs and PNM all mention the strategy of engaging actors who possess usefull resources. Involving the inhabitants of the neighbourhood and using their investments for a heating system for the S.I. project is the perfect example of creating a social network. The reason that this could be done in EVA Lanxmeer was especially due to the major focus on social infrastructure in the neighbourhood and the overarching residents association.

5.2.2 ATTRIBUTES OF THE COMMUNITY



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Manifest - The manifest "Circulair Buiksloterham" caused both challenges and opportunities. It was initially used as a strategic tool to create consensus between actors, but also resulted in a lot of expectations. Cityplot suffered from this as some actors took an awaiting role and expected initiatives and actions to come from others.

Making sure that involved actors share similar expectations and that these are based on experimental results is a strategy from SNM theory. Additionally, drawing attention to an issue (niche entrepreneurs) and exploring opportunities for goal convergence (PNM) correspond to the intentions of the manifest. It appears from the case that if this strategy is applied, expectations between actors should be managed. A possibile solution for this could be to put expectations or visions into formal agreements at a certain point in the process.

Contractual obligations - Because Cityplot is partly developed by self-builders, challenges arise regarding the obligation to connect to the sanitation system. This challenge is addressed by extensive contractual arrangements, developed by Waternet and De Alliantie. It is essential for them to be 'watertight' (Dutch: waterdicht), as these connections are crucial for the entire system.

Self-builders are important actors that possess the resources to block a 'game'. According to PNM theory, selective (de)activation can be used as a strategy for continuing the game. In this case the game can be understood as the S.I. project. By developing contractual obligations to enforce a connection to the system, not the actors (self-builders) but their resources (the right to a regular sewage connection) are deactivated.

Formal collaboration agreements, central project organisation & joint wallet - The advantage of formal agreements was illustrated by the Waterschoon project, where extensive collaboration agreements made roles and responsibilities more explicit. A central project organisation with a joint wallet created incentives for all actors. The long time span of UAD projects adds to the importance of such formal documents. It provided e.g. sufficient guidance during a merger between housingcorporations De Wieren and Elkien. Roles and responsibilities were an established fact, which clarified Elkien's role after the merger.

Figure 65 Strategies to address the second exogenous variable

The project organisation in Noorderhoek provided a clear approach towards the process. A project group and steering group incorporating representatives from all actors created equality in hierarchie. It also had a positive effect on the transparancy of information and actors' goals. Although goals differed, there existed a clear vision for the end-product.

Because there was a single budget and a joint wallet, all actors ran a certain amount of risk. If the project failed everyone would be affected. This enhanced incentives to achieve a successfull project. There was however one actor who was not involved during the process: heating supplier Feenstra. Elkien has had multiple problems with the heating network, which might be explained by this lack of incentives.

Gathering actors from different fields and making sure that they interact on a frequent basis was ensured by the project organisation in Noorderhoek. The second strategy of SNM and niche entrepreneurs was used: creating and maintaining a coalition of actors that disposes over relevant values or resources. An addition can be made to this strategy which proved to be relevant in the case: the coalition was formally binding and incentives were created by sunk investments.

Visibility of installations and information provision - By developing a transparant building in the middle of the neighbourhood and providing information on the outside, users of the Waterschoon system have the opportunity to see what happens. Visibility created a feeling of pride and support among inhabitants.

This is one of the few strategies in the cases that comprises an actual physical intervention. Because S.I. projects in general entail complicated technological features, making the process visible enhanced communication with the neighbourhood.

Joint venture - Support from the neighbourhood in EVA Lanxmeer was an important pillar of the project. It was used as a strategy to ensure organisational relations within the system for district heating. A joint venture enhanced the important role of the inhabitants. In a later stadium, support was needed to acquire the district heating network. The BEL enhanced possibilities for creating support within the neighbourhood by organising meetings and the provision of information.

Inhabitants were enrolled in the process in order to expand the resource base. Besides them providing a financial contribution to the district heating system, their support was later on used to acquire the whole network. This support was obtained through the following strategy.

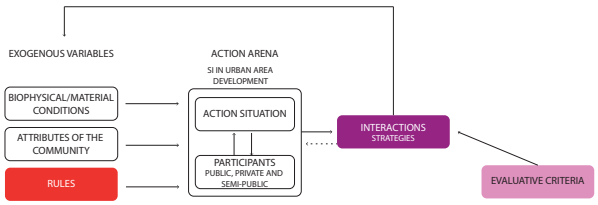
BEL meetings and information provision - There existed reluctancy about the acquisition of the district heating system among inhabitants. By organising meetings and handling information in a very transparent way, the BEL was able to convince a majority.

This strategy corresponds with the building of social networks. It was important to gather inhabitants as enough support was needed for acquisition. The existence of the BEL as a central organisation provided a way to communicate and enhance interaction.

Creation of an improvement plan - Although support from the neighbourhood had a positive effect on the implementation of the S.I. project in EVA Lanxmeer, a challenge occurred after implementation. Inhabitants had a different perception on the amount of participation than the Municipality of Culemborg. It needed to be clear how risks were divided and from there, responsibilities and levels of participation could be determined. An improvement plan was set up between the BEL and the Municipality, which states clearly where responsibilities and levels of participation begin and where they end.

It is important to determine from the start at what level inhabitants can participate. If it is a co-production, risks should also be distributed and if it's not, an actor can, at best, fullfill an advising role.

5.2.3 RULES



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Availability of information and coalition of actors - The pilot project that was executed before the Waterschoon project involved the same actors. It provided technical knowledge but also resulted in the actors knowing each other beforehand. By involving the same actors in Noorderhoek, trust between them already existed. The coalition was used to start and protect the project as a learning experiment.

Enforcement of implementation and connection to the system - Because the Municipality of Culemborg was the commissioner of the development project, opportunties arose. This actor was able to enforce the decision to implement district heating and oblige users to connect to the system.

By engaging the municipality with the project, a very important actor became involved. In other words, the social network and resource base of the experiment was expanded.

Contractual agreements and the creation of trust - The installations of the district heating network in EVA Lanxmeer are located on the property of the drinking water company. This was initially not a problem as the drinking water company operated both systems. When the district heating network was acquired by Thermo Bello, these roles changed.

Aspects such as the ability to undertake interventions and regular practicalities were recorded in contractual agreements. Furthermore, trust between the two actors had to be created. This was achieved partly because the old manager of the drinking water installations became the operator of the district heating installations. The same people stayed involved in the system.

Figure 66 Strategies to address the third exogenous variable

5.3 CONCLUSION

This fifth chapters' intention was to answer the **third subquestion**;

"How and in what way do these variables influence this process [of S.I. in UAD]? "

And the **fifth subquestion**;

"How can challenges and opportunities be addressed by actors using a certain strategy? "

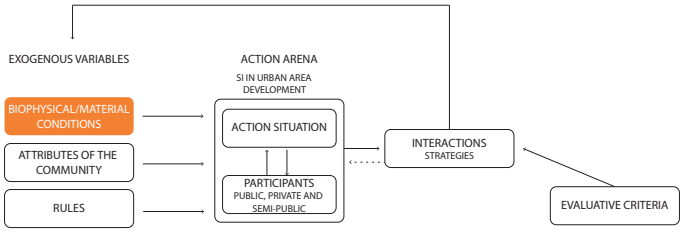
Together, these two subquestions are at the root of answering the **main research question** of this research;

"What are the challenges and opportunities of systems integration in urban development and how can these be addressed by actors?"

The third subquestion will now first be discussed for all three exogenous variables in respectively 5.3.1, 5.3.2 and 5.3.3. The fifth subquestion will be addressed in paragraph 5.3.4.

In order to identify the institutional factors influencing the S.I. process, exogenous variables from the IAD framework were used. The following aspects were found relevant in the studied cases.

5.3.1 Biophysical / Material Conditions



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The physical conditions of an area - proved to be a major factor for the possibilities of integrating infrastructural systems. Availability of space, land prices, location and type of development were all influential during the decision-making process. Because these conditions are coming from a landscape level, they are difficult to change and niche experiments have to adjust.

Financial challenges derived from a restriction in scale and the characteristics and the amount of space needed for the installations. Opportunities arose when no infrastructure was in place yet and houses were built from scratch. This was an important condition for implementing S.I. in all three cases.

Scale restrictions - for S.I. caused by the UAD scale are a challenge for the financial feasibility, but can also be a deliberate consideration. Experimental or niche projects are often first tested on a small scale to reduce risk. They are therefore not immediately financially feasible but provide knowledge to eventually scale up towards a regime level.

Figure 67 Challenges and opportunities from the first exogenous variable
Figure 68 Challenges and opportunities from the second exogenous variable

This is one of the reasons why niches are first protected from the market.

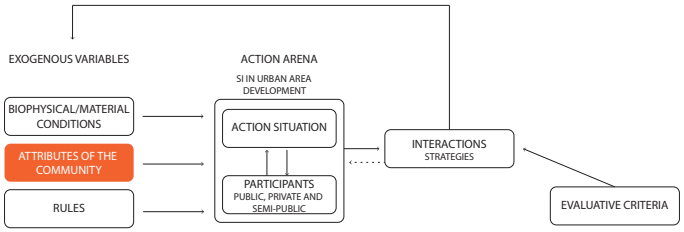
Existing policies - on sustainability ambitions provide opportunities rather than challenges. Awareness and urgency for S.I. or a lack thereof are important aspects and can be created by clear ambitions and goals derived from governmental policy. When policy is scattered due to the many departments involved it is more complicated to achieve this sense of urgency and awareness. This element will be further illustrated in 5.3.2 *.

