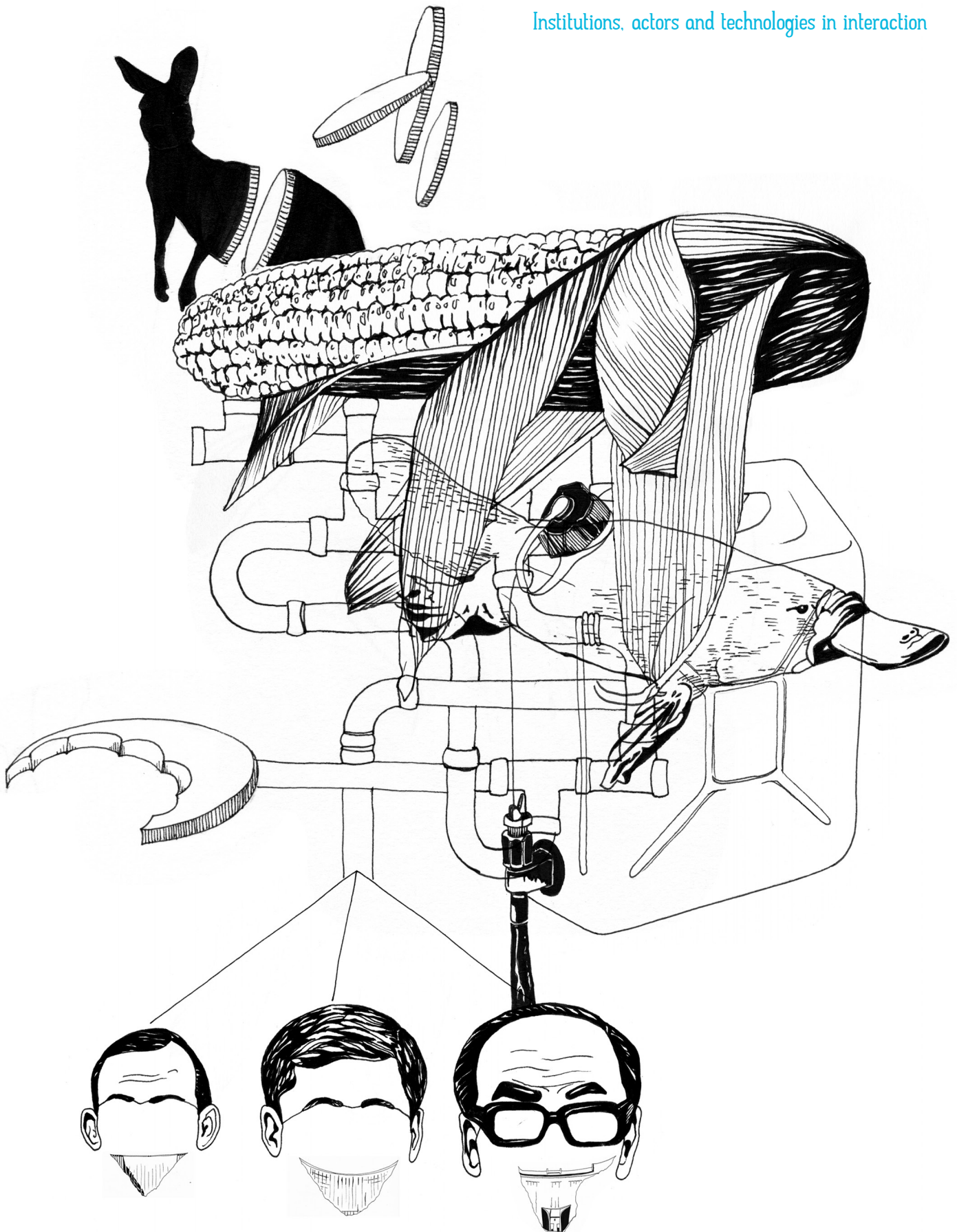Lea Fünfschilling

A DYNAMIC MODEL OF SOCIO-TECHNICAL CHANGE

Institutions, actors and technologies in interaction

A dynamic model of socio-technical change

Institutions, actors and technologies in interaction

Dissertation

zur Erlangung der Würde einer Doktorin der Philosophie

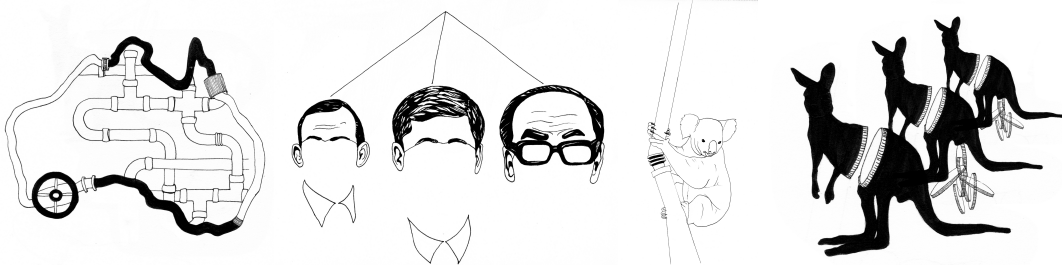vorgelegt der Philosophisch-Historischen Fakultät

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Summary

Many of today's societal problems, such as climate change, resource scarcity or environmental degradation call for some sort of radical social and often also technological change. Especially utility sectors like water, energy or transportation are increasingly pressured to transition to a more sustainable mode of operation, as for instance seen in the recent political efforts in Switzerland and Germany to introduce a transition in the energy sector from fossil and nuclear to renewable energy sources ('Energiewende'). However, the transformation of existing, highly institutionalized social structures and technologies has proven to be a rather challenging societal undertaking. Utility sectors are particularly demanding, since they provide essential services for society, which are often critical for public health and which affect multiple value-laden areas of life. Moreover, infrastructures are heavily comprised of technical as well as social elements that are highly intertwined and have co-evolved over a long period of time, which leads to a significant amount of path-dependency and inertia. Therefore, the questions of how socio-technical change unfolds and how a transition from one socio-technical configuration to the next can be achieved have become crucial in politics and academia alike.

Scholars from different disciplines have picked up this question of social and technological change and generated important insights into the typical features and crucial aspects of such transformation processes. In science and technology studies, for instance, theoretical approaches like large technical systems or literature on socio-technical transitions have conceptualized the interdependence, co-evolution and rigidity of technological and social elements in a system, such as actors, regulations, norms, cognitive mindsets and technologies, and have drawn conclusions for technological innovation and change processes. Approaches from institutional theory, on the other hand, have addressed questions of societal change without a specific focus on technology, instead emphasizing the influence of institutional structures like norms, values or cultural-cognitive frames on the behavior of actors and the development of practices as well as the analysis of the creation, persistence and destabilization of institutions.

The dissertation at hand shall be understood as a contribution to these discourses. The purpose of the thesis is to increase knowledge of socio-technical change by elaborating the relevance of a dynamic understanding of institutional structures, as brought forward in institutional theory, without ignoring the role of technologies, as stressed in science and technology studies. Socio-technical transitions are thus conceptualized as processes of institutional change with a particular awareness for technological specificities. The co-evolutionary processes between institutions and technologies are put forward. Literature on socio-technical transitions, institutional logics and institutionalization build the basis to identify and analyze institutional structures in an organizational field, assess their degree of institutionalization and demonstrate their effect on the development and transformation of the field. In

addition, the question of institutional change will be further highlighted by elaborating more closely on the dialectic relationship between structure and agency. Drawing on the concept of institutional work, an embedded agency perspective is presented that contributes to the understanding of change and/or persistence of prevailing institutional logics in a field, including the development and diffusion of certain technologies.

The overall goal of this dissertation is thus to contribute to an understanding of socio-technical change by presenting a framework that incorporates a) the description and analysis of prevailing institutional structures and their influences on actors and practices, b) a conceptualization of agency that bridges the gap between micro-individualistic and macro-structural approaches and c) a socio-technical perspective, that accounts for the coevolution of technology and society.

Empirically, this dissertation is based on an extensive study of the urban water sector in Australia. Maltreated by severe water scarcity as well as flooding problems, this water sector has been put under a lot of pressure, which resulted in a big public and political debate regarding future arrangements and changes. This state of turmoil makes it an interesting case study object. The empirical analysis focuses on the identification of institutional logics in the water sector since the 1970ies, applying a particular focus on changes in field logics through institutional competition and contradiction, general uncertainty and the role of agency processes. The results suggest that a transformation is visible from the traditional *Hydraulic Logic* based on the logics of the state and the engineering profession towards a more hybrid variant including a *Water Market Logic* as well as a *Water Sensitive Logic*, increasingly incorporating elements of the market, corporation and community logics. However, the degrees of institutionalization of the logics highly differ and therefore also their influences on the direction of field level change. This aspect is analyzed in more detail through an in-depth study of the diffusion of seawater desalination plants around Australia. The diffusion of the technology can be understood as a result of prevailing institutional logics and specific types of institutional work and interpreted as leading to an entrenchment of traditional structures, thereby probably impeding a transformation to alternative development pathways.

Acknowledgements

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ANT   Actor-Network Theory

EPC   Engineering, Procurement and Construction

GWI   Global Water Initiative

IPCC   Intergovernmental Panel on Climate Change

MLP   Multi-level perspective

R&D   Research and Development

RO   Reverse Osmosis

SCOT   Social Construction of Technology

STS   Science and Technology Studies

NGO   Non-governmental Organization
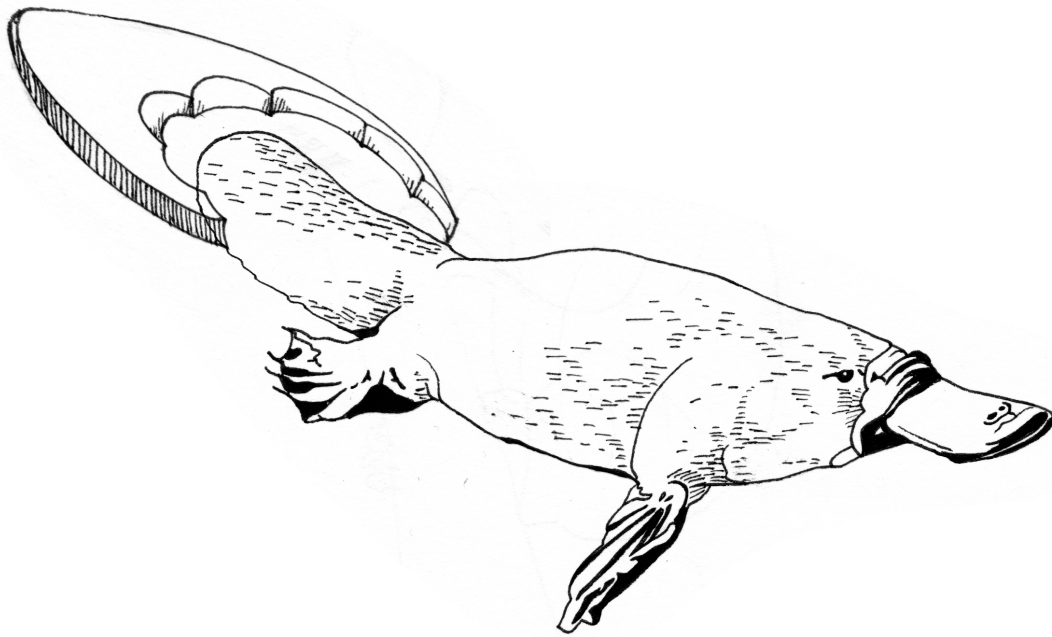
INTRODUCTION

1. Introduction

1.1. The challenge: Societal transitions towards sustainability

It is increasingly acknowledged in politics and academia that many of the 'grand challenges'[1] that contemporary modern societies face are related to unsustainable consumption and production processes and often concern utility sectors such as energy, transport, water or food (Markard et al., 2012; OECD, 2011; UNEP, 2011; van den Bergh et al., 2011). Greenhouse gas emissions, nuclear risks and the depletion of natural resources, for example, pose crucial challenges for the long-term security of energy supply (IEA, 2011). Air pollution, fossil fuel depletion or congestion problems question the current dominance of the automobile in the transportation sector and call for alternatives (Geels, 2012). Extreme climate events like water scarcity or flooding incidents in various countries as well as the micro-pollution of surface waters, e.g. through pharmaceuticals, not only endanger our drinking water supply, but also increasingly challenge the organization of food production and agriculture (Daigger, 2007a; Darnhofer et al., 2012; Gleik, 2003). Furthermore, a considerable part of the infrastructure worldwide is in need of renewal and extension, e.g. leaky water pipes, decayed streets or outdated energy grids, which requires high financial investments (Gil and Beckman, 2009; UNEP, 2011). This ultimately raises questions about financial responsibilities and concerns regarding social equity, especially in times of economic crises (van den Bergh, 2013). Demographic changes, such as worldwide population growth, and urbanization processes additionally intensify the pressure on all of those issues (UN (DESA), 2012; UN (DESA), 2013).

The question thus arises: *how can a transition towards more sustainability be achieved?* Recent political and economic efforts regarding the introduction of change, e.g. financial incentives for renewable energy technologies, international climate targets or corporate social responsibility guidelines, have shown that a the transformation of established production and consumption processes is not an easy endeavor. Utility sectors have proven to be particularly resistant to change due to some of their specific characteristics (Finger et al., 2005; Markard, 2011). Among others, these include the provision of essential services to society (e.g. drinking water, energy, roads) that is based on a complex system of social as well as technological elements that are highly interdependent, e.g. policies, standards, technologies, user behavior, firms, markets or cultural attitudes. Changes of one element will automatically

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[1] The Europe 2020 Strategy selected a range of problems to be of high priority and labelled them ‚grand societal challenges'. These include climate change, resource efficiency, energy security, food safety, obesity and environmentally friendly production (Geels, 2014).

require changes of other elements. As a consequence, infrastructure sectors are highly path-dependent and inert. Nevertheless, the sustainability pressures on these sectors are strong and change sooner or later inevitable.

Different scientific communities have therefore picked up the question of how a fundamental shift towards more sustainable modes of consumption and production could be conceptualized, promoted and governed. In general, many scholars and policy makers believe technological innovation to be a crucial part of the solution (Grin et al., 2010; Huber, 2004; Kates et al., 2001; Metz et al., 2007; Mol et al., 2009; Smith et al., 2010; van den Bergh et al., 2011). The assumption is that new technologies will be more sustainable and fix many of the problems caused by previous technologies or modernization in general, e.g. cars without any emissions, energy technologies without any nuclear risks or water treatment technologies that capture all man-made micro-pollutants. Others believe that a change in technology will not suffice to address problems of sustainability and that only major innovations in economic systems, political processes or lifestyles, i.e. a fundamental cultural transformation, will contribute to the resolution of the grand challenges (Hajer, 1995; Mol et al., 2009).

Based on insights from science and technology studies, institutional theory and evolutionary economics, this thesis will argue that both these arguments have to be thought of as interrelated in order to contribute to a fruitful approach to societal transitions towards sustainability (Markard et al., 2012; Nelson and Winter, 1982a; Pinch and Bijker, 1987; Powell and DiMaggio, 1991). Neither technological innovation can be understood if it is conceptualized as a process isolated from society, nor can cultural change be comprehended without accounting for technological developments. The overarching assumption thus is that a change towards sustainability requires deep-structural changes on a system level, affecting various aspects of actors, technologies and institutions at the same time.

1.2. System innovations and socio-technical change

The conceptualization of (technological) innovation has varied between disciplines and over time. Business and management studies, for instance, tend to understand innovation as the development of new products, processes or services at the firm level that will lead to a competitive advantage for the firm (Tidd et al., 2001). While insightful for the innovation process within organizations, it falls short in addressing the complexity inherent in sustainability challenges. For instance, many of the grand challenges contain an environmental component. In order to achieve environmental sustainability, a (technological) innovation needs to result *throughout its life cycle, in a reduction of environmental risk,*

pollution and other negative impacts of resource use (including energy use) compared to relevant alternatives" (Kemp and Pearson, 2007, p. 7). However, such 'environmental innovations' have very particular characteristics. Van den Bergh et al. (2011, p. 5), for instance, state

> *"the main difference between environmental and 'regular' innovations is the combination of an urgent environmental problem that needs a solution but which is associated with external costs that do not enter the private costs of the polluter. As a result, there is no incentive for the polluter (or other firms) to invest in innovation or adoption of new technologies with more beneficial environmental characteristics (e.g. less pollution)."*

This is only one example that shows that addressing sustainability issues requires a broader definition of innovation than merely the development of new products or processes within a firm. To that end, Freeman and Perez (1988) have introduced a categorization of innovation that allows for a much wider understanding of innovation. They differentiate innovations along the lines of their radicalness and scope:

a) *Incremental innovations* (Products and processes that show a continuity and path-dependency. Changes are mainly based on 'learning by doing' without major R&D investments).

b) *Radical innovations* (Often a combination of product and process innovations that lead to a high discontinuity and disruption. Generally based on deliberate R&D).

c) Innovations on the level of '*technology systems*' (A combination of incremental and radical innovations that affect various sectors of the economy or create entirely new sectors).

d) Innovations on the level of the '*techno-economic paradigm*' (An entirely new technology system that leads to a 'deep structural change' of the whole economy as well as the social and institutional realm of society).

At the bottom of this taxonomy lies a particular understanding of the relationship between society and technology. Since the 1980ies, the disciplines of science and technology studies, sociology as well as evolutionary economics have increasingly focused on the interaction between technology and society and have shown that they highly influence and shape each other (Bijker and Law, 1992; Callon, 1987; Dosi, 1982; Dosi et al., 1988; Latour, 1991; Nelson and Winter, 1982b; Pinch and Bijker, 1987). Soon technology was not seen any more as antithesis of culture or society but instead interpreted as a very product of processes of social construction. At the same time, the once very dominant idea of many sociologists that 'social issues' can only be explained through other 'social issues' and not through biological, technological or psychological aspects, has been challenged. The studies have shown that the materiality of things, although a social product, heavily influences sociality and that a focus

on technological artifacts has explanatory value regarding processes of social change, modernization and society as a whole.

These insights had a big impact on the conceptualization of (technological) innovation and societal transformation in general. They gave rise to a systemic approach to innovation and change that is expressed through the analytical concept of *socio-technical systems*. Socio-technical systems account for the substantial interrelation of technical and social elements in many societal domains (Dolata, 2009; Geels, 2002; Hughes, 1987; Joerges, 1998; Mayntz and Hughes, 1988; Mol et al., 2009; Rip and Kemp, 1998). The main assumption is that socio-technical systems are characterized by the co-evolution of material and social elements into a well aligned socio-technical configuration that influences the functionality and development of a system (Grin et al., 2010). Accordingly, innovation needs to be conceptualized from a systemic perspective that includes changes at many different levels (e.g. individual, organizational, sectoral, societal) and dimensions (e.g. institutional, technological, cultural).

Research on 'system innovations' and socio-technical change has gained widespread attention as potential solution to the grand challenges confronting many utility sectors worldwide (Grin et al., 2010; Markard et al., 2012). Scholars are questioning that incremental innovations along the current technological trajectory will suffice to turn to sustainable development and instead advocate that fundamental changes are needed that counteract the existing 'system failures' through structural 'system innovations' (Elzen et al., 2004; Geels, 2010; Jacobsson and Bergek, 2011; Jänicke, 2008; Kemp, 1994; Loorbach and Rotmans, 2010; Rotmans and Loorbach, 2009; Unruh, 2000). Under the heading of '*sustainability transitions*', a research field has emerged that analyzes *"the co-dynamics of technologies, institutions, social and economic subsystems and conditions in functional domains like energy, water, food, housing etc."* (van den Bergh et al., 2011, p. 8) with the aim of understanding, conceptualizing and influencing societal transitions towards sustainable economies (Markard et al., 2012). A transition, or 'system innovation', is thereby defined as a shift from one socio-technical configuration to another (Geels and Schot, 2010; Kemp, 1994). Socio-technical transitions are characterized as long-term (ca. 50-100 years), transformative change processes that involve many different actors and lead to radical alterations of various (non-) material dimensions (i.e. according to Freeman and Perez's taxonomy, it would be between categories 3 and 4). Classical historic examples are the reorganization of laws, technologies, business models and use patterns that occurred during the replacement of sailing ships by steam ships in the international sea transport sector, the change from horse-drawn carriages to cars as the dominant mode of land-bound transport, or the implementation of sewer systems to replace cesspool based evacuation of waste water (Geels, 2005a; Geels, 2005b; Geels, 2006a).

The notion of sustainability as the ultimate goal of a socio-technical transitions has received much attention in academia and politics. The value of the concept of sustainable development has however often been questioned due to its mostly very vague and unspecific meaning. One widely shared understanding of sustainable development is that it should be aimed at

> *"promoting the human well-being, meeting the basic needs of the poor and protecting the welfare of future generations (intra- and inter-generational justice), preserving environmental resources and global life-support systems (respecting limits), integrating economics and environment in decision-making, and encouraging popular participation in development processes"* (Meadowcroft, 2000, p.73).

Sustainability could thus be summarized as entailing environmental, economic and social components that need to be aligned and reconciled. Hence, the nature of sustainability is highly systemic, but also highly vague. Many transition scholars have therefore intentionally been using sustainability as an open analytical concept instead of a normative principle. It is seen as an *"open-ended orientation for change"* that *"allows pluralistic appropriation in a deeply political and participatory process"* and as a *"quest for new value systems"* that can be made operational in a specific context (Grin et al., 2010, p. 2). Moreover, what is considered sustainable most likely changes over time and is depended on current scientific knowledge as well as on subjective and cultural interpretation (Garud et al., 2010; Markard et al., 2012).

The overall value of research on 'sustainability transitions' is that it offers conceptual and analytical insights into long-term, socio-technical transformation processes without specific a priori assumptions of a normative pathway of change. The dissertation at hand shall be understood as a contribution to this discourse.

1.3. Sustainability transitions: Current state of research and research gaps

Sustainability transitions are specific processes of systemic, socio-technical change. Over the years, different analytical frameworks have gained attention in addressing the particularities of socio-technical change (Markard et al., 2012). The following four approaches have been considered to be at the core of transition research: *technological innovation systems* (Bergek et al., 2008a; Hekkert et al., 2007), *strategic niche management* (Kemp et al., 1998), *transition management* (Loorbach, 2007; Rotmans et al., 2001) and *the multi-level perspective on socio-technical transitions* (Geels and Schot, 2010; Geels, 2004; Smith et al., 2010). Their assumptions and insights often overlap or complement each other. They have been selected as core contributions to transition thinking because they adopt a systemic view

on socio-technical change (Markard et al., 2012). However, there are many more theoretical approaches that have contributed important insights into different aspects of socio-technical transitions, such as actor-network theory (Callon, 1986), social construction of technology (Pinch and Bijker, 1987), evolutionary economics (Dosi, 1982; Nelson and Winter, 1982b), long waves (Freeman and Louca, 2001), sustainability sciences (Kates et al., 2001), ecological modernization (Mol et al., 2009), industrial ecology (Ehrenfeld, 2000), eco-innovation (Kemp, 2010) or management literature on corporate social responsibility (Porter and Kramer, 2006), to name a few. Since societal change and sustainability are very multifaceted topics, the list of relevant research is accordingly long.

This thesis especially engages with one of the most prominent frameworks for the analysis of transitions, i.e. the *multi-level perspective on socio-technical transitions (MLP)* (Geels, 2004; Geels and Schot, 2007; Grin et al., 2010; Smith et al., 2010). The MLP conceptualizes transitions as unfolding by an interplay of three 'levels of structuration' that influence the behavior of actors or the diffusion of practices in different ways (see Figure 1.1). At the center of the model lies the *socio-technical regime*. It is an analytical concept that accounts for the co-evolution of a system's socio-technical configuration and the thereof resulting path-dependency and inertia. As a consequence, radical innovations, which are presumably necessary for a transition, are envisioned to unfold in *technological niches*, a second analytical concept that represents 'protected spaces' where novelties can emerge and grow outside of the highly structured realm of a regime. Typical examples are experimental implementation projects (Hoogma et al., 2002a; Smith and Raven, 2012). The MLP further embeds socio-technical systems within a landscape, i.e. a broader, exogenous context that entails unswayable developments like demographic growth, climate change, financial crises or cultural shifts, which exert their influences on the stability of socio-technical regimes as well as the development of technological niches.

The MLP conceptualizes a transition as unfolding through the interactions between these different 'levels of structuration'. In simplified terms, it is assumed that a) niche-innovations can increasingly create a sound socio-technical configuration capable of competing with the established regime, b) landscape developments put pressure on the regime and c) as a consequence of these two developments, regimes may destabilize and give way to new socio-technical configurations (see Figure 1.1). A transition is ultimately conceived of as a shift from one socio-technical configuration to another, i.e. from one regime to another.

Since the MLP accounts for many aspects of social and technological change simultaneously, it has become a popular framework to analyze transitions towards sustainability in many utility sectors, e.g. energy (Loorbach and Rotmans, 2010; Verbong and Geels, 2007), water

(Brown and Keath, 2008) or transport (Geels, 2012). At the same time, various criticisms have been voiced by scholars, leading to a constructive discourse about merits and weaknesses of the model.[2] Scholars have particularly criticized the rather unsystematic operationalization and delineation of the 'levels', i.e. the conceptualization of structure and structuration, as well as a lack of agency as a source for socio-technical change. Socio-technical regimes are for instance often just equated with incumbent technologies, actors and some forms of institutions, e.g. regulations. A thorough empirical assessment of the historically developed, highly institutionalized socio-technical interdependencies has thus often been neglected. Regimes have therefore been criticized for being depicted too 'monolithic' and 'homogenous', not representing the actual structuration of a system including all its incoherencies and tensions (Berkhout et al., 2004; Genus and Coles, 2008; Markard and Truffer, 2008; Shove and Walker, 2010; Smith et al., 2005). Similarly, the landscape has been accused of depicting a 'residual category' or 'garbage can concept' that accounts for all kinds of contextual effects and therefore loses its explanatory power (Geels, 2011). The weak conceptualization of agency and the thereof resulting over-emphasis of technological niches as drivers for system has furthermore led to the accusation that the MLP is not dynamic enough, depicting transitions as linear stories of small scale, alternative technological innovations having to overthrow a unified block of regime actors and established technologies change (Berkhout et al., 2004; Smith et al., 2004; Smith et al., 2005).

It is acknowledged that the MLP has generated many useful insights for transition research, especially regarding its powerful heuristic of a multi-level change process. Nevertheless, there is still a need for conceptual improvements. The weak points of the approach essentially lie in the under-conceptualization of a) various structural dimensions (regimes, landscape) and b) processes of agency in different types of structural contexts (niche, regime, landscape). Both aspects are however highly relevant for a better understanding and more accurate analysis of socio-technical transitions. The dissertation at hand is a contribution to this research gap. It is argued that the above mentioned deficits regarding the conceptualization of structures and agency can be addressed and mitigated by considering insights developed in the realm of organizational institutionalism (Greenwood et al., 2008; Powell and DiMaggio, 1991). An introduction into the main arguments is given in the next section.

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[2] Major criticisms include the flawed conceptualization of agency, inconsistent operationalization of regimes, over-emphasis of niche as driver for change, unclear conceptualization of landscape level, a misleading representation of levels as hierarchy and an implicit treatment of spatial dimensions. For an elaboration of these criticisms see (Coenen et al., 2012, Genus and Coles, 2008, Markard and Truffer, 2008, Smith et al., 2005, Smith et al., 2010). For a summary and response to these criticisms see (Geels and Schot, 2007, Geels, 2011).

Increasing structuration
of activities in local practices

Socio-technical landscape (exogenous context)

Landscape developments put pressure on existing regime, which opens up, creating windows of opportunity for novelties

New regime influences landscape

Socio-technical regime

Markets, user preferences

Industry

Science

Policy

Culture

Technology

Socio-technical regime is 'dynamically stable'. On different dimensions there are ongoing processes.

New configuration breaks through, taking advantage of 'windows of opportunity'. Adjustments occur in socio-technical regime.

External influences on niches (via expectations and networks)

Elements become aligned, and stabilise in a dominant design. Internal momentum increases.

Niche-innovations

Small networks of actors support novelties on the basis of expectations and visions. Learning processes take place on multiple dimensions (co-construction). Efforts to link different elements in a seamless web.

Time

Figure 1.1: Multi-level perspective on transitions
(Geels and Schot, 2007, p. 401)

1.4. Socio-technical transitions as processes of institutional change

Institutional theory has become one of the most influential approaches in organization science today. Its main contribution is to explain certain core characteristics and behaviors of actors or the emergence and diffusion of practices by pointing to the relevance of higher order principles like rules, norms, taken-for-granted assumptions or cultural belief systems (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Powell and DiMaggio, 1991; Scott, 1995). By giving a unique insight into the relationships between an actor and its environment, institutional theory questions the rational actor model and instead emphasizes legitimacy as an important factor for organizational behavior and survival (Tolbert and Zucker, 1983). The notion of a rational actor that acts according to efficiency criteria is being replaced by an institutionally embedded actor. Scholars assume that social action is structured and shaped by the actor's institutional context. Institutions are generally interpreted as widely diffused and accepted structures (Barley and Tolbert, 1997; Tolbert and Zucker, 1999). Structure is often used as an umbrella term for things that influence an actor's cognition and behavior as well as the diffusion of practices, e.g. regulations, norms, values or culture. Scott (1995) categorizes institutions according to their effect on actors: *regulative institutions* like laws, contracts or regulations generate impact through coercive mechanisms such as the threat of jail or

financial punishment; *normative institutions* include norms and values and function through moral pressures and social obligation –violation is penalized by social shaming or exclusion; and *cognitive institutions,* such as shared perceptions of social reality (scripts), meaning systems, discourse or cultural rules are characterized by internalization and implicitness. The institutional logics approach further elaborates on the content and meaning of institutions (Friedland and Alford, 1991; Thornton et al., 2012). It posits that societies in the contemporary West are mainly influenced by seven central institutions that entail very distinct, ideal type logics, i.e. rationalities or belief systems that shape actors cognition and behavior in very particular ways. These institutions are the family, the community, religion, the professions, the state, the corporation, and the market. An institutional logic is defined as *"the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality"* (Thornton and Ocasio, 1999, p. 804). Each of the seven main institutions thus provides different "master principles of society" (Greenwood et al., 2010), i.e. different norms, values, practices or beliefs that may complement or contradict each other. The institutional logics approach thus characterizes the content of various structural elements present in a system, identifies conflicts and contradictions between them and specifies the way in which these structures influence actors.

Institutional theory has however not only provided many accounts of how institutions affect actors, but also how structures become (de-) institutionalized by a process of social construction (Berger and Luckmann, 1966). On the one hand, this insight has led to the awareness that structures can be institutionalized to different degrees, i.e. that institutionalization should be treated as a variable with different impacts on actor's behavior or the diffusion of practices (Tolbert and Zucker, 1999). An institution, i.e. a structure that has historically grown and is widely diffused and accepted, will have a much stronger influence than a structure that just recently popped up and might only be relevant for a small group of actors. On the other hand, the process of social construction has generated a fruitful dialogue about agency as embedded within social structures (Beckert, 1999; DiMaggio, 1988; Oliver, 1991). The main question thereby is: How can an actor that is embedded in and constituted by its institutional context break out of it and gain the capability to shape it? And if agency is possible, who can act on it and under what circumstances? This challenge is commonly known as the paradox of embedded agency. In recent years, it has been increasingly discussed under the heading of 'institutional work', which is defined as *"the purposive action of individuals and organizations aimed at creating, maintaining and disrupting institutions"* (Lawrence and Suddaby, 2006, p. 215).

As a few transition scholars have already pointed out, some of the most central analytical concepts of transition studies show a close proximity to arguments made in institutional theory (Geels and Schot, 2010; Geels and Schot, 2007). The idea of the landscape, for instance, describes the effect of overarching societal institutions on certain systems, such as markets or certain professions. The regime further accounts for highly institutionalized socio-technical structures that influence an actor's behavior or the diffusion of practices. The description of a socio-technical transition as a shift from one regime to another can be interpreted as a shift from one highly institutionalized socio-technical configuration to a new one. This implies that a dominant regime has been de-institutionalized and is getting replaced by a once loosely coherent niche configuration that has been institutionalized into a new regime. In that sense, socio-technical transitions can be interpreted as processes of institutional change. Institutional theory thus offers useful insights for the reconceptualization and empirical assessment of some of the most crucial theoretical concepts in transition thinking, in particular regarding the above identified weak points concerning the definition of structures within socio-technical systems as well as agency in the context of different structural environments. This thesis thus suggests conceptualizing the structures of a system, i.e. the socio-technical configuration, as a specific institutional logic. This further enables the characterization of agency as institutional work that aims at (de-) institutionalizing the institutional logics of a system. A transition of a socio-technical system can then be understood and analyzed as a change in prevailing institutional logics.

1.5. A dynamic model of socio-technical change: Research questions and research design

As derived from the considerations above, the main purpose of this thesis is to further the understanding of sustainability transitions by developing a dynamic model of socio-technical change that accounts for both, structural conditions and processes of agency. Consequently, the overarching research question is: *How can a dynamic model of socio-technical change be conceptualized and empirically applied?*

In order to approach this research question, three specific sub-questions need to analyzed:

1) *How can structures and their degree of structuration within socio-technical systems be conceptualized?*

2) *How can agency within highly structured socio-technical systems be conceptualized?*

3) *How do socio-technical structures and processes of agency affect change within socio-technical systems?*

To answer these research questions, an analytical framework is developed and an empirical analysis of transformation processes in the urban water sector in Australia is conducted. Urban water management is characterized by a highly stable socio-technical regime in all industrialized countries worldwide. Compared to other utility sectors, such as telecommunication, transport or energy, water supply and sanitation sectors have yet experienced less transformation in terms of deregulation and privatization (Lieberherr, 2012). It can therefore be interpreted as a prototypical inert and rigid utility sector, which makes it a very fruitful ground for the empirical analysis. Recently however, increasing criticism has been voiced in the academic literature and in policy circles questioning the longer term sustainability of this sector (Daigger, 2007a; Lienert et al., 2006; Zehnder et al., 2003). Australia is the country where corresponding reforms have been most vivid and it is considered one of the international leaders paving the way for newly emerging regime structures, e.g. regarding the implementation of new technologies or water governance models. Extreme weather events like droughts and floods accelerated the examination of future challenges and abetted a comprehensive, well-documented and observable discourse around perceived problems and potential solutions.

In regard to the theoretical research questions, the following analysis are conducted:

1) Empirical analysis of the socio-technical structuration of the urban water sector in Australia through the assessment of institutional logics and their degree of institutionalization.

2) Empirical analysis of purposive actions by actors (i.e. institutional work) aimed at influencing the structuration of the socio-technical system of urban water in Australia in order to account for processes of agency.

3) Empirical analysis of past and current transformation processes observed in the sector with explicit regard to the influence of socio-technical structures (i.e. institutional logics) as well as agency by actors (i.e. institutional work) in order to elaborate a dynamic approach towards socio-technical change.

All empirical analyses are based on qualitative methods, in particular semi-structured (expert) interviews as well as qualitative content analyses of various documents such as public inquiries and newspapers.

1.6. Theoretical contributions and practical implications

This thesis aims to contribute to the scientific discourse on societal transitions towards sustainability. This is accomplished by improving the conceptualization of socio-technical structures as well as embedded agency and along with that develop a more dynamic model of socio-technical change. Research on social and technological change has so far been done in different scholarly communities. Science and technology studies, for instance, have conceptualized the interdependence, co-evolution and rigidity of technological and social elements and have drawn conclusions for technological innovation and change processes. Approaches from institutional theory, on the other hand, have addressed questions of societal change without a specific focus on technology, instead emphasizing the influence of institutional structures like norms, values or cultural-cognitive frames on the behavior of actors and the development of practices as well as the creation, persistence and destabilization of institutions. The purpose of the dissertation at hand is to increase the understanding of socio-technical change by elaborating the relevance of a dynamic understanding of institutional structures, as brought forward in institutional theory, without ignoring the role of technologies, as stressed in science and technology studies. Socio-technical transitions are thus conceptualized as processes of institutional change with a particular awareness for technological specificities. It is maintained that only a focus on both, institutions as well as technologies, will contribute to a fruitful understanding of todays 'grand challenges' and contribute to potential solutions.

While institutional theories have highly contributed to the understanding of social change, they have mostly neglected the material dimensions of society, e.g. technologies, which weakens their explanatory value for current societal challenges like sustainability transitions. Even though some theoretical approaches, such as the one on institutional logics, emphasize the relevance of material structures in the literature, they hardly get attention in empirical analyses of institutional logics. Science and technology approaches, on the other hand, although underlining the importance of a socio-technical focus, often miss a thorough conceptualization of the institutional realm. This lack of a useful operationalization of institutions often leads to a very simplified empirical account of social structures. By combining insights of both theoretical approaches, these research gaps are mitigated.

The thesis in particular addresses the conceptualization of socio-technical structures as institutional logics and embedded agency as institutional work and elaborates on their role for processes of sectoral change. This focus enables the advancement of insights for both theoretical traditions. On the one hand, the analysis of the particular constitution and properties of socio-technical configurations improves the operationalization and empirical

assessment of socio-technical structures in transition frameworks, such as the MLP. A conceptualization of socio-technical structures as institutional logics and a focus on their degrees of institutionalization will enable a highly elaborated picture of 'levels of structuration' that accounts not only for the inertia and rigidities of a system but also displays its institutional incoherencies and contradictions. This way, the strength of a socio-technical regime or the influence of certain institutional landscape pressures can be evaluated more thoroughly. On the other hand, it also provides a unique empirical account of institutional logics that pays attention to the material dimension of the concept, which has to date been an understudied area of institutional analysis. Analyzing the institutional logics of a utility sector shows that such system logics often develop in interaction with certain technologies. Therefore, technologies are seen as an important cornerstone of an institutional logic that co-evolve and align with other logic elements into a specific configuration (e.g. dams in the water sector, cars in transport, nuclear technologies in the energy sector etc.).

Furthermore, the examination of embedded agency contributes to a better understanding of processes of social construction. This enables a more dynamic understanding of transitions, which accounts for the yet underdeveloped conceptualization of agency in highly institutionalized systems. At the same time it elaborates on how specific institutional logics are (de-) institutionalized and transformed through purposive actions. A focus on the interaction between different institutional logics will further shed light on the role of institutional contradiction and conflicts. It is shown that institutional contradictions can be interpreted as sources for change and innovation. It thus contributes to research on the transformation of institutional logics as well as field-level change in general.

Since this thesis is based on an extensive empirical study, it also offers some methodological insights. It provides an example of how institutional logics (and their transformation over time) as well as instances of institutional work can be explicitly assessed by the application of qualitative methods such as content analyses of policy documents and newspapers as well as (expert) interviews. In so doing, the analysis sheds light on how to empirically assess the constitution, strength and transformation of theoretical concepts of transition studies, such as the socio-technical regime.

The empirical analysis of urban water sectors in industrialized countries and especially in Australia furthermore generates important insights into water sector management that have practical implications for water sector professionals and policy making. As economic, social and environmental pressures increase on water sectors worldwide, addressing the potential for a transition towards more sustainability is timely. However, the uptake of new approaches has often failed, due to many technological and social hurdles. The call for an elaborated

understanding of incentives and barriers for a socio-technical transition in urban water sectors has thus been strong (Brown et al., 2008; Lienert et al., 2006; Maksimovic and Tejada-Guibert, 2001; Wong and Brown, 2009). Taking on a socio-technical perspective will help to understand the interrelations between technological, economic, political and social challenges inherent in urban water management. By providing a thorough and improved analysis of the current socio-technical structuration of the Australian water sector, this thesis enables insight into the prevailing institutional logics that guide the development of the sector. The analysis of institutional work further sheds light on the purposive actions of actors aiming at influencing the structural setting. Both aspects contribute to a better understanding of the specificities of the Australian urban water sector that determine technological innovation or political governance. Current socio-technical barriers for a transition towards sustainability are identified and ways for the facilitation of a transition discussed. As a result, conclusions can be drawn in regard to potential future transition pathways for urban water management in general.

1.7. Overview of the thesis

Chapter 2 expands on the theoretical background used to develop a dynamic model of socio-technical change. It presents a literature review of the theoretical foundations of the MLP framework and introduces the main arguments from organizational institutionalism. Current research gaps and intended conceptual improvements are presented.

Based on this review, an analytical framework is developed that allows for a dynamic conceptualization of socio-technical change. *Chapter 3* presents the basic assumptions of this framework in detail.

Chapter 4 subsequently lays out the methodology for the empirical analyses. It explains the research design, justifies the case selection and describes all the data sources and methods of data analyses. The operationalization of the main theoretical concepts of the analytical framework is outlined. The chapter concludes with a reflection on the limitations of the methodology.

Chapter 5 and 6 present the results of the empirical analyses. While Analysis I reconstructs past and current institutional logics and their degree of institutionalization in the Australian urban water sectors, Analysis II identifies exemplary forms of institutional work aimed at the maintenance or transformation of the institutional setting of the system. Both chapters conclude with a preliminary discussion of the results.

Chapter 7 subsequently discusses the results of the empirical analyses in regard to the analytical framework and research questions. Implications regarding the conceptualization of socio-technical transitions resulting from a dynamic approach to socio-technical change are reviewed.