Rules and regulations - hampered the implementation of several aspects of the system, but were overcome by exceptions. The legislative system operates from the landscape level and is difficult to change.

The organisational structure - of UAD proved to be a challenge. An unconventional role division in Buiksloterham caused the urban plan to be made by the developer. Installations of the S.I. project had to be integrated but late involvement of actors caused difficulties, resulting in a different location for the raw materials station. Early involvement of actors is therefore considered essential when physical interventions are needed.

Involving important actors and stimulating collaboration can be achieved by a clear project organisation. A steeringgroup and a projectgroup such as in Noorderhoek gives actors within these groups the same amount of authority and eliminates hierarchical thinking.

5.3.2 Attributes of the Community



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Corporate values within ones own organisation - especially caused challenges in the bigger (public) organisations. The more departments involved, fullfilling different tasks, the more diverging values exist within the organisation. This might be more of an issue in public organisations which are influenced through a political background. Municipal departments account to different aldermen with different political backgrounds. Municipalities could be representing different regimes within one organisation: departments and their actors acting from a different background with their own sets of rules.

Values between organisations - tend to differ even more. Different "languages" came forth from different goals: successfully developing an urban area and giving room to the experiment. (5.3.1*) Short lines between organisations provided opportunities for this problem. The two municipalities of Sneek and Culemborg are both relatively small compared to Amsterdam which enhanced more direct relationships between actors. This can also have an effect within the organisation, where decisions need permission from less departments.

Although having **similar goals** with the project is regarded as unnecessary, all actors do need to have an incentive. When the feeling of urgency is lacking, it is difficult to involve important actors and their resources because priorities lay elsewhere.

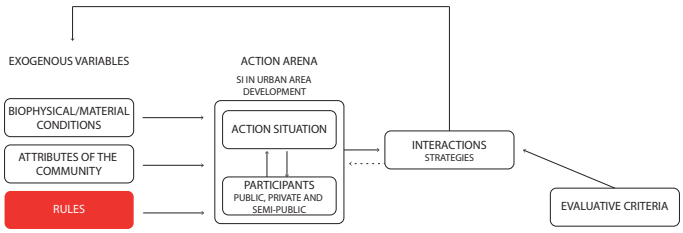
When goals change and a project loses its experimental character it becomes a challenge to continue the S.I. project. This is a very specific challenge for niche projects, as some actors might only be interested in the outcomes of the experiment. When research results turn out negative, the project might be too expensive to keep in operation and partly loses its goal.

The roles and responsibilities of future users - differed very much in the studied cases. Some of the main findings were that the target group for which houses are built usually determines the amount of influence that users can exert. Social housing renters are involved after construction and unknown before development. Self-builders are involved in an earlier phase, before construction. However, they are also unknown in the extensive run-up towards development.
Inhabitants can become involved by setting up a joint venture. This provides them with ownership and gives them a more important role. When users are involved from the beginning, the are able to provide a financial contribution for the new infrastructure.

Concluding, the target group is an indication for when inhabitants will become known/involved. Nevertheless, end users are in general not involved during the whole UAD process, which can sometimes take years before construction starts. Phasing of the development can provide a way to integrate feedback from inhabitants into the S.I. project.

Another important element is the amount of say they have about their own house and infrastructure. Some target groups will be more specific on their wishes for e.g. sanitary products and appearance.

5.3.3 Rules



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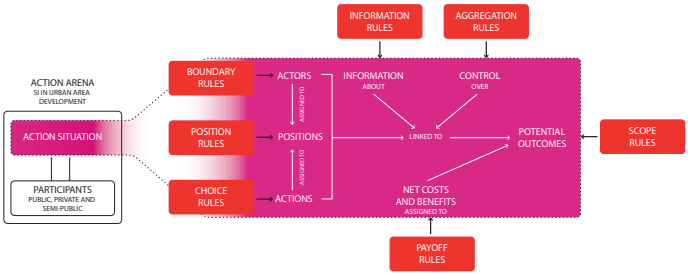
Seven rules, often described as the institutional arrangements, were the third and last set of variables influencing the action arena in the IAD framework. In a way, this is a special set of variables, as it influences specific parts of the action situation.



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Boundary rules - are the conditions for entering or leaving the process. UAD processes and their actors are very much bound to a location, resulting in the presence of certain actors and no selection procedures taking place. This enhances complexity for S.I., as key players and existing monopolists become automatically involved.
A second element that caused multiple challenges in the cases was tender procedures. Besides making it complex to engage product suppliers and developers in an early stage of the project, the long time span of UAD adds to this problem.

Boundary rules clearly derived from the regime and landscape level of the UAD system. The rules for the type of actors that are involved in the action situation are therefore difficult to change, and niches such as S.I. projects have to adjust.

Position rules - specify which positions are available and how many actors can hold these positions during the process. Although studying innovative projects where new types of roles and responsibilities are argued to emerge, responsibilities stayed more or less the same in the studied cases. Due to the long time span of UAD and S.I., roles did change during the process due to mergers and acquisitions or new (economic) impulses. Formal agreements provided guidance during these changes.

Because roles and responsibilities stayed more or less the same, actors could incorporate their expertise. Acting from one's own field provides stability and trust. However, for some actions actors might need to start fullfilling new types of roles. This will be discussed into more detail at the choice rules.

The scope and geographical domain of the projects were determined by the **scope rules**. Because S.I. took place in UAD projects, the scope was restricted to the location and had a certain geographical outreach. This was influenced by tender procedures and risk considerations. The technical scope of the S.I. project was additionally influenced by a district heating concession in one case.

Because these projects were considered as niche experiments, the scope was furthermore determined by its experimental character. Financial and economic outcomes were therefore considered less important, and results from research more important. When upscaling towards the regime is required, this scope shifts and a (financially) feasible businesscase will become a more important outcome.

Information rules - determine the amount and type of information available for actors. Because niches often entail multiple innovations, little (technical) information is available beforehand. A pilot project on a small scale can provide this missing information which is especially essential for actors handling the UAD process.

Information about innovative technologies will remain largely unknown beforehand as the main goal of a niche is to experiment. This can cause challenges in S.I. as multiple regimes are integrated.

Choice rules - determine the authority that actors have and the actions they can perform. Actions of actors in two cases (Buiksloterham & Sneek) stayed within the actors' traditional tasks. New opportunities for S.I. can emerge when actors start to perform actions which are not part of their regular responsibilities. Culemborg is a good example where a drinkingwater company started successfully operating a district heating network. These rules on what actions actors can take is often determined within one's own organisation. They are part of the regime level.

Rules about action within the project that were recorded in informal documents caused a challenge as actors took awaiting roles and (unfair) expectations about taking action were created.

Decision-making procedures were referred to as the **aggregation rules**. Actors' contribution to decisions differed in the three cases.

When there is no central project organisation, the way in which actions are performed remains largely unclear and stays within the organisation. A central project organisation where all actors have the same amount of authority enhanced collaboration. Insight into each others decision-making procedures enhances trust.

The payoff rules - for niche experiments are often related to the outcomes of the research. However, when the experimental goal is missing or changes, economic and financial feasibility becomes more important. This illustrates how the transition from a niche towards the regime level takes place.

Figure 69 Challenges and opportunities from the third exogenous variable
Figure 70 The rules that influence the action situation

5.3.4 Strategies

This paragraph addresses the last and **fifth subquestion**;

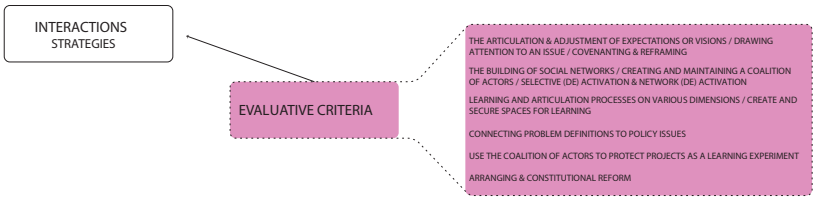
"How can challenges and opportunities be addressed by actors using a certain strategy? "

We discussed what challenges and opportunities emerge during the process of S.I. in the previous paragraphs.

The interactions between actors in the studied cases were analysed and the **fourth subquestion** that was addressed in chapter 2,

"What are the existing strategies for systems integration in urban development projects?"

provided six criteria from theory of Strategic Niche Management (SNM), Niche Entrepreneurs (NE) and Policy Network Management (PNM) in order to evaluate the strategies that were used.



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I will conclude with the main findings for each of the evaluative criteria. Similarities and differences with the studied cases will be described and if possible additions to literature will be given.

1

Drawing attention to an issue was used to address challenges in the case of Buiksloterham and connected to two documents: the program of "New Sanitation" and the manifest "Circulair Buiksloterham".

Challenges arose during the process because there was a lack of urgency, knowledge and awareness on the topic in some municipal departments. The program "New Sanitation" is currently being developed to get the topic of new ways of sanitation into the decision-making process of the municipality at an early stage. Its intention is to bring the niche experiment into the regime level decision-making process of UAD.

The aim of this program is to attract attention from an external actor, which coincides with the first criteria of SNM. Although the program is focussed on articulation of a vision (new ways of sanitation as an opportunity for new developments) it is unsure whether it also addresses the adjustment of expectations and explores the opportunities for goal convergence.

The manifest "Circulair Buiksloterham" was used to draw attention

Evaluative criteria 1

The articulation and adjustment of expectations or visions (SNM)
provide guidance for innovation processes and aim to attract attention and funding from external actors. It is about making sure that all of the involved actors share similar expectations and that they are based on experimental results

Drawing attention to an issue (NE)

Covenanting (PNM)
meaning that similarities and differences in actors' perceptions are explored and opportunities for goal convergence are studied

Reframing (PNM)
changing the way in which actors perceive the network

to circular urban development and create enthusiasm among all actors in the area. This strategy was specifically focussed on the creation of niches. Because there were no formal agreements on the stated ambitions, this unfortunately resulted in awaiting roles from all actors.

The articulation and adjustments of expectations or visions addressed challenges from the first (governmental policy) and second (attitude of actors) exogenous variable. Although policy was mentioned in literature as a possible barrier for S.I., it is actually used as a strategy to change interests and positions of participating actors in one of the studied cases.

From the experiences of actors regarding the manifest we would like to make an addition to this criteria. Drawing attention from external actors is necessary, but expectations about the project should at a certain point be formalised.

2

Evaluative criteria 2

The building of social networks (SNM)
the enrollment of more actors, which expand the resource base of niche innovations. The aim here is to gather actors from different fields around the innovation and make sure they interact on a frequent basis

Creating and maintaining a coalition of actors that disposes over relevant values or resources (NE)

Selective (de)activation (PNM)
selecting and de-activating certain actors that possess the resources to block a game, or selecting and activating actors that possess the resources to continue/start a game

Network (de)activation (PNM)
changing the configuration of the network by bringing in new actors or changing the positions of existing actors

The building social networks was used in all three cases to address challenges and opportunities of all three exogenous variables.

The two documents (program and manifest) that were compared to the previous evaluative criteria partly match with this second criteria as well. By drawing attention, actors that possess important resources such as the municipality can be enrolled in the project.

Several resource bases were expanded within the cases. Involving the municipality with the district heating network in Culemborg enabled the implementation and enforcement of connections. Inhabitants were gathered in a joint venture to expand financial resources. The existence of the inhabitants association (BEL) made it possible to engage users through meetings and provided the means to spread information. These actions were all based on successfully developing a niche.

There was one example in which actors were *de*-activated. The self-builders in Buiksloterham form a potential threat to the system and have to be obliged to connect to the new infrastructure. Their resources to block the S.I.project are currently deactivated by contractual arrangements.

3

Evaluative criteria 3

Learning and articulation processes on various dimensions (SNM)
e.g. technical design, market demand and user preferences, infrastructure requirements, organisational issues, business models, policy instruments and symbolic meanings. This allows identifying and implementing necessary technological adjustments.

Create and secure spaces for learning (NE)

Several learning processes took place in the cases of Noorderhoek and EVA Lanxmeer.

Differing perceptions on authority between inhabitants and the Municipality of Culemborg brought up challenges. By setting up an improvement plan, the role division and amount of participation were clarified. This shows how a niche can be used to create spaces for learning processes on organisational issues between actors.

The waste shredders in Noorderhoek in the first phase caused some

trouble. By incorporating feedback from the inhabitants, shredders for the second building phase were improved. The identification of necessary technological adjustments was further facilitated by the independent research that is performed by STOWA.

4

The one case where a problem was connected to a policy issue was in Noorderhoek, Sneek. Existing policy ambitions of becoming a water technology HUB and facilitate water related companies was connected to the wish of other actors to experiment with new ways of sanitation.

The fact that the municipality was involved and motivated facilitated the project. Connecting a problem to a policy issue can be a major incentive to enroll an essential actor such as the municipality with the S.I. project.

5

The influence of coalitions to protect the S.I. projects was illustrated by the cases in several ways.

The manifest in Buiksloterham was aimed at bringing actors together and drawing attention to the topic of circular development. The coalition of actors that signed the manifest was used to set up several experiments ('living labs') in order to test sustainable solutions for urban areas. However, when the economy started to recover and the building sector picked up, it was difficult to keep this experimental character.

The pilot project in Sneek created a coalition of actors that was willing to test new sanitation on a larger scale. By incorporating the same actors, the coalition was used to start the experiment in Noorderhoek with the Waterschoon system. Even though construction was stalled after the first phase, the coalition still pursued with the experiment. The phasing was positively used to integrate feedback in the second phase and extrapolate the results from the first phase.

When coalitions of actors were able to protect the project as an experiment it had a positive influence on the S.I.

6

An example of constitutional reform in order to address a challenge was found in Buiksloterham. Rules for the selling of phosphate on the market prohibited the complete use of recovered resources.

A legislative amendment was pursued by Waternet which means that the rules of the entire network would need to change. Connecting this to the MLP, landscape levels are addressed by a niche project. This was stimulated due to their large sales market and therefore more incentives for change.

Evaluative criteria 4

Connecting problem definitions to policy issues given the existing political and institutional context (NE)

adjustment of preferred problem definition and policy change to the interests and expectations of other actors

Evaluative criteria 5

Use the coalition of actors to protect projects as a learning experiment (NE)

Evaluative criteria 6

Arranging

on the institutional level, ad hoc provisions which suit groups of interactions have to be created, sustained and changed.

Constitutional reform

on the institutional level, changing the rules and resources in the entire network or changing the ecology of games in a fundamental game

Figure 71 Evaluative criteria vs strategies from the cases

5.3.5 Conclusion

Strategies that were used in the cases did more or less respond to the evaluative criteria from literature. Some strategies even corresponded with multiple criteria. Most strategies were used to start or continue the niche project. It was also our aim to do research into the process within a niche. However, some strategies also addressed challenges for upscaling towards the regime level. The program of new sanitation and legislative amendments for selling of phosphate are examples of such strategies.

Activating actors and expanding the resource base for S.I. was endeavoured through multiple strategies: incorporating the municipality in order to enforce implementation and connections, involving inhabitants through a joint venture and obtaining a financial contribution and the creation of incentives for all actors by a single project organisation and joint wallet.

At some points, the evaluative criteria remain quite general. Although attention is drawn to an issue, in order for a niche to be created some formal agreements are needed.:

The articulation and adjustment of expectations can attract attention and funding from external actors. This way, a coalition of enthusiastic stakeholders can be established. When high ambitions are set, the expectations between actors should be managed. Besides articulation of expectations they need to be put into detail and it should be clear who's responsible for what.

Problem definitions can be connected to policy issues in order to establish S.I. projects. Issues regarding sustainability ambitions provide opportunities for experimenting with circular solutions. We saw this happening successfully in Sneek; where the ambition to become a water technology HUB was connected to the . However, a remark regarding the size of organisations should be made here.

The strategy to connect the wish to experiment with S.I. to an existing policy issue can be successfull. Municipalities are actors that can be the owner of such policy issues. Smaller municipalities (such as Sneek) have less different departments and tasks are therefore less scattered. People working at these departments are often aware of existing policy issues on multiple levels.
Big municipalities (such as Amsterdam) have a lot of different departments with different tasks and different aldermen. These aldermen have different political backgrounds and different policy issues. When multiple departments are involved in e.g. UAD, not all departments are aware or alligned with policy issues in other departments (PMB, G&O, R&D, Maintanance, etc). It is more difficult to connect a problem to a policy issue when multiple departments have to be aware and convinced.

VI CONCLUSION & DISCUSSION

6.1 CONCLUSION

Integrating multiple types of infrastructures in urban area development was at the root of this research. Although this is often considered to be a technical challenge, the institutional part of connecting socio-technical systems is underexposed. By examining the process of systems integration on a niche level, challenges and opportunities and strategies to address them were analysed in this research.

After the theoretical part and empirical analysis in the previous chapters, it is time for the conclusions. For this, the main research question will be repeated:

"What are the challenges and opportunities of systems integration in urban area development and how can these be addressed by actors?"

The five subquestions that lead to the answer to this main question will now be answered consecutively.

SQ 1 and 2 provide input for SQ 3, while SQ 4 serves to answer SQ 5. Because SQ 3 and SQ5 eventually lead to the answer of the main research question, they are intertwined and will be answered together at the end of this paragraph.

Subquestion 1: What is systems integration and what does it mean in an urban context?

Systems integration is perceived as an opportunity to make our cities function in a more sustainable and circular way. It constitutes the coupling of two (or more) infrastructural systems where waste products of one system are used as resources for another system. The technical innovations that are needed for this cut accross disciplines and requires the involvement of actors from different backgrounds. Consequently, socio-cultural change is needed in order to reach urban sustainability. This is a complex process.

Technologies can be conceptualised as socio-technical systems. Systems integration is about combining these socio-technical systems, which has the following effects: the connection of previously unconnected networks of actors and their rules, the development of shared rules and the change of rules. The process of systems integration can therefore be seen as a transition where existing structures of institutions are broken down and new ones are established.

Transitions of socio-technical systems take place at three scale levels: the micro (niche), meso (regime) and macro (landscape) level. During the systems integration process in a niche, multiple regimes and sets of rules start to overlap. Because urban area development is a complex process on its own due to its long time span and many actors involved, it adds a lot to the complexity of systems integration. The urban development process is an additional system on the regime level and contains a lot of influences from the landscape level.

Subquestion 2: What are the variables that influence the process of systems integration?