Chapter 8 answers the research questions, summarizes the contributions of the thesis and outlines avenues for future research.[3]

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[3] Parts of this thesis have recently been accepted for publication: *Fuenfschilling, L., Truffer, B. (2014). The structuration of socio-technical regimes – Conceptual foundations from institutional theory. Research Policy 43 (4), 772-791.*
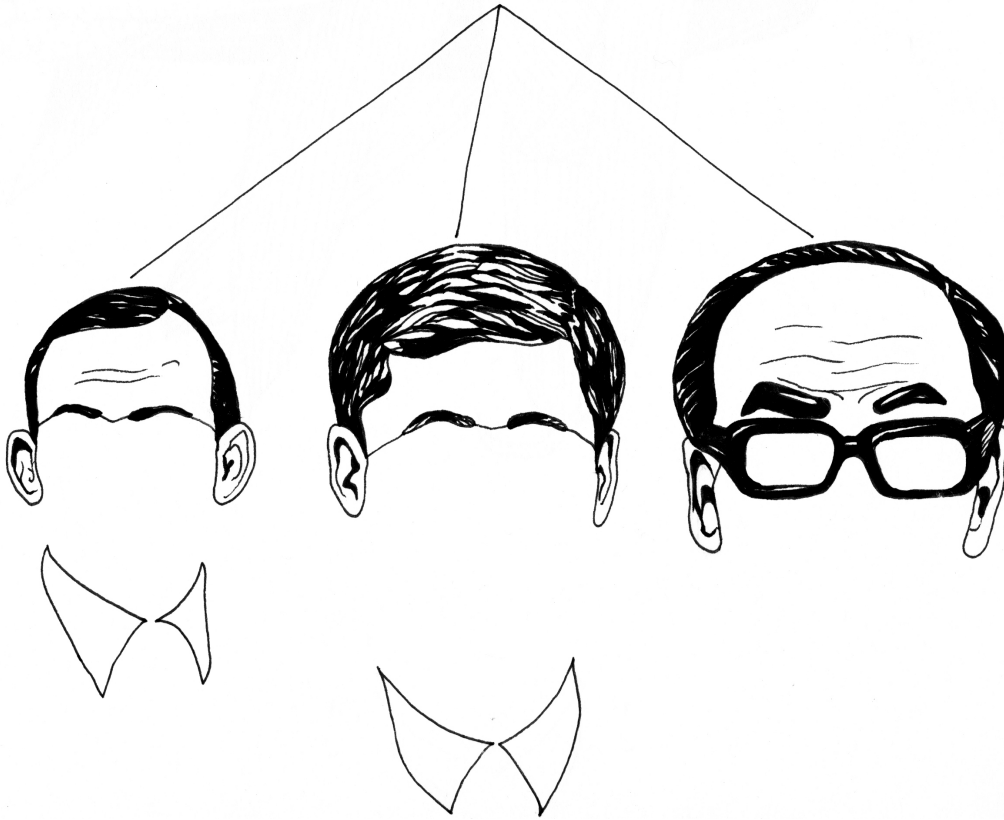
THEORETICAL BACKGROUND

2. Theoretical background

This chapter presents the theoretical background of the analytical framework of this thesis. First, the conceptual basis of transition studies, such as concepts of evolutionary economics and science and technology studies are outlined followed by a review of literature on institutional theory. The respective specific conceptualization of structure, agency as well as change thereby builds the main focus.

2.1. The multi-level perspective (MLP): Theoretical foundations

The MLP is one of the central frameworks to analyze socio-technical transitions (Grin et al., 2010; Markard and Truffer, 2008; Smith et al., 2010). It understands transitions as long-term, transformative change processes that unfold between technological niches, socio-technical regimes and external landscapes. Scholars have defined the MLP as *"middle-range theory that combines specific elements from other theories (…), and as such it is geared to answering particular questions on the dynamics of transitions"* (Geels and Schot, 2010, p. 19). The MLP borrows its theoretical assumptions for the conceptualization of socio-technical change and innovation from three sub-disciplines of the social sciences: For the theoretical development of the structural environment of actors and practices it mainly draws on insights from evolutionary economics (Dosi et al., 1988; Nelson and Winter, 1982b) and later on also from institutional theory (Powell and DiMaggio, 1991) as well as Giddens' structuration theory (Giddens, 1984). Science and technology studies (STS), on the other hand, in particular actor network theory (ANT) and the social construction of technology (SCOT), build the basis for the elaboration of agency in processes of socio-technical change (Bijker, 1995; Latour, 1991; Pinch and Bijker, 1987).

2.1.1. Agency in the MLP: Science and technology studies

Over a long period of time, the process of technological innovation and change has been thought to be very linear (Godin, 2006). This linear model postulated that innovation starts with basic research, followed by applied research and development, which finally leads to production and diffusion. Two specific versions of this approach are the 'technology push' and 'market pull' models (Dosi, 1982). While the former sees innovation happening by invention through basic research, the latter assumes a market demand to be the source of a new idea that subsequently guides R&D efforts. At the basis of such linear models lie two crucial assumptions about the relationship between technology and society (Geels and Schot, 2010). First, it is assumed that technologies have an own internal logic, a predetermined

functionality that shapes their development pathway. Second, it is believed that technologies, once put on the market and diffused within a society, will lead to social changes. Hence, the view of the linear model of innovation on the relationship between technology and society is coined by an explicit technological determinism, for which it has been highly criticized by many innovation scholars. At the forefront of this criticism were sociologists of technology, whose empirical analyses focused in detail on the very micro processes of technological development (Callon, 1987; Latour, 1991; Pinch and Bijker, 1987). By following actors very closely and analyzing their actions and relationships, these studies were able to reveal the messiness of technological innovation. Innovation is not happening in clear-cut phases or distinct development steps, as the linear model suggests. Instead, it is highly chaotic: Actors use a diverse range of resources during the innovation process, including money, knowledge, material components like infrastructures and technologies, standards and laws or various human resources, and they move back and forth from different societal domains, such as science, production or marketing and sales. Furthermore, the ultimate end of a technology is not predetermined. It is negotiated during an extensive process of social interactions. STS scholars thus see technological innovation as a systemic and heterogeneous process that unfolds in various societal domains, draws on different resources, and involves a diverse range of actors at once. As a result, technological innovation and change has been labeled 'heterogeneous engineering' (Law, 1987) and the notion of a systemic process has been described as the creation of 'seamless webs' (Hughes, 1986).

By explicitly studying processes of social construction, the SCOT approach has shed light on the influence of actors regarding the shaping of technology (Pinch and Bijker, 1987). It conceptualizes technological innovation and change as a process of sense making (Geels and Schot, 2010). One of the central assumptions is 'interpretative flexibility', which posits that scientific knowledge is always exposed to the manifold interpretations of different social groups. Therefore, technological design is seen as a social processes and thus highly contingent. The various opinions of different social actors result in an ongoing debate over the most feasible design. This process only finds an end when a compromise is reached and conflicts are minimized. SCOT literature calls this process 'closure' that eventually results into a 'stabilization' of a certain technological design and function. In short, it is assumed that form and function of technology is always an outcome of agency and social interactions and could thus also have turned out differently. SCOT scholars have tried to incorporate some form of structural environment, e.g. through the concept of the 'wider context' that accounts for the embeddedness of actors into broader societal structures or through the idea of the 'technological frame', which represents a common cognitive scheme for social actors in regard to a certain technology. Nevertheless, it was often criticized to focus only on processes

of agency and thereby totally neglect the structural realm of society. This ultimately led to the accusation of taking a socially deterministic approach.

Actor-network theory (ANT), on the contrary, tried to escape any form of deterministic approach by equating social and technological elements (Callon, 1986; Latour, 1991; Law, 1987). It is assumed that also material objects can 'act' and that human and non-human actors have analytically the same position. This is visualized by the notion of socio-technical networks. It is assumed that society consists of heterogeneous networks, i.e. 'seamless webs', which connect all elements to each other, e.g. humans, organizations, technologies, rules, regulations, materials, etc. In so doing, ANT studies emphasize the interrelations of material and social objects and show that they both constitute each other. Behind every person and every material object is a network of social and technological elements. It is only through those socio-technical networks that elements achieve meaning. ANT does not have a concept for an overarching social structure or wider societal environment. It assumes that the networks are very situational and that structure is represented in each network differently. This has thus also been criticized for being one of the central weak points of the approach (Geels and Schot, 2010).

In general, STS has been very insightful regarding the micro foundation of socio-technical change, which is why the MLP has drawn extensively from these approaches in order to conceptualize agency in regard to technological innovation as well as to point to the socio-technical systemness of society. However, STS approaches alone will not suffice to explain socio-technical transitions. Geels and Schot (2010) for instance, argue that they fall short in regard to the following aspects: First, the lack of a satisfying concept of a wider structural environment runs the risk of over-emphasizing agency as explanatory factor while neglecting issues of power or structures. Second, the overestimation of society on technological innovation (or the equation of social and material elements in the case of ANT) has sometimes led to downplaying the role of technology in societal change processes. Since transition scholars assume technology to play a crucial role in sustainability transitions, it is important to understand the influence of materiality on social processes. Third, STS studies have a tendency to analyze rather short-term, local projects, such as British aircraft development (Law and Callon, 1992) or an attempt by a French utility to create an electric vehicle (Callon, 1986). Transition studies, however, aim at the analysis of long-term and large-scale processes and are therefore interested in *"patterns and regularities at a more aggregate level (e.g. technological trajectories)"* (Geels and Schot, 2010, p. 34). In order to compensate for these missing insights, MLP scholars have made crossovers with evolutionary economics as well as institutional theory and structuration theory.

2.1.2. Structure in the MLP: Evolutionary economics, structuration and institutional theory

To counteract the agency focus of STS approaches, MLP scholars integrated insights of evolutionary economics as well as structuration theory and some institutional theory in order to account for the influences of a wider structural context. In the current MLP model, the main analytical level to represent such a context is the socio-technical regime (Geels, 2002; Rip and Kemp, 1998). Albeit defined in various ways, the primary purpose of the socio-technical regime has been to account for the path-dependent and inert nature of socio-technical systems and the thereof resulting consequences for innovation and change. The concept of the regime originated in evolutionary economics. First introduced by Nelson and Winter (1977; 1982b), the *technological regime* referred to common beliefs and assumptions amongst engineers about which technological advances to pursue, resulting in *"(...) a sense that innovation has a certain inner logic of its own"* and that *"(...) advances seem to follow advances in a way that appears somewhat 'inevitable' and certainly not fine tuned to the changing demand and cost conditions"* (Nelson and Winter, 1977, p.65). In a similar vein, Dosi (1982) explained the determinants and directions of innovation by pointing to *technological paradigms*. Providing firms with a certain set of problem-solving activities, these paradigms steer change and innovation along specific, pre-structured *technological trajectories*. In both cases, the authors point to shared cognitive routines and an actor's embeddedness within a broader environment to explain technological change and innovation. Not technology is seen to follow an internal logic (as in the linear model of innovation), but the innovation process itself. The structural embeddedness of actors (i.e. the engineering community) within cognitive rules and routines is seen to streamline innovation efforts along certain pathways. By focusing on actors' embeddedness in a wider social context, evolutionary economists break with neo-classical assumptions about rational actors as well as simple supply and demand dynamics. Structures, here in the form of cognitive schemes as well as routinized behavior, become highly responsible for the evolution of technological innovation and change.

Even though the concepts of technological regime or paradigm have made a first step into the direction of accounting for the structural embeddedness of actors, the definition of the structural environment is still rather narrow. It only includes a few actors that are directly linked to the technology development (e.g. R&D firms) and it merely looks at shared cognitive routines. Literature in the realm of sociology, in particular structuration theory and institutional theory, had a much broader conceptualization of structures and social context. Therefore, MLP scholars have used their insight to further the conceptualization of structural environments (Geels, 2004; Geels and Schot, 2007; Grin et al., 2010). It became apparent,

that what is called 'regime' in evolutionary economics, is mostly called 'institution' in sociology. Three main theoretical extensions have been made: a) the regime has been re-conceptualized in institutional terms; b) the field of relevant actors has been broadened; and c) the 'duality of structure' has been introduced. Mainly drawing on Scott (1995), institutions have been defined as regulative, normative and cognitive rules that structure and coordinate an actor's behavior. These rules are believed to appear in 'rule systems', where they are linked together and organized (Geels, 2004). Socio-technical regimes are defined as such rule systems, i.e. *"as semi-coherent sets of rules, which are linked together. It is difficult to change one rule, without altering others. The alignment between rules gives a regime stability, and 'strength' to coordinate activities"* (Geels, 2004, p. 904). These rule sets, i.e. the socio-technical regime, thus represents the institutional environment of a socio-technical system that structures and coordinates the actions of system actors. Following insights of STS as well as institutional theory, the notion of relevant actors has been broadened to encompass not only engineers and firms, but also policy makers, users, associations and other actors, who are in one way or the other contributing to the social construction of the field (Geels, 2004; Markard and Truffer, 2008). Socio-technical systems are thus conceptualized as *organizational fields*, a central concept of organizational institutionalism that is defined as *"those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products"* (DiMaggio and Powell, 1983, p. 148). At last, the relationship between an actor and its institutional environment has been re-evaluated. The concept of '*duality of structure*' by Giddens (1984) has thereby been used to show that structures are both, socially constructed and structurally powerful. This way, a first attempt of characterizing the relationship between structures and agency has been made. MLP scholars try to reconcile STS and evolutionary as well as institutional approaches through the use of structuration theory. The structures of a socio-technical system, i.e. the regime, are believed to be constructed and enacted by actors. At the same time, they influence actors' behavior and cognition. Ultimately, this interaction between agency and structure is seen as one of the central mechanism for change in socio-technical system. The next section elaborates on this topic in more detail.

2.1.3. Change in the MLP: Socio-technical transition pathways

MLP scholars interpret the interaction of structure and agency along the lines of Rammert (1997, p. 171): *"Inspired by Giddens's new rules of sociological method, a constructivist explanation of technology's generation on the local level is combined with a social evolutionary approach of structural selection on the global level"* (see Geels and Schot,

2010). The unification of insights of STS, evolutionary and institutional theory requires a model that accounts for agency as well as structure. Transition scholars have therefore introduced a multi-level framework, consisting of technological niches, socio-technical regimes and landscapes. The three 'levels' represent a continuum of structuration, coordination, stability and size. Whereas the landscape encompasses exogenous, seemingly unchangeable elements, the regime refers to the institutional patterns of a dominant socio-technical configuration. Both thus constitute the structural side of the framework. The niche is described as a locus for radical innovation and change, protected from the 'selection pressures' or institutional pressures by the dominant regime and therefore more likely to incorporate entrepreneurial agency that evolves around an alternative socio-technical configuration. In the literature, this has especially been elaborated under the heading of strategic niche management (e.g. Kemp et al., 1998; Schot et al., 1994). In this manner, change in socio-technical systems is conceptualized as interplay between three 'levels of structuration' (regime: high; niche: low; landscape: very high and exogenous). Put simply, it is assumed that a) niches build up a socio-technical configuration that is able to replace the regime, b) landscape forces put pressure on the regime and c) the subsequent destabilization of the regime enables the breakthrough of the niche. Depending on the timing of these processes as well as the nature of the landscape forces (reinforcing vs. disruptive) and the adaptive capacity of the regime, different transition pathways are expected (Geels and Schot, 2007; Smith et al., 2005). Table 2.1 gives an overview of four ideal type transition pathways by Geels and Schot that illustrate the dynamics between the 'levels' that are expected to lead to change in socio-technical systems.

The '*technological substitution pathway*' is the most straightforward representation of a socio-technical transition. It builds on the assumption that an extreme event triggers the breakthrough of a fairly well developed niche technology, which would have otherwise not diffused. The '*de-alignment and re-alignment pathway*' is similar, additionally accounting for a struggle between various potential, but not sufficiently developed niches. Ultimately, however, also this path leads to a reconfiguration on the basis of a niche that is triggered by an extreme event. As Geels (2002) showed, an example of the technological substitution pathway is the British transition from sailing ships to steamships between ca. 1850-1890. Steamships developed over years in a subsidized market niche and slowly proved to be faster and more reliable than sailing ships, but also more expensive. The socio-technical regime around sailing ships as the dominant mode of sea transport was stable enough to prevent steamships from getting more popular. It was not until external shocks, such as mass emigration from Europe to America due to political revolutions and famines or the opening of the Suez Canal, attacked the regime and accelerated the diffusion of steamships. Sailing ships

were not able to pass the Canal and could not accommodate as many people. The diffusion of steamships ultimately led to an economic competition, dropping the prices for steamships through economies of scale. The sailing ship regime dissolved, partly because the incumbent actors could not transition to a new manufacturing process based on iron and steam. Hence, a new socio-technical regime around steamships became dominant. This led to changes in various areas, not just in regard to shipbuilding. One of the most prominent is probably the facilitation of the creation of a global coal industry.

A transition pathway may also develop more incrementally and gradually, as seen in the *'reconfiguration pathway'* or *'transformation pathway'*. In the latter case, pressures on the regime, e.g. in the form of social movements or professional lobby groups, leads to a reorientation of regime activities. Technological niches have not build up sufficiently as to substitute the regime, but the steady contestations and power struggles between actors nevertheless facilitate a gradual regime change: "*In this path, new regimes grow out of old regimes through cumulative adjustments and reorientations*" (Geels and Schot, 2007, p. 407). In a similar vein, the reconfiguration path shows that a steady uptake of niche innovations into the regime will over time ultimately lead to a complete transformation of its basic architecture. Geels (2006b) illustrates this pathway with an empirical analysis of the American transition from traditional factories to mass production. Small (technological) changes since the 1850ies slowly led to a stepwise transformation, as for instance the introduction of division of labor and machines (ca. 1850ies), development of processing industry (e.g. canning or meatpacking, ca. 1860ies), invention of battery driven electric motors (e.g. for drills, ca. 1870ies) or the rise of big firms in many industries as well as the dominance of the profession of industrial engineering. Although initially all these innovations were adopted by the regime to solve specific problems, all together enabled transformative changes of the whole regime.

Overall, the development pathways exemplify the different mechanisms for socio-technical stability and change in the MLP. Stability is granted through the historical alignment of socio-technical structure within a regime as well as a thereof supportive landscape. Change, on the other hand, is envisioned to unfold through two distinct mechanisms. First, there are structural reasons for regime changes, such as landscape pressures or extreme events, e.g. big cultural changes, climate events, demographic changes or economic crises. Second, regime change is caused by agency that is aimed at pushing a new socio-technical configuration. This agency is mostly seen as originating in niches, where rule patterns are still weak and flexible.

Table 2.1: Typology of socio-technical transition pathways by Geels and Schot

Name and description	Graphical representation
Transformation pathway: *"If there is moderate landscape pressure ('disruptive change') at a moment when niche-innovations have* not *yet been sufficiently developed, then regime actors will respond by* modifying the direction *of development paths and innovation activities"* (Geels and Schot, 2007, p. 406)	
De-alignment and re-alignment pathway: *"If landscape change is divergent, large and sudden ('avalanche change'), then increasing regime problems may cause regime actors to lose faith. This leads to de-alignment and erosion of the regime. If niche-innovations are* not *sufficiently developed, then there is no clear substitute. This creates space for the emergence of* multiple *niche- innovations that co-exist and compete for attention and resources. Eventually, one niche-innovation becomes dominant, forming the core for re-alignment of a new regime."* (Geels and Schot, 2007, p. 408)	
Technological substitution pathway: "*If there is much land- scape pressure ('specific shock', 'avalanche change', 'disruptive change') at a moment when niche-innovations* have *developed sufficiently, the latter will break through and replace the existing regime.*" (Geels and Schot, 2007, p. 409)	
Reconfiguration pathway: "*Symbiotic innovations, which developed in niches, are initially adopted in the regime to solve local problems. They subsequently trigger further adjustments in the basic architecture of the regime.*" (Geels and Schot, 2007, p. 411)	

34

To achieve a full transition, i.e. a change from one socio-technical regime to another, both these mechanisms, extreme pressures from outside as well as agentive behavior to push an alternative socio-technical configuration, need to occur more or less simultaneously. Theadaptive capacity of the regime, i.e. its ability to counteract or adapt to new circumstances, ultimately decides on the nature of the transformation.

2.2. Criticisms and potential avenues for improvement

The MLP model has generated many useful insights into socio-technical transitions by starting to conceptualize socio-technical change as interplay of structure and agency as well as exogenous events and internal processes. Nevertheless, the model has been criticized for lacking a clear operationalization of those concepts and processes, which ultimately leads to rather fuzzy empirical applications (Genus and Coles, 2008; Markard and Truffer, 2008; Smith et al., 2010). Since the MLP grounds on various ideas from a range of scholarly communities (STS, evolutionary economics, institutional theory, structuration theory), there is a risk of trying to integrate insights from different ontological origins. Even though MLP proponents have argued that the theories used are similar enough for a fruitful combination (Geels and Schot, 2010; Geels, 2010), this thesis argues that it will most likely be more promising to base the central idea of the MLP, i.e. the structure-agency interplay, on more coherent grounds. This can be achieved by inducing a further institutional turn in MLP thinking. Structure and agency as well as thereof resulting change processes can be conceptualized using only institutional theory, in particular literature on institutional logics (Thornton et al., 2012), institutional work (Lawrence et al., 2009) and the process of institutionalization (Tolbert and Zucker, 1999). The underlying hypothesis is that such a turn will mitigate the most central weak points of the MLP as follows.

2.2.1. Conceptualizing structures and structuration in socio-technical systems

One of the most central criticisms voiced in the transition community resides around the operationalization, specification and delineation of the 'levels', in particular of the socio-technical regime, which complicates and distorts the empirical use of the model (Berkhout et al., 2004; Genus and Coles, 2008; Markard and Truffer, 2008; Smith et al., 2005; Smith et al., 2010). In theory, the 'levels' are defined as *"(...) heterogeneous socio-technical configurations"* that *"(...) provide different kinds of coordination and structuration to activities in local practices"* and that *"(...) thus differ in terms of stability (and size)"* (Geels and Schot, 2010, p. 18). In other words, they represent *"different degrees of structuration"*

(Geels, 2011) and therefore differ regarding their potential to influence actors and their activities. However, despite their key role in the conceptual set-up, the issues of structures and structuration have not attracted much attention in most previous MLP studies, which can be interpreted as the root of many criticisms. Since the methodology for identifying 'levels' has not been spelled out explicitly, the empirical application of the model was repeatedly accused of being fuzzy and sometimes rather arbitrary. Regarding the regime, for instance, scholars have used different levels of analysis, e.g. regimes as the structural environment of a single technology to regimes as the institutional backbone of entire socio-technical systems (Berkhout et al., 2004). While some define the regime as to entail material and tangible elements, such as artifacts, technologies, infrastructures (Hoogma et al., 2002b; Rip and Kemp, 1998), others have used it in a purely institutional way as semi-coherent rule sets (Geels, 2004). Furthermore, scholars tend to delineate niches and regimes according to the maturity of technologies and actors (e.g. niche as synonym for emerging technologies and their supporters; regime coinciding with established technologies and incumbent actors), thereby assuming, rather than empirically assessing a low or high structuration and internal coherence for niches and regimes (Smith et al., 2005). In addition, most studies disregard a thorough description of the structures in a socio-technical system and how these structures interact or affect actors and activities. Since such an analysis is however necessary in order to display the tensions, conflicts and debates in a system, the presentation of the 'levels', and especially of the regime, has a tendency to be too homogenous and harmonious in the empirical accounts. The regime is thus frequently criticized for being portrayed as one homogenous rule system without any conflicts or tensions (Smith et al., 2005). Ultimately, such a simplified depiction of socio-technical regimes reduces the explanatory value of this crucial concept and tends to illustrate transitions as linear pathways of technological niches having to overthrow a black box called regime.

The other structure concept of the model, the landscape, has been accused of being a 'garbage can concept' that accounts for all kinds of vague external influences on socio-technical systems (Geels, 2011). As a consequence, various internal regime processes as well as niche-regime and regime-landscape interactions have been neglected. There is a need for more theorization on what constitutes landscape forces and how they influence socio-technical regimes and niches. Moreover, the reversed question of how activities on the level of regimes or niches shape landscape changes is also understudied. It is therefore maintained that a more detailed view on structures and structuration is necessary to substantiate the operationalization of the MLP and strengthen the understanding of transition dynamics.

This thesis offers a conceptual foundation for assessing structures and degrees of structuration within socio-technical systems by drawing on concepts of institutional theory. In institutional

theory, structure is often used as an umbrella term for things that influence an actor's cognition and behavior as well as the diffusion of practices, e.g. regulations, norms, values, culture, actors or practices. Since structural influences represent one of institutional theory's core interests, it offers valuable insight for elaborating some of the core concepts of the MLP, such as the regime. Based on previous work on the institutional nature of the regime (Geels and Schot 2007), it will be argued that structuration can be conceptualized as a process of institutionalization and that the strength of a regime can be assessed by identifying the degrees of institutionalization of its core elements (Barley and Tolbert, 1997; Barley and Tolbert, 1997; Tolbert and Zucker, 1999). In addition, the institutional logics concept (Thornton and Ocasio, 2008) will be used to analyze the specific content and coherence of structures in a socio-technical system. Institutional logics represent examples of the *"deep-structural rules that coordinate and guide actor's perceptions and actions"* (Geels, 2012, p.3). It is shown that how actors make sense of and act upon reality is contingent on prevailing institutional logics, i.e. on coherent arrangements of beliefs, norms, values and practices that stem from dominant societal institutions. Putting together these two conceptual approaches enables the empirical assessment of the content of structures as well as their degree of institutionalization. In so doing, this thesis presents a way to a) assess the structuration of a socio-technical system, b) identify its core structure, i.e. the regime, without ignoring institutional tensions, conflicts and incoherence (i.e. its "semi-coherence") and c) connect the structures of a socio-technical system to societal institutional logics, i.e. to landscape developments. In doing so it is possible to derive implications for the related issues of transition dynamics, especially regarding the conceptualization of agency.

2.2.2. Conceptualizing agency in socio-technical systems

While the MLP provided adequate framings for the reconstruction of many historical transformation processes in various sectors, it has repeatedly been criticized for promoting an overly deterministic account of socio-technical transformations (Genus and Coles, 2008; Markard and Truffer, 2008; Smith et al., 2005). Although the MLP model incorporates insights of STS and assumes that structures are socially constructed, the actual application of the model and thereby generated insights into socio-technical transitions often neglect the role of agency. MLP proponents have defended themselves by arguing that "*the different structural levels are continuously reproduced and enacted by actors in concrete activities*" and that transition dynamics are seen to be similar to Garud and Karnøe's view on path creation: "*By stressing path creation, we draw attention to phenomena in the making, that is, the temporal processes that underlie the constitution of phenomena. Such a perspective assumes reciprocal interactions between economic, technical and institutional forces that*

constitute technological artifacts and actors involved. Thus, social orders, institutional orders, and artifacts are both the medium and outcome of human endeavors" (Garud and Karnoe, 2001, p. 3; Geels, 2011, p. 29). Obviously, actors and their actions have often been an integral part of empirical transition analyses, as for instance seen in the research about the role of power or social movements in bringing about change (Avelino and Rotmans, 2011; Ornetzeder and Rohracher, 2013) in work regarding transition management and governance issues (Loorbach and Rotmans, 2010; Smith et al., 2014; Weber and Rohracher, 2012) in the realm of firm strategies that purposefully foster or hinder innovation and change (Geels, 2014; Musiolik et al., 2012; Turnheim and Geels, 2013), or in the context of influencing sectoral discourses and rationales (Penna and Geels, 2012; Späth and Rohracher, 2010). However, so far no explicit conceptual framework has been elaborated on how agency can be positioned within highly institutionalized social contexts. Hence, despite the theoretical notion of agency in the sense of the dual structuration cycle à la Giddens, the empirical emphasis on institutional rigidity and path-dependency bears the risk of providing an over-socialized account of transformation processes (Granovetter, 1985). This thesis proposes such a conceptual framework for tackling the paradox of "embedded agency" within socio-technical systems by drawing on the concept of 'institutional work'.

Institutional work is a concept from institutional theory that focuses explicitly on how actors shape their institutional context. It is defined as *"the purposive action of individuals and organizations aimed at creating, maintaining and disrupting institutions"* (Lawrence and Suddaby, 2006, p. 215). The authors do not ignore the effects of institutions on actors, but put their attention on the consequences of actions for institutions (Lawrence et al., 2009). They propose to take on a practice perspective that focuses on the different forms of work that actors engage in to construct meaning, beliefs, rules or standards and thereby shape their structural environment and thus also the course of institutional change. In doing so, they present a way of integrating agency into the analysis of institutions without falling back to a different, more rationalistic actor notion. It therefore offers valuable insights into the conceptualization of embedded agency in socio-technical systems.

In sum, it can be stated that despite a fruitful theoretical elaboration on the dynamics of transition studies as an interplay of different degrees of structuration and different processes of agency, there is still more theorization needed to substantiate the core concepts and processes of the MLP. This thesis contributes to this endeavor by offering insights from institutional theory that will improve and advance the conceptualization of structure and agency. Consequently, this will also help to re-conceptualize change processes based on those new insights. One of the core advancements thereby is that the concept of structure as well as agency will both be drawn from institutional theory and thus they will be

ontologically compatible, which is expected to enable a fruitful empirical assessment of both concepts and thus of socio-technical transitions as a whole.

2.3. Insights of institutional theory

This section reviews the most important concepts of institutional theory that are used in this thesis to contribute to the advancement of a more substantial conceptualization and empirical assessment of socio-technical transitions. The relevant concepts have mainly been elaborated in the realm of organizational institutionalism, a strand of institutional theory originating from the sociology of organizations and organization studies in general (Greenwood et al., 2008; Powell and DiMaggio, 1991). Its main contributions lie in relativizing the neoclassical rational actor model by emphasizing the importance of the impact that institutional environments have on the cognition and behavior of actors and thus on the diffusion of practices. This focus on the power of social embeddedness was first developed by John Meyer and Brian Rowen (1977) as well as Paul DiMaggio and Walter Powell (1983). Whereas the former article elaborates on the hypothesis that organizations in a field become similar in structure and behavior due to their pursuit of legitimacy, the latter describes the ways in which this isomorphism diffuses. The main assumption is that if organizations (or actors in general) built their structures and adjusted their behavior according to their very functional needs, a crucial difference between organizational characteristics would be expected. However, this is not the case. Organizations act and look for the most part very similar. The reason for this homogeneity is found in the institutional environment of actors, which comprises various myths about proper, rational and efficient action and practices that have to be adopted by actors if they want to attain legitimacy: *"Organizations that incorporate societally legitimated rationalized elements in their formal structures maximize their legitimacy and increase their resources and survival capabilities"* (Meyer and Rowan, 1977, p. 53). This process then creates a structural isomorphism between the actors and their environment. As an example of such a societal myth the authors analyzed the diffusion of bureaucratic structures. Bureaucracy was considered to be the only efficient and rational way to structure an organization for a long time. Bureaucratic structures were applied in places where the need for them was not even remotely apparent, e.g. the establishment of ministries for education in regions that do not even have the capacity to provide pencils or notebooks for their schools. DiMaggio and Powell subsequently analyzed how this institutional isomorphism is transported. They came up with the analytical framework of the *organizational field*, which contains all organizations that are exposed to the same institutional environment and thus experience the same legitimacy pressures. Within an

organizational field, actors become similar through three distinct institutional processes: *coercion* (e.g. adhering to the same regulations and laws), *imitation* (e.g. copying actors that are considered successful) and *normative pressures* that stem from processes of standardization and professionalization within the field. The organizational field has since been the most popular concept to account for an organizations institutional environment.

A further reason why efficiency criteria cannot be the only explanation for an actor's structure and behavior was put forward by Marshall Meyer and Lynn Zucker (1989). The authors combined two of the most approved assumptions of organization studies at that time and in so doing gained new insights: 1) organizational mortality decreases with age and 2) organizational performance decreases with age. The conclusion results that old organizations do not necessarily disappear, even though their not as efficient as their young competition: *"Efficient performance is only one - and not necessarily the most important - determinant of organizational survival. In other words, we are surrounded by organizations whose failure to achieve their proclaimed goals is neither temporary nor aberrant, but chronic and structurally determined"* (DiMaggio, 1989, p. 9). The authors thus showed how resources get acquired and survival is guaranteed through the legitimate status of an actor in society.

Institutional theory thus managed to show how actors become fundamentally influenced by their institutional environment. These insights into processes and aspects of isomorphism and legitimacy enabled interesting explanations for homogeneity between actors, the survival of inefficient organizational forms as well as other irrationalities in organizations. These insights have since then been further developed by many scholars. While for a long time the structural influences remained at the center of institutional analysis, scholars soon began to theorize about the role of interests, power and agency for shaping the institutional setting and affecting institutional change. In the following sections, institutional concepts are reviewed that offer a promising contribution to the understanding of socio-technical transitions, i.e. that contribute to the advancement of the conceptualization of a) structure and structuration, b) embedded agency and c) institutional change in general.

2.3.1. Institutional logics and degrees of institutionalization

The description and assessment of structures within socio-technical systems represents one of the core weaknesses of the empirical application of the MLP, among other things leading to an undifferentiated representation of socio-technical regimes. While in theory conceptualized as 'semi-coherent', empirical studies often equate regimes with mature technologies and incumbent actors. Such an analytical approach compromises the strength of the MLP argument, which conceptualizes transitions as an interplay of different degrees of

structuration. Institutional theory provides the vocabulary to analyze structures and structuration processes and therefore offers useful insights for the reconceptualization and empirical assessment of this crucial theoretical concept.

To improve the operationalization of regimes, i.e. of intangible, deep-structural rules that guide the behavior and perception of actors, two aspects need to be put forward: 1) how to assess the content of those structures in order to understand the 'rules of the game'; and 2) how to determine their degree of structuration and coherence so as to account for the actual heterogeneity in a given empirical field. First, it will be shown that 'levels of structuration' can be conceptualized as degrees of institutionalization, which have consequences for the impact on actors and the stability of the system. Second, the institutional logics approach is used to reveal and understand the content of various structures present in a system and to trace conflicts and contradictions between them.

Structuration as a process of institutionalization

Since Berger and Luckmann's (1966) seminal contribution on the social construction of reality, scholars have implicitly assumed that institutions are socially constructed. But only a few contributions have examined the process of institutionalization and its consequences for the impact on actors. Zucker (1977, p. 726), for instance, points out that *"institutionalization is defined (…) as a variable, with different degrees of institutionalization altering the cultural persistence which can be expected"* and Barley and Tolbert (1997, p. 4) state that *"(…) practices and behavioural patterns are not equally institutionalized. This variation depends, in part, on how long an institution has been in place and on how widely and deeply it is accepted by members of a collective. Institutions that have a relatively short history or that have not yet gained widespread acceptance are more vulnerable to challenge and less apt to influence action."* These scholars have also successfully merged insights of the process of institutionalization (Berger and Luckmann, 1966; Zucker, 1977) with structuration theory (Giddens, 1984; Sewell, 1992). They conclude that institutionalization is a process of increasing structuration and that the terms can be used synonymously. A structure that is highly institutionalized, i.e. that reaches a high age as well as scale and degree of acceptance, can thus be considered an institution (Barley and Tolbert, 1997; Tolbert and Zucker, 1999).

Tolbert and Zucker (1999) define three main stages in the process of institutionalization: habitualization, objectification and sedimentation. The three stages represent an institution's increase in exteriority, i.e. the degree to which it is experienced by actors as part of an objective, external reality and as a 'coercive fact' (Berger and Luckmann, 1966; Tolbert and Zucker, 1999). De-institutionalization can then be interpreted as the reversal of this process. The first step of institutionalization is *habitualization*. It represents the phase wherein an

innovation is created by a small number of actors in response to a recurring problem and as such achieves some sort of habitualized form. This process is mostly an uncoordinated activity; there is no consensus about the usefulness of the innovation, no explicit theory or knowledge base for it, no associated values or legitimated users. These structures thus tend to be very unstable and impermanent, often disappearing with the actor's that established them in the first place.

Objectification represents the next phase of institutionalization. It *"involves the development of some degree of social consensus among organizational decision-makers concerning the value of a structure, and the increasing adoption by organizations on the basis of that consensus."* (Tolbert and Zucker, 1999, p. 182). This step implicates extensive institutional work by actors, such as problem and solution framing, persuasion, theorizing, making alliances, mobilizing resources etc. It is successful, if a collective rationality about the innovation has been generated. Normally, the actors who adopt the innovation are becoming more heterogeneous, discourse is high and variance of the innovation decreases.

Sedimentation, as the last step of institutionalization, is *"a process that fundamentally rests on the historical continuity of structure, and especially on its survival across generations of organizational members. Sedimentation is characterized both by the virtually complete spread of structures across the group of actors theorized as appropriate adopters, and by the perpetuation of structures over a lengthy period of time."* (Tolbert and Zucker, 1999, p. 184). The structure has become normative or even taken for granted, discourse about it has settled down, change in design is rare and failures rather low. Furthermore, there is a distinct group of actors who have vested interests and will maintain the structure, resistance by opposing actors is low and the functionality is not questioned. Sedimented structures are thus most likely to be stable, hard to deinstitutionalize and change and exert their full power over actors and practices.

In sum, this perspective suggests that the power of structures varies depending on their degree of institutionalization. Institutionalization is thus conceptualized as a variable. Literature furthermore suggests that a high degree of institutionalization of a structure goes along with an increase of the scale and scope of diffusion (e.g. use or implementation), duration of existence (e.g. path dependency, historical embedding), invulnerability to social intervention (e.g. resistance regarding innovations or counter movements), starkness (e.g. low dissent and controversy) or coherence (e.g. embeddedness in an institutional framework, good match with surrounding structures) (Jepperson 1991, Zucker 1977, Scott 1987). Furthermore, the degree of exteriority of a structure is experienced the most when principles are translated from a discursive level into practice, for instance in the form of laws, technologies, organizations,

financial investments or routinized practices (Hajer 1995). The overall structuration of an organizational field and along with it its coherence then depends on the degree of institutionalization of its structures. While some fields are characterized by a high structuration, i.e. a dominance of sedimented structures, others rather entail habitualized and objectified elements and can thus be seen as newly evolving or undergoing a transformation. In order to fully assess the coherence of a field, it is also necessary to analyze the specific content of the structures and in so doing assess their compatibility. The institutional logics perspective provides a suitable framework to analyze the content of institutional structures.

The content and coherence of structures: Institutional logics

The institutional logics approach highlights how actors are influenced by their institutional context. It shows that institutions regularize behavior, but at the same time enable agency and change. The strength of the approach lies in its focus on the content and meaning of institutions (Friedland and Alford, 1991; Haveman and Rao, 1997; Thornton and Ocasio, 1999). It suggests that society consists of various institutional sectors that entail different rationalities, i.e. different beliefs, norms, values and practices that shape actors cognition and behavior. These rationalities are called institutional logics and are defined as *"the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality"* (Thornton and Ocasio, 1999, p. 804). Scholars have identified seven main, ideal type institutional sectors that influence actors in western societies in very particular ways: the family, the community, the religion, the professions, the state, the corporation, and the market (Friedland and Alford, 1991; Thornton and Ocasio, 1999; Thornton et al., 2012). Each of these institutional sectors exhibits a distinct logic by entailing a very particular belief system and defining its own "master principles of society" (Greenwood et al., 2010), which may be complementary or contradictory. For instance, they *"define the ends and shape the means by which interests are determined and pursued. Institutional factors determine that actors in one type of setting, called firms, pursue profits; that actors in another setting, called agencies, seek larger budgets; that actors in a third setting, called political parties, seek votes; and that actors in an even stranger setting, research universities, pursue publications."* (Scott, 1987, p. 508). But also the strategies, authorities, norms, organizational forms or control mechanisms typically vary between those institutional sectors (see Table A.1 in the Appendix for detailed characteristics of institutional sector logics).

These ideal typical institutional sector logics get reconfigured and translated in organizational fields. Field logics emerge as a combination of one or more institutional sector logics. Since

actors are assumed to be bounded in their rationality (Simon, 1947), field logics are used as guiding principles that offer specific rationalities, set the rules of the game, allocate power and status and steer attention towards specific problems and solutions (Thornton and Ocasio, 2008). A change in field logic will lead to a change in actors' strategies, problem focus or technology. Therefore, studies have predominantly looked at a change from one specific field logic to another, implicitly assuming that organizational fields are usually dominated by a single field logic that gets replaced over time (e.g. by shifting the relative importance of the institutional sector logics prevailing in a field). Since the 1980s, for instance, the rise of market and corporation logics with their focus on business and management models, shareholder value or economic efficiency has transformed many fields such as higher education, health care or infrastructure. Thornton and Ocasio (1999) analyze the field of higher education publishing in the US and show that a shift from a craft- and profession-based logic towards a market- logic led, among other things, to a significant rise in M-form organizations. On the other hand, there is also evidence that fields can be characterized by competing logics, which coexist and compete because they are supported by equally powerful actors and arrangements. Ruef and Scott (1998) study the health care field in California and document how a managerial reform leads hospitals to develop a structural separation between technical tasks, which are legitimized in terms of a medical-professional logic and administrative tasks, which are evaluated by managers. This way, two contradictory rationalities shape one organizational field. In general, organizational fields are often rather heterogeneous, consisting of institutional elements that belong to different institutional sector logics and that have developed into a more or less coherent and distinct institutional field logic. The overall structuration of the field is thus often characterized by the relative strength of alternative field logics. At any moment, these logics may coexist, compete, contradict or complement each other and thereby reinforce or weaken the structuration of the field.