The institutional and spatial variables that influence the systems integration process in urban area development can be classified into the three categories of biophysical/ material conditions, attributes of the community and rules or institutional arrangements. These exogenous variables exert influence from the regime or landscape level.

The variables from the IAD framework were used as the three leading aspects influencing the decision-making process of a systems integration project. They were further subdivided into the biophysical variables (the physical characteristics of the area and installations and the type of urban area development), the economic variables (subsidy and other financial menas and possibilities for a business case), other necessary/ available means (policy, rules and regulations and organisation of the project), general corporate values (understanding and preferences within and between organisations), attitudes of actors towards each other (actors' point of view and willingness to cooperate) and user involvement (the extent to which users were involved during the project and the amount of influence they could exert).

Additionally, the seven "rules" or institutional arrangements identified by Ostrom were found as relevant variables for the process: the boundary rules (number of participants, their attributes and resources, whether they can enter freely and the conditions for leaving), the position rules (roles and positions of actors), the scope rules (potential outcomes and actions linked to outcomes), the information rules (the amount and type of available information), the choice rules (actions that actors can or can't perform), the aggregation rules (how actions are performed) and finally, the payoff rules (affecting the costs and benefits related to actions and outcomes).

These variables were at the basis of the conceptual model and mainly determined the interview questions for the empirical part.

Subquestion 4: What are the existing strategies for systems integration in urban development projects?

Systems integration is a relatively new and innovative concept and no *specific* strategies to achieve a succesfull process exist. They take place in niches and entail complex networks where multidisciplinary actors interact. Theory on Strategic Niche Management, Niche Entrepreneurs, and

Policy Network Management provided insight into the criteria for achieving successfull niche projects. Because the descriptions sometimes showed similarities, some have been considered as one.

1 The articulation and adjustment of expectations or visions (also drawing attention to an issue or covenanting/reframing) aims at attracting attention and funding from external actors. It is about making sure that actors share similar expectations based on experimental results. Differences and similarities in actors' expectations should be explored in order to find opportunities for goal convergence. On a higher scale level, this means that actors' perceptions of the network (regime) need to change.

2 The building of social networks (also creating and maintaining a coalition of actors and selective (de) activation/network (de)activation) is the enrollment of actors that possess relevant values or resources for the niche experiment. The aim is to gather actors from different fields and make sure they interact with each other frequently. Actors that possess the resources to block the experiment need to be deactivated, while actors possessing the resources to continue or start the experiment should be activated. On a higher level, this means that the configuration of the network (regime) shoud be changed by bringing in new actors, or the positions of existing actors need a change.

3 Learning and articulation processes on various dimensions (and the creation of spaces for learning) aims at identifying and implementing necessary technological adjustments based on e.g. market demand, user preferences, organisational issues etc.

4 Connecting a problem to a policy issue given the existing and political context aims at adjusting the specific problem definition and ideas for policy change of one actor to the interests and expectations of other participants. This is also known as issue linking.

5 Use the coalition to protect projects as learning experiment is related to the third strategy of creating spaces for learning. Besides creating them, the project should also be protected as a learning experiment.

6 Arranging and constitutional reform aims at creating, sustaining and changing provisions that suit a group of interactions. On a higher level this means changing the rules and resources in networks (regimes) or trying to change the ecology of the niche fundamentally.

These are six strategies that can be used by actors in systems integration projects.

Subquestion 3: How and in what way do the variables influence the process of SI?
&
Subquestion 5: How can challenges and opportunities be addressed by actors using a certain strategy?

The ways in which these variables influenced the process of S.I. in UAD was researched by analysing the three cases of Cityplot in Buiksloterham, Waterschoon in Noorderhoek and EVA Lanxmeer in Culemborg. Influential variables were identified and analysed on whether they influenced the process in a positive (providing opportunities) or a negative (providing challenges) way. The strategies that actors used to deal with these challenges and opportunities were then described and evaluated against the six criteria from subquestion 4. The main findings were as follows.

1 The impact of the UAD system

Variables derived from the urban area development (UAD) system had a large impact on the studied projects. Urban development and systems integration processes are both very much bound to their location. This makes the choice to select specific actors difficult, and projects in general have to "deal" with the presence of existing actors in the area. Actors from the UAD system such as municipalities and housing associations are responsible for a certain region. Monopolists furthermore often control infrastructural systems in urban areas. Depending on the willingness of these actors to cooperate, their sense of urgency and awareness of a problem, existing actors can be either a challenge or an opportunity.

This characteristic of present actors is determined by the boundary rules. Institutional arrangements determine the number of participants, their attributes and resources, whether they can enter freely and the conditions they face for leaving. These aspects are often entirely determined by the location of the UAD project. For the few actors that can be selected, long time spans and tender procedures form a barrier to become engaged in an early phase of the process. This makes it challenging to select e.g. product suppliers, include the fertilizer industry (Dutch: kunstmestindustrie), homeowners and organic waste processors in an early stage of the systems integration process and make use of their expertise. Additionally, not engaging actors from the start can also create fewer incentives for the system and installations working in an optimal way.

Because there is little flexibility of the boundary rules and actors can hardly be selected, the activation or (de) activation of actors is difficult. The building of social networks, with the goal of expanding the resource base, has to be achieved with present actors.

One of the most important actors that plays a role in the UAD process is the municipality. Municipalities are an important actor due to (among other things) their power over the land-use plan and permit provision. This is especially the case in Amsterdam, where a lot of land is still in leasehold (Dutch: erfpacht). Municipalities furthermore have the power over the sewage system in most cases. Consequently, they are an essential actor to incorporate in the decision making process of integrating (wastewater) infrastructures.

Connecting a problem with a policy issue is one of the possibilities to get the municipality engaged. We found a difference between small and large organisations regarding the effects of policy. Although smaller municipalities are often said to possess less capacity or financial means to realise innovative projects, policy does have a better outreach in small organisations. Lines are short and departments seem more alligned and less extensive. In large organisations, where tasks are scattered over multiple departments accounting to different aldermen, policy seems unsufficient to achieve awareness and urgency at all levels. It became clear in BSH that although a topic is integrated in the municipal sewage plan or the water management plan, additional steps have to be taken towards creating awareness.

Although the main focus is often on the infrastructural actors in such projects and the (new) roles they should fullfill, the actors of the UAD process seem to play a major role for realisation. Not only are they location bound and already present, actors also bring specific restrictions regarding their ways of working and regulatory framework. Besides organisational challenges (e.g. tender procedures, urban plans, municipal practices, etc.), the financial opportunities of UAD are embedded on a higher level of land prices and projects are economically and politically dependent.

For complex UAD projects, multidisciplinary projectteams within the organisation can be set up. These teams integrate multiple departments, which enhances the input of expertise on every aspect of the development. Besides putting systems integration ambitions in official documents such as the building envelope, it could be usefull to integrate people from energy, water and waste departments within this projectteam. If the urban plan (Dutch: stedenbouwkundig plan) is developed by a developer, the municipality needs to reconsider their role: a regulating role or a more prescriptive one. This decision is also bound to legal obligations regarding the building regulations (Dutch: bouwbesluit). The type of role that the municipality wants to fullfill in systems integration projects is an important part for determining a course of action.

2 Physical characteristics of the systems' infrastructural requirements

Systems integration often requires new types of infrastructure, also within houses (e.g. vacuumtoilets, low temperature heating systems, etc). Because infrastructural systems comprise long-term investments, it is not always possible to integrate new installations and systems with the existing infrastructure. Newly built houses and greenfield developments (where no infrastructure is in place yet) or where there exists a replacement task provide the best opportunities. Besides the type of development, the location also plays an important role. Spatial requirements for the installations are less feasible in the inner city, where land prices are high and space is scarce.

The amount of connections to the system is limited to the scale of the UAD. In order to find a financially feasible and sustainable scale for S.I., the amount of houses built should ideally coincide. Connecting e.g. surrounding UADs enhances risk for delay and difficulties regarding tender procedures. This is more of a challenge when upscaling towards the regime level is required. Niches are in general first protected from market mechanisms and experiments are often performed at a smaller scale due to risk considerations. Not only should the scale of UAD be taken into consideration, ideal scales for the infrastructural systems also differ. The scale for transportation, buffering or supply of different systems does not automatically coincide. However, this is perhaps more of a technical aspect that should be solved.

When additional space is required, integrating physical interventions within the urban plan has to be done at the very beginning. Involving relevant (UAD) actors with the S.I. process is therefore crucial if installations need to be integrated in the urban plan. In order to achieve this, social networks between actors with relevant resources should be built in an early stage. Making sure they interact on a frequent basis secures continuous information exchange and facilitates physical implementation of the system. This is often a challenge as little (technical) information is avaible during innovative projects in an early stage.

The requirements for systems integration are physically depending on the UAD project. Besides the necessity for new infrastructure and interventions within the houses (opportunities therefore depending on the type of development), the necessity of physical space for installations is directly connected to the location of the development. Integrating installations in the historic centre of Amsterdam is evidently more complex than a greenfield development on agricultural land.

3 Distribution of roles and responsibilities

Keeping the organisation similar to the traditional distribution of roles and responsibilities provides opportunities. Existing knowledge from actors can be used to optimalise the product and system. Additionally, trust is established when actors perform their regular duties. However, transitions in socio-technical systems were argued to require new types of roles and institutional arrangements in the introduction of this thesis.

The case of EVA Lanxmeer showed that an infrastructural actor (a drinking water company) was able to succesfully take on another role (operating a district heating network). Challenges then arise regarding finding a place within the existing organisation, especially when the system is still operating on a niche level. Changes in the organisation (mergers, acquisitions, political direction, etc.) can lead to other ideas about roles. Because S.I. projects require long-term commitment, they will be affected when this happens. Nevertheless, combining tasks within one organisation has a positive effect as well: the amount of actors diminishes which can facilitate collaboration processes.

Whether actors should or can take on a different role or shift their responsibilities is very much depending on the ambitions and focus of the organisation. When certain roles are missing in a new type of system (e.g. the energy component of new sanitation is lacking) a specific demand is created. The ambition of taking on a different role for public or semi-public actors is driven by other incentives than those of private actors. Public actors will probably start thinking about new roles when the market is not willing to offer a certain service or product or when it is being considered as a public good.

Barriers for actors to act as urban system integrators were mentioned in theory on niche entrepreneurs. They included difficulties for public actors to be involved in activities that are market driven while private actors face difficulties in organising public activities. Questions about roles specifically arise regarding the responsibility for infrastructural systems such as energy and water.

Water has always been part of a collective system, while the energy system (more specifically energy supply) experienced a shift towards the privatised market in the '80s. However, the idea that public actors are responsible for infrastructure and more capable of making these long-term investments still exists. This means that municipalities or watercompanies/district water control boards might need to invest in energetic infrastructure in order to make systems integration a success. This causes difficulties, as intervening in a privatised market as a public actor results in unfair competition. The distribution of costs and benefits between public and private actors is complex when public actors finance parts of the systems and services operated by private actors.

4 Collaborating with different corporate cultures

Actors from different disciplines bring multiple corporate cultures together in systems integration projects. Challenges arose in Buiksloterham from differences in 'language', as some (UAD) actors were more projectoriented and some (infrastructural) actors rather processoriented. These different perceptions were strengthened by the creation of an official document stating circular and sustainable ambitions for the area. Although all stakeholders signed it, nothing was put into formal or binding agreements. As a result, different expectations about taking action existed. The choice rules (actions that actors can (t)/should (n't) take) were not made explicit enough.

The articulation of expectations or visions was mentioned as criteria to make sure that actors share similar expectations, based on experimental results. Similarities and differences in actors' perceptions should indeed be explored in order to reach goal convergence, but the importance of making ambitions formal at a certain point needs to be emphasized.

Working together in formal ways proved successfull and necessary in the studied cases during the long-term commitment that S.I. comprises. Additionally, UAD projects also have long time spans. It was not uncommon that companies merged or were acquired by others, and goals changed. Formal agreements provide clearity on roles and responsibilities during the process and afterwards.

Difficulties exist regarding collaboration between different organisations, which increase when systems are combined. Although the articulation of expectations between actors is essential, this might not be enough to reach an actual course of action. Formal agreements can help making this more explicit, and play a role during the long time spans of UAD and S.I. The downside of formalities is that they can make processes rigid and inflexible which is not desirable in innovative projects. This is a trade-off that organisations need to make.

5 Connecting the MLP and IAD framework to the process of S.I.

Transitions as discussed by the MLP usually take place over long periods of time. The focus of this research was not on the transitioning process of S.I. but on the institutional process within a niche. However, regime and landscape levels were found to be important for this.

Influential factors that came from the regime level were differences in 'language', ways of working together and the distribution of roles and responsibilies. More broad and external factors that are argued to be beyond the range of influence of actors (landscape level) were, among others, rules and regulations, policy, tender procedures and land prices. These influences were considered as the exogenous variables in the IAD framework.

Niches are perceived as protected spaces where innovations can be developed and have the ability to act as an incubator for regime (meso) changes in the MLP. We adjusted the IAD framework in the second chapter by adding a relation between interactions (strategies) and the exogenous variables. This connection between strategy and exogenous variable became especially apparent in the BSH case, where actors from the niche level pursued a legislative amendment (landscape level). In EVA Lanxmeer, a change in the regime was made when a drinking water company started operating a district-heating network (taking on a different role). Furthermore, the acquisition of the network by inhabitants also required changes in the set of rules (regime) of the involved actors.

The IAD framework provided a possibility to analyse the influence of exogenous variables on the institutional process. This was important for this research as it focussed on projects within a specific spatial environment: an urban area development. The biophysical/material conditions of the urban context and the infrastructural systems turned out to have a large influence on the institutional process. The physical and economic conditions of an area (in)directly determine the possibilities for systems integration, especially due to scale restrictions. The ideal scale of urban developments and infrastructure for water transportation, treatment, energy storage and -supply does not automatically coincide. The more systems are integrated, the more important diverging scales become.

Integrating different disciplines and sectors was another central part of the problem definition. Values that participants share or do not share, their preferences and the size and composition of the community were handles provided by the IAD for analysis. The creation of consensus and mutual understandings did indeed provide challenges. However, creating mutual goals seemed less important for success than creating cooperative attitudes.

The institutional arrangements are particularly special in S.I. because this is a new type of process and there are no rules yet. Nevertheless, actors bring their own ways of working and institutional arrangements with them when getting involved. Creating new institutional arrangements and rules for this kind of process was at the root of the IAD framework. Recommendations for this are discussed in the next paragraph (6.2)

6 Continuation of experiments in niches

Finally, the question exists on what to do with niches in which the experiment does not function in an optimal way. This seems more difficult when innovations are related to a long-term investment such as infrastructural systems. When research has been performed and the niche has fullfilled one of its main goals (namely providing knowledge), outcomes are more difficult to adjust. It might be necessary for actors to think about the phase after experimentation and research, especially with infrastructure and urban developments, as these are not easy aspects to change when outcomes turn out dissappointing.

6.2 RECOMMENDATIONS

The main goal of this research was to give recommendations to the stakeholders of systems integration projects in urban area developments. It was initially especially focussed towards the actors of "Straat van de Toekomst", a project planned for the Floriade, taking place in the Netherlands in 2022. The infrastructural systems that are to be combined in this project was leading for the selection of cases for this thesis.

After having obtained the results we argue that there is a variety of factors influencing the process. The research shows that elements such as location, type of development en involved actors have a large impact besides the type of systems that are integrated. It is therefore unlikely that the outcomes of the three studied cases can function as a specific guide for "Straat van de Toekomst".

However, the studied cases did provide valuable (but more general) insights into the institutional process taking place in such projects. Recommendations will therefore be given that can be used by a broader range of actors integrating infrastructural systems in urban areas.

1 Determining the actors with relevant resources, adjusting strategies towards it and the creation of incentives.
First of all, we concluded that the physical conditions of an area have a large impact on the integration of infrastructural systems. Because these conditions normally derive from a landscape or regime level, they are difficult to change and the S.I. project initially has to adjust. When the main goal is to experiment with new technologies a protected space for learning can be made (niche), often called a 'living lab'. However, in order to get the systems integration project connected to the regime and landscape level of the urban area one should consider the location (land prices and availability of space) and the type of development (greenfield and no infrastructure in place). The higher land prices are, the more difficult it becomes to integrate installations that require space. The implementation of S.I. (taking into account that it is still in its experimental phase) seems only possible on specific locations and specific developments.

If installations have to be integrated in the urban plan, actors from infrastructural systems such as water- or energy companies should provide technical information in an early stage of the process. In order to do this it is important to determine who 's developing the urban plan. There are multiple possibilities for this, ranging from municipal departments to developers or housing associations. Getting involved in the decision making process of a public actor requires a different strategy than with a private actor. Insight into the incentives of the actor developing the urban plan need to be clear. A developer in general probably wants to make it attractive for potential buyers by e.g. providing a discount on municipal taxes (waste collection or water tax). Housing associations want to provide their renters with affordable housing. This range of incentives for collaboration differs a lot. In order to get a clear overview of actors and their incentives, an extensive actor analysis will be usefull.

2 Making a distinction between small and large organisations and choosing the appropriate strategy
If large organisations are involved with the project, corporate values between departments seem to be more divergent. Even worse, some activities of one's own organisation could be negatively affected by the systems integration project. Especially in municipalities, where different departments account to different aldermen, tasks and values are diverse. All departments that possess the resources or authority that is needed for the S.I. project, have to be convinced.

Policy can have a stimulating effect on the creation of niches and experimenting with new technologies. By connecting a problem to a policy issue, actors with important resources can become involved. Although it can indeed enhance opportunities, the extensiveness of involved public actors should be taken into consideration. When tasks and responsibilities are spread over multiple departments it becomes more difficult to connect to a singular policy issue. It is then usefull to get the topic/problem into the decision making process at a smaller scale and make it politically independent (mainstreaming).

3 Managing expectations and formal agreements for action

Goals between organisations differ, as actors come from different sectors and backgrounds and have different tasks and responsibilities. Making sure that actors share similar expectations about the project and exploring the possibilities for goal convergence were mentioned in literature as important strategies.

Having exactly the same goal is not considered to be necessary in order to reach a successfull process. Actors might work towards a different goal which is obtained by realising the S.I. project. More emphasis should be on the expectations about the process instead of the product.

To prevent difficulties from differences in language and expectations about action, ways of working should be formally agreed upon. In order to identify different perceptions beforehand, communication about expectations and visions is a key element.