This is where the process of institutionalization described above meets the institutional logics idea in order to refine the assessment of the structuration of organizational fields: Field logics, i.e. their structural elements and coherence between them, can be institutionalized to different degrees. The institutionalization of a field logic can be described as an evolution from loosely structured, habitualized elements towards a highly stable configuration of sedimented practices, values and actors (Heinze and Weber, 2010). Over time, institutional elements may align into a very coherent field logic, which then exerts a high degree of structuration. This is characterized, for instance, through the awareness of field actors that they share a common meaning system, the clarity of field boundaries, similarities between actors and practices or a low level of disagreements as to the basic principles of the field logic (Scott, 1987). However, in times of change, this coherence may be threatened by the emergence of new field logics

that result from the increasing legitimation of other institutional sector logics in the field, e.g. the development of a market logic in publishing as described above. New actors may enter the field, new values, regulations or norms are created or new technologies invented. The evolution, overthrow, or modification of an existing field logic depends on a number of factors including: the degree of institutionalization of the existing logic (i.e. its robustness), particular events (e.g. major technological disasters like the melt-down of the Chernobyl or Fukushima reactor), the power distribution among actors (e.g. legitimated formal decision-making power) and their effort to engage in institutional work (e.g. by lobbying) (for a detailed elaboration of change in institutional logics see Section 2.3.3). Overall, the underlying assumption is that the structuration of organizational fields is characterized by the institutionalization of one or more distinct field logics that themselves are variations from the general institutional sector logics. As a consequence, fields may differ regarding coherence and likelihood for change. A high structuration of an organizational field can be expected if there is a dominant field logic that is highly institutionalized, coherent and not challenged. Structuration will decrease if the emergence of new field logics leads to an erosion of dominant structures and instead gives way to competing rationalities that may present opportunities for change.

2.3.2. Embedded agency as institutional work

"The major criticisms of institutional theory have been its assumptions of organizational passivity and its failure to address strategic behavior and the exercise of influence in its conceptions of institutionalization" (Oliver, 1991, p. 173). Very early on in the rise of organizational institutionalism the lack of a plausible theory of action has been the main concern of many scholars (Beckert, 1999; DiMaggio, 1988; Lawrence, 1999; Lawrence and Suddaby, 2006; Oliver, 1992; Oliver, 1991). The main goal was to solve the paradox of embedded agency without returning to a methodological individualism. They argued that to really understand the origins, the reproduction and the deinstitutionalization of certain institutionalized forms and practices, i.e. the process of institutional change, a closer look into an actor's handling of interests and agency is necessary (DiMaggio, 1988). The subject of interest and agency should not be seen as contradictory to institutional theory, but as an important addition, which helps to clarify and understand institutionalization as a process and not just consider its outcomes.

Several authors contributed to the advancement of this endeavor under different headings, e.g. institutional entrepreneurship (Battilana et al., 2009; Dorado, 2005; Eisenstadt, 1980; Hardy and Maguire, 2008) or institutional work (Lawrence and Suddaby, 2006; Lawrence et al.,

2009). While the former has been more interested in studying the causes and conditions that enable agency, in particular in terms of institutional creation by entrepreneurs, the latter has focused more on the characterization of the actual nature of agency, i.e. the practices applied by actors.

As stated by Lawrence (1999, p. 166), the general understanding of embedded agency by most scholars is as follows: "*The fundamental relationship between action and social rules implies the possibility of change, as well as reproduction. The legitimacy of rules and practices is dependent on their continual reproduction in social action. Consequently institutional rules are not fixed and determined, but rather the subject of ongoing formations and transformations by motivated actors*". Lawrence further claims that 'institutional strategy' is a concept to understand the relationship between organizations, their strategies and the institutional context. Institutional strategies represent "*patterns of action that are concerned with managing the institutional structures within which firms compete for resources*" (Lawrence, 1999, p. 163). Institutional strategies differ from 'normal' competitive strategies in that they represent actions that try to maintain, create or disrupt institutional settings, whereas competitive strategies are usually concerned with enacting, managing and leveraging already existing and legitimate institutional constellations.

Enabling conditions for embedded agency: Actors' characteristics and field properties

Research in the realm of institutional entrepreneurship that studies the enabling conditions for agency has primarily focused on two aspects: *actor's characteristics* and *field conditions*. Why do certain actors in a field successfully innovate while others do not? How is an entrepreneur different from a regular actor? Some studies propose that special characteristics, qualities and abilities enable certain actors to become institutional entrepreneurs, such as psychological capabilities to recognize opportunities and reflect critically about a situation (Beckert, 1999; Dorado, 2005; Fligstein, 1997; Hardy and Maguire, 2008; Seo and Creed, 2002). Fligstein (1997) in particular stresses the importance of 'socially skilled actors' that show a great amount of empathy and thus are able to persuade other actors, to win them for collaborations, to engage in important discourse, to sell their ideas, to frame their project and deliver a convincing theorization of it. Also Beckert (1999, p. 789) notices: "*The entrepreneur is the analytically distinguished social type who has the capability to take a reflective position towards institutionalized practices and can* envision *alternative modes of getting things done*". However, explaining agency by pointing to special actor characteristics has earned much criticism in the literature. The representation of actors as heroic entrepreneurs is rather hard to reconcile with the institutional program and has a tendency to

fall back to a particular sort of methodological individualism that is based on psychological factors.

Other scholars have focused more on the analysis of an actor's position in the field and have thus made a more structural argument. They have argued that an actor's social position has a direct impact on its ability for agency (Battilana et al., 2009; DiMaggio, 1988; Dorado, 2005; Garud et al., 2002; Hardy and Maguire, 2008; Leblebici et al., 1991). The position influences an actor in various ways: legitimacy, perception of the field, access to resources, allocation of power or social capital. While actors in the center of the field tend to be highly exposed to a field's institutional structures and thus rather constricted, actors at the periphery of fields experience a lighter embedding, which is likely to be more favorable for engaging in agency. On the other hand, a central position will most likely allow a better access to resources and hence provide more political power, financial means or social capital.

Scholars have also analyzed the way in which certain field conditions favor agency. One of the central indicators thereby is the degree of uncertainty experienced in a field that is closely related to the degree of institutionalization of the field. While some authors believe that stability, i.e. a high institutionalization, is favorable for strategic action (Beckert, 1999; Dorado, 2005; Oliver, 1991), others highlight the importance of uncertainty for the development of purposive action (DiMaggio, 1988; Fligstein, 1997). Oliver (1991, p. 171) argues in favor of a high institutionalization and states: *"As the uncertainty of the environment diminishes, the need for security, stability, and predictability from the persistence of institutionalized norms decreases and organizations grow more confident in their predictions about the acquisition of future resources and legitimacy. Under these conditions, the manipulations and defiance of institutional values and the constituents that express them are seen as less risky strategic alternatives for achieving organizational goals."* Beckert (1999) follows this argument and assumes that the kind of rational assessment that is needed to act strategically is only possible when uncertainty is low and thus the expectations of all involved actors clear. Actors need to be able to calculate the consequences of their actions. His main thesis therefore is that institutions reduce uncertainty and secure expectations to the point where strategic actions become possible. At the same time, the institutional environment also provides a starting point for actors to recognize its constraining aspects and to manipulate it in order to profit and get an advantage. Institutional stability therefore is seen as the basis for interest driven action by institutional entrepreneurs that in the end leads to institutional change. In a similar vein, DiMaggio and Powell have showed that mimetic isomorphism, the 'blind' imitation of actors or uptake of perceived successful models, occurs mostly during times of high uncertainty. Mimetic isomorphism can be

interpreted as the opposite of purposive agency that leads to institutional change, but rather as an uncertainty driven institutionalization process.

However, most studies have rather focused on agency and entrepreneurship in emerging fields and hence in surroundings where institutionalization is not far developed and uncertainty thus rather high (Battilana et al., 2009; DiMaggio, 1988; Dorado, 2005; Fligstein, 1997; Garud et al., 2002; Garud and van de Ven, 2002; Haveman and Rao, 1997). An unstructured field bears much more possibilities for strategic action because it leaves enough freedom to maneuver. Moreover, it is assumed that in times of uncertainty actors engage in various activities to regain stability and thereby engage in a process of institutionalization and thus institutional change. In sum, it can be stated that uncertainty and thus the degree of institutionalization will be relevant in determining the possibility of agency by actors. Therefore, also everything that influences the degree of uncertainty within a field will be crucial to analyze. This includes, for instance, also the state of the field: emerging, mature or in crisis. Greenwood et al. (2002) state that sudden shocks like technological disruptions, social upheaval, regulatory change or competitive discontinuities may disturb the field and its institutional setting by altering actor and power relationships, bringing in new ideas or a change in climate. This consequently leads to opportunities for agency.

In a similar vein, also contradictions between institutions within a field will play a role for processes of agency (Clemens and Cook, 1999; Greenwood et al., 2010; Greenwood et al., 2011; Kraatz and Block, 2008; Seo and Creed, 2002; Thornton et al., 2012; Zietsma and Lawrence, 2010). Heterogeneity of institutional arrangements within a field, i.e. institutional plurality, is very likely to cause contradictions and thus offer different sources of rationality. Such contradictions present alternatives to actors and enable a reflection of the current situation, which in turn may lead to purposive and innovative agency: *"...institutional multiplicity should undermine reliable reproduction, whether strategic actors are playing off competing alternatives, normative actors are torn between competing ideals, or actors are trying to make reconcile diverse cognitive schemas"* (Seo and Creed, 2002, p. 461). Institutional plurality is thus seen as one of the central preconditions for embedded agency.

Practices of embedded agency: Institutional work

Besides these preconditions for embedded agency, some scholars have focused more on the actual *process of agency*. Based on the notion of institutional strategy, Lawrence and Suddaby (2006) reviewed numerous scientific articles concerned with purposive actions of individuals or organizations aimed at influencing institutional settings and subsumed it under the name of institutional work (Lawrence and Suddaby, 2006, p. 215). The authors propose to take on a practice perspective on agency whereby the main focus lies on the different kind of work that

actors engage in to shape the process of institutional change (Jarzabkowski et al., 2009; Jarzabkowski, 2004). The goal is to understand how actors accomplish the social construction of scripts, habits, rules or standards by understanding their everyday actions. By focusing on the process instead of field conditions or actor characteristics, the concept of institutional work finds a fruitful compromise between the constraining effects of institutions on the one hand and the idea of entrepreneurs as heroes with superior qualities on the other. By focusing on the interactions of an actor with the institutional context, a picture of a dynamic interplay between agency and institutions is elaborated.

The different forms of institutional work that have been analyzed in the literature have been categorized as actions that primarily aim at the *creation* of new institutions or the *maintenance* or *disruption* of previous structures. In order to accomplish that, actors engage in practices that either involve the *mobilization of resources* or the *(de-) construction of rationales* (Hardy and Maguire, 2008; Lawrence and Suddaby, 2006). Both strategies, the rather cognitive and symbolic ones as well as the more tangible ones, are used to target their institutional environment, i.e. prevailing institutional logics.

In this context, resources may be interpreted as stemming from a variety of sources, e.g. from political power, money, organizational capabilities, knowledge or social capital (Battilana et al., 2009; Hardy and Maguire, 2008). Examples thereof are for instance state interventions through regulations, the patenting of innovations to secure knowledge, the establishment of new relationships with actors to become more powerful or gain legitimacy or the investment in skilled personnel or superior technologies in order to gain competitive advantage. For the purpose of illustration, two specific forms of institutional work of this category are highlighted in the following: *political work* and *advocacy* (Lawrence and Suddaby, 2006). The former can be defined as the direct use of political power to achieve specific goals. This includes the creation of coercive barriers to change via laws and regulations as well as other forms of direct political interventions or overruling. Powerful decision-making actors, such as ministers, may directly intervene in order to stop certain developments by means of legislation, e.g. forbid certain practices or technologies or set specific standards and regulations. An example thereof is the political obstacles that Edison was confronted with when trying to introduce electric lightning, such as a denied operating license or, compared to the gas companies, inflated fees for wiring (Hargadon and Douglas, 2001). Since infrastructure sectors show a particular proximity to public actors and are characterized by high regulation (Markard, 2011), political work is a crucial form of agency that is expected to determine the development of such sectors.

Advocacy is a form of institutional work that is defined as *"the mobilization of political and regulatory support through direct and deliberate techniques of social suasion"* (Lawrence and Suddaby, 2006, p. 221). It can be seen as an umbrella term for actions that aim at representing the interests of certain actor groups. The most prominent example is lobbying, e.g. by industry associations but also social movements (Clemens, 1993; Holm, 1995). The main goal usually is to mobilize financial and political resources or social capital to support one's cause, e.g. influence policymaking, create new norms or attack old ones.

Institutional work that aims at the (de-) construction of rationales, on the other hand, rather focuses on the cognitive elements in the process of the (de-) institutionalization of structures. It concerns for instance the legitimation of an innovation or development of narratives that establish what is morally right or wrong by means of discourse and communication. The development and diffusion of a scientific knowledge base, education, raising awareness by campaigning or the creation of specific meaning for an artifact, problem or solution are instances of this work. One of the most central has been called "*theorizing*", defined as the *"development and specification of abstract categories and the elaboration of chains of cause and effect"* (Lawrence and Suddaby, 2006, p. 221). It is an important step in the creation of institutions, e.g. through the development of specific names, concepts or categories that enable a common language and create a 'cognitive map' (Lawrence and Suddaby, 2006). This played for instance an important role in the establishment and legitimation of environmental issues, such as climate change, air pollution or sustainability, where the 'truth' of the scientific knowledge and its implications has been and to a certain degree still is heavily debated (Garud et al., 2010; Penna and Geels, 2012).

In a similar vein, also other forms of institutional work aim at shaping normative and cognitive assumptions of actors. *Imagery*, for instance, describes the specific use of visual images to invoke certain feelings and associations, e.g. use pictures of lung cancer on cigarette packs or photographs of environmental disasters in news articles. *Mythologizing* refers to the deliberate use of myths in order to *"preserving the normative underpinnings of an institution"* (Lawrence and Suddaby, 2006, p. 223). Very popular are for instance stories about 'great men' ranging from successful entrepreneur (e.g. Steve Jobs) to footballer (e.g. Maradona) to political and social leaders (e.g. Mandela, Martin Luther King or Che Guevara) that sustain societal values such as creativity, hard work, social rise, freedom and equality. A more general version of this work has been called *changing/stressing normative associations*. It refers to the plethora of ways that new norms or values are legitimated or old ones defended. An example is the rise of new public management, whereby norms of the private sector, such as managerial and market efficiency and effectiveness are promoted in public sectors like schools or health care. One particular way of doing that has been labeled *mimicry*,

defined as *"associating new practices with existing sets of taken-for-granted practices, technologies and rules in order to ease adoption"* (Lawrence and Suddaby, 2006, p. 225). The acceptance of new technologies among users can for instance be increased if the design and functions are very similar to previous, already known devices since this makes innovations more accessible and understandable (Hargadon and Douglas, 2001). The last form of institutional work discussed here for the purpose of illustrating the concept is *educating* (Lawrence and Suddaby, 2006, p. 227). Educating people can be crucial for the creation of a new institution in that knowledge and skills are diffused which are necessary to support and sustain the new institution. This refers to scientific training to operate specific technology, but it also encompasses 'softer' forms of knowledge, e.g. environmentally sustainable behavior or hygiene (e.g. hand washing).

Although the various forms of institutional work that Lawrence and Suddaby have collected throughout the literature are all used to create, maintain or disrupt institutions, the authors have identified a certain pattern in terms of the primary aim of an institutional work practice. The creation of an institution, for instance, is likely to include practices that a) are very political in nature, such as reconstructing *"rules, property rights and boundaries that define access to material resources"* (Lawrence and Suddaby, 2006, p. 221) and b) aim at altering an actors' belief systems as well as a general meaning system. Hence, the creation of institutions may entail the application of advocacy, political work, theorizing or changing normative associations. The maintenance of institutions, on the other hand, *"involves supporting, repairing or recreating the social mechanisms that ensure compliance"* (Lawrence and Suddaby, 2006, p. 230). It may thus rather apply practices such as mythologizing or forms of political work that establishes barriers to certain developments or ensures compliance with current regulations. Almost the opposite of such strategies are implemented if the aim of institutional work is to disrupt institutions, because this *"involves attacking or undermining the mechanisms that lead members to comply with institutions"*, as for example undermining certain assumptions or beliefs as well as political work that aims at *"disconnecting rewards or sanctions associated with some set of practices, technologies or rules"* (Lawrence and Suddaby, 2006, p. 235). For a summary of some of the main forms and aims of institutional work discussed by Lawrence and Suddaby see Table 2.2. Table 2.3 furthermore presents a graphic summary of the different aspects of embedded agency discussed in this section.

Table 2.2: Forms and aims of institutional work
(adapted from Lawrence and Suddaby 2006)

Forms of institutional work	Definition	Primary aim
Advocacy	The mobilization of political and regulatory support through direct and deliberate techniques of social suasion	Creating/maintaining/disrupting institutions, mobilization of resources, construction of rationales, establishing new relations
Changing normative associations	Re-making the connections between sets of practices and the moral and cultural foundations for those practices	Creating/maintaining/disrupting institutions, construction of rationales
Constructing normative networks	Constructing of interorganizational connections through which practices become normatively sanctioned and which form the relevant peer group with respect to compliance, monitoring and evaluation	Creating/maintaining/disrupting institutions, establishing new relations
Mimicry	Associating new practices with existing sets of taken-for-granted practices, technologies and rules in order to ease adoption	Creating institutions, constructing rationales
Theorizing	The development and specification of abstract categories and the elaboration of chains of cause and effect	Creating institutions, construction of rationales
Educating	The educating of actors in skills and knowledge necessary to support the new institution	Creating institution, construction of rationales
Policing	Ensuring compliance through enforcement, auditing and monitoring	Maintaining institutions, mobilization of resources
Deterring	Establishing coercive barriers to institutional change	Maintaining institutions, mobilization of resources
Valorizing and demonizing	Providing for public consumption positive and negative examples that illustrate the normative foundations of an institution	Creating/maintaining/disrupting institutions, construction of rationales
Mythologizing	Preserving the normative underpinnings of an institution by creating and sustaining myths regarding its history	Maintaining institutions, construction of rationales
Disassociating moral foundations	Disassociating the practice, rule or technology from its moral foundation as appropriate within a specific cultural context	Disrupting institutions, construction of rationales
Undermining assumptions and beliefs	Decreasing the perceived risk of innovation and differentiation by undermining core assumptions and beliefs	Disrupting institutions, construction of rationales

Table 2.3: Overview of approaches towards embedded agency

Enabling conditions for agency		Processes and practices behind agency	
Actors	*Org. field*	*Aim of practice*	*Nature of practice*
Characteristics of actors	*Uncertainty*	*Creation of institution*	*Mobilization of resources*
- Psychological capabilities	Agency aimed at reducing uncertainty and due to light embedding vs. agency on the basis of a stable environment and clear expectations	- Political work	- Money
- Reflexivity		- Reconfiguration of belief systems	- Capabilities
- Skilled actors			- Political power
		- Change categories of meaning	- Social capital
			- Discursive power
Position in the field	*State of field*	*Maintenance of institution*	*Construction of rationales*
- Center	- Mature	- Securing compliance	- Knowledge development
- Periphery	- Emerging	- Reproduction	
	- In crisis	- Internalization	- Collective framing
			- Persuasion
	Institutional plurality		- Justification
	- Contradictions	*Disruption of institution*	
	- Alternative Rationalities	- Redefining and Recategorizing	
		- Violating and undermining social conventions	

2.3.3. Institutional change

A focus on embedded agency has crucial implications for the conceptualization of institutional change. Friedland and Alford (1991) mention four major types or phases of institutional change: institutional formation, institutional development, de-institutionalization and re-institutionalization. In a similar vein, Tolbert and Zucker (1999) have characterized institutional change referring to habitualization, objectification, sedimentation and de-institutionalization. Both categorizations suggest that institutional change is seen as a process. In terms of institutional work, institutions are created, maintained or disrupted in various ways and through different mechanisms.

For a long time, the only way that institutional change has been accounted for in the literature has been through the impact of extreme events, shocks or jolts that were believed to break up the rigidities of an institutional setting and in so doing provide opportunities for a reinterpretation of reality and thus for change (Jepperson, 1991; Meyer, 1982; Sine and David, 2003). This notion of institutional change is strongly related to the focus of institutional stasis, continuity and persistence. While exogenous shocks may contribute to institutional change, it is by far not the only possibility. Taking on a more agency and process oriented perspective on institutions allows for a more multifaceted conceptualization of institutional change. On the one hand, it is acknowledged that institutions are exposed to a

continuous process of social construction, and in particular of a process of reproduction. The stability of an institution, i.e. its maintenance, is not at all guaranteed or effortless. Instead it involves a constant active reproduction and enactment. As soon as this is not achieved anymore or purposive work is targeted at de-institutionalizing a structure, change is underway. Such a process-oriented understanding of institutional change has thus opened up an array of research on gradual transformation processes (Dacin et al., 2002; Djelic and Quack, 2007; Dolata, 2011; Mahoney and Thelen, 2009; Streeck and Thelen, 2005).

Forms and preconditions of gradual institutional change are thus related to the forms and preconditions of embedded agency discussed above. One of the most discussed causes for gradual institutional change is institutional plurality, i.e. the contradiction and ambiguity that comes with different sources of rationality. Thornton et al. (2012), for instance, call this precondition a 'structural overlap'. It is seen as one of the main reasons for a change of institutional logics within an organizational field. It is assumed that a structural overlap, caused for example by mergers and acquisitions or a turnover in personnel, may foster change by imposing new institutional logics onto the field. As a consequence, the entrenchment of certain institutional configurations decreases and actors may become aware that reality can be evaluated in different terms. This way, new values, practices, technologies and actors may gain increasing legitimacy in a field and different forms of agency become possible.

Besides the fact that an agency perspective enables a conceptualization of endogenous change, studies have also increasingly shown that not all exogenous, extreme events have transformative power (Hoffman and Ocasio, 2001; Munir, 2005; Munir and Phillips, 2005). The relevance of an event for institutional change is not objectively given, but instead highly depended on the meaning that actors attach to it. The construction of meaning can be interpreted as a purposive act that aims at the creation, maintenance or disruption of institutions. It is a form of embedded agency, i.e. an application of institutional work (Lawrence and Suddaby, 2006). To understand the role of an extreme event for bringing about change, it is therefore also necessary to analyze the different forms of institutional work that actors apply to frame an event as a relevant crisis. An event can either develop into a crisis or stay unattended and thus have no significant meaning for processes of change.

Overall, a conceptualization of institutional change based on the understanding of a *"relative swing between agency and embeddedness"* (Clemens and Cook, 1999, p. 222) leaves much more room for explanations than just referring to exogenous events. How institutional field logics change or how new logics emerge in a field have thus become central topics in institutional analysis (Thornton et al., 2012). A change in institutional logics may, but does not necessarily have to result from exogenous shocks or jolts. It may as well result from

various interactions between structures, i.e. institutional logics, and embedded agency, such as institutional work. This enables a more gradual and endogenous understanding of institutional change that nevertheless is able to account for radical transformations of organizational fields, defined as a change from one dominant institutional logic to another.

Based on the elaboration above, this thesis places the focus on the following particularities of institutional change:

1) Institutional logics built the structural backbone of an organizational field.

2) Institutional logics in a field can be institutionalized to different degrees (habitualized, objectified, sedimented states of institutionalization).

3) The degree of institutionalization influences the impact a structure has on an actor's cognition and behavior and therefore also the likelihood of opportunities for agency (strong institutionalization equals strong embedding and thus less room for purposive maneuvering and vice versa).

4) All events or preconditions that lead to a decrease in institutionalization of a certain logic, such as structural overlap and institutional plurality or, in some cases, extreme exogenous events, will thus increase opportunities for agency.

5) An expansion of opportunities for agency is assumed to lead to an increase in institutional work activities. Since those activities may aim at the creation or disruption of institutions, it can be assumed that the likelihood for institutional change increases. However, institutional practices may also be targeted at maintaining prevailing institutional logics and in so doing hinder change. Whether institutional change occurs will thus ultimately be an empirical question.

In sum, institutional logics are socially created, maintained and disrupted. The more institutional contradictions are generated within a field, may this be through exogenous events that open up opportunities for agency or entirely endogenous processes of institutional work, the more the overall structuration of a field decreases and opportunity for change, based on processes of embedded agency, are provided. A change in institutional logics is thus likely to include the deinstitutionalization of existing logic elements coupled with the institutionalization of new elements. In this manner, a (gradual) change of institutional logics can result in a radical transformation of the whole field.
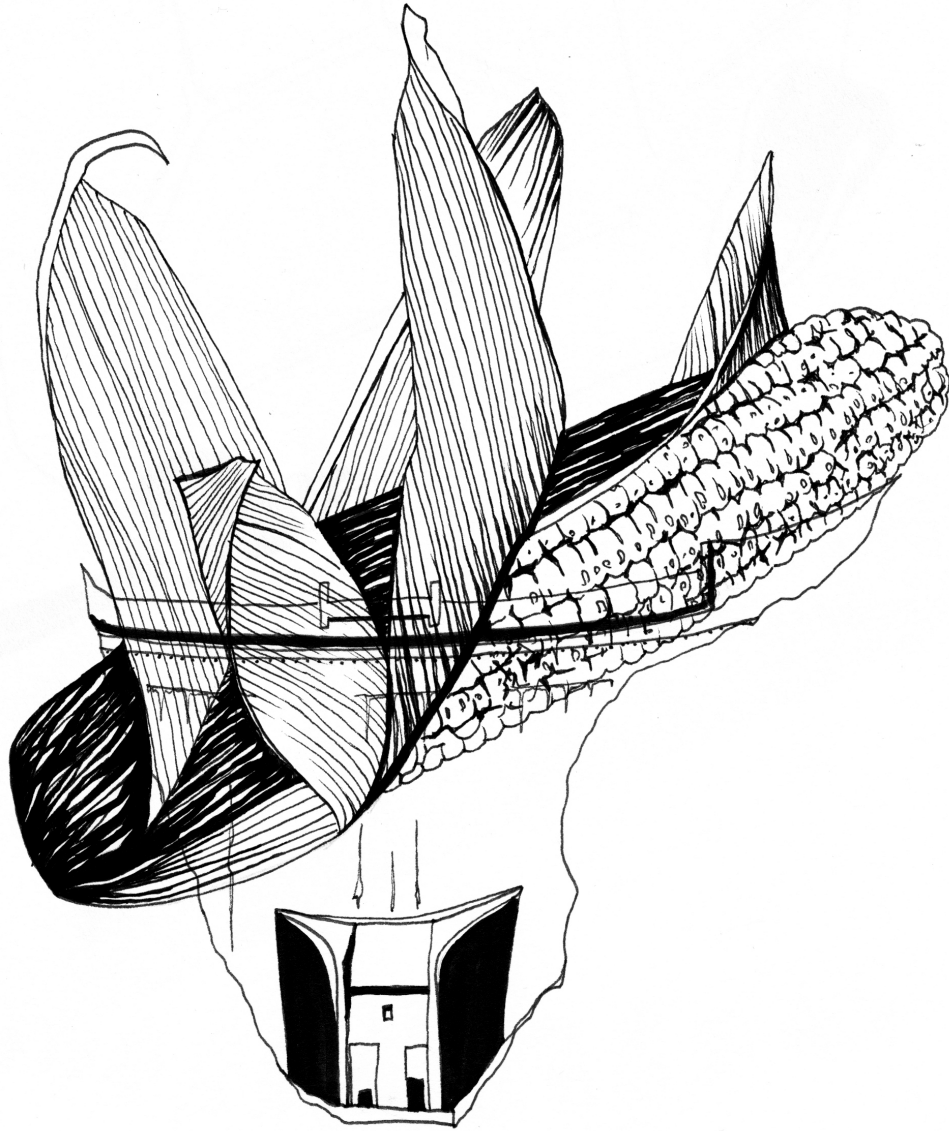
ANALYTICAL FRAMEWORK:
A DYNAMIC MODEL OF SOCIO-TECHNICAL CHANGE

3. Analytical framework: A dynamic model of socio-technical change

The MLP conceptualizes transitions as a dynamic interplay between 'levels of structuration'. The socio-technical regime is described as the 'deep structure' of a socio-technical system, which gets challenged by alternative niche developments as well as landscape pressures that in combination lead to the transformation of prevailing system structures. This idea of change through the interaction of different structures has proven promising to conceptualize socio-technical transitions and the heuristic of it has thus become rather popular. However, in most MLP studies, the empirical assessment of structures and their degree of structuration has been rather implicit. As a consequence, regimes are often presented as homogenous and coherent, niches are equated with emerging technologies and the landscape concept tends to be a residual category that accounts for a variety of exogenous influences. In so doing, the explanatory value of the interplay between 'levels of structuration' has been diminished. Furthermore, the model has been criticized for lacking a systematic conceptualization of agency within highly structured environments. Although the theory draws on ideas of ANT, SCOT or the work of Giddens to account for the 'duality of structure', the empirical application of the model has had a tendency to focus on path-dependency and inertia instead of processes of social construction. As a consequence, the dynamics of change have an overly structuralist focus that borders on determinism, with an emphasis on niches or external shocks as drivers for change while ignoring processes of agency.

By introducing the insights of institutional theory discussed above, a more elaborated understanding of structures and agency as well as a dynamic conceptualization of socio-technical change becomes possible. First, the content and coherence of socio-technical structures can be conceptualized as institutional logics. Second, structuration is seen as the result of a process of institutionalization. The degree of institutionalization is treated as a variable that alters the impact of a structure on actors and thus on processes of agency. Third, agency within socio-technical systems is conceptualized as institutional work. This enables a practice-oriented perspective on processes of social action and a representation of action as embedded within structures. Together, these assumptions lead to a more elaborate understanding of the mechanisms of socio-technical transitions as processes of institutional change that are based on the interplay between structures and agency.

3.1. Structures and structuration in socio-technical systems

Drawing on the theoretical perspectives described above, it is argued that a socio-technical system is a special case of an organizational field, which has an explicit focus on technologies. Socio-technical systems contain a range of material and cultural structures that are institutionalized to various degrees and have more or less aligned into specific field logics. These field logics have often developed in interaction with certain technologies. Therefore, technologies are seen as an important cornerstone of a field logic that co-evolve and align with other logic elements into a specific configuration (e.g. dams in the water sector, cars in transport, nuclear technologies in the energy sector etc.). The internal coherence of a logic, its degree of institutionalization and dominance in the system may however vary. The stability of a configuration is always an empirical question. In line with the MLP definition, a socio-technical regime can now be interpreted as denominating the most highly institutionalized core of a socio-technical system or organizational field, respectively. If the field is mainly dominated by one established field logic, the regime is likely to be highly coherent and stable. It thus exerts a strong power over an actor's behavior and cognition and, along with that, determines the course of development of the socio-technical system. As a result, the system is likely to be very stable and resistant to change. On the other end of the scale, a weak regime would be described as rather incoherent and unstable with different field logics competing for legitimacy and therefore diminishing the overall structuration of the field. This might be the situation in the midst of a transition process, where a once dominant field logic is being challenged by a new one, resulting in various (de-) institutionalization processes of old and new elements and constant institutional work by actors. In most empirical cases however, socio-technical systems will be characterized by intermediary degrees of structuration and as a consequence appear as 'semi-coherent'.

Empirically assessing prevailing and emerging institutional logics within a socio-technical system, i.e. assessing structures such as values, practices, regulations, actors, technologies or cultural beliefs and determine their degrees of institutionalization as well as coherence, provides an analytical 'map' of a system's current structuration. This structuration may be graphically represented as shown in Figure 3.1. The figure presents a potential structuration of a hypothetical socio-technical system that consists of three ideal type field logics. As visible in the picture, the different elements of the three logics are institutionalized to different degrees. While some are closer to the center of the dartboard (representing a high institutionalization), others are rather peripheral (low institutionalization). A regime core can thus be identified that stretches around the center of the dartboard. Since this center is

predominantly populated by elements of Field Logic 1, this logic can be interpreted as being dominant in the field. However, as the figure shows, the entire system, including the regime, is populated by three different socio-technical configurations that are based on distinct rationalities. Hence, the system and the regime are semi-coherent. The dots, triangles and stars graphically represent this semi-coherence that expands deeply into the core of the regime.

Such an analysis of institutional field logics and their degree of institutionalization and coherence are crucial to understand a system's development and thus conceptualize socio-technical change. First and foremost, it facilitates an in-depth understanding of the semi-coherence of a socio-technical system and in particular of its regime. The conceptualization of structures as institutional logics enables an ideal-type characterization of different rationalities within a system and thus an assessment of the prevailing contradictions between them. It is assumed that the more contradictions are present within a system, the weaker its structuration becomes and the more opportunities for agency and change open up. The hypothesis is that the availability and power of alternative institutional configurations broadens the range of legitimate agency within a system and offers alternative ways of doing things. However, while contradictions might be seen as a favorable structural precondition for socio-technical change, it will ultimately depend on how actors act upon it, i.e. how they negotiate the conflicts and tensions.

The analysis of the structuration of a socio-technical system thus furthermore enables an understanding of which structures, i.e., which institutional field logics will influence the cognition and behavior of actors within a system and where opportunities for agency might be found. Structures within the regime core are thereby expected to have the greatest impact on the type and range of potential agency. Since the analysis of structuration uncovers prevailing conflicts and tensions within a system, it is furthermore useful to identify areas that may be in need of a purposeful interference, e.g. by politics. Examples of such targeted events of institutional work are, for instance, the changing of regulations and standards that hinder the diffusion of certain technologies or influencing the public perception by systematic campaigns for or against particular matters.

Moreover, a detailed knowledge about the structuration of a socio-technical system can be used to assess the disruptive capacity of an emerging technology by comparing the compatibility of its features to the highly institutionalized structures within a system, e.g. the compatibility of inherent values, responsible actors, required regulations or designated users. Such a comparison helps to evaluate whether a new technology should be classified as a niche: Does it provide an alternative socio-technical configuration to the one institutionalized

at the moment, which, if it diffuses, will lead to a radical socio-technical transformation that considerably alters the prevailing institutional logic of the system or is it compatible with the current socio-technical configuration so as to blend in and at the most lead to incremental changes? Per definition, the interesting aspect of the concept of the technological niche is to account for system changes that are facilitated by technological innovation. However, not every technological innovation will contribute to change. In order to determine which emerging technologies will lead to radical transformations, it is necessary to compare their inherent features to the current system structuration and evaluate their compatibility. In order to be able to do this, in-depth knowledge of a system's structuration is crucial. The analytical framework at hand enables such an analysis. An illustrative example can for instance be found in the energy sector. Different emerging technologies are discussed in terms of their contribution to a transition away from nuclear power plants and fossil fuels, e.g. photovoltaic, wind or carbon capture and storage (CCS). While the first two are providing a clear alternative to the current system (new actors, regulations, users, values, technological specificities, standards etc.), CCS is mainly trying to mitigate negative impacts of current technologies. While this is per se not an indication of its contribution towards a more sustainable energy system, it does however not classify as a technology that induces a radical system transformation. Instead, it might even be contributing to the entrenchment of the current fossil fuel based energy system because it offers ways of mitigating negative effects.

A further consequence of framing structures as institutional field logics is that in so doing system structures are deducted from broader societal institutional logics and thus show a close connection to the exogenous societal environment, i.e. the landscape. On the one hand, this enables a specification of the nature of institutional landscape pressures, i.e. of the grand institutions that influence in one way or the other action and cognition in contemporary modern societies: The market, the corporation, the profession, the family, the religion, the state and the community. Big cultural influences such as neoliberalism, patriarchy, democracy or certain ideologies can thus be placed within a specific institutional configuration and historical context and are not treated as somewhat 'random' exogenous influences on systems. Moreover, the relationship of system structures with societal institutions will shed light on some of the particularities of those structures that would have otherwise been missed or interpreted as a system-specific attribute instead of a 'local' reconfiguration of broader societal institutions. The institutional logics of an organizational field do not emerge out of the particularities of the field. Instead they are specific translations of broader societal logics in a field that lead to unique and field-specific reconfigurations. In so doing, the landscape entails a clearer idea of the relevant institutions in current industrialized, western societies and their relationship with a socio-technical system.

In sum, the analysis of the structuration of a socio-technical system through institutional logics and a focus on institutionalization as a variable enables a detailed reconstruction of the semi-coherence of systems and their regimes, which in return facilitates the identification of matches and mismatches between various structural elements that shape processes of agency and change. This gives way to a more thorough analysis of internal regime processes as well as to a more systematic identification of niche technologies and a localization and explanation of specific institutional landscape pressures.

3.2. Embedded agency in socio-technical systems

Although agency in the sense of STS is an integral part of the theory of MLP, so far neither a systematic conceptualization nor a fruitful empirical application has been put forward. This is partly due to a primary focus of the model on structural aspects of change as well as a rather difficult reconciliation of the different ontological assumptions of the basic conceptual approaches used (e.g. evolutionary economics vs. ANT or SCOT). By adopting an institutional perspective on embedded agency as institutional work, these weaknesses may be mitigated. The concept of institutional work enables a process and practice oriented approach on social action and social construction. This allows focusing on the process of the (de-) institutionalization of structures as well as elaborating on the practices that actors apply in regard to creating, maintaining and disrupting institutions. Structures thereby enable and constrain the range of possible agency. At the same time, many actions contribute to the reproduction or transformation of these exact structures. Since one of the most defining characteristics of socio-technical transitions is the idea to overcome highly institutionalized structures, it is crucial to have a conceptualization of agency that accounts for the relevance of structures. Institutional work is thus a promising approach.

In regard to socio-technical transitions, the concept of institutional work is suited to improve the conceptualization and understanding of the following processes. On the one hand, there are intrasystem processes that are mediated through institutional work. These include a) the institutionalization of new field logics, b) the (de-) institutionalization of particular system structures and c) the mediation of institutional contradictions, conflicts and tensions. The institutionalization of a field logic often progresses from loosely structured, habitualized elements towards a coherent and highly institutionalized logic. This process involves a considerable amount of institutional work. A new logic does not present itself at once as a coherent rationality. Instead, the formation of a field logic takes time and involves much trial and error as well as negotiation among actors. Authoritative actors, suitable regulations, associated values, functional technologies, related norms, financial systems or firm strategies

not only need to be institutionalized and legitimated individually, but also in relation to each other. They need to find an alignment. As the idea of socio-technical systemness emphasizes, the replacement of a technology, for instance, does not only include switching from one technology to another. Instead, it always also relies on a transformation of the whole socio-technical configuration around it. This socio-technical configuration, however, has to be developed first in order to be considered as a serious and effective alternative to an incumbent variant. This is a process of social construction that can be traced and understood by analyzing the different forms of institutional work involved. Such an analysis gives insights into how new field logics come about that might contribute to a socio-technical transition.

Another angle of analysis focuses on the (de-) institutionalization of particular logic elements, i.e. of certain socio-technical structures. Obviously, the (de-) institutionalization of a particular element is closely related to the (de-) institutionalization of the entire logic in a field. If, for example, a specific value such as environmental sustainability becomes legitimized, it might induce a change in regulation that benefits and thus boosts the diffusion of alternative technologies, which itself might trigger the institutionalization of new actors that establish different strategies and promote new norms and so forth. Therefore, it is important to analyze how the central cornerstones of a particular institutional logic, such as values, actors or technologies, are constantly affected by institutional work, either aiming at their institutionalization and maintenance or their disruption. Overall, it contributes to the understanding of how a shift in institutional logics may unfold through internal agency processes.

A third instance where the analysis of institutional work is crucial for the understanding of transition processes concerns the mediation of institutional contradiction within a system. As elaborated above, institutional plurality is seen as an opportunity for institutional change because it represents a situation where actors are able to draw from different rationalities. However, change only occurs if contradictions, tensions and conflicts within a system are negotiated, mitigated or resolved. This can be seen as a constant and on-going act of social construction by actors. While certain structures might be defended and survive, others get abolished and make space for alternative ones. Another possibility is that a compromise emerges that represents a totally new kind of structure that has not existed before. Focusing on institutional work aimed at mediating institutional contradiction thus provides insights into how a structural overlap might lead to innovation and change.

On the other hand, also the relationship between the socio-technical system and its exogenous environment is moderated and shaped by institutional work. The rise of new societal institutional logics, for example the market and corporation logic in the late 70ies, are picked

up and translated in every socio-technical system differently. Also the relevance of exogenous developments, such as demographic growth, big technological revolutions or climate change are interpreted and addressed in every field uniquely. In a similar vein, extreme shocks like wars, crises or weather disasters are attended to in different manners. Whether one of these exogenous influences is paid attention to and what kind of meaning is attached to it not only depends on the current institutional field logic that generally steers attention towards certain problems and occurrences, but also on the particular efforts actors put into their framing, valuation or theorization. By focusing on institutional work, landscape pressures are thus always accounted for in relation to the agency that attends to those pressures as well as to the particularities of a socio-technical system in general.