4 Creating a central projectorganisation with a joint wallet en risk division

A project organisation where actors with essential resources are involved early in the decision making process is needed for successfull implementation. First of all, actors that possess these resources need to be identified. Experimental niche projects make this more challenging as this might be unknown at the start.

The actors that possess essential resources within their own system are known. This can be the municipality in the development system or a monopolist of district heating in the energy system. One of the barriers could be that the systems integration project affects the activities of an organisation in a negative way.

A central project organisation with a joint wallet enhances incentives for all actors. Equality in hierarchy within the organisation can improve collaboration.

5 Thinking about the future

Niche projects often have an experimental character and goal. When results of the experiment become known, some actors lose their incentive for continuation of the project. The fact that S.I. and UAD entail long term investments and time spans makes this an important characteristic of niches. Actors should think ahead about the project after experimentation.

This reflects on the third recommendation. Although not everybody needs to have a similar goal, when long term investments are required for infrastructure, differing goals should have similar timelines.

Difference between actors that stay involved or that are only involved for a certain period during the project.

Results

This research is explorative of nature. Because there was not a lot of information available beforehand about the process of systems integration (and especially the combination with urban area development), little expectations about the results existed.

However, I would like to shortly reflect on the approach of the research and usage of the framework. In the second chapter, the MLP was argued to be lacking handles to perform research into the institutional process of a niche. Although the MLP is often used to describe and analyse transitions, the process within a niche remains a "black box". Besides, the MLP originally derives from theory on product innovation. Transitions in governance and policy areas are more of an extension. The IAD framework was therefore chosen as an alternative to obtain more insight into the institutional elements of systems integration projects in niches.

Looking back, this provided a lot more depth into the research. The IAD was found to be usefull in the first place for showing how institutional processes work and how changes within them come about in a very systematic way. The framework was the backbone of the interview questions and proved to provoke good interviews with actors. Exogenous variables that were determined beforehand by literature were often recognized and found relevant by the interviewees.
An important characteristic of this research was that it specifically focussed on S.I. in an *urban context*. The IAD made it possible to integrate spatial elements into the theoretical framework. This was essential as projects proved to be very dependent on the urban development.

Additionally, the IAD provided a way to reflect on the interactions between actors. Three theories (SNM, niche entrepreneurs and PNM) provided six criteria for evaluating how actors responded to challenges and opportunities emerging from the exogenous variables. We found that the six criteria responded to some of the strategies that actors used, but remained quite general. Strategies in the cases were dependent on a lot of factors and originated from the specific characteristics of the development. Additions that can be made exist of e.g. the formalization of processes (arising from the long time spans of systems integration and urban area developments) and making a distinction in estimating the influence of policy in large and small organisations (such as the municipality).

Finally, the traditional IAD framework provides an opportunity to evaluate outcomes. This element was not addressed in this research. In order to assess whether the outcome of a project was successfull requires certain criteria (e.g. economic efficiency, accountability or adaptability). It was not the aim of this research to investigate these aspects of the system. Furthermore, this would've been impossible for most of the cases as this information was not available (yet).

Limitations

Although this thesis has led to an extensive set of challenges and opportunities for systems integration in urban area development and provided well-funded insights into the strategies that actors used to address these, some side notes should be made regarding the research process and outcomes.

Collaboration processes often entail sensitive information. Especially when the project is still being developed, it is not unthinkable that some information is kept private. Interviews were held with people who were willing to provide insight into some very specific issues. This provided extra depth for the results. By coincidence, most of the interviewees in Buiksloterham had just stopped with the Cityplot project. This resulted in more openness about the challenges that were encountered because the interviewees didn't have to work together anymore.
It would be a good idea to interview actors after the project has been finished or they've stopped working on it, as collaboration is vulnerable and interviewees will be carefull giving sensitive information.

Second, one of the cases has been operating already for over a long period of time. Multiple actors from the S.I. project in EVA Lanxmeer were therefore no longer involved and reachable for an interview. The actors that were able to provide information did sometimes have difficulties with remembering details from 20 years ago. A lot of information from the first phase was gathered through the extensive research on this case performed by Vernay (2013). This provided the opportunity to cover most of the process from the first implementation to the period of acquisition by Thermo Bello. Although such a case provides valuable information about a long period and enables us to see how such projects develop over time, obtaining acurate information is easier in recently developed cases.

Last but not least, only a limited amount of cases has been researched. This was partly due to time limitations, but also due to a limited availability of innovative S.I. projects. Little urban area developments have integrated multiple infrastructural systems. It is a relatively new concept, and research results should be conceived as a first intent to extent the knowledge on these types of collaboration processes.

Recommendations for future research

1.0 The development of a model that tests the impact of challenges and opportunities for collaboration in S.I.

2.0 The development of more specific strategies for the institutional process of S.I. in UAD.

3.0 Further investigation is required in general for the roles of actors, the coalitions and ways to collaborate in the water/energy nexus.

4.0 The realisation of more niches incorporating S.I., in which not only technical but also social configurations are experimented with.

5.0 Further investigation into the use of the IAD framework for the (institutional) transition towards circular cities.

VII REFLECTION

Systems integration projects were at the root of this research. Although I do believe that the recovery of resources can help us in reaching more sustainable development, there are some important considerations before implementing S.I. projects in UAD.

Integrating multiple infrastructural systems such as energy with (waste)water is often connected to decentralisation. This is caused by technical aspects such as the fact that vacuumsystems for sewage do not work over large distances, and social aspects e.g. active citizens wanting to operate their own system and being independent.

Opinions on whether decentralised solutions are desirable are divided. Although decentralisation might technically provide opportunities for more circular, sustainable and efficient ways of living, the current (waste)water system is well-functioning and robust. Furthermore, large amounts of investment are sunk into the current infrastructure.

The transition from a centralised towards a decentralised system has multiple consequences. When urban development projects disconnect from the collective system, less people bear the costs for a central network. As a result, the collective system becomes more expensive. Population groups that have the financial means to built and maintain their own sanitation system and make infrastructural adjustments within their homes are often wealthy and highly educated. Decentralisation of the energy sector has similar consequences: people who have their own roof on which solar panels can be placed, and have the ability to make the investment. Decentralised systems can therefore cause a social gap. The differing opinions on this should be seen in a broader political perspective. The choice for a collective system (whether it is infrastructure or health etc.) is dependent on the political background of a country. England e.g. has a largely privatised market, and prices for services are determined by market mechanisms, while the Scandinavian countries have much more collectively oriented systems and prices are protected.

The idea of disconnection is often related to the idea that these people don't pay for the collective system and infrastructure anymore. Integrating systems with each other on a larger scale could be a solution. The recovery of resources would still be aimed at, while costs and benefits can then be divided over a more extensive network and remain equal for all consumers. This can be further achieved by raising/diminishing taxes or a financial compensation system/subsidies.

Decentralisation does not only raise social difficulties. Technical and organisational issues also arise. We will illustrate this with an example from the water sector. The quality of our drinkingwater is highly controled and regulated by a public actor. Water control boards and drinking water companies have the expertise in this area. The Netherlands is known for its water related knowledge all over the world. When inhabitants disconnect from the collective system, it becomes complicated to control the quality of water. Additionally, it is much more expensive to check on an individual scale then on the large scale of RWZI's. The question arises who will control the quality and who will bear the responsibilities for this.

A lot of research is being done into the concept of circular solutions for urban areas. As described in the introduction, a lot of experiments are focussed on the technical aspects of sustainability. Living labs are an example of a popular way to test sustainable and circular innovations. However, actors from different disciplines and sectors have to work together and as we've seen in this research, this does not always result in a smooth process. Differing rules and ways of working proved hamper collaboration. This research has intended to provide more insight into the process around technical innovations.

It was not my goal to provide actors with a standard way of working which they can use during such processes. There is no single method to achieve a successfull process, and every case must be tailored towards the specifics of an area. In my opinion this is even more necessary for S.I. projects in UAD.

UAD is one of the main 'systems' that influences the S.I. process. Ways of working are often traditional and roles and responsibilities predetermined. The fact that a lot of actors from UAD find themselves within the public sector results in specific rules and regulations (e.g. the obligations around tendering procedures) that can be a challenge for innovative experiments during development. Policies come from the regime and landscape level, and are (especially for public actors) dependent on political views. In order to reach a true transition, ideas on S.I. should be integrated in the decision-making process at several levels and within multiple departments, making it a politically independent topic (mainstreaming vs dedication).

We've seen that the innovations were often facilitated and initiated by public and semi-public actors. Examples are the municipality and housingassociation in Sneek, the drinking water company in Culemborg and the drinking- & wastewater company Waternet in Amsterdam. This is quite different from product innovation processes, where market parties are often the first ones to kickstart innovation. Possibilities to attract private actors in S.I. lie in e.g. product suppliers, organic waste processors and fertilizer users (farmers).

VIII TERMINOLOGY

Many definitions of **sustainability or sustainable development** exist. The 'Brundtland Report' defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 37). Hellström (2007) argues that sustainable development consist of roughly three pillars: ecological, economic, and social sustainability. These three pillars correspond with the commonly known People Planet Profit approach. However, this research does not focus on the question what the correct definition or the best way for sustainable development is, but rather on the process of implementing multiple technical innovations with the purpose of achieving more sustainable ways of development. These technical innovations will be specifically focussed on reaching ecological sustainability. Therefore, sustainability in this research is in general defined as the ecological pillar, also known as the 'planet' aspect of the PPP approach. It should however be noted that the economical and social pillars most certainly also have played a role during decisionmaking-processes. These aspects will therefore not be ignored and will be kept in mind.