3.3. Sources for socio-technical change

As derived from the considerations above, this thesis conceptualizes socio-technical change as resulting from various interactions between a) structures that are institutionalized to different degrees, b) agency, c) exogenous occurrences and d) endogenous processes. As a consequence, a range of different 'sources' or 'starting points' for change can be identified (see Figure 3.1): *extreme events* (wars, financial crises, technological disasters), *exogenous developments* (e.g. climate change, technological revolutions, demographic changes), *rise of new societal institutional logics* (e.g. rise of market logic), *institutional plurality* (availability of different rationalities) and *institutional work* (agency aimed at (de-) institutionalizing structures). While some are located within the system, others are exogenous. However, internal and external sources are assumed to shape each other since external influences are mediated and processed within the system. In a similar vein, some sources of change are primarily structural, while others are predominantly based on agentive processes. But also this distinction is highly interrelated: In the case of structural opportunities for change, the institutional environment is merely seen to offer favorable preconditions for agency, while sources of change that are based on agency are always understood as being mediated by the structures around them. The five sources of change are discussed in detail below.

Extreme Events

One of the most common sources for change is the classic notion of an extreme event or shock, e.g. war, financial crisis or environmental disaster that has the potential to break up the institutional rigidity of a system and give way to new, alternative structures. However, it needs to be acknowledged that the meaning and relevance of such an event is not objectively given, but depended on the meaning that actors attach to it. The construction of meaning can

be interpreted as a purposive act, i.e. as institutional work. To understand the relevance of an extreme event for change, it is therefore crucial to empirically analyze the social construction of a crisis. An event can either develop into a crisis or stay unattended and thus have no significant meaning for change. If it develops into a crisis, however, it can have a destabilizing effect on prevailing system structures: the functionality and legitimacy of current arrangements might get questioned and the need for the development of alternatives increases, which opens up opportunities for agency. The role of extreme events for change can thus only be assessed in combination with an analysis of related institutional work. It is important to note, however, that the institutional work applied does not necessarily lead to change. Crises merely broaden the range of the search radar for potential solutions, technical or otherwise. It is the choice of the solution that ultimately decides if change is fostered or whether the chosen solution will rather lead to a re-stabilization based on the traditional system structures and thus to a maintenance of the dominant socio-technical configuration.

Exogenous Developments

Not only shock-like events can be interpreted as providing opportunities for change, but also more steady exogenous developments might impact the structuration of a socio-technical system. An example thereof is radical technological change, i.e. innovations that alter the 'techno-economic paradigm' of society, to quote Freeman and Perez, e.g. the invention of electricity or the Internet. Although such technological changes may sometimes appear as occurring as a 'shock', they are often rather slow and small systemic adjustments that accumulate over time and are translated into system specific changes (Dolata, 2011). In a similar vein, the subjects of climate change and resource scarcity have slowly diffused into many socio-technical systems and have created various pressures for change. The political realm is thereby particularly affected, since these topics need to be addressed if one wants to be legitimate. Another example is the issue of demographic growth, which may pressure a system to adjust accordingly, which might induce change. Either way, all of these exogenous developments are constantly mediated by the actors as well as the structural preconditions within the field.

Rise of new societal institutional logic

A further external source for system transformation is field logic change triggered by the rise of a new societal institutional logic. A prominent example thereof is the rise of neo-liberalism, i.e. the increasing importance of the market as well as corporation logic in many sectors from the 1970ies onwards. The global dominance of certain societal institutional logics varies over time and is historically contingent. The way such logic shifts influence specific organizational fields and thus particular socio-technical systems is however again

dependent on the way actors deal with these new sources of rationality. New rationalities need to be translated into the specificities of a socio-technical system. Translation can be interpreted as a long process of sense making. This reconfiguration is based on an extensive amount of institutional work. Therefore, different fields react differently to the pressures and/or opportunities brought to them from outside. While some sectors have undergone many changes due to the rise of the market and corporation logic, i.e. strong liberalization, others have not (e.g. electricity vs. water sectors).

Institutional plurality

An internal source for socio-technical change is institutional plurality. It is argued that opportunities for change in a field depend on the availability and power of alternative institutional configurations. Many socio-technical systems are populated by different institutional field logics and can thus be described as semi-coherent. Although usually institutionalized to different degrees, there is likelihood for institutional contradictions, conflicts and tensions because different logics provide different sources of rationalities. These places of contradictions are thus seen as a major opportunity for change. The hypothesis is that the more competing logics present in a field, the less stable a field becomes and the higher the potential for change. However, also this structural precondition ultimately depends on how actors act upon it, i.e. how they negotiate the conflicts and tensions. In addition, the broadening of opportunities for agency always bears the danger of triggering actions and practices that entrench the prevailing system structures.

Institutional work

Although agency in the form of institutional work is constantly present within systems, two specific internal processes are particularly crucial for socio-technical change: On the one hand, there is institutional work aimed at the (de-) institutionalization of particular logic elements, e.g. a certain technology, regulation or value, which as a consequence will strengthen or weaken the respective institutional logic. On the other hand, there is much work involved in the creation of the institutional coherence of a logic. The latter is particularly important in regard to the institutionalization of an alternative socio-technical configuration, i.e. a niche that might replace an existing regime. The more an institutional logic is coherent, the more it becomes a serious alternative to a prevailing configuration. Internal coherence thus increases the power of structuration of a logic. In order to achieve a high internal coherence, each logic element needs to undergo a process of institutionalization. At the same time, institutional work that is aimed at the deinstitutionalization of dominant structures will contribute to the institutionalization of the alternative logic, since the 'open position' needs to be filled. The processes of institutional work that will lead to institutional change can thus be

summarized as either targeting the degree of institutionalization of a particular logic element or increasing the institutional coherence of a logic.

In sum, it can be stated that exogenous and endogenous as well as structural and agentive influences and processes, which are highly interrelated, are crucial for the provision of opportunities for change. Whether and how these opportunities are taken and enacted within a specific socio-technical system remains however an empirical question.

3.4. Dynamics of socio-technical change

Figure 3.1 presents a graphical representation of a hypothetical structuration of a socio-technical system and locates the potential sources for change discussed above. The system is populated by three distinct ideal type institutional field logics. The positions of the graphical symbols represent the degree of institutionalization of a specific logic element in the field: The nearer to the center of the dartboard, the stronger its institutionalization. It is important to note that a socio-technical system consists of both, material and social elements, such as values, technologies, actors, regulations, and the like. It is furthermore assumed that each ideal type field logic has a corresponding ideal type technology with which it has aligned over its process of institutionalization. Although the three logics are institutionalized to different degrees, it is visible that elements of Field Logic 1 (white dots) are comparatively closer to the center of the dartboard and can thus be interpreted as being dominant. However, it is also clearly visible that the socio-technical regime is semi-coherent, since it is made up of elements of different logics. The structural precondition of the entire system and also of the regime is thus to some degree institutional plurality.

The potential transformation pathways of such a socio-technical system will ultimately depend on whether the different opportunities for change can be capitalized on and whether these sources for change align and reinforce each other or not. A socio-technical transition, defined as a shift from one dominant socio-technical configuration to another, or from one prevailing institutional field logic to another, could be graphically represented as follows: most of the white dots move to the periphery, i.e. the edge of the dartboard figure, while either the triangles or stars or a specific combination thereof dominate the core of the regime. A new, strong realignment of the system with a high structuration can be seen as achieved if the contradictions between the elements within the regime are low, i.e. if either a logic has become dominant or a highly compatible combination of different institutional logics has been found. Taking the hypothetical socio-technical system of Figure 3.1, such a transition could unfold in different ways. Similar to Geels and Schot (2007), three ideal type transition

pathways can be described that are based on the interaction of exogenous/endogenous processes as well as structural preconditions and agency. For a graphical representation of the three pathways see Figure 3.2.

Exogenous and endogenous reinforcement: One of the most powerful situations exists when external and internal events and processes reinforce each other. Thereby, an extreme event of any sort is picked up in the system and put forward by the actors so that a system crisis is generated and pressure for change created. Since actors have been heavily engaged in institutional work for a long time, an alternative field logic, for instance Field Logic 3, has achieved a strong coherence that renders it a viable alternative to Field Logic 1. This engagement in institutional work might have been the consequence of institutional plurality in the field, e.g. caused by an emerging technology or the rise of a new cultural value that offered an alternative rationality. Field Logic 1 is thus pressured by a crisis pushed from the outside as well as by the constant further institutionalization of Field Logic 3. Since the institutional work applied by proponents of Field Logic 3 is very effective in valorizing the new logic and at the same time demonizing Logic 1 and the institutional work aimed at maintaining the dominance of Field Logic 1 is insufficient, elements of Logic 3 are progressing into the regime core while elements of Logic 1 are slowly pushed out of it. As a result, Field Logic 3 now dominates the regime core, which can be interpreted as a transition form a socio-technical configuration based on Logic 1 to one based on Logic 3 (see Figure Y).

Endogenous transformation: Although there is always an interaction between a system and its context, it is not necessarily a prerequisite to have specific pressures from outside in order to achieve system change. Instead, system internal dynamics may also enable a transition. A favorable structural precondition for it is institutional plurality that enables new forms and directions of institutional work that can lead to a gradual, but nevertheless radical transformation of dominant system structures. Since institutional plurality is assumed to weaken the structuration of a system, opportunities for agency open up that can lead to changes. In such a case, institutional work is aimed at further the coherence of an alternative institutional logic, institutionalize the corresponding structures while disrupting the prevailing logic of the field. All three parts entail various forms of institutional work, ranging form theorizing, advocacy, educating or mimicry to establish the new Logic to demonizing and changing normative assumptions in order to deinstitutionalize existing structures. For a graphical representation see Figure 3.2.

Exogenous transformation: This ideal type characterizes socio-technical transitions that are mainly triggered by changes in the system context, i.e. the landscape. Exogenous

developments, such as technological changes, or the rise of a new societal institutional logic slowly find their way into the system where they lead to gradual, but also substantial transformations. It is not a shock-like event, but rather a constant pressure. Naturally, this development involves institutional work by system actors. The main difference, however, lies in that the work is not aimed at pushing some elements to the periphery and others to the center. Instead it can rather be understood as a transformation of one element into another, e.g. a white dot in Figure 3.1 transforms itself into a triangle. This has for instance been observed during the rise of the market logic, where many state agencies have been transformed into profit oriented corporations. Even though the actual actors have not changed, their goal orientation, strategies or basis of legitimacy have. In this manner, transitions can unfold without including a total replacement of all elements of a logic (see Figure 3.2).

These ideal type transition pathways are by no means exhaustive. In general, a combination of all sources of change, structural, agentive, endogenous or exogenous can be imagined that will affect the development of the system in different ways. Particular attention should especially be placed on 'transition failure', i.e. on instances where all the starting points for change rather prove to be sources of system maintenance or entrenchment. All exogenous events and processes, e.g. crisis, societal logics, or various other external developments bear the risk of hindering instead of fostering a transition by reinforcing the status quo or de-legitimizing emerging structures. In a similar vein, institutional work by actors within the system may be very successful in maintaining the prevailing logic while the institutionalization of coherence of a new logic may fail.
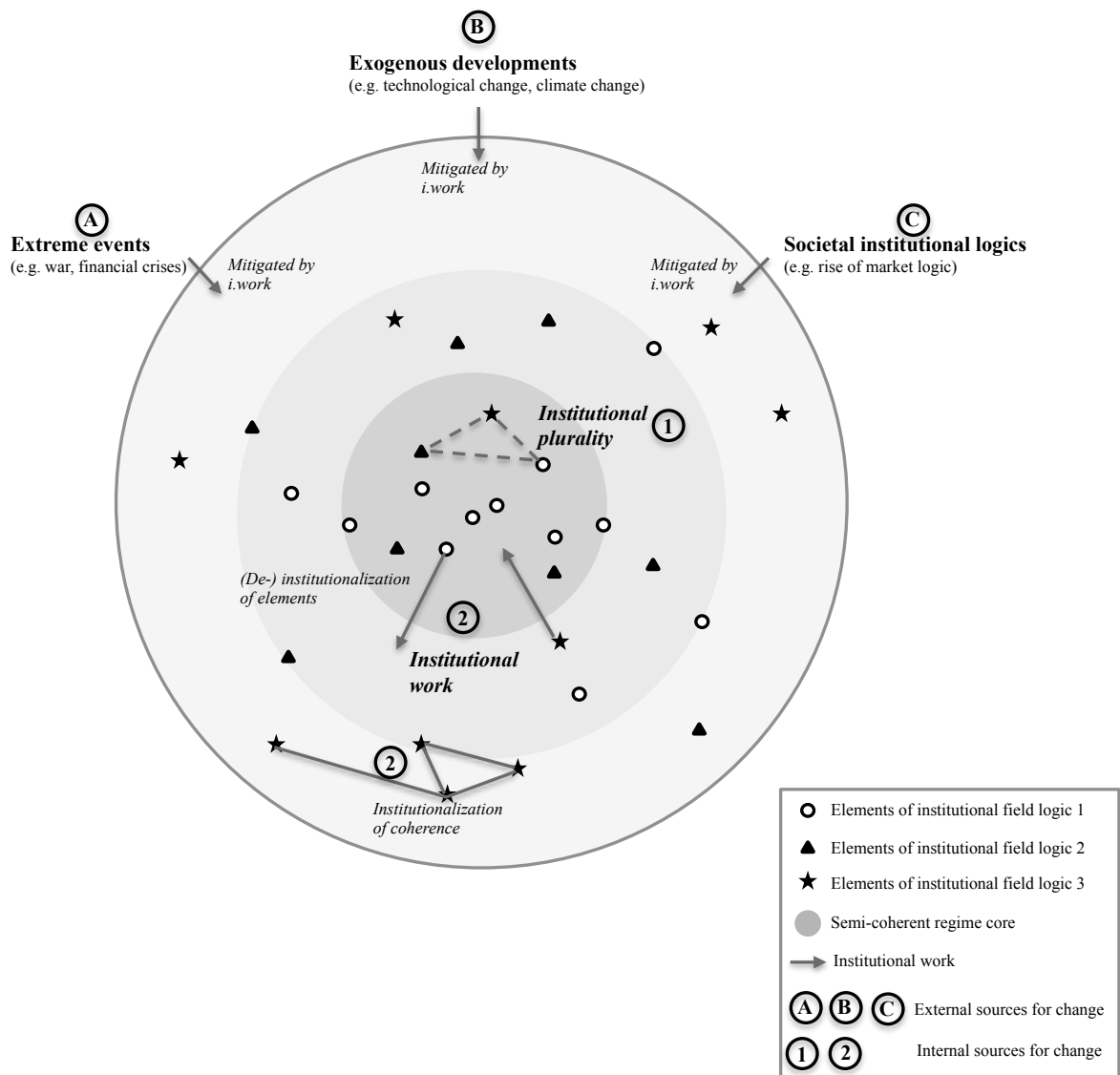
Figure 3.1: A dynamic model of socio-technical change

Positions of graphical symbols represent the degree of institutionalization of a specific logic element in the field: The nearer to the center of the dart board, the stronger its institutionalization. Three external sources (institutional logics, exogenous and extreme events) as well as two internal sources (institutional contradiction and institutional work) for change are highlighted.

Transition pathway	Graphical representation
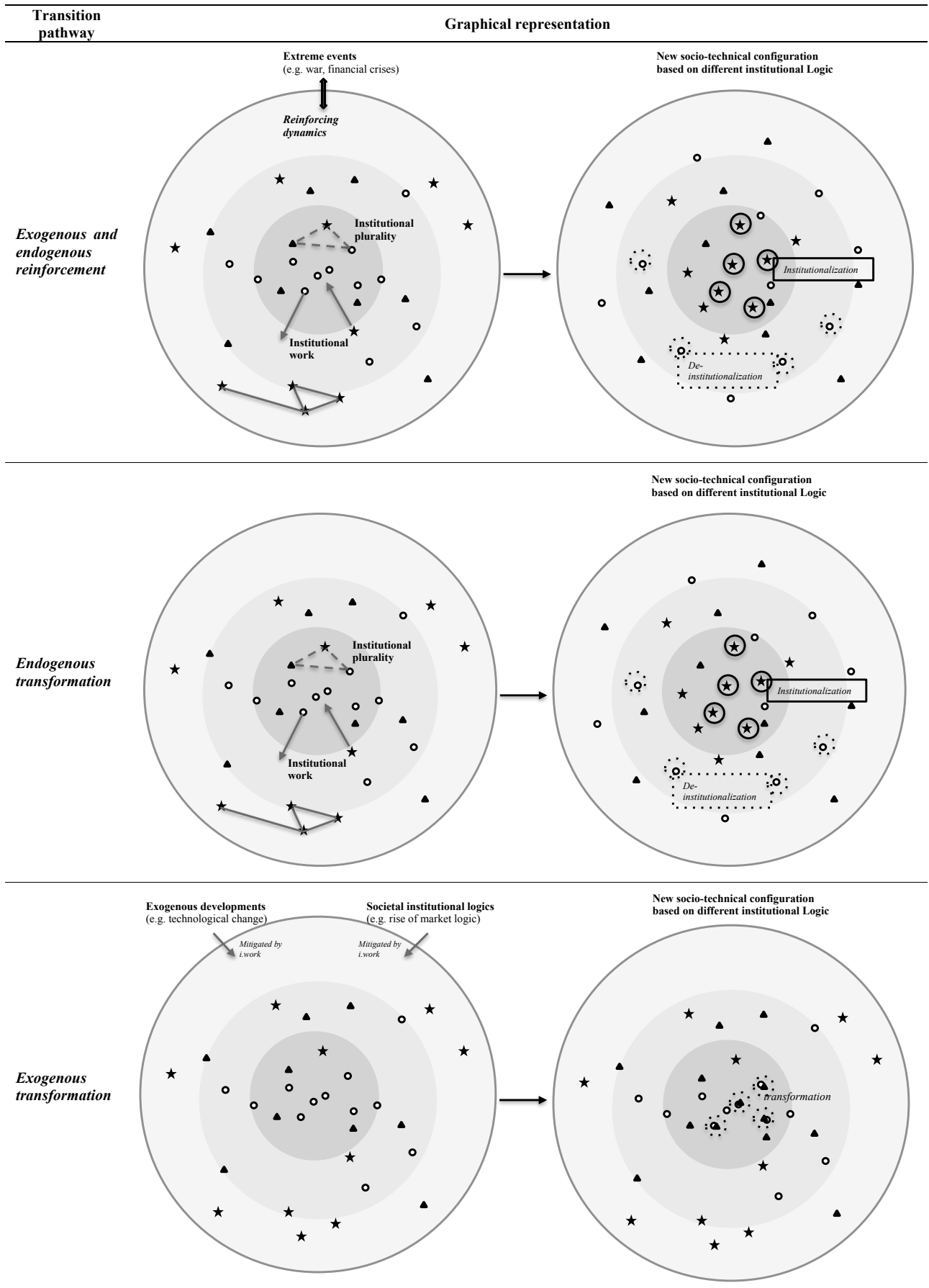
Figure 3.2: Ideal type transition pathways

3.5. Contributions and limitations of the analytical framework

The analytical framework of this thesis provides a new approach to the analysis of socio-technical change with a particular emphasis on institutions and the process of (de-)institutionalization. It characterizes socio-technical transitions as shifts in institutional field logics. Institutional logics are thereby conceptualized with a specific awareness for technological specificities. In addition, the social construction of institutional logics by means of institutional work plays a central role. Institutionalization is understood as a variable with various degrees of potential impact on actors' behavior and cognition. In so doing, a dynamic model of socio-technical change is developed that accounts for structural preconditions as well as agency.

The dynamic nature of the analytical framework is expected to provide particular insights into the following aspects of socio-technical transitions:

- It is assumed that the conceptualization of structures as institutional logics will improve the empirical analysis of the content and coherence of structures within socio-technical systems and in addition link them to a broader societal context.

- The analysis of the structuration of a socio-technical system based on an assessment of the degree of institutionalization and coherence of its structures is expected to provide information about a system's likelihood for change as well as about its potential transformation pathway. The higher a systems structuration, the less likely a transition will be.

- The conceptualization of agency as institutional work is assumed to enable an analysis of the 'duality of structure' by focusing on the actual process of social construction as well as on the practices actors engage in in order to (de-)institutionalize their institutional context. This provides a process-oriented perspective on how socio-technical transitions unfold.

Analyzing the structuration of a system as well as the ongoing institutional work within it is expected to contribute to the understanding of socio-technical transitions as follows:

- *The diffusion (or not) of emerging technologies*: The structural analysis will enable an assessment of a technology's fit with the current socio-technical structures of a system and the analysis of institutional work will provide insights into the purposive actions of actors in terms of hindering or promoting it. Taken together, these analyses

are expected to contribute to the understanding of the likelihood of a technology's diffusion.

- *The relevance of exogenous events and processes for change*: Conceptualizing structures as institutional logics and characterizing socio-technical systems as organizational fields enables a more informed account of exogenous events and processes. By understanding exogenous influences as being mediated within a system through institutional work, it is moreover expected to gain insights into why certain events lead to opportunities for change while others do not and how these opportunities for change can be characterized.

- *Intrasystem dynamics*: It is furthermore expected that a more dynamic approach towards socio-technical change will enable a thorough analysis of intrasystem dynamics, especially regarding the regime. An analysis of the semi-coherent structuration of a system is assumed to provide explanations for change that are not triggered from the outside but are entirely resulting from the interaction of structures and agency within a system, i.e. from institutional work made possible by institutional plurality.

- *Transition pathways*: The conceptualization of socio-technical change as interplay of structure and agency as well as internal and external interaction allows for the localization of a variety of sources and starting points for change. It is thus ultimately expected to lead to a more dynamic and hence a less deterministic variety of transition pathways that account not only for changes caused by niches or landscape pressures, but also exemplify how these pressures are mediated within a system and how internal dynamics contribute to radical transformations.

The epistemological position put forward in this thesis assumes that empirical observations are highly relative to the specific frame of reference adopted by an observer. This also holds true regarding the analytical framework elaborated in this thesis. It is thus important to note that the transition processes observed in the following are specific to what the analytical framework allows to see. The particular focus on institutions thus coins all the empirical observations made. The ontological position, for instance, posits the embeddedness of actors and practices within an institutional environment. This obviously affects the conceptualization of envisioned dynamics, especially in regard to the exclusion of all explanations based on rational actor models. Furthermore, the particular focus of the framework leaves out other explanatory factors that are potentially relevant for the understanding of socio-technical transitions. Examples thereof are a critical examination of

the role of power for change (Avelino and Rotmans, 2011), the significance of an explicit conceptualization of the geography of transitions (Coenen and Truffer, 2012), the efficiency and effectiveness of particular governance modes (Loorbach, 2007), the meaning of political and policy processes (Kern, 2009) or the role of specific actor groups, such as consumers (van Rijnsoever and Farla, 2014).

On the other hand, different theoretical approaches would obviously offer different foci for an analysis of socio-technical change. An example thereof that might be a promising avenue for research in transition studies is network theory (Burt, 1992; Granovetter, 1985; Mizruchi, 1994; White, 1992). While institutional theory and network theory have in common that they both argue for the importance of an actor's embeddedness, the latter has a more elaborated concept of an actor's social position. Some authors argue that the structural position of an actor as well as its ties will determine its interests and agency and therefore also the course of development of certain networks. The term network is thereby used rather broadly, ranging from networks of firms within a particular sector towards discourse networks that include all actors contributing to a particular discourse. Scholars have primarily focused on modeling and formalizing different network ties and network positions. Such an approach might contribute to research on transitions by giving insights into the consequences of networks within particular socio-technical systems.

A critical reflection about the presented analytical framework furthermore needs a note regarding the reflexivity of the topic under study. Socio-technical change is itself subject to socio-technical change, which obviously affects research in this area. The way transitions may have unfolded in the 18th century is different from today. The pace of technological change, for instance, has drastically accelerated and it encompasses a broader range of interlinked domains and processes, as for example interdependencies between information and communication technologies with all other sciences show (e.g. internet for worldwide diffusion of new knowledge, use of computer technologies for research, etc.). Also the rise of sustainability as a norm has clearly influenced the study of socio-technical change and as a consequence socio-technical change itself (e.g. due to new heuristics and cognitive mindsets, proposed governance models or firm strategies). This thesis and its analytical framework can thus be interpreted as an instantiation of exactly such a development.
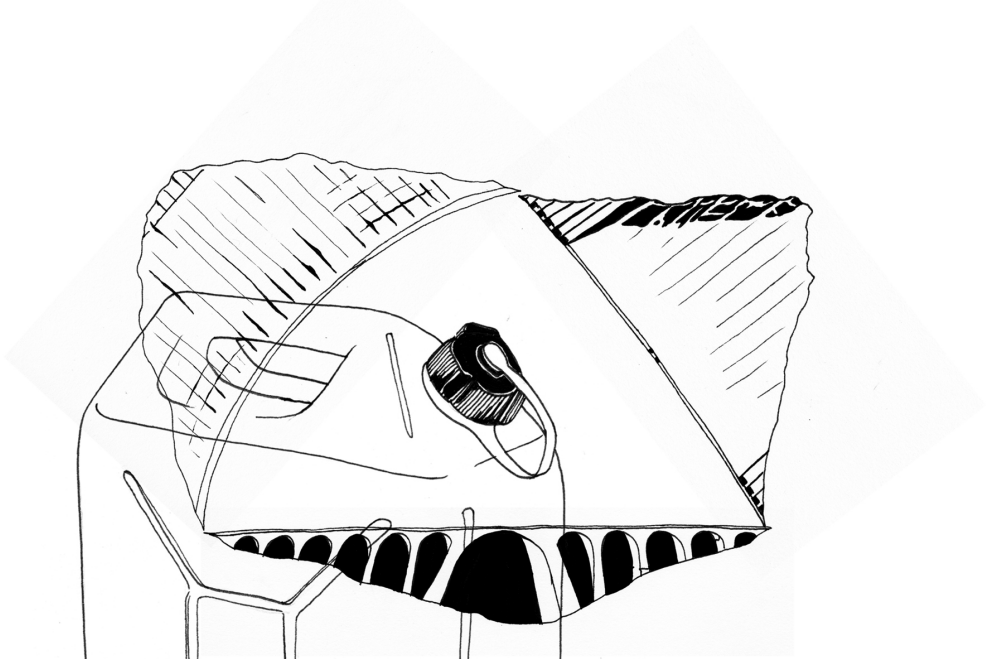
METHODOLOGY

4. Methodology

This chapter presents the methodology for the empirical analyses of this thesis. It describes the studies undertaken in order to answer the research questions, outlines the sources of data collection and the methods of data analysis, elaborates the operationalization of the main analytical concepts and justifies the case selection.

4.1. Case selection: The Australian urban water sector

To answer the research questions outlined above and apply the analytical framework developed in this thesis, different empirical analyses have been conducted that are primarily based on data from the Australia's urban water sector. Water sectors can generally be classified as infrastructure sectors that are highly relevant for society as a whole. They are not only crucial for human well-being (e.g. drinking water, hygiene, recreation), but also a cornerstone of all other economic sectors, especially agriculture (Gleick, 2012; Heberger, 2012; Künneke et al., 2005). Water sectors, like infrastructure sectors in general, entail some very distinct characteristics that make them particularly interesting and suitable for the analysis of socio-technical change and transition processes (Finger et al., 2005; Lieberherr, 2012; Markard, 2011).

Utility sectors can thus be described as industries that provide a service that is fundamentally important for society as a whole and thus rather value-laden (e.g. food, water, energy, transport).

Water provision and sanitation services are based on a highly complex system of interrelated technical and social elements: technologies, pipes, policies, standards, or scientific know-how are coordinated by a diverse range of actors (e.g. firms, public actors, users) and aligned across various geographic and jurisdictional areas. This 'socio-technical systemness' causes water sectors to be very path-dependent, rigid and inert. This path-dependency is further reinforced by high asset durabilities and high financial investments. Physical infrastructures, like treatment and power plants as well as pipes, work without any major re-investments between 40-80 years. The initial financial investment, however, is extensive. This creates high barriers of entry for competitors and thus often leads to natural monopolies. As a consequence, public ownership and a high regulation are very common. Regulation, or institutional governance in general, is however rather complex (Finger et al., 2005; Lieberherr, 2012). Market failures are very common, mainly due to the 'collective good' nature of the services as well as various external effects. Traditional market-based solutions

are thus often not feasible. In addition, the fundamental importance of water reinforces issues such as accessibility, affordability, reliability and quality of provided services and puts them under great public scrutiny. Moreover, water services have a comparatively high environmental impact that triggers additional regulation in order to mitigate negative impacts.

These characteristics not only have implications for the governance of water sectors, but also for change and innovation (Lienert et al., 2006; Loorbach et al., 2010; Markard, 2011). On the one hand, the longevity of the infrastructures coupled with their capital intensity leads to vested interests and long-term profit expectations, which causes a high resistance to change. On the other hand, the systemic nature of the sector implies that changes in one place have consequences for other parts of the system. Dominant technologies, for instance, have coevolved with matching business models, organizational structures or regulations. Introducing a new technology will affect all of these other dimensions as well and thus lead to considerable additional expenses for achieving new compatibilities. As a consequence, technological innovations are believed to diffuse rather gradually and be of incremental instead of radical nature. Nevertheless, the pressure imposed on water sectors is steadily increasing – in particular regarding substantial needs of re-investments, resource scarcity as well as problematic environmental impacts – and transformation, presumably spurred by technological innovation, therefore crucial.

Compared to other infrastructure sectors like electricity or transport that have recently undergone substantial transformations towards liberalization, urban water management in most industrialized countries is still characterized by a highly stable socio-technical regime. Recently however, the longer-term sustainability of this sector has been questioned (Daigger, 2007b; Lienert et al., 2006). Academia as well as politics have thus started to develop major reforms of water sectors all over the world (Wong and Brown, 2009). Particularly relevant and delicate topics include: water as a natural resource that is scarce, essential, irreplaceable and thus highly politicized; transportability issues, since water is not as easy and cheap to transport as for instance electricity; monopoly vs. competition debate that tries to find new business models based on more liberalization; public vs. private good debate, which represents a highly value-laden debate over water ownership and thus profit-making capabilities (Lieberherr, 2012).

Australia is the country where corresponding reforms of urban water sectors have been most vivid, which is why it is considered one of the international leaders paving the way for the development of new socio-technical structures, e.g. regarding the implementation of new technologies or water governance models that might once become a new dominant urban water management regime. In addition, Australia is often exposed to extreme weather events

like long-lasting droughts and heavy floods, which have accelerated the examination of future challenges and abetted a comprehensive, well documented and observable discourse around perceived problems and potential solutions. These current transformation processes are thus seen as a suitable and fruitful ground for the analysis of socio-technical change through the application of the analytical framework of this thesis.

In line with the analytical framework, two specific empirical analyses have been undertaken. The first analysis aims at the reconstruction of the semi-coherent structuration of Australia's urban water sector by assessing past and current institutional field logics and their degree of institutionalization. The second analysis traces instances of agency within Australia's urban water sector by assessing the various types of institutional work aimed at influencing the structuration of the socio-technical system. Combined they enable a comprehensive overview of the sector's transformation process. Both analyses rely on a qualitative approach, since qualitative methods allow for a more exploratory as well as explanatory research that aims to answer 'how' questions and to provide analytical explanations for the manifold social processes under study (Creswell, 2009; Gläser and Laudel, 2006; Mayring, 2003).

4.2. Analysis I: Data sources, methods and operationalization of key concepts

The following analysis shows how the semi-coherence of a socio-technical system, and particularly of its regime, can be described by identifying prevailing and emerging institutional logics in a particular field and assessing their degree of structuration. A triangulation of different methods and data sources allows the elaboration of these research questions. The major focus of the analysis will be put on: 1) identifying the specific content of past and current field logics in in the Australian water sector and 2) assessing their degree of institutionalization over time.

In order to reconstruct the content of past and current institutional field logics in urban water sectors in industrialized countries, a general historical analysis of the character and essence of water sectors has been conducted, based on a qualitative content analysis (Creswell, 2009; Mayring, 2003) of various secondary sources, such as websites of water organizations or government departments for water, books and scientific articles about water governance, policy, technologies or history as well as various water sector reports. The aim was to trace the underlying rationalities of urban water management, i.e. the different kind of structures that in one way or another influence an actor's cognition and behavior. These were operationalized as fundamental beliefs and assumptions of actors, sources of legitimacy for

action, dominant authorities, basis of strategies, norms, rules, focus of attention, values, material practices such as technologies, economic systems and prevailing control mechanisms (adapted from the operationalization of institutional logics by Thornton and Ocasio (2012) as shown in Table A1; see also Table 4.1 below for a summary of the operationalization of the key concepts). Also the notion of storylines, in the sense of a *"generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to specific physical or social phenomena"* (Hajer, 1995, p. 56) was helpful to grasp the content of institutional logics within a system. Storylines may represent certain key metaphors, analogies or myths that are at the basis of a collective understanding of actors within the same organizational field.

As a major analytical step the insights gained from the qualitative document analysis were categorized and translated into institutional field logics using the method of ideal types (Thornton and Ocasio 2008). Ideal types as a tool for comparative social analysis were originally created by Max Weber (e.g. Weber, 1904/1949). They represent an intelligible and distinct characterization of a particular meaning scheme (here, an institutional logic) that can be used as a yardstick to compare actual behavior and meaning arising in an organizational field. The ideal types that were created are thus not describing the actual situation in the water sector, but are an analytical construct to pinpoint and interpret all possible occurrences. The three ideal typical water sector logics that are developed in the next chapter thus describe the content of structures that have been and most likely will influence in one way or the other every industrialized water sector in the world and therefore also the one in Australia.

In a second step, it was elaborated how the different ideal typical field logics exert their influence in Australia, i.e. how institutionalized each of these logics are in this specific water sector and what kind of implication this has for the overall structuration of the field. It is assumed that institutionalization is a variable and that the degree of institutionalization of a structure increases with scale and scope of diffusion, duration of existence, starkness, invulnerability to social intervention, internal coherence and emeddedness (Zucker, 1977; Jepperson, 1991). It is thus crucial to analyze how widely a structure is diffused and accepted, how long it has been in place, how contested it is and if it is supported by and compatible with the surrounding structures. In addition, institutionalization is assumed to be highest when principles are translated into binding formal or material structures in practice, such as policies, regulations, technologies, actors, financial investments or practices (Hajer, 1995). In order to achieve a comprehensive analysis of all of these aspects and in so doing describe the degree of institutionalization of each field logic over time, two different studies were conducted.

On the one hand, a document analysis was undertaken to trace important historical developments of the Australian water sector and to filter out indicators that suggest the (de-) institutionalization of particular field logic elements in practice, such as changes in policy, regulation, technology, actor structure, financial investments, consumer behavior, water management strategies etc. This research was based on secondary data, e.g. comprehensive sector reports from industry associations and governments and scientific articles on water sector issues. The interpretation of certain developments as an indication of (de-) institutionalization processes enables the reconstruction of changes in the institutional logics of the field. Overall, it gives a systematic overview of the scale and scope of the diffusion of specific field logic elements as well as their manifestation and thus summarizes why certain logics are assumed to be more institutionalized than others.

A second study included a qualitative content analysis of the recent water sector discourse in order to a) uncover institutional plurality, i.e. the contradiction and tensions within the sector at the moment and b) validate and/or adjust the ideal type field logics found before. The primary data source for this analysis was a recent public inquiry on the future of the Australian urban water sector. The analysis of discourses has proven to be useful to study institutions and institutionalization processes (Hajer, 1995; Philips et al., 2004; Schmidt, 2008). The main assumption is that language is a crucial tool used by actors for the construction of reality (Berger and Luckmann, 1966). It is mostly in the form of text that actors formulate their beliefs, ideas, problems and solutions and in so doing negotiate dominant storylines that give meaning to reality. In this way, discourses constantly generate and modify institutions (Philips et al., 2004). This thesis uses a rather broad definition of discourse, one that is closer to the everyday use of the term than to a discourse analytic approach such as the one by Foucault. The term refers to what is generally talked or written about and thus to the different perspectives or opinions actors have, the meaning they give to something or the various topics they address. A qualitative analysis of the current water sector discourse will offer insights into the location of what has been called 'discursive hotspots', i.e. areas of high discursive activity. Discursive hotspots suggest an objectification phase in the institutionalization process, where (de-) institutionalization is happening and negotiated and where change is currently in the making. High discursive activity usually indicates that there is contestation among actors. It reveals where institutions are infringed upon, criticized or defended and therefore allows the assessment of the importance of certain institutions to particular actors. Robert K. Merton's seminal work on norms in science is one of the most influential examples of how to identify institutions through the reactions to their violation. The assumption is that the mere fact of actors engaging in a discourse indicates the importance of an institution: *"For, as we know from the sociological theory of institutions,*

the expression of disinterested moral indignation is a signpost announcing the violation of a social norm. (...) The very fact of their entering the fray goes to show that science is a social institution with a distinctive body of norms exerting moral authority and that these norms are invoked particularly when it is felt that they are being violated" (Merton, 1957, p. 639). Furthermore, analyzing discursive hotspots allows to identify the degree of consensus between the actors and accordingly draw conclusions regarding the internal coherence of an institutional logic as well as the institutional coherence of the whole field.

The data source for this qualitative content analysis was the national public inquiry process "Australia's urban water sector" initiated by the Productivity Commission of the federal government in 2010. The inquiries by the Productivity Commission are a platform to integrate all points of view present in a community, ranging from submissions from established industry actors, governments departments to private persons. The Commission's inquiries are undertaken when the Australian government needs a foundation for creating and specifying policy recommendations. After taking all submission into account, the Commission releases its policy recommendations that will ultimately be decided on and implemented by the state governments. Therefore, being part of such a discourse is of high importance for actors that want to shape future policy-making. The inquiry regarding the Australian urban water sector was launched to examine the microeconomic reform of the industry and assess efficiency gains through new governance arrangements. Interested parties had the opportunity to express their opinion by handing in a written submission or participating at one of the six public hearings taking place in different cities across Australia. The material was collected and made available online by the Productivity Commission. Given the broad participation of major utilities, government agencies, scientists and NGOs active in the Australian urban water management discourse, this body of texts may be interpreted as an inventory of discourses that actors find important for coping with future challenges of the sector. It is therefore assumed that the sum of these submissions represents an adequate collection of various field logic elements that are currently being discussed by the actors.

The analyzed text corpus included the first round of submissions, counting 87 written submissions made by 66 different actors representing government departments, industry associations, water utilities, consultants, firms and NGOs. The submissions varied greatly, ranging from a three-page word document issued by a local governor towards a 300-page detailed report written by a consultancy. The qualitative content analysis of the submissions was carried out in two main steps. First, a coding scheme was developed to trace examples of the before developed institutional field logic ideal types. This was achieved in a bottom-up process, allocating exemplary text parts to each coding category, while constantly refining the existing coding scheme. For this process a qualitative data analysis software (MaxQDA) was

used. As a second step, the qualitative codes were aggregated into semi-quantitative measures to display the use of logic elements by specific actors. This step also enabled the localization of specific institutional contradictions within the field and it gave an idea regarding the institutional coherence of the ideal type field logics.

4.3. Analysis II: Data sources, methods and operationalization of key concepts

Australia has been considered a country where water sector reforms are rather advanced. This is often related to the extreme weather conditions like droughts and floods, which are believed to make water a more relevant political issue. During the first decade of the new century, Australia has been hit by an exceptionally severe drought, which triggered a range of reactions by different actors, among others the construction of six large-scale seawater desalination plants. These developments make Australia a particularly interesting case to study a) the meaning of an exogenous event and the social construction of a crisis and b) the institutional work that pushed the diffusion of a certain technological solution, i.e. desalination with its associated socio-technical configuration, while hindering the diffusion of other possibilities, in particular waste water recycling. Hence, this empirical reality narrows down the plethora of potential starting points for an analysis of institutional work. This thesis will focus on analyzing these two particular aspects of the transformation of the water sector in regard to institutional work.

Institutional work, defined as the purposive actions of actors aimed at creating, maintaining or disrupting institutions (Lawrence and Suddaby, 2006, p. 215), can be operationalized along the lines of the different forms of institutional work found in the literature, e.g. advocacy, theorizing, educating, mythologizing, political work, etc. (see Table 2.2). It thus represents actions that purposefully aim at constructing rationales, e.g. relations of cause and effect or storylines, as well as mobilizing resources (material, financial, social) in order to achieve some kind of structural transformation. While some of this work by actors may be documented in newspapers, organizational brochures or websites (firms, political parties, NGOs), the bigger part of it is usually not documented or even confidential. Therefore, the prime data source for the analysis of institutional work were 25 semi-structured interviews with water sector experts and industry leaders in Australia, ranging from scientists, government officials, utility representatives to people from associations and multi-national companies, most of them with an explicit knowledge about the subject of desalination in Australia (for a list of interviewees, see Table A.2 in the Appendix). Interview candidates were chosen according to their expert status in the field or their position in central water

sector organizations. Furthermore, a snowballing sampling method was used, where these first contacts suggested other relevant people to talk to that took center stage in the decision-making and political processes studied (Creswell, 2009). Semi-structured interviews are particularly useful in cases where processes have to be reconstructed that are complex and may be the subject of different opinions. Including a wide range of actors with different backgrounds thus enables an approximation of which aspects are seen as pertinent by most of the interviewees and thus might be of broader relevance (Creswell, 2009; Gläser and Laudel, 2006). The interviews particularly focused on the interviewee's personal thoughts and knowledge on the rise of desalination in Australia. Questions included issues such as when they first heard about desalination, who seemed to be for or against it, what were the primary arguments around desalination, whether alternatives had been considered, how proponents of these alternatives explain the reason for the implementation of desalination and how the actual decision process unfolded (for the entire interview guideline see Appendix 3). The interviews lasted between 30 to 120 minutes, were recorded and transcribed. The transcripts were then subject to a qualitative content analysis based on a coding scheme that was informed by the theoretical assumptions regarding institutional work. The coding was conducted with a computer software (MaxQDA) that allowed to allocate exemplary text parts to each category by a bottom up process. Thereby, the coding scheme itself was constantly refined.