The terms **"institution" and "organization"** are used interchangeably. It is useful to draw a distinction between these two concepts. An organization can be thought of as a set of institutional arrangements and participants who have a common set of goals and purposes, and who must interact across multiple action situations at different levels of activity. Like institutions, organizations may be formally or informally constructed.

It is relevant for this research to understand the **institutional context** SI. "Broadly defined, institutions are the prescriptions that humans use to organize all forms of repetitive and structured interactions" (Ostrom, 2009). Buitelaar et al. (2014, p.249) define institutions as "the man-made structures that guide and give meaning to human interactions." This corresponds with both definitions of Geels (2004), institutions functioning as rules instead of, with what it is often mistaken for, public organizations; and Topsector Energie (2016), institutions as by people developed restrictions that structure economic, social and political behaviour. For this research we follow Crawford & Ostrom (1995) and define institutions as widely understood rules, norms or strategies that create incentives for behavior in repetitive situations.

Institutions can be formal and informal in nature (Heurkens, 2016). Formal institutions can be defined as the "government rules that are enforced by the legal system, such as laws, constitutions, ordinances and local land-use plans" (Buitelaar et al., 2014, p. 249). Informal institutions are "less explicit rules of conventions, codes of behaviour, traditions and values" (Heurkens, 2016, p. 728). On the one hand institutions enable interactions, provide stability and certainty, and form the basic for trust, while on the other hand they codify incumbent power relations and might hamper reform (Ghorbani, Ligtvoet, Nikolic, & Dijkema, 2010). In essence, institutions can be understood as "rules of the game" which both influence decision-making processes of actors as well as are cultivated through the actor interactions (van Bueren & ten Heuvelhof, 2005). In this research, institutional variables are referred to as informal and formal institutions that influence the decision-making process.

Rules & Institutions - Ostrom distinguishes two types of rules (also called institutional arrangements): 'rules in use' and 'rules in form' (Lammers & Heldeweg, 2016). Rules in use are defined as the rules that actors would refer to if they had to explain their behaviour to other actors in the action situation (Ostrom, 2011). These rules in use correspond to the informal institutions discussed before by Heurkens (2016). Rules in form are the written statements that result from formal legal procedures (Lammers & Heldeweg, 2016). This corresponds with the earlier discussed formal institutions by Buitelaar et al. (2014).

These rules, or institutional arrangements, can take place at the three previously discussed levels. In general, rules in use will mainly present at the operational (niche) level, while rules in form can be established at all three levels. However, formal institutions and government rules will be especially present at the constitutional (landscape) and collective (regime) level. It is important for this research to identify this distinction, as some rules will probably be easier to change than others.

Systems integration is in this research understood as the usage of 'waste products' from one system as input by another systems production process in urban environments. Different opinions on what waste exactly means exist (Kwakernaak, 2014), but for this research they entail products such as organic waste, household waste, and waste water and products that are normally discarded into the environment such as residual heat.

It is assumed that all cases and system integration processes in this research had the mutual goal of achieving sustainable urban development through the implementation of multiple innovations. Urban development, innovations and integration of infrastructural systems were therefore not addressed specifically with the "sustainability" term.

A **challenge** was in this research considered to be a constraining factor in reaching a successfull SI process.

An **opportunity** was considered to be an enabling factor in reaching a successfull SI process.

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All other figures are drawn or designed by Eva Ros or can be found in the caption.

X APPENDIX

The Feeding City

AMS Institute, gemeente Almere, provincie Flevoland, Aeres Group

Test- en onderzoeklocatie: De Straat van de Toekomst / The Greenhouse Village
(The Feeding City thema: Voedsel in de stad als aanjager van de circulaire economie)

Perspectief. Al eeuwen wordt huishoudelijk afval en afvalwater gebruikt in de land- en tuinbouw: een efficiënte en effectieve manier om grondstoffen optimaal te gebruiken. Pas bij de stedelijke ontwikkeling van de afgelopen decennia is dit naar de achtergrond gedrongen, met onder andere als gevolg dat grondstoffen langzaam maar zeker uitgeput zullen raken. De eenvoudig winbare hoeveelheid fosfaat, onontbeerlijk element voor gewassen en voeding, dreigt op termijn van enkele decennia uitgeput te raken. Dit maakt de ontwikkeling naar een meer circulaire stad noodzakelijk, terwijl ook de terugwinning van energie en nutriënten in het algemeen steeds belangrijker wordt.

Achtergrond. In the Greenhouse Village (Mels et al., 2006) wordt onderzoek gedaan naar processen om de verschillende grondstoffen zoals fosfaat, water, nutriënten, koolstof en energie terug te kunnen winnen. Het unieke van the Greenhouse Village is dat er een integrale aanpak wordt gevolgd waarin naast de proces ontwikkeling en de mogelijkheden voor toepassing van de teruggewonnen grondstoffen ook de fysieke uitwerking van de concepten in de praktijk wordt uitgewerkt. Naast de fundamentele aspecten komen ook de praktische aspecten aan de orde in een pilotomgeving om te bepalen welke schaal van de processen in combinatie met de toepassingen optimaal is. In eerste instantie richt de toepassing zich op gesloten systemen zoals kassen bouw.

Doel. Het doel van de ‘Straat van de Toekomst’ is het concept van the Greenhouse Village verder uit te werken en in een demonstratie project zoveel mogelijk technieken op pilot schaal te testen. Dit is een living lab situatie dat dient als studie object, maar ook als demonstratie- en proef locatie om verschillende ontwikkelaars een plaats te bieden om ideeën in een realistische omgeving uit te werken. Deze ‘Straat van de Toekomst’ zal een plek krijgen in de te ontwikkelen woonwijk op het Floriade terrein.

Opzet. Het ‘ombouwen’ van de huidige steden naar een samenleving gericht op duurzaamheid en optimaal gebruik van grondstoffen is een proces dat decennia lang zal duren. Deze transitieperiode zal beginnen met nieuwe gebiedsontwikkeling, maar zal uiteindelijk ook gericht moeten worden op het aanpassen van de huidige stedelijke ontwikkeling. Dit stelt een bijzondere eis, namelijk dat de overgang geleidelijk moet kunnen plaatsvinden en dat nieuwe concepten moeten kunnen bestaan naast en in samenhang met de bestaande concepten.

Centraal in het project staat een living lab, de ‘Straat van de Toekomst’: een proeflocatie van zo’n 20 huizen, inclusief voortuinen, een deel van de straat met parkeerplaatsen, complete infrastructuur (water, riolering en warmtenet) en een grote, gezamenlijke achtertuin met daarin een moderne tuinbouwkas.

Naast dit pilot- en demonstratiegedeelte kent het project een meer theoretisch en modelmatig gedeelte. Het is een iteratief proces, waarin de resultaten van de proefinstallaties vertaald kunnen worden naar grotere systemen. Een aspect dat nu nog niet expliciet wordt meegenomen, maar dat in de loop van het project zeker moet worden ontwikkeld is de bestuurlijke en maatschappelijk kant van de technologische ontwikkelingen.

De concrete demonstratie-/pilot projecten zijn:

- Inzameling en transport van gescheiden afvalwater stromen en de interactie met regenwater afhandeling;
- Verschillende technieken voor het terugwinnen van grondstoffen uit huishoudelijk afvalwater in verschillende concentraties en samenstellingen;
- Gesloten kassensystemen met gebruik van uit huishoudelijk afvalwater teruggewonnen meststoffen en water;
- Energie terugwinning en toepassing, bijvoorbeeld in een ATES (Aquifer Thermal Energy System) of directe toepassing in verwarming of warm water toepassingen;
- Kwantificering van de huishoudelijke waterstromen c.q. de huishoudelijke waterbalans;
- Next generation Urban Harvest Approach.

De onderzoeken die daarin gedaan zullen worden:

- Het rioolsysteem van de toekomst: afhandeling van stedelijk regen- en afvalwater afgestemd op optimaal gebruik van water en grondstoffen naast de traditionele eisen van veiligheid, hygiëne en volksgezondheid;
- Integratie van kassenteelt en terugwinning en gebruik van grondstoffen;
- Inzet van verschillende bronnen voor de kwantitatieve én kwalitatieve invulling van de huishoudelijke waterbalans, inclusief geavanceerde modellering hiervan (gebaseerd op het SIMDEUM concept);

- Analyse en beheersing van de hygiënische en milieutechnische risico's van de 'Straat van de Toekomst';

- Stedenbouwkundige integratie van huishoudens en kassen.

De omgeving van het Floriade terrein in combinatie met de ontwikkeling van de wijk Oosterwold in Almere geeft een unieke mogelijkheid om de concepten van The Greenhouse Village te ontwikkelen en te realiseren. De Flevocampus speelt een centrale rol om de kennis en huidige praktijk ervaring bij elkaar te brengen en daarnaast als wetenschappelijke omgeving om nieuwe processen en technieken te ontwikkelen.

Deelnemers. Het onderzoek wordt geleid door: Prof.dr.ir. Grietje Zeeman (Milieutechnologie, Wageningen UR) en dr. Jan Vreeburg (idem; jan.vreeburg@wur.nl). Op termijn zullen ze het onderzoeksteam verder vormgeven.