The interviews were further complemented by the analysis of secondary data on the topic of the drought, desalination and recycling (e.g. annual reports of utilities and government ministries and company websites) in order to validate the interview data as well as deepen the understanding of the way the drought as well as the different technologies were framed and what kind of storylines, metaphors or myth they represent. In addition, a qualitative analysis of the newspaper coverage on desalination in three Australian newspapers has been undertaken. The Australian (federal newspaper), The Sydney Morning Herald (central newspapers of the East Coast) and The West Australian (main newspaper on the West Coast) have been chosen to represent a data source of the public discourse concerning desalination. The articles were selected via a search for 'desalination' in LexisNexis, an online platform containing the archives of all three newspapers. All articles were carefully read and irrelevant contents for this research or doubles (e.g. agency news reports printed in all three papers) were eliminated. The remaining articles were then analyzed again with MaxQDA, using a qualitative content analysis approach. The media analysis was crucial to a) complement the interview data in regard to institutional work by detecting relevant actors and their actions that were reported on; and b) trace the public discourse about desalination over time and get an overview of which ideas, i.e. which institutional logics dominate. The newspaper coverage

is itself interpreted as a source of institutional work in that it can influence the framing of the different technologies or the perception of the severity of an extreme event, which may affect the legitimacy of certain actions or practices. Moreover, the discourse analysis contributed greatly to the strengthening of the validity of the other qualitative data sources. The sources from within the water sector (interviews, public inquiry etc.) were thus complemented by insights of a more 'intermediary' data source.

Table 4.1 provides a summary of the operationalization of all the key concepts of the analytical framework.

Table 4.1: Operationalization of key concepts of the analytical framework

Concept	Definition	Dimensions/Indicators	Data sources
Institutional logics	"The socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" (Thornton and Ocasio, 1999, p. 804).	Beliefs, sources of legitimacy/authority/identity, values, technologies, practices, assumptions, basis of strategies/norms/attention/rules, control mechanisms, economic system, storylines, metaphors, etc.	Secondary sources, public inquiry, newspaper articles
Institutional work	Purposive actions aimed at the creation, maintenance and disruption of institutions (Lawrence and Suddaby, 2006).	Advocacy, theorizing, educating, mythologizing, changing normative assumptions, constructing normative networks, political work, valorizing and demonizing, etc.	Secondary sources, interviews, newspaper articles
Degrees of institutionalization	Degree to which a structure has solidified into discourse and practice (Hajer, 1995).	Actor structure, discourse activity, contestation, scope of implementation, duration of existence, invulnerability to social action, translation into laws, technologies, financial investments, routines, actors	Secondary sources, public inquiry, newspaper articles
Institutional coherence of an institutional logic	Degree to which the different dimensions/elements of a logic have been institutionalized and aligned into a coherent framework (Heinze and Weber, 2010).	Match/mismatch of structures, completeness of specification of all dimensions, functionality, viable alternative	Secondary sources, public inquiry, newspaper articles
Institutional plurality	Presence of different institutional logics within an org.field (Thornton and Ocasio, 2012).	Cognition and behavior based on different, maybe contradictory rationalities, conflict and contestation	Secondary sources, public inquiry, newspaper articles
Exogenous, extreme events and processes	Events and processes that are perceived to be unswayable by system actors (Geels 2007).	Uncertainty, imposition, state of crisis	Secondary sources, public inquiry, newspaper articles, interviews

4.4. Limitations of the methodology

The limitations of the chosen methodology are on the one hand caused by the nature of the phenomenon under study, that is institutions and their transformation, and on the other hand they lie in the selection of the case as well as in the type of methods used.

Institutions can be interpreted as a rather complicated variable to analyze empirically. The main criticism usually concerns the causal mechanisms between an institution and an actor's cognition and behavior as well as the form and diffusion of practices (including technologies). One of the key problems is whether institutional mechanisms are affecting actors and practices the way it is postulated or if it might be due to other causes. In a similar manner, it is sometimes criticized that the existence of an institution is hard to empirically confirm, especially if it is so highly institutionalized that actor's might not be able to articulate it. Both points are ultimately a matter of internal validity of an empirical study. It is argued that the research design of this thesis has been created in a sensible manner, especially in regard to these concerns. The triangulation of a diverse range of data sources, such as secondary data, interviews and media coverage, has explicitly been chosen to mitigate possible 'blind' spots and to confirm the results from different angles. In addition, the analysis of discursive hotspots particularly accounted for these difficulties. The existence of institutions is thereby only confirmed through the effects of their violation, which is empirically more visible and thus easier to detect.

Furthermore, basing the empirical study primarily on one country might attract criticism regarding the generalizability of the results. Although a comparison of the phenomena under study across countries might generate even more useful insights, it is argued that the results presented in this thesis entail explanatory value of their own. The generalizability is first and foremost of analytical and not statistical nature (Yin, 1994). The analytical framework is thus not at all bound to a specific country, but may be applied to various other units of analysis. Furthermore, qualitative methods are often criticized of leading to overly descriptive results that have no broader significance. This thesis rejects this criticism based on the assumption that an elaborate research design grounded on an analytical framework will ultimately contribute to the deduction of important mechanisms and as such should not be considered descriptive.

An additional limitation concerns the reliability of interview data. On the one hand, there is the uncertainty whether or not interviewees answer truthfully or leave out certain parts of the story because of issues like shame, blaming or loyalty to others. On the other hand, there is always the problem of ex-post rationalization. Interviewees may now make up certain cause-

effect relationships or interpret a particular situation in a way that is rather far away from the reasons of actions at the actual moment. Both challenges were tried to be minimized by asking questions about the same issue from different perspectives in order to approach as many rationalizations as possible. Furthermore, each interview was complemented by notes and remarks of the interviewer. If the interviewer felt that the interviewee was hesitant or uncomfortable to answer a question or struggled with a proper explanation, it was noted and factored in during the analysis in order to avoid obviously corrupt statements.

A further challenge regarding the reconstruction of institutional work through interviews is related to the access to suitable candidates to interview. Especially multi-national companies are hard to contact, since there is often no direct way of getting in touch with the right person. Furthermore, if a contact can be established and an interview takes place, confidentiality agreements are often so strict that no interesting conversation results. One strategy to circumvent this problem was to talk to people that are closely related to such companies but have themselves less stringent rules and regulations. Furthermore, the snowball sampling method allowed getting in contact with people through their colleagues, which often increased the legitimacy for the interview. The urban water sector in Australia has been described by an interviewee as 'old boys club', meaning that many of the influential people know each other and have worked in various positions over the life of their career. Hence, an approximation of many decision-making processes could be achieved.
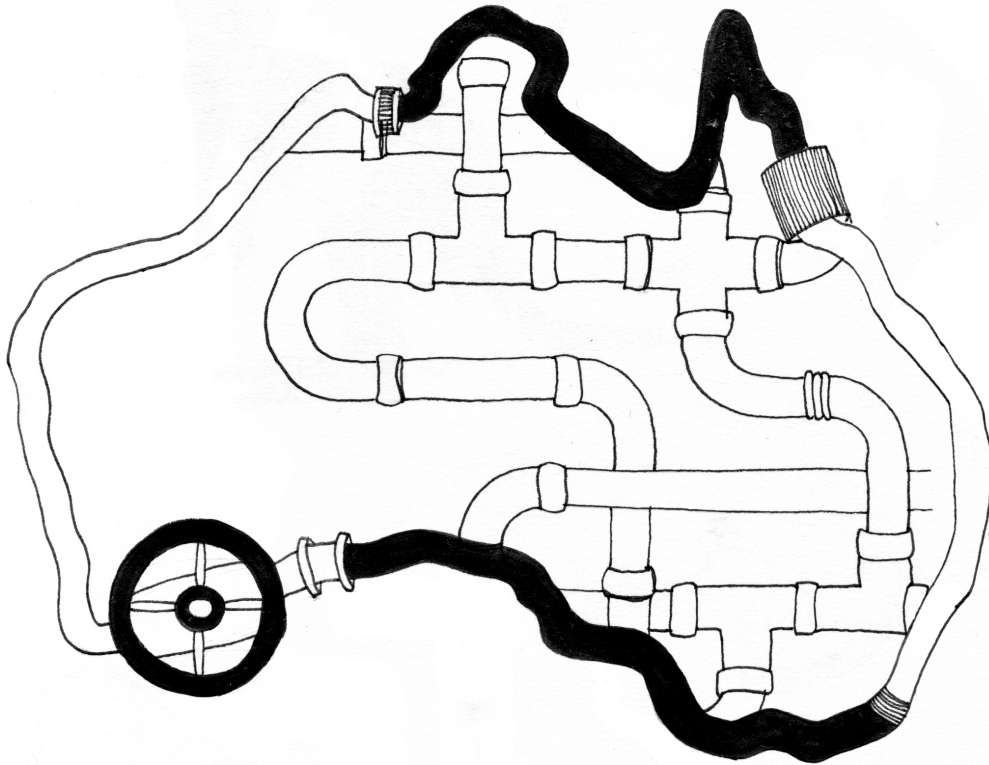
ANALYSIS I:
THE STRUCTURATION OF AUSTRALIA'S URBAN WATER SECTOR

5. Analysis I: The structuration of Australia's urban water sector

The presentation of the results starts with a broad reconstruction of institutional logics impacting urban water management sectors in industrialized countries over the past few decades. It describes how a prevailing field logic has been challenged in the past decades by the influence of new institutional sector logics and outlines the thereof resulting consequences for water sectors. This reconstruction displays the content of various structural elements of water sectors in industrialized countries today. In section 5.2 the focus then lies on the specific interplay of these logics in the Australian urban water sector as well as on the assessment of their degree of institutionalization. To this end, a short overview of the historical and recent developments in the Australian water sector is presented and the (de-) institutionalization of various logic elements in practice is discussed. Subsequently, the results of the discourse analysis shed light on agreements, tensions and contradictions between the actors' use of competing field logics and in so doing reveal the semi-coherence of institutional structures. Chapter 5 concludes with a short summary as well as a first discussion of the results.[4]

5.1. Institutional logics of urban water sectors in industrialized countries

Water sectors in industrialized countries all over the world show a striking similarity regarding central values, technologies, actors, organizational forms or funding schemes. Hence, a certain ideal-typical institutional logic of water provision and sanitation can be identified that has been institutionalized over the past centuries, regardless of specific regional particularities (Espeland, 1998; Evers and Benedikter, 2009; Gottlieb, 1988; Molle et al., 2009). Drawing from various data sources described above, a historically dominant water sector logic has been identified that will be named "Hydraulic Logic". Its ideal type characterization is as follows:

For a long time, the prevailing field logic of water sectors has been heavily coined by the institutional sector logics of the state and the profession (mainly engineering). Issues such as democracy, public good orientation, personal expertise and reputation as well as professional associations played a vital role (see Table A.1 in Appendix). As a result, the most influential *values* have been the security of supply through technological efficiency, national welfare and social equity. The idea that nature can and should be exploited through technology in order to foster national development lay at the heart of traditional water resource development. The

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[4] This chapter has originally been published in Fuenfschilling and Truffer (2014).

mission of the water sector was to produce hygienic drinking water for all citizens equally, to facilitate water for irrigation purposes and to produce electricity. Since agriculture is seen as a symbol for sovereignty and national development, irrigation is the prime water outlet in many countries and farmers are thus often the most powerful lobby group. Aridity and water scarcity are interpreted as a sign of poverty and failed politics: *"Water is the basis of all subsequent development; all profit depends on water supply. Westerners' response to aridity has typically been to understand it not as the natural state of a desert but as a mistake to be rectified with big, federally funded water projects"* (Espeland 1998, p. 4). The dominant multi-purpose *technology* to accomplish this was the large-scale dam, that itself, through its specific features, strongly contributed to the development and consolidation of this field logic configuration. Dams are a symbol for the domination of human kind over nature and for political and national success. They are considered one of engineering's most impressive achievements: *"...scarce and valuable water resources must be put to use at any cost and in their entirety before they run waste to the sea"* (Molle et al. 2009, p. 336). Between 1950 and 2000 substantial investments in dams have been made worldwide: on average, two new dams were built each day, increasing the number of dams from 5000 in 1950 to 45000 by 2000. Irrigated areas doubled from 140 million hectares to 280 million hectares (Molle et al. 2009, referring to the World Commission on Dams). The most important decision-making *actors* in the water sectors were the state and public water utilities. While the government was responsible for the *funding* and regulation of the sector in order to guarantee a secure water provision, the utility engineers designed the technical solutions. Hence, the predominant *expertise* and thinking was extremely engineering laden. The corresponding typical *organizational form* present in water sectors was the vertically integrated state owned utility.

Over time, these elements have aligned into a taken-for-granted field logic that has reached a high degree of sedimentation and defined who, why and how things are done in a water sector. However, societal developments since approximately the 1970s have challenged this prevailing logic in various respects. The results indicate that there has been a shift towards the integration of principles stemming from other societal institutional logics that became dominant during that time: A "Water Market Logic" with an increased focus on economic efficiency and a "Water Sensitive Logic" with a focus on environmental sustainability.

Since ca. the 1970ies, the institutional sector logics of the market and the corporation have been infiltrating many sectors, focusing the attention on economic efficiency and rationalization (Thornton et al., 2005).[5] Politics in many countries turned neo-liberal and the

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[5] The market logic is generally characterized by principles such as efficient transactions in the market place, share price, shareholder activism and self-interest. The corporation logic brings in principles like managerial capitalism,

call for liberalization, less state and more market triggered a public sector reform with the idea of 'new public management'. The resulting consequences and changes for water sectors were, for example, an increased focus on market mechanisms and new pricing schemes, the corporatization or even privatization of public utilities, the establishment of independent economic regulators, the heavy involvement of consultancies or multinational firms for the planning and implementation of large-scale water projects (e.g. desalination) and a shift in funding from government to consumers. In 1992 the United Nations even declared water to be an economic good. It can thus be stated that a development of a "Water Market Logic" has occurred and is still ongoing, which continuously challenges the "Hydraulic Logic". As pictured in Figure 5.1, the ideal-typical "Water Market Logic" is described as follows: Instead of focusing on the security of supply or the public good aspect of water, its central values are economic efficiency and rationalization, which results in the main mission of transforming the water sector into a water market. This development is mainly led by economists and consultants, who trust in the 'invisible hand' of the market. Since the expertise is thus mainly economic, technology choice is made by cost-benefit analysis as well as by supply-demand calculations, establishing the water-consuming citizen as a regular customer.

Around the same time, various environmental movements emerged, fuelled by new values of the post-war, post-materialistic generation, such as conservation and anti-growth thinking (Hajer, 1995). But also new scientific indicators for climate change or influential writings, e.g. 'Limits to Growth' from the Club of Rome, have broached the issue of the environmental crisis associated with societal and economic development (Hajer, 1995).[6] Over the years, the various activists and scientific streams have converged into a more homogenous idea of environmental sustainability that has become influential in politics and economy (e.g. Brundtland report 1987 or the UN Earth Summits starting 1992). Regarding the water sector, the main consequence of these developments has been to establish the environment (e.g. rivers, lakes, groundwater) as an 'actor' with rights to sufficient and clean water. An integrated view on the water cycle as an interdependent system of groundwater and surface water sources has been established and the idea of water conservation has become prominent. As a result, regulations for environmental water allocations, water reclamation activities, new recycling technologies, water conservation campaigns or the emergence of fit-for-purpose water categories (e.g. different water qualities for different activities like showering, garden irrigation, toilet flushing or washing machines) can be observed in various water sectors. It

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M-form organization or a focus on the increase of size and diversification of firms. See Table A.1 in Appendix. Both logics are highly compatible and can reinforce each other.

[6] For a summary of Meadows et al. (1972) 'Limits to Growth' and a historical reconstruction of the roots of 'ecological modernization' see Hajer (1995).

can thus be assumed that a second new field logic has been challenging the "Hydraulic Logic" over the years: the "Water Sensitive Logic". Stemming from the institutional sector logics of the community and the profession (e.g. biology, ecology), it shows a strong focus on community based values and arrangements as well as a belief in trust and reciprocity (see Figure 5.1).[7] This often leads to the ideal-typical idea of a decentralized organization of water services in the form of small-scale recycling schemes in certain residential areas, where the purpose of water resources is not limited to consumption, but rather constitutes an important part of general human wellbeing in terms of a livable surrounding. Such projects are typically transdisciplinary and involve a range of environmental scientists and stakeholders.

These results indicate that the once dominant "Hydraulic Logic" is being challenged greatly by new principles and that a new mix from different field logics has established itself in the organizational field of urban water management in industrialized countries (see Figure 5.1). However, the degree to which the new "Water Market" and "Water Sensitive" Logic have been institutionalized, i.e. have found a solid alignment and have solidified into policies and practices of water sectors varies among countries. Since the new principles offer different rationalities, they are often contradictory to the existing dominant logic and also to each other. Hence, a vivid dynamic and a struggle for legitimacy can be observed at the moment. In the following section, the example of the Australian urban water sector is presented to illustrate these dynamics in more detail.

5.2. Competing field logics in the urban water sector in Australia and their degree of institutionalization

In order to assess the degree of institutionalization of the field logics in the Australian urban water sector presented above and demonstrate their interplay, two analyses have been conducted. This section presents an overview of important developments in the sector since the 1970ies that indicate (de-) institutionalization processes or events in regard to the different field logics. The next section then presents an analysis of the current discourse, which reveals how actors make use of the logics and illustrates the most important tensions and conflicts between them. Together, these results enable the description of the overall structuration of the Australian water sector and in particular of its regime core.

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[7] The institutional sector logic of the community is characterized by principles like the unity of will, ideology, emotional connection, group membership or the visibility of action. The logic of the profession focuses on aspects such as personal expertise and reputation, professional association or quality of craft. See Table A.1 in Appendix.
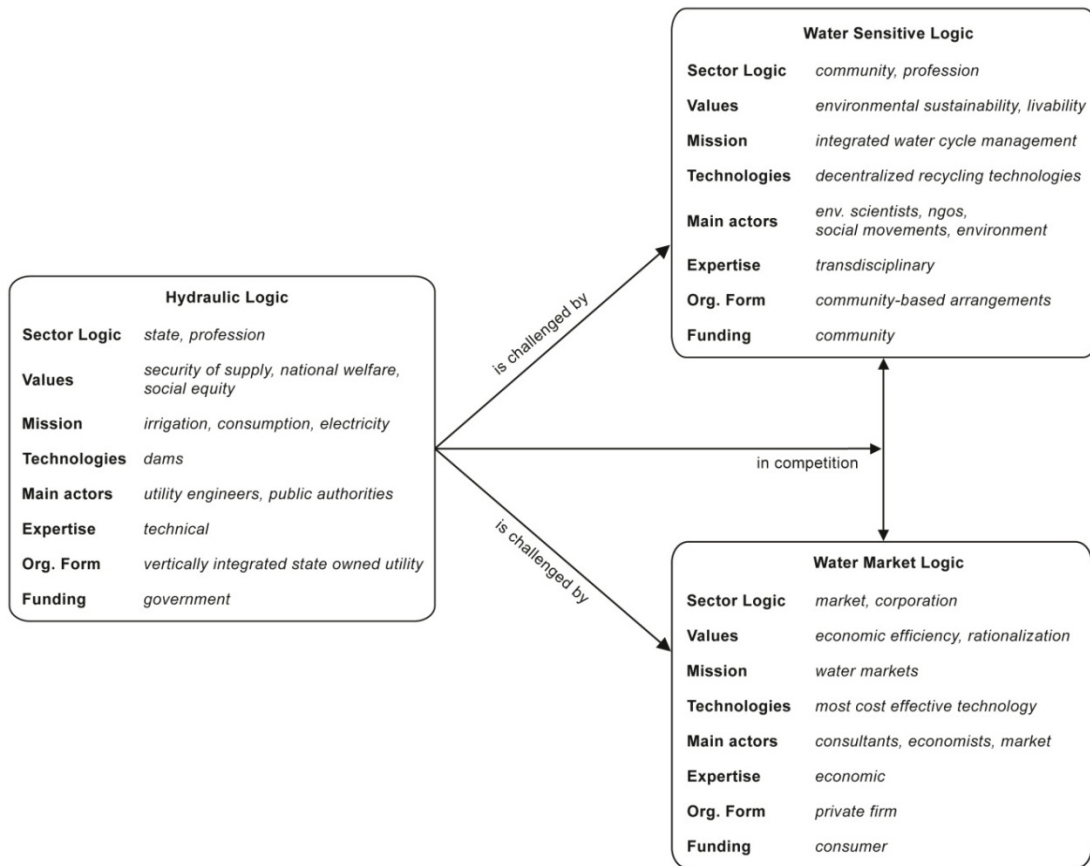
Figure 5.1: Institutional logics in the water sector

5.2.1. Historical developments as indication of the institutionalization of new field logics

Since Australia is influenced by extreme weather events like droughts and floods, water governance has always been a crucial political issue. British colonialism in 1788 brought with it the taken for granted "Hydraulic Logic" that characterized the Australian water sector ever since: exploitation of the resource in order to foster economic growth (agriculture, mining), centralized system of large-scale dams run by public water utilities and a dominant engineering culture were the cornerstone of the sector (Abbott et al., 2011; Cathcart, 2009; Colebatch, 2006; Crase et al., 2009; McKay, 2005; Tisdell et al., 2002). But the discourses of the "Water Market Logic" and the "Water Sensitive Logic" also affected water management

thinking in Australia. Debates around water reform began in the early 1980s. Important sector reforms include the Council of Australian Governments (COAG) reforms of 1994 and 2007 as well as the National Water Initiative of 2004, establishing a national approach towards water and emphasizing ecosystem health and liberalization of the water industry. A severe drought between ca. 2003 and 2010 confronted Australia with the reality of climate change and shaped the awareness for water problems even more. Agriculture and other industries were hit hard and storage levels of the dams in the eastern seaboard states and in South and Western Australia were unprecedented low. After this drought, Australia has repeatedly been struck by heavy floods. These extreme weather events triggered various reactions and again intensified the discourse about water issues in politics, economy and civil society alike. The analysis below summarizes the most important changes visible in the sector since the 1980ies, e.g. regarding policies, regulations, technologies, strategies or actors, which indicate the institutionalization of either the Water Market Logic or the Water Sensitive Logic and thus, at the same time, suggest a deinstitutionalization of the once very sedimented Hydraulic Logic.

Indications of the institutionalization of the "Water Market Logic": The first phase of a broader, strategic economic water reform started with the COAG reform in 1994 and was based on a general national policy framework for economic competition and public sector reform. Some of the core elements were pricing reforms with the goal of full-cost recovery, establishment of water markets, the corporatization and structural separation of public utilities and a general increase of the sectors efficiency and productivity by introducing more economic principles. In 2004, all of these aspects have again been emphasized in the National Water Initiative, which represents the blueprint for water sector reform until today. The implementation of these policies into practice is still an ongoing process and has sometimes proven to be rather difficult, but some changes are clearly visible. For instance, while urban water services have traditionally been supplied by vertically-integrated, state-owned monopolies with a strong engineering focus, the new principles of rationalization and economic efficiency led to a significant change in the actor structure of the water sector. Most of the utilities have been restructured from public sector departments to corporations with a profit orientation. Furthermore, a significant amalgamation of local government utilities into a few corporatized, state-owned utilities occurred. In Victoria, over 140 small utilities were merged into 13 bigger state utilities and in Queensland the number of local councils responsible for water was reduced from 157 to 73 (Productivity Commission Report, p. 49). In general, the focus on efficiency gains and rationalization led to a heavy decrease in employees. The industry went from over 50'000 people working in water supply, sewerage and drainage services in 1985 to less than 20'000 by 2000 (Productivity Commission Report, p. 45). In 2010, this number increased again to 40'000. This is often interpreted as a result of

new investments in supply augmentation like desalination that required an additional workforce. However, a shift towards employment of the private sector has occurred, due to outsourcing of services, public private partnerships or various build-own-operate-transfer (BOOT) contracts with engineering and consulting firms. Even though full privatization is hardly visible, the role of the private sector has become crucial. For instance, all six large-scale desalination plants are built and operated by private consortia. Furthermore, the representative 2011 State of the Water Sector Survey of the Australian Water Association revealed that 28% of the respondents work for technical services providers or consultants compared to 38% for water utilities and 14% for government departments. This report also showed that the engineering ethos is clearly challenged by consultants: 29% of the respondents described their role as consultant/general management compared to 25% engineering and 10% other scientific/technical researchers. Furthermore, the general policy principles for economic efficiency have been more or less successfully translated into specific state policies for pricing and third-party access. Most states recently established independent economic regulators in order to counteract the monopoly situation as well as to regulate prices so that they achieve a full cost recovery from the consumers. While the typical residential water bill rose considerably in the past several years, e.g. an increase of 32% since 2006 in Sydney, the role of pricing in demand-management or supply augmentation is still rather modest and various pricing schemes exist (NWC Performance Report 2011). For example, the heavy use of water restrictions has been criticized by many economists to be financially infeasible. In addition, as recent investments in large-scale water supply technologies have shown, government subsidies are still very common. Regarding the introduction of competition through third-party access arrangements, a successful court intervention of Sydney Water against a private water service company that wanted access to the water infrastructure indicates that actual implementation has been problematic as well. Nevertheless, current regulations try to enable more competition in the sector. Another indicator for the uptake of economic principles is the increasing creation of water markets for trading between irrigators and urban users. Even though there still exist various policy obstacles for large-scale water markets, allocation trade in the Murray-Darling Basin region has gone from 0 GL in 1984 to 1600 GL in 2010 (NWI Assessment Report 2011). Current policies stress the need to further enable trade as a tool to balance water supply and demand without technological supply augmentation. While all these developments indicate an increasing institutionalization of the principles of the Water Market Logic, it also shows that this process does not go without tensions and conflicts with traditionally highly institutionalized structures. These contradictions will be analyzed in more detail in the next chapter.

Indications of the institutionalization of the "Water Sensitive Logic": As a second major principle, the COAG water reforms of 1994 and 2004 focused on environmental sustainable development, mainly regarding the introduction of environmental water allocation and restoration of water health. Special transdisciplinary research programs have since been established in order to improve the understanding of water resources and new water supply technologies (e.g. CSIRO Water for a Healthy Country Flagship or the CRC for Water Sensitive Cities), which developed a strong focus on Integrated Water Cycle Management (IWCM). This new water management principle has been translated into various state regulations and indicators are being developed for the handling of environmental water. In 2007, an important legislative change established the Murray-Darling Basin Authority. This is the first time a transboundary approach to water management has been adopted, being oriented at the actual river catchment area and not state jurisdictions. In addition, many states established independent environmental regulators. However, accountability for environmental water management remains unclear - many regulations tend to be unspecific, monitoring capacity is weak and reporting systems non-transparent. Nevertheless, sustainability, climate change and resource management has been identified by the water industry as number one priority in the future (AWA State of the Water Sector Survey 2011). Many education and information campaigns by NGOs, governments or utilities aimed to raise awareness for the sustainable use of water. In particular, the long-lasting drought between 2003-2010 put environmental sustainability on the Australian agenda. When water supply became scarce, heavy water restrictions came into place, emphasizing a water conservation ethos. Since 1997, total water use has decreased 46%, which is remarkable, considering that this contradicts the recently introduced profit orientation of the utilities (less water sold to consumers). On the other hand, high environmental standards caused an increase in costs for building new technologies, such as dams or desalination, e.g. because of energy efficiency standards or increased demands from new environmental or safety regulations. In general, the reliance on dams has become more difficult. For one, due to their rainfall dependency, they are criticized for not being climate change resistant. Furthermore, community acceptance of dam construction has decreased due to the associated environmental impacts. This is reflected in a number of recent unsuccessful dam proposals, such as the Traveston Dam in Queensland, which was vetoed by the Australian Government based on environmental concerns. While Australia built approximately a hundred dams per decade between 1960 and 1990, this number dropped in the 1990s to 57 and since 2000 only 38 new dams or dam extensions have been built. Instead, the industry invested in other technologies, such as recycling and desalination schemes. Approximately 17% of Australia's wastewater was recycled in 2009/10. Until now, however, recycled water is not allowed as a drinking water source, since problematic public acceptance has not rendered the implementation of recycling technologies

politically feasible. An example thereof is the city of Toowoomba, which rejected the use of recycled water with 62% in a plebiscite in 2006 (despite heavy drought conditions). Nevertheless, various large- and small-scale recycling and stormwater harvesting schemes have been built around Australia, focusing on non-potable water uses, such as laundry, watering gardens etc. Furthermore, there is a high diffusion of residential rainwater tanks due to rebates and other financial incentives (32% of eligible households had one in 2010) and also water efficiency labels for technologies, such as washing machines, became rather popular. As an alternative to recycling, all major cities chose to build rainfall independent large-scale desalination plants. In theory, they are capable of supplying up to 49% of the overall capital city water consumption in Australia (WSAA Report Card 2009/10). However, since the drought broke in 2010, only Perth is using desalinated water in a significant way, with desalination accounting for one third of its drinking water. The other plants are mainly considered an insurance policy for future droughts, therefore justifying the billion dollar investments. Time will tell if the heavy investment in desalination plants and the associated financial and technological path dependency will hinder further development of alternative technologies, such as recycling or stormwater harvesting. For a summary of the various indicators for institutionalization just described see Table 5.1.

5.2.2. Discursive activity as indication of institutional coherence

So far the content of the institutional logics in the water sector has been analyzed and different indications for their institutionalization in the Australian urban water sector have been presented. However, it is still unclear how these field logics are used by the different actors and what kind of conflicts and tensions arise out of their diversity. The qualitative analysis of the public inquiry on Australia's urban water sector reveals the main issues presently discussed in the field and the range of actors active in the discourse. Most issues can be interpreted as belonging to a certain field logic. Analyzing the current discourse thus provides an overview of the use of different logics in the field and enables the identification of discursive hotspots, i.e. areas of high discursive activity. A high discursive activity indicates an objectification phase, where (de-) institutionalization is happening and negotiated through framing, mythologizing, theorizing, developing storylines, demonizing or valorizing specific narratives. It is visible how institutional logics collide, coalesce or coexist and which actors draw from which field logic to make sense of problems and solutions. Discursive hotspots identify issues that have not yet been settled and thus indicate where change is currently in the making and a transition may be occurring. Analyzing them in more detail allows us to identify the major lines of conflicts and contradictions and thus say something about the institutional coherence or, more likely, semi-coherence of the field.

Table 5.1: Indicators for the Institutionalization of new water sector logics

Water Market Logic

Pro	Con
• COAG reforms 1994/2004 with focus on economic efficiency and public sector reform • Heavy restructuring of water management arrangements in each state • Corporatization of utilities, profit orientation • Amalgamation of small local councils into few corporatized state utilities • Heavy decrease in water sector employment between 1984-2000 (ca. -60%) • Engagement of the private sector through outsourcing, PPPs, BOOT contracts etc., especially to consultants and multinational water companies • Scientific focus on economics principles • State policies for economic regulation for pricing, third party access, licensing: Enable liberalization and competition • Full cost recovery pricing principle is being implemented in many utilities, hence substantial increase in water prices • Creation of water markets (mainly between irrigators and urban users, from no trade in 1984 to 1600 GL in 2010 in the southern MDB region) • Introduction of cost-benefit evaluations for technologies	• Policy obstacles for large-scale water trade • The consistency and transparency of economic regulation varies between states and the separation of institutional roles is still not implemented everywhere • Role of pricing in water supply augmentation during the past decade is rather modest. State and federal subsidies are still common in large-scale projects (e.g. desalination). • Recent supply augmentation have proven to be economically questionable (e.g. desalination) • Competition through third party access arrangements mostly on paper, e.g. successful intervention of Sydney Water in court against a private competitor; still all water ownership is public • Reliance of non-price demand management instead of price-demand management • Civil society and NGO activities against privatization of the 'public good' water

Water Sensitive Logic

Pro	Con
• COAG reforms 1994/2004 with focus on env. sustainability, env. water allocations • Murray-Darling Basin Plan 2007: first water management on catchment level • Special research programs to improve understanding of water resources and new water technologies form an interdisciplinary perspective (e.g. CSIRO Water for a healthy country flagship, CRC for water sensitive cities) • State and local policies for managing water cycles sustainably (IWCM) • Increase in water recovery for env. purposes • Creation of a env. water managers/regulators on federal and state levels • High env. standards for building new technologies, e.g. dams or desalination or even partial bans for new dams • Awareness for energy consumption and greenhouse gas emissions associated with water services • Implementation of recycling technologies: Increase from 2005-2010: 34%, which is ca. 17% of wastewater • Various recycling/stormwater harvesting projects, e.g. Rouse Hill Water Recycling Scheme (community level: largest residential recycling scheme) or City of Salisbury Stormwater harvesting (treatment through wetlands), both non-potable use • Diffusion of rainwater tanks (32% of eligible households had one in 2010), also due to rebates and financial incentive structures • Water Efficiency Label on technologies to increase awareness for water saving (e.g. shower heads, washing machines) • Widely spread water restrictions: total water use has decreased 46% since 1997 • Development of fit-for-purpose water • Education and information campaigns by NGOs, governments, utilities to raise awareness of env. water problems • Sustainability, climate change and resource management number one priority in the water sector in the future (AWA)	• Still knowledge gaps of env. water situation in many areas • Env. policies/objectives often unspecific and unclear • Jurisdictions reluctant to identify over allocation and implement measures • Accountability for env. water management often remains unclear, monitoring capacity is weak, non-transparent reporting • Env. needs often last to consider • Stakeholder involvement and trust in water planning is still weak • Policy bans on indirect potable reuse hinders recycling as supply option • Large-scale recycling scheme in Brisbane not used to supply drinking water • Problematic public perception of wastewater recycling (e.g. referendum in Toowoomba against water treatment plant despite heavy drought conditions)

The entire text corpus was codified into 1703 text fragments, which were assembled into 16 more or less homogenous thematic sub-categories. These sub-categories were then assigned to the three previously described field logics as well as two general categories. The actors were grouped into 5 more or less homogenous types. Table 5.2 gives an overview of the category system and displays the number of text elements that were coded. Since the analysis is qualitative, the code frequency should be interpreted with care as statements may span from short propositions to elaborations running over several pages about specific aspects (e.g. pros and cons of specific forms of water pricing). Nevertheless, they indicate the specific emphasis that actors make in their submission and enable a comparison between them. For an overview of exemplary quotes for each category see Table A.4 in the Appendix.

Table 5.2 shows that issues relating to the "Water Market Logic", such as economic efficiency, pricing, competition, corporatization or water markets, make up 29% of the qualitatively relevant discussion, followed by issues resembling the "Water Sensitive Logic" (26%), e.g. environmental concerns, IWCM, recycling, water conservation or community aspects, and the sub-category governance (23%), which includes planning and decision making processes or regulation. This indicates that various aspects of the newer field logics are represented and constitute a discursive hotspot. But aspects relating to the "Hydraulic Logic" also get attention (15%), which suggests that its sedimented status is challenged. Furthermore, the high discursive activity around governance issues can be interpreted as a sign for uncertainty and transformation, since previous arrangements seem to be inadequate and new ways of organizing the sector must be found. Regarding participating actors, the table shows that the officially responsible actors for water services, namely governments (local/state/national), are represented with 41%, followed by different utilities with 23%. More 'intermediary' actors, such as academia, consultants and firms or NGOs are represented with 19% and 9% respectively. This emphasizes the vested interests that governments and utilities have in the industry, but also shows that new actor types are influencing water sector discourse.

Table 5.2: Overview of the category system used in the discourse analysis

Meta Category	# of text elements	Subcategory	# of text elements/ actors
Hydraulic Logic	253 (15%)	Health/Safety	50
		Reliability	51
		National Growth	7
		Social Equity	145
Water Market Logic	498 (29%)	Efficiency	86
		Pricing	256
		Competition	115
		Corporatization	24
		Market	17
Water Sensitive Logic	452 (26%)	Environment	173
		IWCM	41
		Recycling	85
		Water Conservation	76
		Community	77
General Indicators	500 (6%;23%)	Technology	102
		Governance	398
Government	694 (41%)	National Government	4
		State Government	7
		Local Government	11
		Independent Regulators	2
Utility	388 (23%)	State Utility	6
		Local Utility	4
		Professional Association	1
Academia	323 (19%)	Professor	8
		University Department	1
		Scientific Organization	4
Consultant/Firm	150 (9%)	Consultant	3
		Technology Firm	6
NGO	148 (9%)	Social NGO	6

In order to illustrate the discursive hotspots in detail, the specific actor profiles have been identified by cross-tabulating the statements by field logic elements and actors. This enables the identification of the relative importance that actors attribute to specific issues as well as the dominance of an actor in a particular discourse. Table 5.3 shows the relative frequencies of topics addressed by the different actors. Entries in the table represent deviations of a specific actor group concerning a specific topic. Positive values indicate a higher than average engagement in the specific topic, negative numbers show a relatively lower engagement and -100% indicates that the respective topic was not mentioned in a substantial way within the actor group. Percentages have also been normalized with regard to the number of codes

attributed to the different actor groups in order to make the profiles more easily comparable. Therefore, values of 100% (and above) indicate that the respective topics have been mentioned (more than) two times as often compared to what could have been expected from the overall share of this actor group in the inquiry.

Table 5.3: Relative importance of topics addressed by actor groups in the public inquiry: fields set in dark grey represent values > 20% above the overall share of this actor group in the discourse

Category	Subcategory	Gov.	Utility	Academia	Consultant /Firms	NGO	SUM
Hydraulic Logic	Health/Safety	23%	-21%	-5%	-9%	-31%	0%
	Reliability	40%	-31%	14%	-55%	-77%	0%
	National Growth	75%	-37%	-25%	-100%	-100%	0%
	Social Equity	-32%	-33%	-49%	-100%	448%	0%
Water Market Logic	Efficiency	-14%	33%	23%	-21%	-46%	0%
	Pricing	-7%	11%	26%	-60%	8%	0%
	Competition	-13%	64%	-77%	97%	-40%	0%
	Corporatization	12%	83%	-78%	-100%	-4%	0%
	Market	-13%	3%	-7%	167%	-100%	0%
Water Sensitive Logic	Environment	-5%	-24%	58%	12%	-53%	0%
	IWCM	26%	-14%	41%	-72%	-100%	0%
	Recycling	1%	-59%	36%	154%	-86%	0%
	Water Conservation	-13%	44%	4%	-25%	-39%	0%
	Community	-4%	8%	-11%	-56%	79%	0%
General	Technology	-13%	-57%	40%	189%	-66%	0%
	Governance	20%	10%	-23%	-3%	-65%	0%
	SUM	0%	0%	0%	0%	0%	0%

Read horizontally, Table 5.3 identifies discursive hotspots relating to each field logic. It summarizes which issues receive above average attention by actors and can thus be seen as rather controversial and unresolved. It also points out the dominance of specific actors in each institutional logics discourse. Incoherencies within and between logics can thus be revealed. Read vertically, the table shows the specific actor profiles, i.e. it demonstrates which topics get prioritized and attributed a comparatively high importance. This enables a comparison between the field actors and an overview over who supports or impedes certain principles.

Looking at the "Hydraulic Logic" two specific discursive hotspots can be identified (for quotes see Table A.4 in Appendix, category "Hydraulic Logic"). In general, the discourse reveals that traditional issues like public health, water security and the importance of the

water industry for national development are still at the heart of the sector and are mentioned throughout the inquiry. But it is noteworthy that governmental actors are particularly stressing these issues. Especially the introduction of new technologies like recycling and stormwater harvesting challenges the idea of water security in quantity and quality (e.g. small-scale arrangements and different water treatments). Since governments are the ones ultimately responsible for water services, uncertainty and resistance is recognizable. This can be interpreted as a backlash to the above mentioned changes during recent decades and as a defense from incumbent actors of once highly sedimented and taken-for-granted principles. As a second hotspot the issue of social equity was identified. Questions regarding the affordability of water, price increases, right to have a say in a matter, water as public good etc. are given a certain attention. This can be seen as a reaction to various corporatization and privatization developments in the industry that led to higher water prices and a profit orientation for utilities. Notably, the issue of equity is frequently discussed by social NGOs, who can be said to start to take on the role of a social conscience in the sector. While the "Hydraulic Logic" has become deinstitutionalized by the emergence of new water sector logics, the discourse analysis shows that it is still enacted and defended, amongst others by some of the most incumbent and formally powerful actors and by some new ones.

The "Water Market Logic" generally receives a high discursive activity, which indicates a considerable involvement of the actors with the associated issues (for quotes see Table A.4 in Appendix, category "Water Market Logic"). On the one hand, Table 5.3 shows a relatively high contribution of academia regarding economic efficiency and pricing. This can be traced back to the submissions of professors in economics that are heavily engaged in theorizing about the effects of various pricing schemes and other economic measures. It can thus be assumed that the economic discipline represents the intellectual backbone of the "Water Market Logic". In addition, consultants and technology firms focus on competition and market structures. While consultants tend to advocate water markets as the future tool to regulate water supply and demand, private firms voice their interest in doing business in the water sector and thus encourage the regulators to further liberalize the industry and guarantee third-party access to the monopoly infrastructure. Their main interest lies in accessing wastewater for private recycling schemes. At last, the submissions of the utilities form a particular discursive hotspot around "Water Market Logic" issues. This can be interpreted as an outcome of the uncertainties involved with the water sector reforms, e.g. the significant corporatization and mitigation of their monopoly position. While some argue that the changes led to an improvement of the sector's efficiency, there are also critical voices that stress internal problems of adjustments as well as uncertainties and dangers associated with competition by the private sector, which is why the call for regulation is strong. Overall, the

discourse analysis reveals that 'intermediary' actors like academia, consultants and firms lead the discourse related to issues stemming from the "Water Market Logic", while utilities are the ones affected most by all the recent changes and thus sometimes show a reactionary and defensive attitude.

Regarding the "Water Sensitive Logic", Table 5.3 indicates that the topics of environmental protection, IWCM and recycling technologies represent discursive hotspots in the academic actor group (for quotes see Table A.4 in Appendix, category "Water Sensitive Logic"). This goes back to a high involvement of environmental science and engineering groups that research innovative, environmentally sustainable water technologies and governance modes. They advocate a diffusion of alternative technologies and a more conscious treatment of water resources. Similar to the economics professor for the "Water Market Logic", they bring in the scientific foundation for the "Water Sensitive Logic". While in some cases the rivalry between these two logics is strong and their assumptions highly contradictive, other cases reveal the attempt of an integration of both, at least on a rhetorical level, e.g. visible in the popularity of green liberalism in many countries. In addition, utilities point out the high public legitimacy of water restrictions, which should be kept in place, even if many economists argue that they are financially unsustainable. NGOs demand a greater community involvement in water planning, arguing that water is a public good and that recent technological investments, such as desalination, have been decided undemocratically. Additionally, state governments advocate a more integrated water resource management, indicating the uptake of environmental sustainability as a legitimate value and, as already mentioned above, firms are interested in doing business with recycling technologies. Overall, the discourse analysis shows that water sensitive issues are discussed across all actor groups, with a specific part of academia taking the lead.

In terms of the specific actor profiles, Table 5.3 indicates that issues relating to newer logics, i.e. the "Water Market Logic" and the "Water Sensitive Logic", are theorized and framed in a positive way by rather 'intermediary' actors from academia, consultants, firms and NGOs. On the other hand, traditionally very institutionalized actors such as governments and utilities are trying to incorporate the new demands where possible, but also show a considerable amount of concern, resistance or even ignorance towards certain topics. Hence, sedimented, hydraulic values can still be considered highly institutionalized with the core actors, however, the discourse has shown that they are being challenged and increasingly pushed aside by new principles. Regarding actor centrality, the analysis shows that governments and utilities are still at the forefront for decision-making power as well as the organization and handling of water services. They are therefore considered to be highly institutionalized and very central. Academia, on the other hand, has come to represent the intellectual backbone of the newer

field logics, mainly resided in the disciplines of economics and environmental science, biology and ecology. They thus play an important part in carrying out institutional work in the form of theorizing and educating. Consultants have established a close relationship with utility and governments and thus play a vital role in advancing considerations that are usually related to the "Water Market Logic". Technology firms show a strong interest in engaging in business with recycling technology and are thus pushing for the liberalization of the water sector, which indirectly affects both the "Water Sensitive Logic" and the "Water Market Logic". NGOs, on the other hand, have a rather limited profile by protecting the traditional values of water as a public good.

5.3. Summary and preliminary discussion of the results

The study reconstructs three institutional logics present in the Australian urban water sector and describes how two of them have emerged since the 1970ies and to what extent they have replaced earlier institutional configurations. Furthermore, the study sheds light on the current semi-coherence of socio-technical structures within the sector by highlighting indicators for the co-existence of various logic elements and identifying discursive hotspots that reflect the different use and engagement of actors vis-à-vis the three field logics.

The Australian urban water sector can be characterized as an organizational field that went from being dominated by one highly institutionalized and coherent field logic, the "Hydraulic Logic", to a field consisting of three logics that exhibit different points of conflict and cooperation. Until approximately the 1970ies, the socio-technical regime can therefore be described as a rather coherent institutional structure that included a well aligned configuration of dams, utility engineers and public authorities that enabled the fulfillment of the main societal function of the sector, e.g. the provision of secure water for drinking and irrigation. This field logic had been in place for decades, the dam as the main technology had diffused rapidly and coevolved with corresponding health regulations or utility strategies. A high agreement between actors on the core values in the water sector thus resulted in a low level of controversy within the field. This coherent and strong structuration started to slowly dissolve when the institutional sector logics of the market, the corporation as well as the community started to infiltrate water sectors and over time provided alternative rationalities for managing water resources or, to be precise, a "Water Market Logic" and a "Water Sensitive Logic". As a consequence, also the coherence of the regime decreased.

The research suggests, however, that both these field logics, even though distinctly identifiable, have not yet gained the same internal coherence as the "Hydraulic Logic". For

instance, while the "Water Market Logic" has a strong focus on pricing, it is yet very unclear what kind of water pricing models are efficient or how to deal with customers that cannot afford the price increase. Also, there is a high uncertainty regarding the calculation of technology costs, which complicates technology choice. On the other hand, the "Water Sensitive Logic" struggles with the development of a universal definition for environmental sustainability in regard to water resources and there is still a need for further research on the safety and potential for recycling technologies. A high level of discourse activity around all of these emerging themes indicates that they have not yet reached a strong degree of alignment. As a consequence, the newer field logics can be said to take a weaker position within the field and that they do not (yet) represent equally strong alternatives to the "Hydraulic Logic".

Nevertheless, as is presented in the analysis of the institutionalization of different elements in practice and discourse, it is clearly visible that the "Water Market Logic" and the "Water Sensitive Logic" have left their traces in Australia's water sector, e.g. regarding the corporatization of utilities, the importance of consultants for the planning of water projects, the implementation of water markets, the adoption of recycling technologies or IWCM as new water management model. While some of these developments are highly contested, others were integrated rather quietly. The analysis suggests that this has to do with the degree of contradiction between these elements and thus indicates again, where certain developments attack the core of the regime. The corporatization of utilities, for example, has been implemented quite quickly, whereas third-party access regulations have shown to hurt many barriers. While the corporatization process does not change the position of utilities in a significant way, the entrance of private firms into the infrastructure would lead to a considerable shift in the power positions within the sector. Similarly, adding desalination plants to the bulk water resources does not concern the regulators as much as implementing wastewater recycling, since potential risks to human health is perceived as being weaker and the reliability of supply is undoubtedly higher.
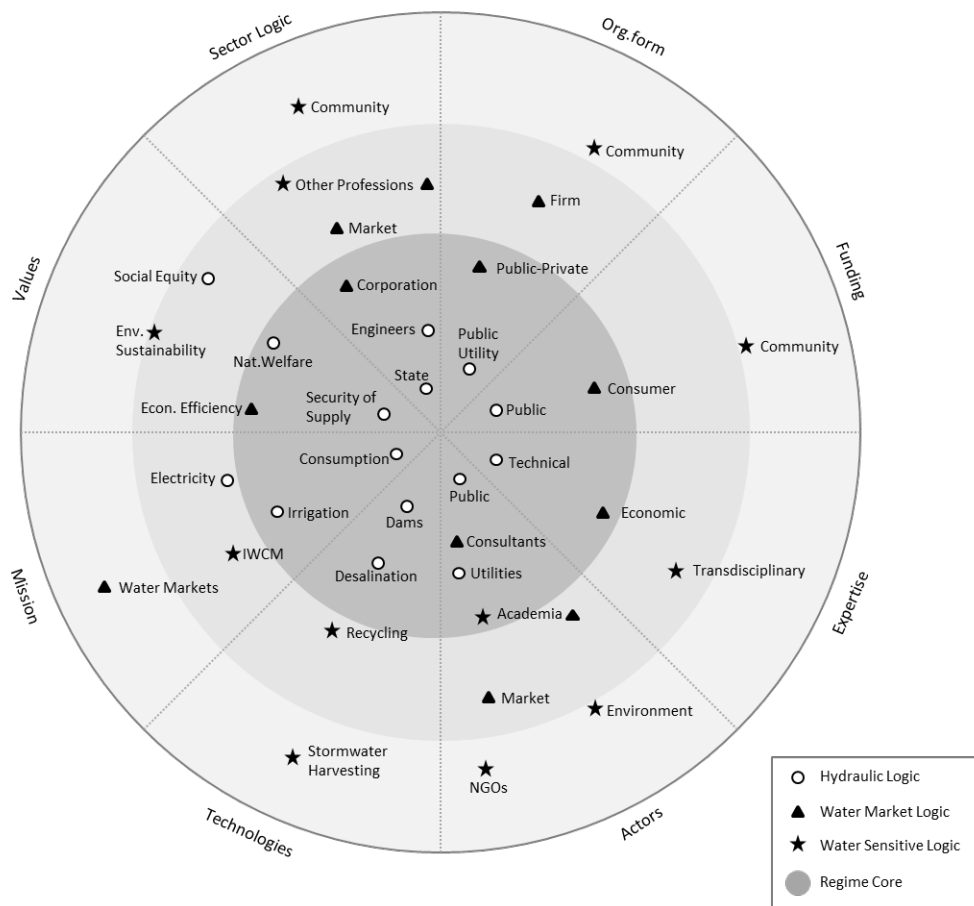
Figure 5.2: The semi-coherent structuration of the organizational field of the Australian urban water sector

The graph is a snapshot of the situation in 2010 when the public inquiry was ongoing. Positions of graphical symbols represent the degree of institutionalization of a specific logic element in the field: The nearer to the center of the dart board, the stronger its institutionalization. This measure was derived qualitatively from the analysis elaborated in the text.

Taking into account the various results of the study, the current structuration of the Australian urban water sector can be described along the lines of the institutionalization of the field logics. Figure 5.2 depicts the degrees of institutionalization of the ideal typical logic elements in the organizational field of urban water in Australia. The center of the dart board shows the most highly institutionalized elements of each field logic and thus represents the current semi-coherent regime. It becomes visible that the core consists of "Hydraulic Logic" elements, such as security of supply, dams or public authorities that rival with "Water Market" elements like consultants or public-private organizational forms. Also the "Water Sensitive Logic" has found its way into the sector, but its effects on actors and practices are not (yet) as strong.

However, since the structures in an organizational field often represent a continuum of institutionalization, the regime boundaries are rather fluid and they permeate into the rest of the organizational field. As the analysis shows, there are many elements that are in the midst of a (de-) institutionalization process and time will tell in what direction they will develop (into the core of the regime or to the edges of the organizational field). Overall, it can be stated that the emergence of new field logics has decreased the overall coherence of the structuration of the field and thus also the strength of the regime by making it more heterogeneous. As a consequence, the potential for change has increased.

ANALYSIS II:
INSTITUTIONAL WORK IN THE AUSTRALIAN URBAN WATER SECTOR

6. Analysis II: Institutional work in the Australian urban water sector

This chapter presents the results of the analysis of different processes of agency observed in the Australian urban water sector. Two specific cases of an extensive application of institutional work are analyzed: the creation of the drought as millennium crisis and the 'win' of seawater desalination over wastewater recycling as the major technological solution to the drought. While the former demonstrates how extreme events are interpreted and socially constructed within a field, the latter sheds light on how certain actors purposively promote or prohibit certain technological solutions. In addition, it illustrates how the diffusion of a technology in return contributes to the transformation of a field. This section concludes with a short summary as well as a preliminary discussion of the findings.

Australia's water sector has since ca. the 1980ies undergone various changes that can be traced back to the global emergence and institutionalization of economic and environmental principles. Until then, the socio-technical regime of the water sector has been very stable and rather uncontested. The dominant "hydraulic" configuration that had developed over a long period of time was characterized by public actors and engineers building a centralized system of large-scale technical infrastructure (dams) in order to guarantee water security and reliability as well as national welfare. By the 1980ies, this logic came under greater scrutiny due to the introduction of neoliberal and environmental ideas. As a consequence, the water sector has taken up a more market oriented approach towards water management, including the corporatization of public water utilities, an increase in water prices to recover the cost through consumers or collaborations with private companies. On the other hand, environmental movements triggered various environmental water regulations, a focus on integrated water resource management (IWRM) and the implementation of decentralized recycling technologies for waste and storm water. State governments, who have jurisdiction over water supply and sanitation, as well as the federal government had initiated major reforms that targeted the liberalization of the water industry as well as the protection of aquatic ecosystems. By the year 2000, all the Australian states had set a more or less pronounced water management strategy with a strong focus on IWRM and recycling technologies: "*We aim to protect and enhance the environment by developing and implementing recycling schemes. We believe that effluent and biosolids, previously regarded as waste, are now potentially valuable resources.*" (Melbourne Water Annual Report, 2000, p.51).

The institutionalization of these new principles in the water sector contributed to the destabilization of a once very coherent regime. The subsequent regime can be described as

less coherent, since it incorporated elements from different rationalities that are sometimes rather conflicting (e.g. market vs. environment). Actors within the water sector were subject to different guiding principles, which enabled a multifaceted range of institutional work that had an increasing focus on the institutionalization of a new water regime based on principles like economic and environmental sustainability.

However, between ca. 2002 to 2010, most parts of Australia were affected by a severe drought, now known as the 'millennium drought'. Dam levels in all major cities dropped to an unprecedented low, industries and agriculture were hit hard and the fear of running out of drinking water circulated among politicians and the public. Water was put first on the political agenda and a diverse range of actions were taken by the different governments that were mainly based on two pillars: heavy water restrictions and supply augmentation through large-scale infrastructure, mostly seawater desalination plants. Even though demand management programs achieved a decrease in water use of about 46% (compared to 1997), all major cities decided to additionally invest in desalination plants, despite concerns from expert circles and the public regarding the environmental sustainability of the technology as well as its economic efficiency and necessity. Western Australia (Perth) was the first state to decide on a desalination plant in 2004, followed by Queensland (Brisbane), New South Wales (Sydney), South Australia (Adelaide) and Victoria (Melbourne) within the next few years (see Table 6.1 for an overview of Australia's desalination plants). By 2008, the water industry had seen an unprecedented 80% increase in capital expenditure, most of it going back to investments in desalination that were heavily subsidized (WSAA performance report 09/10). Unfortunately, as soon as the construction of the different desalination plants was decided and had begun, the drought on the east coast broke and was followed by heavy rainfalls and flooding, filling the dams up again and therefore rendering the need for additional water sources, such as desalinated water, at least for the coming years obsolete. Consequently, none of the desalination plants on the east coast has ever been significantly in use. Instead, they have now been put on standby. The exception is Perth, where the drought is still ongoing and both constructed desalination plants are supplying water to their local drinking water system. As can be expected, the idea of having invested billions of dollars into infrastructure that is not used has created a lot of tensions within the industry as well as between decision makers and the public. While advocators see desalination as an "insurance policy" for future drought periods that are expected to occur more often and more intense due to climate change, opponents call desalination an unnecessary "white elephant" that proves the poor decision making capabilities of the sector and the politicians.

Table 6.1: Overview of large RO seawater desalination plants in Australia

Location	Announcement	Construction Start	Operation Start	Cost	Actors	Size (megalitres/day)	Current Status (August 2013)
Kwinana Desalination Plant, WA	2004	May 2005	Nov 2006	A$387m	*Water Corporation* with *Multiplex-Degrémont JVC*, (separate design/build and operate/maintain contracts for 25 years)	144-250 (ca. 17% of Perth' water supply)	operational
Gold Coast Desalination Plant, QLD	2006	Sep 2006	Feb 2009	A$1.12bn	*Water Secure* with *Gold Coast Desalination Alliance*: Veolia Water, John Holland, SKM and Cardno (design, build and operate contract for 10 years)	125-167 (27% of SEQ's water supply)	Stand-by mode since 2010
Kurnell Desalination Plant, NSW	2006	Aug 2007	Jan 2010	A$1.9bn	*Sydney Water* and *BlueWater* joint venture: John Holland (construction), Veolia Water (operation and maintenance for 20 years) Since 2012: Sydney Water sold the plant to the Ontario Teachers' Pension Plan Board (50%), Utilities Trust of Australia and The Infrastructure Fund (together 50%).	250-500 (ca. 15% of Syndey's water supply)	Stand-by mode since July 2012
Port Stanvac Desalination Plant, SA	2007	April 2009	Dec 2012	A$1.83bn	*SA Water* with *AdelaideAqua*: McConnell Dowell Constructors, Abigroup Contractors, Acciona Agua and Trility (design, build, own, operate contract for 20 years)	270 (ca. 50% of Adelaide's water supply)	Stand-by mode since Oct 2012
Wonthaggi Desalination Plant, VIC	2007	Sep 2009	Dec 2012	A$3.5bn	*Victoria Dep. of Sustainability and Environment* and *AquaSure*: Degrément, Thiess, Macquarie Capital (30 years contract to finance, design, build, operate, maintain the plant)	410-550 (33% of Melbourne's water supply)	Stand-by mode since Dec 2012
Binningup Desalination Plant, WA	2007	Jul 2009	Sep 2011	A$955m	*Water corporation*, DBO contract with *Southern SeaWater Alliance*: Tecnicas Reunidas, Valoriza Agua, WorleyParsons and AJ Lucas (25 years)	270 (ca. 30% of WA's water supply)	operational

The drought can thus be interpreted as an extreme event for the sector that had considerable effects on the focus of water management. It can be assumed that the heavy investment into desalination will have consequences for the development of the whole system, i.e. the transition of the water sector. Analyzing the institutional work that led to this outcome will provide a detailed picture of these developments.

This section will thus focus on various instances and processes of agency that significantly contributed to the transformation of the Australian urban water sector. First, it will be shown how a drought was developed into a significant crisis that ultimately legitimated the implementation of seawater desalination technology. Second, it will be elaborated in detail how this implementation of desalination can be explained through a combination of highly effective institutional work and favorable structural preconditions in the field. This illustration is completed by comparing it to the less successful establishment of wastewater recycling as an alternative solution to water scarcity. The section is concluded with a short summary as well as a preliminary discussion of the findings.

6.1. When is dry too dry? The evolution from drought to crisis

Australia is a country of extreme weather events and therefore used to alternate between drought periods and heavy rainfalls. Overall, it is often considered the driest continent on earth and therefore its history and culture is closely related to the struggle against water scarcity (Cathcart, 2009). However, as this research suggests, water scarcity or droughts are not objective concepts. Their existence and effects are usually heavily debated and rely on previous experiences (e.g. a drought normally breaks after some years), on different models that experts use to calculate rainfalls and runoffs into dams, on political strategies and programs (e.g. attention to and relevance of water issues), on decision-making in water utilities or on various ways of public suasion (marketing, media campaign). Especially the step from observing 'normal' drought conditions to declaring a water crisis, i.e. an event outside of every known regularity, involves various forms of institutional work that will be subsequently review.

The interview data suggests that one of the most present forms of institutional work in creating a water crisis in Australia is *theorizing*. It is often mentioned that the experts, mostly climate scientists and civil engineers, did not agree on the severity of the drought, neither on the scenarios for the future. Therefore, the predictions of when and if the drought will break, varied considerably, rendering strategy making by the utilities and water departments rather difficult. While some scientists claimed that certain cities, such as Perth or Brisbane, would

soon run out of water and therefore needed a supply augmentation, other experts contended that it would be sufficient to rely on water restrictions until run-off into the dams increases again. Depending on what model was used to calculate the remaining water, the results varied and thus led to a different sense of urgency:

> *"They normally do their big stochastic analysis over a thousand years, and then, well, they started modeling what happens if this persists for the next two years, so when will we run out of water, and they started getting numbers like 2007, 2008 and 2009, and this is in 2005 and 2006, so suddenly, this became a crisis." (Interview 22)*

> *"So there was a real perception in people's minds of shortage, but there was never a shortage, this may have been a bit of misinformation, there was really never a shortage in terms of internal use of water. But there was certainly not enough to use potable water on the outside. So there was a lot of modeling of the issues for sure." (Interview 4)*

This uncertainty of scientific knowledge gave way to a broad scope of interpretation and debate. Therefore, also ***advocacy*** was very central in the process of constructing the crisis. Since the scientific foundation of the drought and its consequences was very contested, there was a lot of room for lobbying to convince politicians or utility managers from a certain point of view. Many interviewees mention that the "realization" of the crisis was a process, rather than an event:

> "*So 2000 the drought started, but it wasn't until 2005 that there was a concern that we're in a long drought, so it was a bit like, you heard of the saying boiling the frog in hot water? (...) There were a few out crying voices, in February 2005, that said something is not right, and that's where the fight started with the civil engineers. I was on one side, and the civil engineers on the other. We have a problem, they said no, we haven't got a problem.*" (Interview 24)

In addition, there was a broad public campaign launched by various actors (e.g. water utilities, governments, media) to raise the awareness of water issues and encouraging water conservation. The goal of the campaign was **educating** the public in terms of drought conditions and appropriate behaviors:

> *"The shower timer campaign – A change in Burnside can change the world – was a city-wide campaign designed to raise awareness in the community about the importance of water conservation. Between 25 June and 2 July 2008, each household within the Burnside Council area received a water conservation pack containing a four-minute shower timer, fridge magnet ("It may be winter, but we're still in drought") and information card. Before and after the distribution of the shower timer, a series of information seminars to raise awareness of water conservation were included in Council's community environmental awareness program."* (Water Campaign Action Profile 2009, ICLEI Oceania, p. 10)

This campaign often also relied on institutional work such as ***imagery*** to cause fright and worry in the public by distributing pictures of empty dams, dry farmland, gardens or rivers:

> *"I remember pictures of the empty dam, the cracked bottom of the dam, you know, dead fish lying on their side, and a very vocal mayor up there [Toowoomba], and all that was coming into the Brisbane press, even though it's a separate water system, different catchment, but it was there, and I think that was in advance of the decisions made here."* (Interview 22)

Also within the public space water scarcity was a central theme. Most restaurants, hotels and schools participated in raising awareness and convincing people to save water by putting up signs that encourage people to reuse their towels or to have short showers or they were proud to announce that they have water efficient technologies (e.g. toilet flushes or washing machines) or use non-potable recycled water.

In general, Australia's experience with water scarcity was highly emphasized by way of *mythologizing* the historically well-adapted handling of scarce water situations. Stories about heavy droughts that occurred in earlier times and how grandparents reacted to this were very common. In a similar vein, there were efforts aimed at **changing normative assumptions**. This is especially visible in the discourse about gardens. Having a nice, green garden is considered a must-have status symbol in Australia. However, green gardens require a lot of water, which is why there were (contested) attempts to introduce a more native approach to gardens, e.g. with cactuses and other plants that are drought resistant:

> *"If we have cities that are going to run out of water in the next decade then we should be focusing on making sure that it's normal for people to understand that you don't plant that type of garden, you plant this type of garden, and we did a lot of that, there were very water intensive gardens, private gardens, public gardens, which were pulled out, and we have a lot more native species in there now."* (Interview 10)

Furthermore, after a while actors realized that having a water crisis opens up a range of possibilities and legitimizes actions that would have never received support before, e.g. investing billions of tax money in desalination plants or implement strong water conservation programs: *"When I was in my last job, we tried to do it with the community, over ten years, and couldn't do anything, we did all in fifteen minutes, you know, just by having a crisis and the communities just coming on board, and agreeing, it was just so easy to roll stuff out"* (Interview 24). Therefore, having a crisis was sometimes politically interesting and thus intentionally "created" (**political work**):

> *"When I spoke to the director general, he basically told me that they've done their modeling on ten years, and expected the drought to break. But if it didn't, the consequences could have been catastrophic. He basically said no, I'm going to model just for two years, and he created, he was quite proud of the fact, that he created this crisis down there, which led them to basically go right, let's get a desal plant, and let's get the biggest one we can get, as quickly as we can get it."* (Interview 22)

All these examples show that the crisis was not just objectively given, but highly constructed by actors using different forms of institutional work. It can thus not only be seen as an exogenous, climatic event that was extreme enough to cause troubles within the field. Instead, the event was mediated and interpreted from system actors and sometimes also deliberately used to legitimate other sorts of actions, e.g. the establishment of desalination plants. Table 6.2 provides a summary of the above mentioned types of institutional work.

Table 6.2: From drought to crisis: Forms of institutional work applied by actors

Quotes adapted from Lawrence and Suddaby (2006)

Type of Institutional Work	Description
Theorizing	*"The development and specification of abstract categories and the elaboration of chains of cause and effect"*, e.g. creating scientific models and predictions, elaborating scenarios for the future, constructing categories of water restrictions, defining the beginning of water crisis etc.
Advocacy	*"The mobilization of political and regulatory support through direct and deliberate techniques of social suasion"*, e.g. convincing utilities and politicians of the (non)-existence of a crisis (personal communication, lobbying, presentations, conferences etc.)
Educating	*"The educating of actors in skills and knowledge necessary to support the new institution"*, e.g. public marketing campaign to raise awareness of water issues
Political work	*Direct use of political power to achieve specific goals*, e.g ignoring expert opinions, overruling public bodies or advisory boards, diverting issues from its intended meaning in order to achieve political goals
Imagery	*Invoking images that cause fright and worry and associate an issue with danger*, e.g. pictures of empty dams, dry farm land, gardens and rivers etc.
Mythologizing	*"Preserving the normative underpinnings of an institution by creating and sustaining myths regarding its history"*, e.g. underlining Australia's history and experience with water scarcity, etc.
Stressing/Changing normative associations	*"Re-making the connections between sets of practices and the moral and cultural foundations for those practices"*, e.g stressing the meaning of green gardens in Australia or, respectively, establishing a restrictive, water sensitive approach that leads to a change in cultural habits such as green gardens

6.2. Finding a solution to the crisis: Being caught between a rock and a hard place

As the phrase 'millennium drought' suggests, the construction of the water scarcity crisis was ultimately very successful, spanning across different media, politics, economic sectors, and public life. As a consequence, the search for a solution became the center of attention not only within the water sector but also within the whole Australian society. The water crisis made more than once front-page news of major newspapers in the country. In general and put simply, two types of solutions existed: saving drinking water to be able to prolong the reserves, e.g. through various water efficiency measures and water restrictions (no car washing or sprinklers, water saving shower appliances etc.) or find new sources of water,

either trough water recycling or desalination. The question, whether water savings were sufficient to survive the drought without running out of water, was highly contested. So were the opinions about which additional water source would be best, stormwater, rainwater or wastewater recycling or desalination. Although stormwater and rainwater recycling was proposed as one of the most sustainable options, many experts thought it was too expensive and too small-scale to help relieving the tight drinking water situation. In addition, it was often mentioned that these solutions are not efficient in times of no rain or storms. It therefore essentially came down to a 'battle' between large-scale wastewater recycling and desalination. Being based on highly similar membrane technologies, the main difference between the two is the source of water: wastewater or seawater. While wastewater is said to be cheaper to recycle, use less energy in the reverse osmosis process and be environmentally friendlier, seawater is seen as less prone to pollution and more likely to gain public acceptance. However, the arguments used by experts in the media as well as in scientific articles were rather contradictory and opinions varied greatly. Hence, the battle between desalination and recycling was ultimately decided by how successful actors engaged in institutional work. While the next paragraphs take a closer look at institutional work in the realm of recycling, the next sections are dedicated to trace in detail the processes that led to the breakthrough of desalination in Australia.

Wastewater recycling has many different forms. It can be small-scale (household level) or large-scale (big treatment plant for the whole city); there is direct potable reuse (wastewater is treated directly to drinking water quality) or indirect potable reuse (it is treated to a very high quality and then put back into the environment (groundwater, river) to be extracted at a later point in time); or there are different water qualities, e.g. non-potable water quality for outdoor uses or toilet flushing. Australia has explored many of those options in various experimental projects and it can be said that a lobby has developed around many different recycling applications that aims at **mobilizing resources** and **constructing normative networks**. In particular, a few research centers have been founded with the goal of advancing know-how of those technologies and come up with a fruitful way for implementation (**theorizing**). Here an excerpt of the homepage from the Centre for Water Sensitive Cities:

> *"The CRC for Water Sensitive Cities brings together the inter-disciplinary research expertise and thought-leadership to undertake research that will revolutionise water management in Australia and overseas. (…) The dissemination and application of research will be facilitated through a number of knowledge sharing and capacity building activities. These include: industry capacity building activities (...); formal education opportunities (PhD scholarships and Masters programs); developing a National 'Alliance' for transitioning to water sensitive cities and towns."* CRC for Water Sensitive Cities, http://watersensitivecities.org.au/about-the-crc/, 03.09.2013.

Besides the actual theorization of what recycling is and can or cannot do, one of the central forms of institutional work applied by recycling proponents is **changing normative associations**. Recycling turns the way people think and have thought about water provision for hundreds of years upside down. Especially in terms of direct potable reuse, where drinking water is made out of wastewater without any further step in between, such as flow down or rest in a river for a while, challenges not only the perception of many laypeople:

> *"Their idea of what standard water supply was, was very natural. Going from a pristine catchment to supply their water to taking the sewage and turning it into drinking water was just too big a step. And I don't just mean for the people of Melbourne, I mean the people that ran the water business, the people that have got PhDs."* (Interview 16)

Wastewater is clearly not seen as a source for drinking water, no matter what the sciences say. Therefore, many activities of recycling proponents have engaged in various **advocacy** activities to change how people think about the use of waste water: *"We spent a lot of trouble, a lot of time talking to the community, reassuring them that's the big thing, you know, basically getting community gradually acclimatized, their education facilities and lots of research"* (Interview 16).

The biggest concern in the community was seen to be water safety: Is water made out of wastewater healthy enough? As put by one of the leading researches in Australia:

> *"When recycling became a big issue in Australia around about 2006, 2005, 2006, it really focused a lot of community attention on this issue of chemicals. How do we know that we can remove all those pharmaceuticals and hormones and pesticides, and industrial chemicals that we know are in waste water or even how do we even know what's in waste water?"* (Interview 10)

Nevertheless, the pressures put on water supply during the drought was strong and governments started to see recycling as a potential option for supply augmentation, even though there were various policy bans in place that forbade the use of indirect and direct potable reuse as a safety precaution (**political work**). The Environmental Protection Agency of Victoria, for instance, released a document with the following statement:

> *"Reusing and recycling alternative water supplies is a key part of reducing the pressure on our water resources and the environment. Helping us adapt to climate change and population growth. When considering alternative water supplies, you should choose the most appropriate water source, taking into account end use, risk, resource and energy requirements."* EPA Victoria, http://www.epa.vic.gov.au/your-environment/water/reusing-and-recycling-water, 03.09.2013

However, even though recycling slowly got on the radar of some politicians and many experts argued for the use of recycling technologies, resistance to it was extensive. There was a lot of **demonizing** involved, putting up public campaigns against 'drinking poo water' or 'shit

water' and establishing the metaphor 'from toilet to tap'. People were seen as guinea pigs for new technologies and there was a fear of being kept in the dark regarding the negative impacts of drinking recycled water. No matter what all the scientific studies said, trust in science or in scientists was not granted:

> *"The government in New South Wales really snubbed their noses at it (recycling), straight away, so much so that they actually made it harder I think, for future governments to make that decision. The water minister at the time, a very abrupt politician, not one known for being terribly polite. He was on the news one night saying, well, we're not going to make Sydney drink they're own sewage, or whatever it is, drink their own shit, or I can't remember exactly what he said, but it was a pretty crude comment and it presents all of the images, all of the imagery that you don't want people to associate it with, if you're trying to convince them, this is a safe way to supply drinking water."* (Interview 10)

The development of this rather negative image of recycling culminated in a plebiscite in Toowoomba, a small town in Queensland. Running almost out of water, the government wanted to introduce wastewater recycling. In the last minute, however, a huge campaign, started by a rich citizen of Toowoomba who refused to drink 'poo water', resulted in a tight public vote with the majority saying no to the implementation of the recycling scheme. This event set the political climate regarding recycling: from then on, wastewater recycling was considered politically unfeasible:

> *"There was a plebiscite down in Toowoomba to put recycled water into their dams, and it lost. There was an enormous amount of publicity, and even today, people from Europe and America still refer to the Toowoomba experience, which really, in the scheme of things, it might just be a blip. Because there was a lot of local politics involved, and there was also an exceptionally clever campaign run by the opposition."* (Interview 16)

Nevertheless, one large-scale indirect potable reuse scheme was built. Together with a small group of experts, the Premier of Queensland decided on building the scheme without public consultation (**political work**): no plebiscite, no referendum:

> *"It had a potential to become a major political issue in Queensland. So it was a courageous decision to make, even though he started off making it in a fairly whippy way by saying that we were going to have a referendum about whether we want to build this, but that only lasted a couple of weeks before they changed the jury and came out and said no, we're not going to have a referendum, we just have to do this."* (Interview 10)

This decision was built on a lot of **advocacy** from certain water sector experts:

> *"We built a group of credible scientists that governments had a level of confidence about their capability and their expert advice. And so when we came into looking at options, one of the options you look at obviously is recycling and one of the issues is, can we be confident that recycled water is safe for consumption and all that sort of things. And so there was work done to show that is was. Because of that confidence, the state, because they had been part of this process, they were confident that the advice they were given*

was good advice and therefore they were comfortable in making that decision."
(Interview 18)

However, the Premier retired and soon thereafter the rain came and filled up the dams before the building of the recycling scheme was completed. The new Premier did not want to take on any political risks, which is why she decided not to pursue the same course and only put the recycled water into the dam if dam levels drop below 40%. To date, this has not yet happened. Hence, the recycled water is only used for non-potable purposes, such as cooling power plants. The frustration among the recycling proponents was huge and many of them believe that if Queensland would have taken the step to introduce recycled water into their dams, then it could have become feasible for all of Australia:

> *"Even if Toowoomba had gone the way it did, but Queensland had turned on its recycling scheme, that would have made the difference across the country. It's almost unquestionable that that would have been the case."* (Interview 20)

> *"What I really remember is all of these people in government just working so hard to award the introduction of this water source, you know, they'd been doing lots of market research, they'd been out in the community, you know, handing out bottles of water, recycled water, and talking to people about the issue. (...) and then, you know, the government went, the politicians said we're not going to turn on the tap, or we're only going to turn on the tap if the dam levels combined fall below 40 percent. And I looked at all those people that had been working so hard toward that point, and you know, it was like, ah, what do we do now?"* (Interview 19)

Although many forms of institutional work were applied to institutionalize wastewater recycling as a feasible technological and political option, the institutional work that was aimed at preventing this from happening seems to have been more powerful: *"For water, private recycling enterprises don't currently have a strong voice. We're trying to get them to have that voice, and if they had had that voice back in 2003, 2004, (...) maybe they would have added their weight of voice to the government about how this [the supply augmentation] could be done"* (Interview 20). However, the 'failing' of recycled water can only be explained by looking at the success of the alternative: desalination. The next sections thus trace the diffusion of desalination worldwide and particularly in Australia. For a summary of forms of institutional work regarding wastewater recycling see Table 6.3.

Table 6.3: Institutional work regarding wastewater recycling

Quotes adapted from Lawrence and Suddaby (2006)

Work for recycling	Work against recycling
Constructing normative networks and mobilization of resources: *"Constructing of interorganizational connections through which practices become normatively sanctioned and which form the relevant peer group with respect to compliance, monitoring and evaluation"*, e.g. Urban Water Security Research Alliance 2007 (SEQ), Australian Water Recycling Centre of Excellence 2009, CRC for Water Sensitive Cities	*Political work*: *Direct use of political power to achieve specific goals, e.g.* policy ban for indirect/direct potable reuse, Toowoomba plebiscite, decision not to use water from the recycling scheme in SEQ
Advocacy: *"The mobilization of political and regulatory support through direct and deliberate techniques of social suasion"*, *e.g.* scientific advisory boards as consultants for governments; political campaigns	*Demonizing*: *"Providing for public consumption negative examples that illustrate the normative foundations of an institution"*, e.g. campaign against drinking 'poo-water', 'toilet to tap' metaphor
Changing normative associations: *"Re-making the connections between sets of practices and the moral and cultural foundations for those practices"*, *e.g.* distribution of information, demonstration of technology	*Advocacy*: *"The mobilization of political and regulatory support through direct and deliberate techniques of social suasion"*, *e.g.* political campaigns
Theorizing: *"The development and specification of abstract categories and the elaboration of chains of cause and effect"*, *e.g.* development of fit-for-purpose water categories, concept of water sensitive urban design (WSUD), experimental recycling projects like Rouse Hill, Salisbury	
Political work: *Direct use of political power to achieve specific goals*, e.g. decision to build recycling scheme in SEQ without democratic process	

6.3. Drought-proofing cities: Establishing seawater desalination as panacea against water scarcity

6.3.1. An international perspective

The diffusion of desalination plants across Australia can only be understood if we take a look at the global development of the technology. Since more than 97% of all water on earth is saltwater, the idea of turning it into freshwater has a long global history and ancient roots (Birkett, 1984; Delyannis and Belessiotis, 2010; Glater, 1998). Small scale distillation application can already be found at the end of the 19th century, but the first significant interest in desalination has occurred during the 1930ies in California, supposedly triggered by a severe drought(Delyannis and Belessiotis, 2010). Population growth and industrialization furthermore led to an increasing concern regarding water security, which got attention in the US Congress in the 1940ies and 1950ies. Presidents Truman, Kennedy and Johnson subsequently authorized grants for research programs on desalination. The underlying idea

was clear: *"What we can – and must do – now is to free mankind from nature's tyranny by setting out to produce water when and where we need it at a price we can afford. Desalting is not a dream."* (President Johnson, 1972, cited by(Delyannis and Belessiotis, 2010, p. 207). Research on desalination soon became dominated by a rather small, well connected, global community. The first international symposium took place in 1957 in the US, followed by a European one in Athens in 1962. A journal specifically created to promote research on desalination was launched in 1966. The framing of desalination found in the first editorial has remained highly similar until today:

> *"As lack of usable water in many parts of the world causes increasing concern, more and more people become involved in water desalination. Scientists and engineers, encouraged by Governments and international organizations, have tackled the many challenges presented by the need to make saline water usable at an economically bearable cost."* (Editorial, Desalination 1, 1966, p.3)

Two different technologies for desalinating seawater became prominent: thermal and membrane desalination. Membrane based technologies, such as todays most used reverse osmosis (RO), experienced a significant boost since the 1960, partly due to innovative firms from different industries who discovered the potential of water desalination (Glater, 1998). Between 1995 and 2006, the world wide capacity of desalination doubled, with RO being the most popular technology (see Figure 6.1). Among other things, this can be related to technological improvements and the thereof resulting drop in costs, e.g. a decrease of 80% in energy cost for RO technologies (Shortell and Maggs, 2012; Zhou and Tol, 2005). However, seawater desalination is still significantly more expensive than conventional water provision. According to the Global Water Intelligence (GWI), the biggest market for desalination in 2010 was in Saudi Arabia, followed by the US, the United Arab Emirates and Australia.
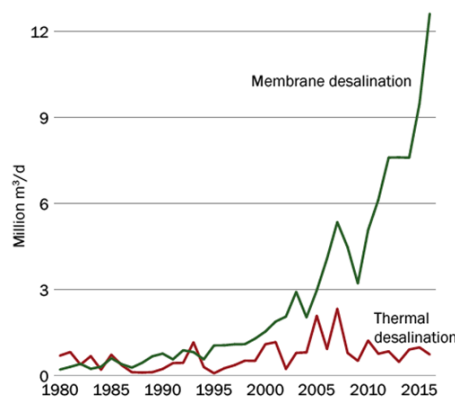
Figure 6.1: Annual new contracted capacity: thermal vs. membrane

(Source: DesalData.com)

Seawater desalination also got attention in reports of the World Bank around 2003 (Interview 8) as well as in highly influential scientific journals: 'Science' featured a special issue on the potential of the technology in 2006, 'Nature' in 2008 and 'National Geographic's' in 2010: "*Desalination Freshens Up: Cheaper materials, more efficient equipment, and some promising new approaches could make large-scale extraction of clean water a major force in the battle against global thirst*" (Service, 2006).