Er wordt een consortium voorbereid waarin zoveel mogelijk spelers uit de keten participeren. Het is daarnaast nadrukkelijk de bedoeling om een dynamisch test- en demonstratie gebied te ontwikkelen waarin op verschillende plaatsen ook verschillende aspecten van de 'Straat van de Toekomst' kunnen worden ontwikkeld. In de opzet van een living lab is het voor sommige toepassingen zelfs wenselijk om verschillende testomgevingen te creëren om vergelijkingen te kunnen maken. Als geïnteresseerde partners kunnen genoemd worden: LeAF BV, Fiwihex BV, Kristinsson Architects BV, Elannet BV, Vitens waterbedrijf, Evides Waterbedrijf, Sign, KWR Watercycle research Institute. Potentiële andere partners zijn vooral partners die industriële producten ontwikkelen als Geberit en Jets (toiletten en andere sanitair producten), maar ook leidingfabrikanten als Wavin en Dyka, technolgie bedrijven zoals DESAH BV (toepassing van, decentrale, op grondstoffen terugwinning gerichte, afvalwater zuivering) en bedrijven zoals Priva BV, werkzaam in het ontwikkelen en produceren van technologie om omgevingscondities te besturen in de tuinbouw en gebouwde omgeving.

Impact. Circulaire systemen staan erg in de belangstelling, zowel nationaal als internationaal. Het unieke van de 'Straat van de Toekomst' is dat er een integrale benadering is die nadrukkelijk de toepassingen en de transitie van het traditionele stedelijke concept naar het nieuwe meeneemt. Deze praktische toepassing heeft grote meerwaarde om nieuwe "locked-ins" te voorkomen die op diverse aspecten weer lijken op te doemen.

De internationale uitstraling in combinatie met de Nederlandse reputatie op watergebied, zal zorgen voor een sterke internationale belangstelling voor deze unieke locatie.

Budget. Dit onderzoek heeft het in zich deels door bedrijfsleven gefinancierd te kunnen worden, in combinatie met een subsidie door regionale ontwikkelingsfondsen.

II Interview Questions

VARIABLES (IAD)	OPERATIONALISATION	INTERVIEW QUESTIONS (DUTCH)
Biophysical conditions	physical possibilities of the area type of innovations physical space of innovations scale	1 Wat zijn de fysieke kenmerken van het gebied? 2 Welke innovaties worden in het gebied uitgevoerd en bij welke bent u betrokken (als organisatie)? 3 Hoe is deze innovatie georganiseerd (centraal, decentraal, mix)? 4 Kunt u beschrijven hoe de innovatie eruit ziet? 5 Hoeveel fysieke ruimte neemt de innovatie in? 6 Hoe is de innovatie vorm gegeven in het gebied? 7 Wat is de schaal van de gebiedsontwikkeling en wat is de schaal waarop de innovaties worden toegepast?
Economic conditions	funding means value creation	8 Hoe en door wie wordt het project gefinancierd? 9 Welke financiele middelen zijn er? 10 Is er sprake van een businesscase voor alle partijen? 11 Waar zit de waardecreatie?
Other necessary/available means	government policy rules and regulations organisation subsidy systematics taxes	12 Zijn er nieuwe vormen van beleid nodig voor het implementeren van de innovaties? 13 Is er andere wet- en regelgeving nodig voor het implementeren van de innovaties? 14 Zijn er organisatorische aanpassingen nodig (bv. in de organisatie van de gemeente)? 15 Is er gebruik gemaakt van subsidie mogelijkheden en zoja, op welke manier zijn deze benut? 16 Zijn jullie tegen bepaalde vormen van belasting-heffing of juist ontheffing aangelopen (bv. energiebe-lasting?)
General corporate values	mutual understanding mutual preferences measure of consensus	17 Is er algemene overeenstemming tussen de betrokken partijen over de doelen van het project? 18 Is er overeenstemming over bepaalde voorkeuren tussen de betrokken partijen? 19 Wat is de mate van consensus tussen partijen in het project?
Attitudes of actors towards each other	willingness to cooperate interests/positions (point of view)	20 Is iedereen bereid samen te werken? 21 Werkt iedereen naar hetzelfde doel toe? 22 Heeft iedereen dezelfde visie? Of moest deze naarmate het proces vorderde wellicht worden bijgesteld?
Organizing capacity	entrepreneurs or initiators organisation of collaboration	23 Zijn er bepaalde sleutelpersonen (overtuigers, trekkers die initiatieven mogelijk maken)? Wie? En wat doen zij? 24 Wie neemt het initiatief tijdens het innovatiepro-ces? 25 Hoe gaan partijen de samenwerking aan? 26 Wie organisaeert de samenwerking?
User involvement	measure of participation measure of ‘having a say’	27 Hebben de toekomstige gebruikers inspraak gehad op de manier waarop innovaties worden geimplementeerd? Is hun oordeel meegenomen tijdens het proces? 28 Hoeveel invloed kunnen toekomstige gebruikers uitoefenen op het proces en het ontwerp van de innovatie 29 Is er medewerking nodig van toekomstige bewoners om de innovaties te laten werken? Zoja, op welke manier?

VARIABLES (IAD)	OPERATIONALISATION	INTERVIEW QUESTIONS (DUTCH)
Boundary rules	number of actors contributions and means free access to the process exit conditions	30 Hoeveel partijen doen er in totaal mee in het proces? 31 Moeten actoren bepaalde kenmerken of middelen hebben om toe te kunnen treden? 32 Kunnen alle actoren toetreden tot het proces? 33 Worden partijen uitgenodigd? Zoja, hoe? 34 Kunnen actoren uit het proces worden gezet? Zoja, hoe?
Position rules	roles changing/improving positions number of actors with the same position	35 Wat zijn de posities van de verschillende partijen en hoe worden deze bepaald? 36 Hoe kunnen posities veranderen/verbeteren? 37 Hoeveel actoren kunnen dezelfde positie innemen?
Scope rules	results boundaries (functional and geological)	38 Wat zijn de potentiele resultaten? 39 Zijn er afspraken m.b.y. belemmeringen/grenzen (geografisch of functioneel)? 40 Wat zijn de kaders of hoofdlijnen (balans tussen algemeen belang en het creeeren van vrijheid)?
Choice rules	actions of specific actors	41 Welke afspraken zijn er m.b.t. mogelijke/verplichte/verboden acties van actoren? 42 Welke keuze hebben actoren m.b.t. mogelijke acties?
Aggregation rules	control of positions permission of other actors	43 Zijn er afspraken m.b.t. de 'choice rules' hierboven? Is er toestemming nodig voor bepaalde acties? 44 Hoe worden besluiten genomen? 45 In welke mate kunnen actoren controle uitoefenen bij het nemen van een besluit?
Information rules	degree of available information transparency	46 Welke informatie hebben actoren nodig? 47 Is de informatie voor iedereen beschikbaar? Zijn hier afspraken over gemaakt?
Payoff rules	costs and benefits sanctions	48 Wat zijn de kosten en baten van de innovaties (financieel en maatschappelijk)? 49 Welke kosten en baten zijn verplicht of verboden en voor wie? 50 Wat zijn de stimulansen/beloningen en barrieres? 51 Zijn er sancties voor het verbreken van de regels?

III List of Interviewees

SEMI STRUCTURED INTERVIEWS

RESPONDENT	PROJECT	ORGANISATION	ROLE	DATE
Rob Ververs	Cityplot Buiksloterham	Waternet	Former projectleader Cityplot	27.2.2017
Mark Wets	Cityplot Buiksloterham	Waternet	Program manager 'New Sanitation)	8.3.2017
Els Daems	Cityplot Buiksloterham	Gemeente Amsterdam (PMB)	Project manager BSH	9.3.2017
Renate Heppener	Cityplot Buiksloterham	Gemeente Amsterdam (R&D)	Member of team BSH/ sustainability consultant	24.3.2017
Sven Hillecamp	Cityplot Buiksloterham	De Alliantie	Projectmanager Cityplot	14.3.2017
Brendo Meulman	Waterschoon Noorderhoek	DeSaH	Projectmanager phase I	28.2.2017
Sybren Gerbens	Waterschoon Noorderhoek	Wetterskip Fryslan	Senior process technologist	29.3.2017
Anne van Scheltinga	Waterschoon Noorderhoek	Gemeente Sudwest Fryslan	Policy advisor (Ruimte en Water)	6.6.2017
Henk Heikema van der Kloet	Waterschoon Noorderhoek	De Wieren/Elkien	Former director of De Wieren	5.5.2017
Marleen Kaptein	EVA Lanxmeer	EVA foundation, initiator, BEL	Inhabitant + initiator EVA concept	22.2.2017
Martin Bonouvrie	EVA Lanxmeer	Gemeente Culemborg	Policy advisor + secretary projectgroup	1.3.2017
Gerwin Verschuur	EVA Lanxmeer	Thermo Bello BEL	Director heating network + inhabitant	1.3.2017

UNSTRUCTURED INTERVIEWS

RESPONDENT	PROJECT	ORGANISATION	ROLE	DATE
Rob Ververs	Cityplot Buiksloterham	Waternet	Strateeg Waternet	10.1.2017
Marleen Kaptein	EVA Lanxmeer	EVA foundation, initiator, BEL	Initiator EVA concept	1.2.2017
Vivian van Nassou	-	Waternet	Investigator	20.3.2017
Erwin Heurkens	-	TUDelft	Researcher	7.3.2017
Fred Hobma	-	TUDelft	Researcher	4.5.2017