The global diffusion of seawater desalination, however, and especially also the diffusion of RO plants across Australia, can only be fully comprehended if we look at the strategies of actors aimed at framing desalination as the panacea of water scarce regions. By now, expertise on desalination has become a domain of multi-national companies, such as Veolia, Doosan and GE (see Figure 6.2). Especially large-scale desalination projects require a contractual financial security that often only multi-national companies are able to provide (Interview 1). Governments usually invite tenders for the building and operating of desalination plants and contenders are typically consortia consisting of an EPC (engineering, procurement, construction) company, an investment bank as well as further engineering and management consultants (see Table 6.1 for actors involved in Australia's desalination plants). Recently, also accounting firms signaled interest in desalination, such as PricewaterhouseCoopers who started a desalination division: "*I think the world is realizing that water is going to be the one*" (Interview 3). Therefore, these actors can be assumed to have a special interest in bringing desalination to the market, which involves different forms of institutional work.
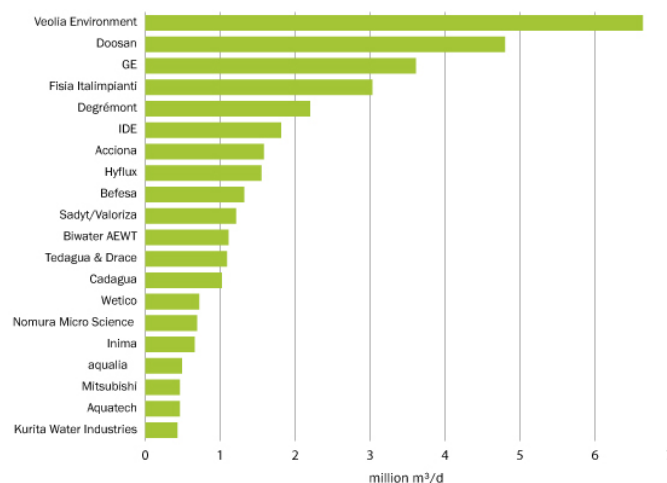
Figure 6.2: Top 20 EPC contractors since 2000

(Source: DesalData.com)

All the multi-national companies, even though competitors, have worked and are working towards the same goal: establishing seawater desalination as the perfect global solution to water scarcity:

> *Seawater accounts for 97% of the water on earth. Since almost 60% of the world's population lives less than 60 km from a maritime coast, seawater is poised to become one of the main alternative resources in those regions in the next several decades. In arid coastal regions, desalination can augment available water resources. It also has the advantage of reducing water dependency on other regions and eliminating the need to import and transport water over long distances.* (Veolia Water, Website)

> *Desalination: Providing access to water for all, while respecting the environment. 40% of the world's population suffers from a lack of fresh water, and this percentage will increase rapidly in the coming years. In large measure, the deficiency affects populations living in coastal areas. This is why desalination is proving to be an important solution. Desalination takes advantage of local resources rather than transporting water over longs distances.* (Degrément, Innovation Guide 2013, p.8)

They work towards this by becoming "desalination's advocates": As the above quotes suggest, they make extensive use of **mimicry**, i.e. associating the technology with existing values and beliefs, such as appealing to the importance of water security for the wellbeing of a country or comparing the technical process of desalination with the natural process of evaporation (Interview 5). Making desalination sound more familiar and genuine leads to the impression that it is the logical way to go. But also issues such as environmental sustainability or social equity are picked up by framing desalination as the only way to provide enough water for everybody without destroying the environment (as opposed to dams or groundwater).

In addition, they are heavily engaged in research and development activities, i.e. **theorizing** about what desalination can and cannot do, where it is appropriate to build plants, which technology to use, how to assess associated risks etc. In general, they build up a certain monopoly situation of scientific expertise. This process gets enhanced by selectively **educating** people that can bring back the knowledge into their home organization. This was also a crucial aspect of the story of desalination in Australia, as one of the most prominent desalination engineers, who first worked for a utility and afterwards for a multi-national EPC company, explains:

> "*So then I got sent to Scotland for a year to go and learn more about desalination at (big EPC). (...) some of our bosses flew across to go and look at that [desal plant in Trinidad], and I would bring in a lot of these experts around the world. (...) So, yes, and then I sort of became a desalination evangelist.*" (Interview 3)

This monopoly situation of expertise thus provides a strong position for **advocacy**, e.g. by lobbying or consulting politicians and utilities. This played a major role in Australia in terms of considering desalination as a solution to the drought:

> *"So if you talk about lobbying I guess there is an information imbalance. So Veolia would be experts in the manufactured water space, and they would understand intimately hopefully, the production cost, the running cost, the technology. Now I'm not sure the government has the same in-depth knowledge. So to some extent, they're kind of beholden too. You know, so if somebody comes along and says here's this magic solution for you and we can solve all your problems, I'm sure that's attractive."* (Interview 22)

> *"We had probably the biggest range of individuals, consultancies, both nationally and internationally here, that we've ever seen. So we had large companies like Veolia, Black and Veatch, all the large consulting firms, GHD, you know, Acom, all here with their experts helping out to do this process."* (Interview 24)

Table 6.4 presents an overview of the institutional work applied by multi-national companies in regard to the institutionalization of desalination.

Table 6.4: Desalination's Advocates: Institutional work by multi-national companies

Quotes adapted from Lawrence and Suddaby (2006)

Type of Institutional Work	Description
Theorizing	*"The development and specification of abstract categories and the elaboration of chains of cause and effect"*, e.g. creating a monopoly of scientific expertise, develop scenarios of global water needs and scarcities, describe the technological efficiency of desalination and develop studies that prove its environmental soundness
Educating	*"The educating of actors in skills and knowledge necessary to support the new institution"*, e.g. education of people around the world in order to run local divisions or distribute knowledge into a utility
Advocacy	*"The mobilization of political and regulatory support through direct and deliberate techniques of social suasion"*, e.g. extensive lobbying and consulting of politicians and utilities
Mimicry	*"Associating new practices with existing sets of taken-for-granted practices, technologies and rules in order to ease adoption"*, e.g. appealing to the importance of water security for drinking water, industry and agriculture, i.e. for the wellbeing of the country

6.3.2. The Australian perspective

Not only the institutional work by multi-national companies fostered the diffusion of desalination in Australia. Looking at annual reports of Australian water utilities, it is evident that desalination was not on the radar of most actors until the drought was qualified as a crisis. In March 2006, for instance, a utility report states that the future strategy foresees the development of a total desalination capacity of 41-55 ML per day starting in 2031 (Gold Coast Waterfuture Strategy, p.12). Later the same year, due to a state intervention, construction started for a plant that delivers 125-167ML per day, potentially providing around 27% of Southeast Queensland's (Brisbane) water supply. How can such a momentous change in strategy happen so quickly? Two arguments are central: 1) There was a lot of institutional work involved to establish desalination as the solution to water scarcity and 2) the uncertainty in relation to the drought led politicians to mimetically adopt a solution that proved to be functional, signaled activity and symbolized control.

Western Australia (Perth) was the first state to decide on augmenting its supply by building a desalination plant. Announced in 2004, the plant was operational in 2006, i.e. long before the states on the eastern seaboard had desalination on their agenda. The data suggests that the reason for this frontrunner role was that the local, public water utility, Water Corporation, and in particular its CEO, Jim Gill, identified that Perth was affected by a declining rainfall pattern and that desalination could be an interesting option:

> "*We actually held a big seminar in 1996 with experts from North America and CSIRO and we realized that the climate was changing and that this could well be a permanent trend and that we better get our skates on. (...) In 1999 we decided to have a closer look at desalination to see if it really was something that would not happen until 2050. (...) We did a deal with a Scottish desalination company, we did a staff exchange (...). We actually produced a report in the year 2000 regarding the prospects of desalination in WA. So that was actually a good study that recalibrated our thinking, made us more aware.*" (Presentation Jim Gill 2012)

This quote shows that there were interactions between the utility and the international level before the decision was made to invest in desalination. Multi-national companies heavily engaged in ***advocacy*** and ***educating*** by organizing workshops and staff exchanges. By the end of 2001, Water Corporation had developed the desalination tender, by mid-2002 they had proposals from international companies that were ready to be implemented (Presentation Jim Gill 2012). As soon as the drought was considered severe enough, they went ahead with the construction of the plant. The CEO of Water Corporation emphasized that the monopoly position of the utility helped to get political influence, i.e to engage in ***advocacy***: "*Political trust, you had to be trusted, that was fundamental. So in July 2004, Geoff Gallop [the premier of WA] and I were talking and I was briefing him on the situation and he said, well Jim, let's*

do it. So there we are, we hit the button on building the Kwinana Desalination Plant." (Presentation Jim Gill 2012)

Besides that, Water Corporation and the politicians agreed that it would be best not to advertise the decision to build desalination in order to avoid a hindering controversy with desalination opponents or the public, i.e. leave out a democratic process (***political work***):

> "*One thing that we did was keep it under wraps. It was being built exactly at the same time like the major railway line and this railway line has been hit by all sorts of industrial strikes and I did not want to happen the same thing here. (...) So what we did is, we kept it out of sight. We did not let any of the media go to it, we did not have a sod turning ceremony, and I actually didn't go to see the thing myself to only a couple of month before we opened.*" (Presentation Jim Gill 2012)

The Kwinana Desalination Plant opened in 2006 and has ever since been an important contribution to the water supply in Perth. Unlike the east coast, Western Australia is still suffering from drought conditions, which is why they decided to build a second desalination plant in 2007. Both decisions have been well received in the public and both plants are still operational.

The story of the desalination plants in the Eastern states, on the other hand, reads differently. Many of them have been heavily criticized by experts and in the media for being an unnecessary, political panic reaction caused by the drought as well as for being environmentally and financially unsustainable (**demonizing**). However, many interviewees mentioned that resistence to desalination was not organized or vocal enough (**advocacy**): "*Somebody could have organized opposition, and there was pockets of opposition, but there wasn't anything systematic. There were people who said, you know, the energy costs, all those issues were raised, but they didn't supervene the actual building of it, as you can see*" (Interview 4).

Some statements even suggested that the drought crisis has been exploited by politicians as an opportunity to legitimize a billion dollar investment into infrastructure that would otherwise never have been politically feasible. In Sydney, for instance, the recommendations of the experts assigned to evaluate the water supply situation for the government have clearly stated that a contingency planning approach would be most efficient that will first explore all other options (e.g. water saving and efficiency measures) and then step by step go in the direction of desalination, i.e. buy the land, call for tenders, get proposals and only if dam levels drop below 30% proceed with building the plant. However, despite these recommendations, the government autonomously decided to build the desalination plant when dam levels were ca. 34%:

"In 2005 the premier retired and a new premier came in and he made an announcement, which said we're going to build a desal plant, drought or no drought. (...) And that changed everything. I mean that's essentially a preemptive build of something which was prior to that considered to be a drought or contingency option." (Interview 12)

Interview statements also suggest that governments were overstrained with the idea of running out of water, which led them to take over power in a very centralized manner, ignore critical voices and quickly decide on a large-scale solution behind closed doors, which altogether is an indicator for extensive **political work**:

"Melbourne ended up agreeing to put in the largest desalination plant in Australia. But there was no public document released to discuss the options, and even today, the reasoning behind it is kept in confidence, so there was no, there was no transparent decision making process" (Interview 16)

"The state government said (...) we need to take charge. So the next thing was a political move (...). They created the Queensland water commission (...) and that's where it all kicked off, so very, very quickly. And I'm talking as fast as we've ever seen. The water restrictions were made consistent, the water grid, that's the new water supply, was designed over a weekend." (Interview 24)

The extreme political relevance of finding a solution to the drought as well as the similarity of the reactions by all the state governments despite the different preconditions indicates that desalination on the east coast became more than a functional, technological solution. Instead, the interviewees often described it as having a symbolic meaning that signaled political activity:

"But at the end of the day, government still want to make a firm decision and they opt to cut a ribbon. A politician doesn't want to gather the public and say, we've done the planning in the prospect of this might happen. A politician wants to gather the public and say here's a problem and I fixed it, we will never have this problem again. There's no rights in saying I'm being sensible." (Interview 7)

"The politicians of the day saw themselves as a bit of a white knight in providing a solution, by building these expensive plant and getting federal money as a subsidy." (Interview 4)

This symbolic dimension indicates that desalination developed into a politically legitimate 'best practice' against the drought independently of local conditions. Data suggests that the diffusion of the technology went from East to West in the form of a 'domino effect', whereby governments on the East Coast imitated the successful story of the West Coast (Perth):

"In a way I think we made the first desalination plant look too easy. (...) The other thing was that the other side of Australia, since 1995, turned to a crisp, they just ran out of water and it was panic all around. They had not planned all that well in my view. But when Alan Carpenter was on TV sipping that glass of water, suddenly the sky was full of planes filled with politicians from the East, asking our people, our politicians, how the

hell did you get one of those in 24 month? So our politicians felt like heroes."
(Presentation Jim Gill 2012)

"Perth was seen as a success story and the other states did try to emulate what had been done in Perth. They got most to the same contractors to come over and advice etc., so yes, we were essentially following that lead." (Interview 10)

This "domino effect" is also visible in the media discourse. Figure 6.3 shows the numbers of articles about desalination in three Australian newspapers. This can be interpreted as a barometer of public interest and importance of desalination. The discussion in the "West Australian" (Perth) started to intensify earlier (already 2002) and had its peak around 2005, while the discourse in the "Sydney Morning Herald" and especially in the federal newspaper "The Australian" started later and can be said to have been more intense (numbers of articles). It reached its high not before 2007. This supports the other results that suggest that the topic of desalination originated in the West and travelled to the East, where it became a more highly debated and thus most likely more political subject. This is also in line with the respective dates of the announcements and beginnings of construction of the different plants (see Table 6.1).
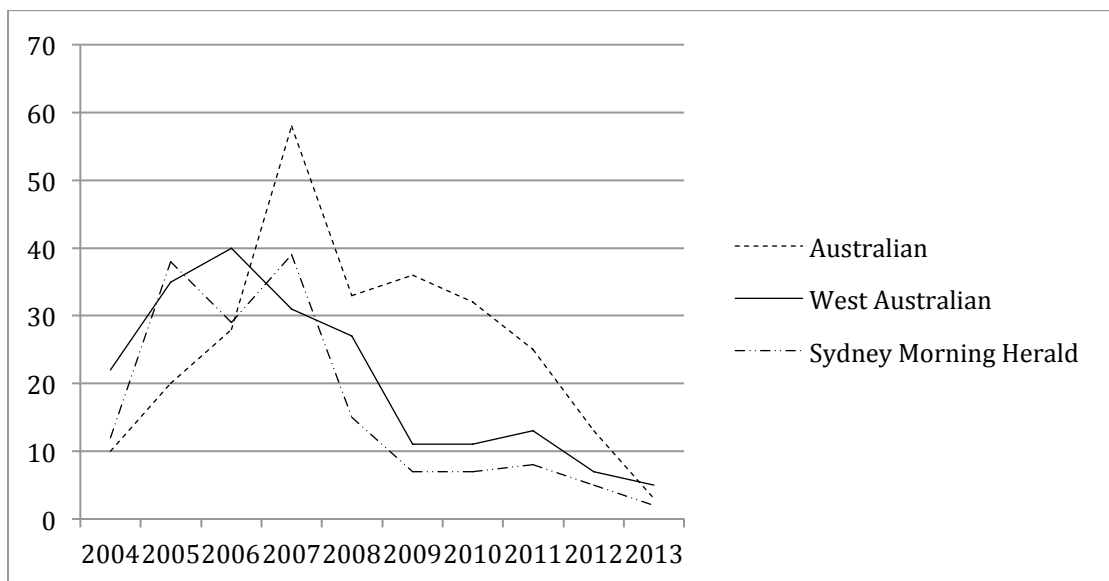
Figure 6.3: Numbers of articles on seawater desalination in three Australian Newspapers 2004-2013

Table 6.5 summarizes the different forms of institutional work regarding desalination in Australia.

Table 6.5: Institutional work regarding seawater desalination

Quotes adapted from Lawrence and Suddaby (2006)

Work for desalination	Work against desalination
Advocacy: "The mobilization of political and regulatory support through direct and deliberate techniques of social suasion", e.g. lobbying by multi-national water companies, but also by farming and mining industries as well as some utilities	*Demonizing: "Providing for public consumption negative examples that illustrate the normative foundations of an institution"*, e.g. NGOs and green parties establish desalination as environmentally problematic and economists as financially unsustainable. Also media coverage rather negative
Political work: Direct use of political power to achieve specific goals, e.g. decision to build desalination plants without democratic process	*Advocacy: "The mobilization of political and regulatory support through direct and deliberate techniques of social suasion", e.g.* expert and consultancy groups that distinctly advised against desalination

6.4. Summary and preliminary discussion of the results

The results of this section shed light on how an extreme event is mediated within a socio-technical system by means of institutional work and how a (technological) solution to such a crisis is developed through an intensive and complex process of social construction as well as mimetic diffusion. The results show that the 'millennium drought' can be characterized as a situation that only due to specific efforts of institutional work by actors slowly grew into a crisis. Until the end, it was highly contested among experts if and how dangerous the event is for the security of water supply and which measures are appropriate for the resolution of the crisis. Some actors were identified that actively contributed to framing the situation as crisis by using scientific knowledge in a favorable way, working with pictures and myths that underpin the severity of the situation, mobilizing political support, raising public awareness by media campaigns, demanding behavioral changes or directly using political power to declare the crisis. Taken together, all these activities suggest that there is a lot of agency going on. The concept of extreme events as external landscape pressures is therefore inaccurate. Instead, also landscape pressures are processed and mediated within a system by being subjected to social agency. In order to understand their effect for system change, they thus need to be conceptualized as socially constructed.

In addition, the study showed that the more the drought was interpreted as a crisis, the more opportunities for institutional work opened up. The scope of legitimate actions was

broadened, suggesting a temporary de-alignment of the regime. The previous focus of utilities on recycling technologies, for instance, was suddenly getting competition by desalination – a technology that was until then not believed to be relevant and viable for Australia until 2030 or even later. The extraordinary crisis situation, however, broadened the accepted search radar for solutions.

However, it was not the technological or functional superiority that made desalination the solution of the drought and secured its diffusion. As the analysis showed, there was a lot of agency involved in making desalination popular as well as recycling problematic. The most crucial actors working on marketing desalination were multi-national companies. They painted a picture of desalination as panacea of water scarce regions worldwide and successfully framed it as the only viable solution. Besides general advocacy, they skillfully used mimicry, i.e. associated desalination with already highly institutionalized values in the water sector: It is a large-scale, technological engineering solution that is climate independent and therefore highly reliable. In the water sector, big and visible technological solutions have always had the allure of getting in control over nature and thus providing security for the people and industries. Desalination can thus be seen as fitting very nicely into this idea and representing a symbol of being in charge. It is much more difficult for a politician to signal control by referring to water efficient toilets or demand management measures than to build something that is visible to everybody. Especially decision makers started to see the attraction of desalination: Water scarcity, one of the worst fears of every country, would not be a concern anymore. This temptation seemed to outweigh the extensive costs and environmental effects associated with it. In short, desalination matches the current structuration of the socio-technical system much better than recycling technologies, which are in many respects more disrupting. Besides its difficult public acceptance, recycling also needs many new regulations to secure health risks or to determine the access to and ownership of wastewater.

Furthermore, after Perth showed that implementing a desalination plant was feasible, technically and politically, the implementation of plants quickly spread across the country. The similarity of the reactions by all the state governments despite the different preconditions suggests that the implementation of desalination became a legitimate 'best practice' that promised political success. Whereas Perth can be interpreted as taking up the role of a desalination leader in Australia, the diffusion of the technology on the East coast is rather the result of imitation. In some jurisdictions, such as Brisbane, desalination can be seen as a last political resort to signal control during the high uncertainties caused by the severe drought conditions in the area. In other states, such as Victoria, the investment in desalination could also be interpreted as having jumped on the bandwagon by intentionally capitalizing on the

political uncertainties of the crisis that legitimated the investment into a technology that would have otherwise never been possible.

In sum, the development of Australian urban water sector during this time can be summarized as follows. Processes of institutional work contributed to the creation of a system crisis as well as to the development of a technological solution to resolve it. The better structural fit of desalination compared to recycling as well as processes of mimetic isomorphism then promoted its diffusion throughout the field.

The interpretation of the meaning of the diffusion of this new technology in regard to a socio-technical transition of the system is to date still ambivalent. What can be said at the moment, however, is that it does not necessarily contribute to a change in the direction of a transition. On the contrary, in might also lead to an entrenchment of the current system structures. Since the drought on the east coast broke in 2010, the desalination plants were rendered obsolete until at least the next 'millennium drought', that might never come. The billion dollar investment thus gives the appearance of having been unnecessary, which has reinforced the public feeling of a political failure. 'White elephant' has become the media's favorite term to describe desalination, thereby pushing the notion of desalination being too expensive and of no use. The proponents, however, think that desalination contributed to finally breaking out of the recurring cycle of droughts by being able to count on desalination as an insurance against water restrictions: "*When I grew up, a Volkswagen was a cheap car, and a BMW was an expensive car. It's a bit more complicated these days, but you had a Volkswagen, now you've got a BMW, someone has to pay for it, but you don't have the same water system that we had before the drought.*" (Interview 1) While it may be true that desalination changed the severity of drought situations for the water sector, it did not change the underlying socio-technical regime. Instead, the data suggests that it even contributed to its entrenchment. First, the heavy financial investments alone will have an effect on future actions. Some interviewees suggested that opportunities for research around alternative technologies for water supply, such as recycling or stormwater, has dropped significantly (Interview 10, 12, 17, 19, 20). The financial debt caused by desalination is remarkable, not enabling any other investments for the next years (Interview 10, 11, 15). Secondly, it is generally questionable if there will be a need for alternative technologies at all, since desalination represents an abundant source of water. Furthermore, it highly supports the central values of traditional water sector regimes: water security and reliability, big engineering solutions and not much concern with environmental and economic issues. In that way, desalination has become a material and financial reality that will most likely influence the future transformation pathway of the system. The features of desalination technology indicate that the diffusion of the plants will however rather support a revival and entrenchment of highly traditional structures and can

therefore be seen as a backlash for a transition of the sector towards more sustainability (see also (Keath and Brown, 2008). Landscape pressures are always mediated and interpreted within the socio-technical system. Processes such as institutional work or mimesis will determine and regulate the degree of reconfiguration of the system. Depending on these processes, a system will re-align either into the traditional, highly institutionalized regime or move towards a more sustainable socio-technical configuration. The case of desalination in Australia suggests that the re-alignment not only led to the maintenance of the system, but rather an entrenchment of the highly institutionalized socio-technical regime.


Excursus 1: Interaction between structure and agency: Sustainable desalination plants

The development of 'sustainable' desalination plants is a good example to interlink the two empirical studies and show the effects of the interaction between structure and agency. While the diffusion of desalination plants in Australia has clearly been advanced by a wide range of institutional work, the technology itself can also be seen as a better fit with the current structuration of the field: Desalination is a large-scale engineering solution that secures water availability and fulfills water quality ideas (e.g. not based on waste water). The diffusion can therefore be interpreted as an outcome of both, structural and agentive aspects. Another aspect of that interrelation can be seen as coming out of the institutional plurality present in the field. The design of the plants in Australia differs from plants in the Middle East, for instance. Since environmental sustainability is a much bigger value in Australia, actors addressed corresponding issues, e.g. environmental regulations and testing, provide renewable energy via wind farms or invest in sustainability measures. Besides leading to adjustments in the design of the plants, these efforts also resulted in a much higher price for the construction of the plants. The institutional plurality present in Australia's water sector has thus led to very particular Australian desalination plants.

Excursus 2: Interaction between structure and agency: Creation of water markets

The creation of water markets is another example of the interaction of structure and agency. Judging from the annual market value of water traded, Australia has become one of the world's largest water markets. However, the importance of water trade compared to other forms of water exchange is still marginal. There are a range of structures that are seen to be a prerequisites for water markets, e.g. regulating water as an economic good, feasible property rights (water entitlements), existence of legitimate sellers (e.g. farmers) and buyers (e.g. municipalities) or water prices. But these structures also need to be created. As the analysis of the public inquiry showed, economists play a pivotal role in pushing the introduction of water markets by framing the discourse and thus providing the intellectual backbone of the institutionalization of the market logic within the water sector. The creation of markets can thus only be understood by looking at both, structures as well as agency processes.
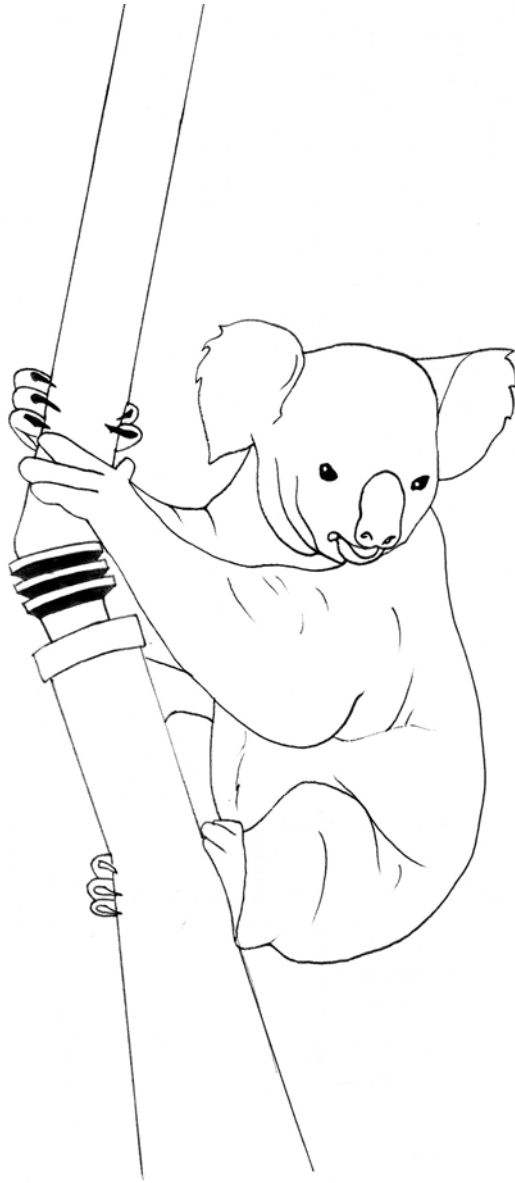
DISCUSSION

7. Discussion

The empirical analyses have shown how some of the central aspects of the analytical framework of this thesis can be applied empirically and to what extent they are able to depict and explain a socio-technical transformation of a specific infrastructure sector. Analysis one has focused on the reconstruction of the structuration of the Australian urban water sector by assessing the institutional logics within the field and their degree of institutionalization over time. A close-up on the current semi-coherent structuration revealed the institutional plurality within the field and thus potential contradictions that can be interpreted as specific sources for institutional change. Analysis two subsequently presented different forms of institutional work in regard to the creation of a system crisis as well as the (non-) diffusion of certain emerging technologies. The variety of institutional work that actors may apply in order to change or maintain their institutional setting has thereby been outlined. The present chapter will now discuss the combination of these results on a broader level, in particular in regard to the transformation of the Australian urban water sector over time as well as in terms of insights gained to address socio-technical transitions in general.

7.1. Transformation of the Australian urban water sector from a dynamic perspective

Based on both empirical studies and in line with the dynamic model of socio-technical change developed in the analytical framework, the transformation of the Australian urban water sector since the 1970ies can be described in two distinct phases. The first phase of transformation has occurred from ca. 1970-2000 and can be interpreted as a combination of the ideal type pathways 'exogenous transformation' and 'endogenous transformation'. On the one hand, the rise of new societal institutional logics, such as the market and corporation logic as well as the notion of sustainability, have offered new rationalities and generated constant pressures for all economic sectors to transform in a certain direction (e.g. environmental sustainability and economic efficiency). Although water sectors have rather slowly picked up these new rationalities, the institutional plurality in the field still increased. Especially central actors such as utilities were gradually forced to include certain principles in order to stay legitimate. This institutional plurality gave way to new ideas and a new thinking of urban water management. Actors thus started to put a lot of work into the translation of general principles such as environmental sustainability and economic efficiency to water sector specific models, theories, strategies, norms or linguistic terms. The concept of water sensitive cities, fit-for-purpose water quality categories, livability as a new value, price demand management strategies or water markets have been developed in a constant struggle

between known and new rationalities. At the same time, technological innovation has brought about new opportunities for water treatment. The process of reverse osmosis, for instance, has provided considerable improvements in water recycling. Under the influence of the new rationalities, these developments were seen as opportunities to replace the questionable reliability on dams and instead promote an integrated water management approach that improves ecosystem health. This way, the Australian urban water sector underwent a gradual transformation towards a regime that was increasingly based on the Water Sensitive and Water Market Logic, slowly replacing the Hydraulic paradigm. By the millennium, the structuration of the regime had decreased considerably, making room for the emerging logics (see Figure 7.1).

However, around 2000, the drought periods prolonged and uncertainty regarding their duration and effect on water security increased. This exogenous influence is interpreted as having triggered phase two of the transformation, which closely resembles the ideal type pathway 'exogenous and endogenous reinforcement'. For a few years, the drought was generally not seen as anything unusual, but rather as part of the typical Australian weather. Utility managers, scientists or advisory committees believed that increasing water efficiency measures, water restrictions and recycling water for non-potable reuse will suffice to get Australia through the drought. However, some out crying voices soon began to stoke fears among the community, politicians and many water sector experts that this strategy will not secure water supply. These voices quickly united and proved to apply institutional work in a highly effective manner. The controversy soon developed into a crisis and spurred uncertainties. This subsequently opened up a window of opportunity for agency and change: Everything seemed possible again, nothing was per se considered illegitimate. For instance, emerging technologies that have until then not been considered at all due to their high costs and questionable environmental sustainability, such as desalination, suddenly became a viable option. Hence, the battle between the different approaches to water management started and as the results have shown, the proponents of desalination won.

The fast implementation of desalination technology had major consequences for the structuration of the regime. Since the features of desalination are highly compatible with the Hydraulic Logic principles, it can be interpreted as strengthening them while at the same time weaken the alternatives. The material substantiation of these principles in the form of desalination technology can thus be interpreted as a very effective form of institutional maintenance. As a result, the structuration of the sector in 2010 is seen to have increased again, forming again around a Hydraulic regime (see Figure 7.1). The extreme event has thus opened up an opportunity to reverse the previous transformation of the sector by re-establishing the traditional rationality.

Figure 7.2 depicts the transformation of the Australian urban water sector with a specific focus on its structuration over time. It shows how exogenous influences, such as the rise of new societal institutional logics, emerging technologies or extreme events increased institutional plurality and created windows of opportunity for institutional work. While from 1970-2000 this institutional work was aimed at institutionalizing the coherence of new field logics and thus decreasing the degree of structuration within the field, the institutional work around the time of the crisis has been aimed at maintaining the prevailing hydraulic logic and decreasing the legitimacy of alternatives. The diffusion of desalination has ultimately contributed to that goal, leading to an entrenchment of the hydraulic logic.
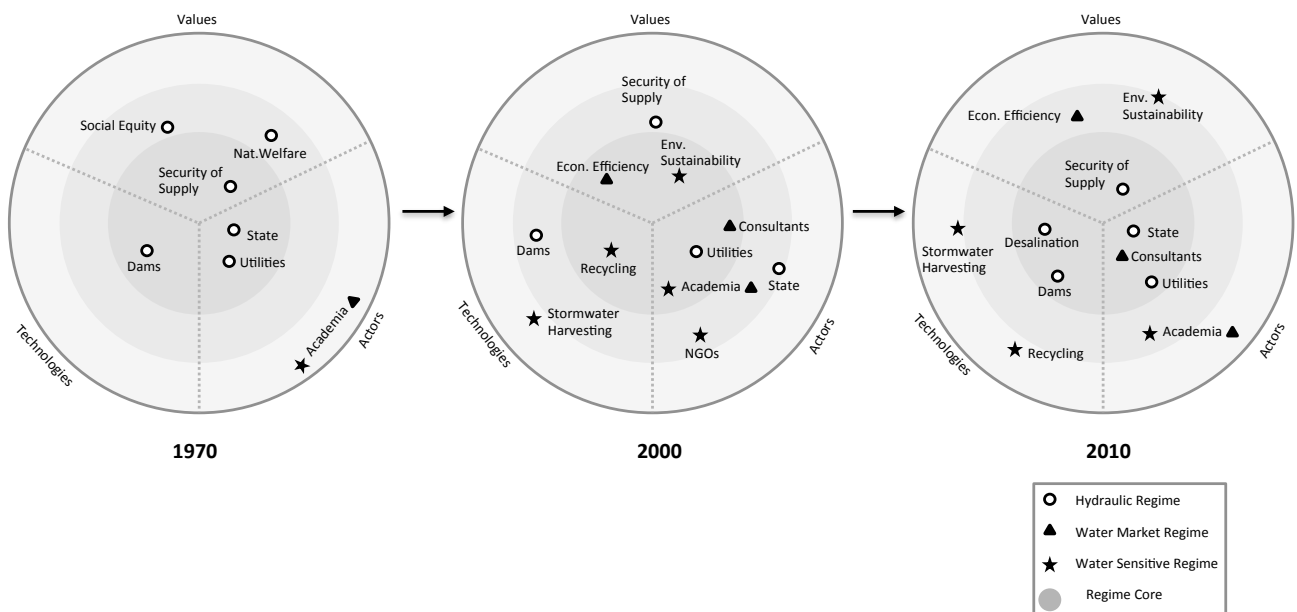
Figure 7.1: The structuration of the Australian urban water sector at three specific times

In 1970 there is a high degree of structuration based on the Hydraulic Logic. Due to the rise of new societal institutional logics, i.e. institutional plurality, as well as thereby resulting institutional work aimed at the institutionalization of alternative logics, a shift towards a more Water Market and Water Sensitive regime can be observed. Until 2010, however, as a combination of the drought, the diffusion of desalination and institutional maintenance work, a shift back to a Hydraulic regime has happened.
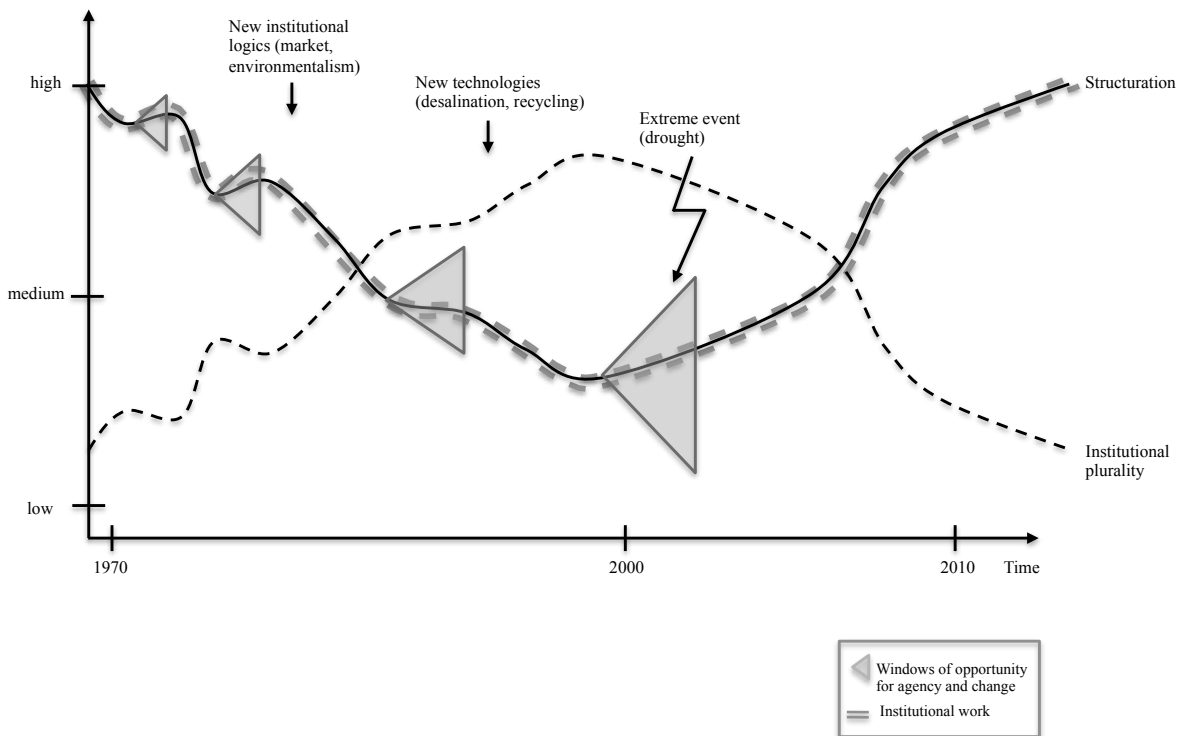
Figure 7.2: The structuration of the Australian urban water sector over time

Exogenous influences, such as the rise of new societal institutional logics, emerging technologies or extreme events increase institutional plurality and create windows of opportunity for institutional work. While from 1970-2000 this institutional work was aimed at institutionalizing the coherence of new field logics and thus decrease the overall structuration of the field, the institutional work around the time of the crisis has been aimed at maintaining the prevailing hydraulic logic and decreasing the legitimacy of alternatives. The diffusion of desalination has ultimately contributed to that goal, leading to an entrenchment of the hydraulic logic.

7.2. A dynamic approach to socio-technical change

Taking into account the results of both empirical analyses, the duality of structures as socially constructed on the one hand and highly structuring on the other, becomes clearly visible. This will be illustrated in more detail along the lines of the analytical framework.

7.2.1. Intrasystem dynamics

It was shown how agency within a field is highly dependent on the structuration of the system. Agency leading to system change is particularly dependent on the availability of alternative rationalities. The first phase of system transformation has been related to broader

societal changes, i.e. the rise of new institutional logics. These logics provided alternative rationalities for water management, along which the new field logics were formed. The range, direction and aim of all agency observed in the empirical studies has clearly been influenced by the available institutional logics. The concrete translation of broad societal principles into the water sector has been achieved through a mediation and mitigation of all the contradictions present in the system. The elaboration and implementation of norms, rules, regulations, strategies or technologies is seen as a result of the actual semi-coherence of the system. It is this process of negotiation, this reconciliation of different principles, that ultimately bears the opportunity for innovation. An example thereof is the development of 'sustainable desalination plants'. Compared to other countries, such as Israel or Saudi Arabia, Australia's desalination plants have cost much more due to the integration of various sustainability measures, such as additional environmental protection devices or renewable wind farms. Since the value of environmental sustainability has achieved a considerable degree of legitimacy in the sector, also the building of the desalination plants had to account for it, at least to a certain degree, in order to be legitimate at all. Although many environmentalists still consider desalination to be unsustainable, the effort that has been put into the integration of environmental concerns in the building process increased the sustainability of the Australian desalination plants. Another example is the introduction of new water pricing schemes by utilities. Since they have been corporatized, i.e. profit-oriented, prices for water service provision have increased. However, NGOs have taken up the role of defending water as a public good and counteracting the privatization of water services. As a consequence, all the pricing schemes from the utilities include some kind of 'hardship' or 'social' pricing models and support schemes for people that cannot afford the new prices. In that sense, a compromise was established between social equity and profit orientation. Along these lines, institutional plurality is expected to further lead to gradual transformations of structures within a socio-technical system.

Furthermore, the results have shown that an additional type of internal dynamic is crucial in regard to socio-technical change: processes of isomorphism. Particularly mimesis, i.e. diffusion of by imitation. High uncertainties within a field, e.g. due to a crisis or extensive institutional plurality, typically causes mimetic isomorphism (Boxenbaum and Jonsson, 2008). The lack of clear expectations or cause-effect-relations leads actors to watch each other and imitate the ones that are perceived to be successful or important. Solutions that are seen as legitimate thus achieve a 'best practice' status and diffuse quickly across a field, not because they are more efficient, but because they signal activity and symbolize success, appropriateness and rationality (Haveman, 1993). Imitation is thus a way of conforming with a structural environment in order to increase legitimacy. This has in particular consequences

for the diffusion of certain technologies within a system as well as for the process of re-alignment and structuration. The bigger the scope of diffusion of a technology, for instance, the faster a system will re-align and increase the degree of structuration again. This has been the case with the diffusion of desalination in Australia, which can be interpreted as having caused a re-stabilization of the system along the lines of the Hydraulic Logic.

7.2.2. Interplay of exogenous and endogenous events and processes

Both empirical analyses have shown that exogenous events and processes, such as the rise of new societal institutional logics or an extreme event, are constantly in interaction with endogenous processes, such as institutional work. The first analysis illustrates how a shift in the prevailing field logic is based on the promotion of different institutional logics on a societal level. These rationalities contribute to an institutional plurality in the field that ultimately reinforces windows of opportunity for agency. On the other hand, analysis two shows that all types of exogenous influences are subject to intrasystem dynamics. Institutional work may hinder or foster the diffusion of alternative rationalities. Within the Australian urban water sector, a crucial reason for the advancement of liberalization lies not only in the rise of the market logic, but also in the purposive work of a few consultants that have already been engaged heavily in the privatization of the electricity sector. Their declared goal is to induce a similar shift in the water sector. However, resistance has been shown to be stronger than in the electricity sector and also more effective. This is party due to water being the more sensible resource in regard to quality and sources of origin. Therefore, the privatization has not yet achieved wide implementation. Analysis two has furthermore illustrated that the uncertainty caused by an extreme event fosters internal processes of mimetic isomorphism that in reverse may accelerate the re-alignment of a system around a certain institutional logic. Overall, socio-technical change, i.e. a shift in institutional field logics, is thus often unfolding as a recurrent interplay of external events and internal dynamics.

7.2.3. Technological diffusion and niche dynamics

The emergence and diffusion of a technology is an additional account of how the duality of structure comes into play. While analysis two has reconstructed the different kinds of institutional work that were involved in establishing desalination as panacea against water scarcity, analysis one and some of the discussion hinted at the better fit of desalination with the current structuration of the system. The analysis of the fit of an emerging technology with its structural environment is thus crucial to assess the disruptive potential of a technology, i.e. identify technological niches.

Technology is seen as a structural element of an institutional logic. An institutional logic develops in relation to material structures, especially technologies, around it. In the water sector, for instance, dams became the dominant technology to fulfill functions like drinking water provision, flood control or energy generation. But the technology did not just fulfill a function, it also coined and shaped these functions in the first place. Only because the dam is a large-scale technology that enables the generation of electricity or the storing of water in huge amounts, values such as water reliability or missions like energy production developed. In short, the technology shapes the institutional environment and the other way around.

The emergence and diffusion of a new technology thus ultimately affects the structuration of a system. Its diffusion will rely on a combination of the institutional work aimed at fostering it and its institutional fit with the structural environment. Some technologies bring about a greater disruptive or transformative capacity than others, because they are based on a different configuration of elements, e.g. new actors, new expertise, new user capabilities or new governance modes. As Smith and Raven elaborate (2012), some technologies, i.e. niches, have the ability to 'fit and conform' with the incumbent logic of a field and others tend to rather 'stretch and transform' the field, which is why their diffusion is more difficult. In regard to the Australian urban water sector, four technologies can be mirrored with the existing structuration of the field (using the structural map developed in Figure 5.2) and conclusions regarding their potential to break through can be drawn.

Dams: Dams have been and still are the prime technology in the water sector. They are part of the Hydraulic Logic, emphasizing security of supply through large-scale engineering solutions. In addition, they stand for national development and progress and thus symbolize political activity. When the economic and environmental discourses hit the water sector, the dam was the first thing to be criticized, especially regarding a lack of environmental sustainability. As a consequence, the construction of new dams has become rather unlikely. But since the 'millennium drought', which was followed by heavy floods, the call for more dams has been heard again. Overall, the dam still fits the most central elements of the current structuration and thus remains, despite criticism, a valid option.

Desalination: Desalination has become very popular during the drought, because it suggests the infinity of water supply. This argument was so strong that it survived all the criticism in other areas, such as water quality, economic efficiency, environmental sustainability or social equity. Desalination brings some disruptions, e.g. the involvement of new actors like multi-national water firms, investment banks or consultancies or the lack of expertise to operate and maintain the plants. In some cases, desalination plants are furthermore operated separately from the utility, which means that the supply chain needs to be rearranged. However, in sum,

desalination plants fit with the regime core of the current institutional structure very well and only cause manageable conflicts.

Wastewater recycling: Recycling can be done large-scale or small-scale and Australia is using both variants. Either way, recycling shows some good matches with the structuration, but also very problematic features. A good fit is achieved regarding environmental sustainability, especially in terms of the idea of water conservation and ecosystem health. Water quality, however, in particular regarding health and safety issues, causes major frictions with the current structuration: public perception is bad and policy bans for direct/indirect potable reuse have been launched in many states. The distrust regarding water quality furthermore requires an extensive regulatory framework, since public authorities fear a potential contamination scandal. Recycling is thus not yet regarded as a source of drinking water, which lowers its performance in terms of security of supply. A further challenge concerns the supply chain: who 'owns' wastewater and who is allowed to treat it and make a business out of it? In some states, first attempts of third party access have failed. Still, academia advances the knowledge about recycling technologies and many firms are interested in delivering technologies and services. Overall, recycling schemes have a positive fit with the Water Sensitive Logic, but cause various frictions in regard to the Hydraulic Logic.

Stormwater harvesting: Stormwater harvesting, a particular form of water reuse, has certain problematic features similar to recycling, especially water quality distrust. Since all of the projects are rather small-scale, water reliability is often criticized. Most experts do not yet see the technology as contributing to drinking water supply, but the recognition for it seems to be growing. After all, the potential is huge, since Australia loses a lot of water in rainy periods because it cannot be captured successfully. Regarding environmental sustainability, this technology represents one of the biggest hopes, because it aims at saving drinking water, at the reticulation of waterways and at increasing the livability and amenity in cities in general (since the water is often harvested through specially prepared lawns or parks). Many projects are furthermore community based, which ensures stakeholder involvement and thus more social equity. However, stormwater harvesting is nevertheless the most disruptive technology of the ones discussed in this section. The most transformative feature is that most these schemes are usually decentralized, i.e. they are not part of the centralized networks that dominate the current system. Hence, many aspects of the socio-technical configuration are still highly uncertain, such as how to regulate these schemes (e.g. ownership, maintenance work, responsibilities), how to finance them (e.g. private or public), whether they are economically feasible over time or whether anybody in the water utilities has the expertise to evaluate or lead such projects. This is true for all decentralized water technologies, as research on so called on-site water treatment schemes shows (Binz et al., 2012; Moglia et al.,

2011). Decentralized stormwater harvesting may thus offset some of the most deeply sedimented existing structures and beliefs, which is why it can be classified as an ideal typical niche.

Niches can thus be conceptualized as socio-technical configurations that are based on alternative institutional logics. The higher their disruptive capacity, the more difficult their diffusion. The disruptive capacity can be assessed by comparing their socio-technical configuration to the existing structuration of a system.

Table 7.1 gives an overview of the fit of technologies with the current system structuration discussed above. Such an analysis contributes to the evaluation of potential disruption caused by the diffusion of a technology. Transformation of the system can be assumed to be highest if stormwater harvesting technologies diffuse, since that will at the same time attract the advancement of corresponding values, missions, expertise or organizational forms. However, the diffusion of the technology will depend on the interplay of internal and external events and processes as well as structural conditions and agency. A good illustration of such a process is the decision of Queensland to implement a large-scale recycling plant during the drought. As shown in the results, the range for legitimate actions opened up and made the political decision for recycling possible. However, the pressure of the crisis was soon relieved due to heavy rainfalls and the resistance towards drinking recycling water had taken the upper hand again. The new premier thus decided not to put the recycled water into the dam. Many experts believe that if that step had been taken, the diffusion of wastewater recycling schemes instead of desalination plants could have been realistic. It can be assumed that the diffusion of recycling schemes would have considerably altered the structuration of the system, since the associated socio-technical configuration would have been developed and institutionalized simultaneously, thus replacing previous constellations.

Table 7.1: Fit of technologies with current system structuration

Technology/ Structures	Dams	Desalination	Wastewater Recycling	Stormwater Harvesting
Org.form	+++	++	--	---
Values	++	++	+	--
Mission	+++	+++	+	---
Actors	+++	++	+/-	---
Expertise	+++	++	-	---
Funding	+++	++	+	+/-

7.2.4. Transition pathways

The dynamic approach towards socio-technical change developed in this thesis enabled a reconstruction of the transition pathway of the Australian urban water sector that is based on the interplay of structure and agency as well as internal and external interactions. By focusing on this interplay, a less deterministic presentation of a transition pathway has been achieved. The analysis of the semi-coherence of structures coupled with the notion of institutional work gave way to an elaboration of socio-technical transition that finds a balance between structure and agency and in so doing enables a more process and practice oriented analysis. This fosters the analysis of the heterogeneity of socio-technical systems and its meaning for change.

The typology of transition pathways developed in the realm of the MLP (Geels and Schot, 2007) can now be reinterpreted within the framework of this thesis. The MLP characterizes transition pathways as results from the interaction of landscape pressures and niche innovations on regimes. While this constitutes a helpful heuristic for socio-technical change, it lacks a theoretical conceptualization of these interactions. This can mainly be interpreted as a consequence of the deficits regarding the conceptualization of the 'levels', in particular a representation of regime structures as too homogenous and a neglect of processes of agency. As a result, it is rather unclear what landscape pressures are and how they act on a socio-technical system; or how niches become institutionalized and in what way their diffusion affects a regime; and how both of these influences are ultimately mediated within the socio-technical system.

Drawing on the insights of this thesis, these shortcomings can now be addressed. For the purpose of illustration, the 'de-alignment and re-alignment pathway' of the MLP will be reformulated as follows.

The original definition of the pathway is as follows:

> *"If landscape change is divergent, large and sudden ('avalanche change'), then increasing regime problems may cause regime actors to lose faith. This leads to de-alignment and erosion of the regime. If niche-innovations are* not *sufficiently developed, then there is no clear substitute. This creates space for the emergence of* multiple *niche-innovations that co-exist and compete for attention and resources. Eventually, one niche-innovation becomes dominant, forming the core for re-alignment of a new regime"* (Geels and Schot, 2007, p. 408).

First, it needs to be acknowledged that the power of landscape pressures, i.e. the meaning of an extreme event, is not objectively given, but highly socially constructed. Therefore, it is crucial to analyze how an exogenous event is mediated within a socio-technical system. Institutional work may or may not successfully frame an event as extraordinary. To understand why and how certain events facilitate change while others do not, it is thus necessary to study intrasystem dynamics. As shown in the case of Australia, the drought only slowly, but highly purposefully, developed into a crisis.

Second, a crisis, if successfully constructed, usually challenges the functionality and appropriateness of current system structures, which increases the legitimacy of alternatives. This advancement of institutional plurality then leads to a decrease in system structuration that opens up opportunities for agency, i.e. institutional work that is aimed at creating solutions to the problem. This thus might be an opportunity for emerging technologies to break through. However, the degree of institutionalization and coherence of an alternative socio-technical configuration may vary. Furthermore, it is not just a question of if a technological niche is ready to break through. This break through is highly dependent on the institutional work applied in order to foster or hinder it. In addition, the potential disruption by a niche relies on its fit with the current socio-technical structuration of the system. This fit can only be determined through an analysis of the semi-coherent structuration as shown in Figure 5.2.

Third, this analysis of the semi-coherent structuration of a system furthermore enables insights into the internal regime dynamics. How landscape pressures or niche developments progress is influenced by regime dynamics. Furthermore, the semi-coherence of a regime reveals accounts of institutional contradictions that can be interpreted as providing opportunities for change that are entirely based on internal dynamics.

Forth, the re-alignment process after a crisis might be accelerated by mimetic isomorphism. Since a system crisis typically increases uncertainty among actors, imitation processes can be central. Actors tend to imitate others that are considered to be leaders. Copying those "best practice models" and thereby signaling appropriateness and legitimacy is a way for actors to deal with the complex nature of uncertainties and reduce some of its complexity. However, this re-alignment process (creation and diffusion of a solution) does not necessarily bring about a new socio-technical configuration. Depending on the nature of the solution, i.e. the disruptive capacity of the technological niche that diffuses, the re-alignment might as well result in the re-institutionalization of previous structures. The idea that a crisis or extreme event automatically leads to change is thus challenged. It is instead maintained that a crisis mainly increases the opportunities for institutional work, which subsequently may or may not enable change.

Figure 7.3 graphically represents the reinterpretation of this transition pathway.
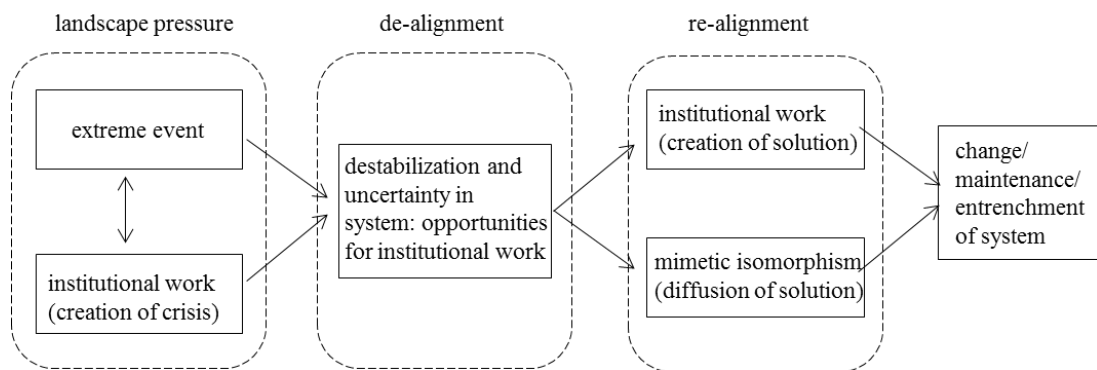
Figure 7.3: De-alignment and re-alignment transition pathway from a process perspective

CONCLUSION

8. Conclusion

This thesis has addressed the challenge of societal transitions towards sustainability. Many of the 'grand challenges' and persistent problems of today are related to unsustainable consumption and production processes, many of which concern infrastructure sectors. Introducing changes in utility sectors has however proven to be difficult. One of the main reasons therefore is the high interdependence of social and technological structures, which makes these sectors path-dependent and inert. Research has shown that only a systemic approach towards innovation and change, which accounts for socio-technical change, is likely to contribute to the understanding of a societal transition towards sustainability. The research of this thesis originated from the ambition to contribute to the advancement of the conceptualization of socio-technical change in order to further develop the notion of sustainability transitions. To that end, three particular research questions had been developed based on the state of the art of the current literature.

8.1. Answering the research questions

The first research question asked: *How can structures and their degree of structuration within socio-technical systems be conceptualized?*

This thesis presented a conceptual foundation for the operationalization and empirical assessment of the structuration of socio-technical systems with a special focus on the socio-technical regime. Literature on institutionalization showed that 'levels of structuration' can be conceptualized as degrees of institutionalization and the institutional logics concept is suited to analyze the specific content and coherence of structures in a socio-technical system. By introducing insights from institutional theory, a deeper understanding of the nature of structures, how they become established and to what extent the different degrees of institutionalization influence the perception and behavior of actors and the diffusion of practices has been provided. The empirical study of the Australian urban water sector furthermore demonstrated how structures and degrees of institutionalization can be identified in a certain field using qualitative methods. The analysis painted a detailed picture on which institutional field logics are dominant and which ones are emerging in the urban water management sector. It therefore allowed the identification of a socio-technical regime, which is heterogeneous and 'semi-coherent'.

The second research question asked: *How can agency within highly structured socio-technical systems be conceptualized?*

The thesis contributed to the micro-foundation of socio-technical transitions by introducing the concept of institutional work. Institutional work is a practice and process oriented approach towards agency that sheds lights on the actual actions taken by actors in order to shape their structural environment. Agency is thus understood as embedded within an institutional setting. A conceptualization of agency within socio-technical systems as 'embedded agency' in the form of institutional work was particularly suitable for the analysis of transitions because it emphasizes the interrelations between structures, such as the regime, and purposive actions. It thereby not only supported the notion of the 'duality of structure' that has been central in transition thinking, but also contributed to its reformulation in a way that allowed a thorough operationalization and thus empirical application.

The third question was aimed at evaluating the implications of the results above: *How do socio-technical structures and processes of agency affect change within socio-technical systems?*

In order to answer this question, this thesis developed a dynamic model of socio-technical change that accounts for both, structures and agency. The model was applied to the study of transformation processes in the Australian urban water sector. This research generated insights into how structures and agency as well as their interaction influence change in socio-technical systems. First, structures and their degree of structuration influenced the potential and direction of change within the system. The higher the system's structuration, the less likely radical change becomes. The lower its structuration, i.e. the higher institutional plurality or uncertainty within the field, the more likely transformative change occured. Institutional contradictions thereby represented a source for innovation and change by offering different rationalities to actors that could translate into innovations. The analysis of the semi-coherence of a system was thus crucial to understand the 'rules of the game' of the system and detect its potential for change.

On the other hand, the research revealed the many ways actors purposefully shaped the structuration of the system. The different forms of institutional work aimed at the creation, maintenance or disruption of structures constantly shifted the structuration of the field and thus the potential for socio-technical change. Extreme events, emerging technologies or cultural changes (i.e. new societal institutional logics) have constantly been mediated within the socio-technical system. Whether they contributed to system change or not was thus highly dependent on what meaning actors attached to them. As a consequence of both insights, this thesis has conceptualized socio-technical change as interplay between the semi-coherent

structuration of a system and institutional work as well as between internal and external events and processes.

8.2. The contribution of this thesis

This thesis is seen as a contribution to the bigger current dialogue in sociology on 'innovation society' or 'knowledge society', where science and technology are assumed to built the foundation of today's society (e.g. Drucker, 1993). The study of socio-technical change can therefore be interpreted as a contribution to the general analysis of contemporary society. The thesis not only depicted the inherent socio-technical nature of a particular societal sector to date, but also explicated how important the focus on science and technology is for the study of transformation. The contribution of science and technology studies thus not only lies in providing a reflection on the state of the 'knowledge society' and the role of science and technology in it, but increasingly offers theories and methods to analyze specific effects of the interaction of science, technology and society and suggests potential strategies or interferences to deal with these effects. The study of socio-technical change can thus be seen as a cornerstone of contemporary sociology.

The particular contribution of this thesis lies in the development of an analytical model for sectoral transformations, which is based on a dynamic understanding of socio-technical change that accounts for the diversity of socio-technical structures as well as embedded agency. In so doing, specific contributions to research on sustainability transition and institutional theory have been made. In addition, some practical implications can be derived from the empirical study of the Australian urban water sector.

8.2.1. Contributions to research on sustainability transitions

By introducing insights from institutional theory, this thesis has contributed to research on sustainability transitions by re-conceptualizing transitions as processes of institutional change with a particular awareness for technological specificities. This 'institutional turn' in the study of socio-technical change has sharpened and refined various analytical concepts of transition research and addressed many scholarly criticisms. First, the conceptualization of socio-technical system structures as institutional logics has enabled a representation of the regime as semi-coherent and heterogeneous, which accounted for important institutional contradictions and tensions within a system. In so doing, it presented a highly elaborated picture of 'levels of structuration' that goes beyond a focus of path-dependency and inertia. The strength of a socio-technical regime can now be evaluated more thoroughly.

Second, since the concept of institutional logics is based on the idea that institutional logics on the societal level get reconfigured in organizational fields, it improved the conceptualization of institutional landscape pressures and clarified the relationship between broader institutional environments and a socio-technical system.

Third, the assessment of the structuration of a socio-technical system via institutional field logics allowed the identification of technological niches. Since the content and coherence of structures is explicitly spelled out, it is possible to detect mismatches or frictions of a niche with the prevailing system structuration and thereby assess the degree and direction of its transformative capacity.

Forth, the dynamic understanding of socio-technical change based on the notion of embedded agency as institutional work enabled a clear explication of intrasystem processes. Change is thereby envisioned to unfold through different forms of institutional work that are triggered by institutional plurality. System transformation thus no longer relies exclusively on extreme events or the breakthrough of niches.

Fifth, the interaction between endogenous and exogenous events and processes has been refined. The concept of institutional work shows how exogenous events are constantly mediated and translated by system actors. Therefore, a more differentiated approach towards the relevance of extreme events for system transformation can be taken. Exogenous events are seen to facilitate windows of opportunity for agency. Depending on the institutional work applied, extreme events can thus also lead to an entrenchment of the regime.

Sixth, the empirical studies provided examples of how to apply these new insights in regard to a specific analysis of sectoral transformation. It was shown how to operationalize the main theoretical concepts in detail and which qualitative methods are suitable to achieve fruitful results.

In sum, this thesis has provided many inputs and suggestions regarding the refinement of the conceptualization of socio-technical transitions and transition pathways that is based on an institutional understanding of socio-technical structures and embedded agency.

8.2.2. Contributions to institutional theory

Socio-technical transitions essentially represent transformative changes of organizational fields. The insights gained in this thesis are therefore also highly relevant for the conceptualization of change in institutional theory. The particular focus on institutional logics and institutional work has generated some specific contributions to the literature on

organizational institutionalism. First, the combination of both concepts allows to focus on the process of (de-) institutionalization of institutional field logics. To date, research on institutional logics has a tendency to concentrate on the output of a shift in institutional logics and thereby ignores the processes and practices that lead to the change in the first place. This thesis has shown how institutional work has the capacity to influence the dominance of certain field logics. In addition, the focus on both, the internal coherence of a logic as well as the degree of institutionalization in the field, pays attention to its development from loosely structured, non-related, habitualized elements into a coherent rationality.

Second, institutional theory tends to neglect the role of materiality regarding social stability and change. By drawing on science and technology studies, this thesis provides a unique theoretical and empirical account of the material dimension of institutional logics. It not only shows how the institutional setting shapes form and function of a technology, but also how crucial technologies and materiality are regarding the substantiation and (de-) institutionalization of culture. Change in utility sectors, for instance, can only be understood by taking on a socio-technical perspective. Similarly, todays 'grand challenges' and the related sustainability issues are inherently technical in nature. If institutional theory wants to contribute to the analysis of this type of societal transformation, it will be necessary to include the role of materiality for social change.

Third, the detailed reconstruction and presentation of the structuration of a particular organizational field shows how institutional plurality may be assessed and evaluated empirically. Institutional theory, like transition research, has struggled to account for institutional change without referring to extreme events, shocks or jolts. Hence, the notion of institutional plurality as a source for innovation thus presents an internal mechanism for field level change.

8.2.3. Practical implications

The centralized water sector regime that is dominant in all industrialized countries is increasingly put under pressure and transformation will sooner or later be inevitable. Water scarcity, pollution, environmental degradation, infrastructure decay, financial deficits or new technologies call for a substantial reformation of the underlying water management paradigm. This thesis contributes to the understanding of incentives and barriers to a socio-technical transition in urban water. The analysis of institutional logics in water sectors uncovers the deep structural rules that guide the sector. It gives insights into why certain things are done the way they are and with what effect. This knowledge is ultimately expected to enable a more profound approach towards management and policy making.

The detailed 'structural map' created in Figure 5.2. is assumed to be helpful in terms of targeted interventions. It presents the current situation of the Australian urban water sector from a holistic perspective including technologies, expertise, values, funding or actors. This way, the underlying contradictions become more evident as well as areas 'under construction' that still need a lot work to achieve sufficient relevance. It becomes visible that processes of liberalization will most likely cause some conflicts of objective, e.g. between the dominance of the state logic, proximity to public agencies, reliance on public utilities and the involvement of consultants or the idea of profit maximization. The legitimacy of the liberalization process will thus depend on balancing these issues (Lieberherr, 2012). In order to achieve a sustainable and successful water resource management, policies and regulations have to be designed in a way that addresses the various specificities of water sectors.

Similarly, it can be assumed that large-scale technologies will stay dominant if the expertise in the water sector will not increasingly include non-engineering sciences. This could for instance be achieved by adjusting the curriculum of water science programs to include more environmental or social sciences as well as the experience of private firms.

Furthermore, the analytical framework and results of this thesis improve technology assessments. The evaluation of the disruptive capacity of some emerging technologies has revealed where the biggest barriers to their diffusion are located. Therefore, a targeted application of institutional work might be helpful to reduce those barriers. In regard to recycling, for instance, it is assumed that this might be achieved by increasingly advocating their benefits while reducing associated fears, such as bad water quality. Public marketing campaigns, educational advertising or further experimental projects could contribute to that end. In addition, an overview of the current structuration of a system will also allow to estimate the consequences of the diffusion of a certain technology for the sector in the long term. While a diffusion of recycling plants may foster the inclusion of private actors, re-formulation of wastewater rights and laws, third party access or river reticulation, the diffusion of desalination will more likely contribute to the present day system that is based on large technical solutions, public actors and state subsidies. Transition pathways of urban water sectors can thus generally be assessed in more detail.

8.3. Avenues for future research

There are a number of potentially fruitful avenues for future research that build on the findings of this thesis. While some contribute to the current sociological discourse, others are rather specific to the questions of this thesis.

The empirical application of the analytical framework was conducted in the water sector of Australia. The arguments would thus benefit from expanding the analysis onto other cases, e.g. other water sectors or different utility sectors as for instance energy or transport. This would enable a cross-case comparison that could reveal important differences regarding the relevance of a system's structuration or the influence of societal institutional logics for socio-technical change. Since the liberalization has been more advanced in electricity sectors, it would for instance be interesting to see how this came about (structural preconditions, institutional work) and to what extent it affected the current structuration of the field. A duplication of empirical analyses is assumed to refine insights on the mechanisms of socio-technical change, e.g. regarding how institutional plurality, institutional work or exogenous events and processes shape the internal dynamics of a system.

A second avenue concerns the categorization of institutional work in regard to sustainability transitions. Different streams of research, such as technological innovation systems (Bergek et al., 2008b) or literature on transition management (Loorbach, 2007) have explicitly focused on certain aspects of socio-technical innovation and change processes that are especially relevant to foster sustainability transitions. These include reflexive governance, market formation, legitimation or knowledge development. It could be worthwhile to reformulate those findings in regard to institutional work. Which practices and what type of institutional work are particularly relevant to foster a transition? Such a categorization of institutional work aimed specifically at socio-technical change would not only offer theoretical insights on field level transformation but also practical implications on what kinds of actions or overall goals are promising to enable a transition within a socio-technical system.

The third idea for future research is the study of sustainability as an institution with a particular institutional logic in its own right. The results of this thesis are not conclusive enough to support this assumption. However, while some empirical occurrences in the Australian water sector were rather easy to relate to a broader societal institutional logic, e.g. privatization or corporatization efforts, others, especially issues regarding environmental sustainability, were rather ambivalent. Thornton and Ocasio (2012) have recently introduced the institutional logic of the community that focuses on ideologies, unity of will or personal investment. Although this captures some of the idea behind sustainability, it might nevertheless be interesting to further investigate if sustainability could be considered an ideal type institution with a corresponding logic. This is especially important, since sustainability, despite its vague concept and sometimes rather empty content, can be interpreted as the prime goal of this millennium.

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Appendix 1

Table A.1: Institutional logics of societal sectors (adapted from Thornton et al. 2012)

Categories	Family	Community	Religion	State	Market	Profession	Corporation
Root Metaphor	Family as firm	Common boundary	Temple as bank	State as redistribution mechanism	Transaction	Profession as relational network	Corporation as hierarchy
Sources of Legitimacy	Unconditional loyalty	Unity of will, belief in trust & reciprocity	Importance of faith & sacredness in economy and society	Democratic participation	Share price	Personal expertise	Market position of firm
Sources of Authority	Patriarchal domination	Commitment to community values & ideology	Priesthood charisma	Bureaucratic domination	Shareholder activism	Professional association	Board of directors, top management
Sources of Identity	Family reputation	Emotional connection, Ego-satisfaction & reputation	Association with deities	Social and economic class	Faceless	Association with quality of craft, personal reputation	Bureaucratic roles
Basis of Norms	Membership on household	Group membership	Membership in congregation	Citizenship in nation	Self-interest	Membership in guild & association	Employment in firm
Basis of Attention	Status in household	Personal investment in group	Relation to supernatural	Status of interest group	Status in market	Status in profession	Status in hierarchy
Basis of Strategy	Increase family honor	Increase status and honor of members & practices	Increase religious symbolism of natural events	Increase community good	Increase efficiency profit	Increase personal reputation	Increase size and diversification of firm
Informal control mechanisms	Family politics	Visibility of actions	Worship of calling	Backroom politics	Industry analysts	Celebrity professionals	Organization culture
Economic System	Family capitalism	Cooperative capitalism	Occidental capitalism	Welfare capitalism	Market capitalism	Personal capitalism	Managerial capitalism

Appendix 2

Table A.2: List of interviewees and their role in the urban water sector in Australia

Position	Interviewee
CEO of a research center	1
Director of educational division of a research center	2
Global business leader desalination, multi-national company	3
Professor of political science	4
Professor of public policy	5
Professor of chemical engineering	6
Professor of economics	7
Senior lecturer in anthropology	8
Project manager industry association	9
Senior lecturer chemical engineering	10
Professor in the area of sustainability	11
Professor in the area of sustainability	12
National manager industry association	13
Associate professor of geography and environmental management	14
Professor of economics	15
Project leader government department, senior research fellow	16
Senior leader research institute	17
Assistant director research institute, prior: senior management government department	18
Senior social scientist	19
CEO research center, prior: director government department	20
Senior fellow research institute, prior: general manager policy government department	21
Senior audit office	22
Executive leader utility	23
CEO utility, prior: executive director policy government department	24
Member of utility	25

Appendix 3

Interview guideline for semi-structured face-to-face interviews on desalination

Introduction:

- Introduction of interviewer and PhD project
- Introduction of interviewee: What is your connection to the water sector? Which roles/jobs/positions have you had in your career?

Desalination:

- **Open question: From your perspective, how does the story of desalination in Australia unfold? What happened between 'not considering this technology at all' towards 'implementing it in all major cities'?**

Follow-up questions:

General:

   o Are there different phases of development? How can they be characterized? When did the discourse about desal start?

   o When did you first hear about desalination and in what context? What did you think of it?

   o What are important milestones for the breakthrough of desalination?

   o Was the breakthrough of desalination ever endangered or particularly difficult?

   o What are central motives for desalination? Do they differ between cities?

   o What were alternative options and why did they not succeed?

   o What consequences does the implementation of desalination have for the water sector in general? What are/were the most remarkable changes since?

Actors:

   o Which actors were/are important for the implementation of desal? What did they do specifically?

   o Which actors show/showed resistance? What did they do specifically?

   o What is/was the role of *politics* (e.g. decision-making power, subsidies, symbolism, election), *consulting* (e.g. mainstreaming of ideas), *science* (e.g. knowledge development, consulting), *firms* (e.g. knowledge development, financing, practice approach), *farmers* (e.g. lobbying), *ngos* (e.g. lobbying), *media* (e.g. influencing public perception)?

   o What kind of networks developed to what end?

   o How does desalination change the actor structure of the water sector?

Regulation:

   o What kind of policies developed over time and in how far did they push/hinder desalination? Regional differences?

o   What policies affected alternative technologies?

Finances:

o   Where does the money come from?

o   Does it play an important role?

o   Have the investments in desalination been financially sustainable?

o   What are the consequences for the consumers in terms of water prices?

Normative/cognitive Institutions:

o   What were/are the main arguments for or against desalination and how did they change during the past 15 years?

o   What are the main advantages/disadvantages regarding desalination?

o   What prejudices exist about desalination?

Public Perception/Acceptance

o   How was/is public perception about desalination and how did it change during the past 15 years?

o   What are the central issues discussed in the public discourse?

o   What influences public perception most?

o   What is the role of media?

o   Do you feel that the technology is well accepted in society? Why (not)? How could acceptance be fostered?

Technologies

o   Why didn't other technologies get implemented more broadly (e.g. stormwater harvesting, recycling)?

o   How does desalination affect the development of other technologies? Rivalry or complementary?

o   What are technological challenges with desalination to date?

Climate change/sustainability

o   How do you see the relationship between desalination and climate change?

o   What role do the droughts and floods play in the decision for desalination?

o   How does desalination contribute to or hinder environmental sustainability?

Future

o   From the current point of view, do you think Australia would still prioritize desalination again?

o   What consequences does the implementation of desalination have for the water sector in general?

o   What are the lessons learnt so far? Is desalination a long-term solution?

Appendix 4

Table A.4: Exemplary Quotes from the public inquiry for each subcategory

Meta Category	Subcategory	Exemplary Quotes
Hydraulic Logic	Health/Safety	„*In developing a strategy to advance the development of water sensitive cities in Australia, which incorporates the use of alternative water supplies, the protection of public health from the use of these supplies needs to be a core consideration.*" (Government)
		"*Primary responsibility for ensuring water quality and health standards should firmly rest with the water utilities themselves with an adequacy of regulation to ensure that such standards are met.*" (Professional Association)
		"*Many aspects of the regulation of urban water aim to protect the public from risks that would have serious or catastrophic consequences particularly with regard to health outcomes. It is essential that any analysis of the urban water supply sector explicitly recognizes the ongoing importance of public health aspects of the urban water sector.*" (Government)
		"*The hierarchy illustrates that water conservation measures will often represent low risk, especially with regard to public health, whereas water recycling projects, such as the recycling of sewage, are higher risk. The risk hierarchy also often reflects the relative cost of urban water management projects, as higher risk projects typically have expensive treatment and monitoring requirements, compared with lower risk water conservation projects. If water reuse and recycling initiatives are to be implemented as part of an integrated urban water management strategy, the department strongly supports the use of a risk hierarchy for sources of harvested water.*" (Government)
	Reliability	"*(...) IAL recommends that one key objective for Australia's urban water sector is to provide a reliable water supply to support a healthy and sustainable community (...)*" (Professional Association)
		"*Critical public facilities such as hospitals, emergency management response centers and some businesses have been designed to be dependent upon the current high levels of reliability and quality.*" (Government)
	National Growth	"*Urban water supply is a critical enabler of economic activity in Australia's metropolitan and regional areas, and a significant economic sector in its own right. The availability of reliable and affordable water is also, of course, fundamental to maintaining a high living standard for all Australians.*" (Government)
		"*In a broader sense the provision of water services should underpin the liveability and productivity of the communities we serve. Safe drinking water and effective sanitation are cornerstones of a healthy and productive society.*" (Utility)
	Social Equity	"*While markets are believed to allocate scarce goods and services efficiently, they also push up prices in pursuit of profits and, in allocating essential services, create financial hardship amongst vulnerable and disadvantaged people. Reform processes in this area should focus instead on the key objective of providing universal access to high quality urban water and sewerage services.*" (NGO)
		"*The organization contends that a strong consumer protection framework is essential to assist in ensuring that all customers, especially those experiencing hardship, can maintain access to water and other essential services.*" (NGO)

		"Many community welfare services, from child care through aged care, are heavily reliant on affordable supplies of water and at risk from increasing prices for services essential to their operations." (NGO)
Water Market Logic	Efficiency	*"A system which produces nationwide underinvestment in its infrastructure for many decades should not be classified as efficient. This has occurred across Australia and across most areas of public infrastructure. It may be necessary for the economists to review their definitions of efficiency."* (Government)
		"We believe that the key reform objective for the water industry should be to promote efficient investment in, and efficient operation and use of, water for the long term interests of water customers with respect to price, quality, reliability and security of supply of water balanced with sustainable environmental outcomes." (Utility)
	Pricing	*"By now urban water prices should be set in line with commercial principles. This has not been generally achieved and water remains under priced leading to higher consumption, the viability of other supply and demand management options has been undermined and the revenue flows required for investment to ensure that all water infrastructure is fit for present and future purposes has been less than it should be."* (Professional Association)
		"Proper pricing at the bulk supply level in particular, is critical if the private sector is to become involved in the development of new resources. Proper pricing at the retail level is also important as a means of promoting conservation and ensuring that consumption choices (such as between potable water and recycled water, where it is available) are not distorted." (Firm)
	Competition	*"It is appropriate that these services, as public goods, are provided by governments and we see no need to artificially impose market structures and/or competition at any level in the water supply and waste water service chains."* (NGO)
		"Scope for competition and contestability: (i)Due to the low number of connections in the Burdekin, it is not believed that competition would improve the level of service. (ii) Current council prices are based on cost recovery, and do not include profit. Commercial competitiveness may ultimately lead to higher prices, as commercial operators include profit. (iii) Competition and contestability may lead to higher regulation by the state water authority." (Local council utility)
		"The main issue with competition for both utilities and governments occurs where competition may not result in more efficiency service delivery, but in "cherry picking" regulated prices." (Utility)
		"Contestability in the provision of water services has the potential to provide efficiency gains equivalent to the benefits from flexible/scarcity pricing." (Professor)
		"A level playing field is essential if competition is to be fostered. Existing utilities and the private sector should be treated equally and be subject to the same regulatory environment. Thus, legislation (...) should not be a barrier to the entry of the private sector (...), nor should unnecessary constraints be placed on corporatized utilities that might distort the market in favour of the private sector." (Professional Association)
		"This is not to say that new players are not entering the market. The majority of licences granted so far have been for small decentralised schemes, servicing a single building or development." (Utility)
	Corporatization	*"Council's decision a number of years ago to clearly define its water business unit and its subsequent decisions to continue this process has enabled Shoalhaven Water to clearly and transparently demonstrate its performance."* (Utility)

		"Financial sustainability of water utilities, in this region will only be achieved through the establishment of a commercially focussed water corporation which is able to provide the necessary professional and technical staff to meet the challenges." (Government)
		"The reforms were enacted purposefully and quickly and this has created a degree of tension between the owners and businesses. The current corporatized model created an expectation amongst the corporation's council owners that returns to owners will be delivered. Managing this expectation been operationally challenging (…)." (Utility)
	Market	*"At the wholesale level, the major allocative efficiency issues affecting urban water are the artificial barriers to trade and resulting price disparities between urban and rural water. The Commission will be familiar with the arguments on this issue and will be well aware of the political problem in allowing rural-urban trade, particularly with large metropolitan water systems."* (Consultants)
		"(…) water trading has become an essential part of our business model, new skills and governance frameworks are required to manage new risks and opportunities with a potentially volatile commodity." (Utility)
		"Impediments to urban-rural trade should be identified and removed." (Economic regulator)
Water Sensitive Logic	Environment	*"Environmental considerations have become significant factors in solutions selected both for water supply and wastewater disposal."* (Government)
		"There is a need for specific environmental objectives for the sector with the primary environmental objectives being achieved through the considered siting and operation of bulk storages. The maintenance of environmental flows should also be ensured; however, this needs to be balanced by the respective community's needs. Environmental externalities such as carbon accounting will also play a significant role in such objectives. Overall, sustainability, security and safety of supply should be the primary objectives for any urban water scheme." (Government)
		"There is considerable scope for further nationally coordinated and funded research to address current limitations with climate models, particularly in relation to modelling future droughts – a key consideration for water planning. Another important issue is the potential impacts of climate change on weather events including east coast low pressure systems which play an important role in filling storage systems." (Government)
	IWCM	*"EA strongly supports integrated water cycle management (IWCM) as a complement to centrally provided water services. EA has articulated its views on IWCM in a guide called Australian Runoff Quality, a copy of which has been provided to the Productivity Commission. IWCM is consistent with sustainable development principles and recognises that all water streams should be optimised to supply the demand for water on a fit for purpose basis."* (Professional Association)
		"Integrated water management is likely to provide significant benefits in the efficient use of water as a natural resource but is financially expensive." (Government)
		"To do this the water sector will employ resource management strategies that are diverse and fully integrated with broader city planning objectives. A water sensitive city will be planned and designed with a view to maximising the capture and use of rainwater that falls on the urban form, and treat all water in the total water cycle as a potentially valuable resource (even "wastewater")." (Utility)
	Recycling	*"Why Recycle: 60% to 80% of residential water to drain is grey water. The reuse of this water is critical for: 1) Environmental Flows: Less use of water from our storage dams means that there is more water available from the dams for release into the river systems. This water is*

better quality than the treated water released from the LMWQCC (Lower Molonglo Water Quality Control Centre). 2) Lifestyles: Natural grass and foliage keeps homes cool. People can be re-empowered in having a vibrant garden. Most people prefer a clean environment and a clean motor vehicle. 3) Overcoming water restricted living." (Firm)

"Significant commitments and long-term planning for extensive re-use programs has placed at the forefront of the sustainable re-use of both liquid and solid by-products of the sewage process." (Utility)

	Water conservation	*"Water restrictions have become a disempowerment to ACT residents. People see a deterioration in their gardens and a reduction of Canberra's social amenity and cultural heritage. We need to revisit the Garden City concept and re-empower residents."* (Firm)

"Council considers that the use of water restrictions has been an effective tool over a number of years of drought." (Utility)

"The water restrictions of the past decade in our view are not an acceptable long term response to the challenges of meeting our water needs. The longer term response should be to replace policies that restrict water use with properly functioning urban water markets where efficient investments in water supply and user demand can adjust over time in response to market-based price signals, with appropriate safety nets in place to ensure minimum levels of service." (Professional Association)

"PIAC supports water restrictions as an effective demand management tool that plays an important role in reducing the need for expensive capital investment. In addition, water restrictions send an important water conservation message to consumers. However, PIAC cautions that reduced consumption as a result of adhering to water restrictions which carry the threat of sanctions, should not result in increased water charges to consumers by virtue of water retailers increasing charges to compensate for losses arising from reduced consumption." (NGO)

"Clearly over the last 10 years, there has been a shift in how the community values water and attitudes to how water is used. Looking ahead it is important that this established water conservation ethos is maintained as it delivers multiple benefits in the form of reduced water extractions from rivers, energy savings (and lower greenhouse gas emissions) through lower water use and deferral of major supply augmentations." (Utility)

	Community	*"In Sydney, the NSW Government undertakes careful and comprehensive water planning, a core part of which is community consultation."* (Government)

"Decisions about water supply security are not solely technological or economic questions, but involve 'values, objective-setting processes, and complex trade-offs'. The impacts of such decisions are varied, difficult to compare, and in many areas, unquantifiable. Because of this, such decisions cannot be made on scientific, engineering or economic grounds alone, but should include deliberative processes that 'elucidate the preferences, values and choices of citizens who are able to have access to information and to engage in questioning of experts and dialogue with each other in a well-facilitated process." (NGO)

"Council believes that in delivering secure and sustainable integrated water cycle management services to our region into the future that the community's interests will be best served through: Decisions on local water, sewerage, stormwater, salinity and water reuse; management and pricing are best made by people who live in the region; Local representatives determining best practice pricing; Sense of regional identity retained; Improved and local customer service." (Government)

Governance	Regulation	*"In an industry with natural monopoly characteristics and which has a critical role in protecting human and environmental health, regulation becomes vital."* (Australian Water Association)

"Currently there is what could be considered an over regulation of issues impacting the water industry in Queensland that has an effect on the efficiency of the Water Service Providers. Whilst it is recognised that there is need to maintain standards there is also a need to allow providers to manage their businesses as they should have these matters in hand." (Rockhampton Regional Council)

"Independent economic regulation and the removal of political interference in pricing of water services should continue to be pursued as necessary conditions for efficient and effective service delivery. (...) Streamlined environmental, public health and economic regulation frameworks are needed to remove areas of regulatory duplication between the States and Territories and the Commonwealth." (WSAA)

"The introduction of policy bans by some governments – for example on indirect potable reuse or water trades – works against the rational setting of a water security objectives. While a ban may merely direct attention to other sources, there is a risk what water security will be lower that it might otherwise be if it banned sources had been available." (Australian Water Association)

Planning/Decision Making	*"ASSA"s primary concern is that many of the water infrastructure decisions taken in the last ten years, for example, have been short-term responses driven in part by the electoral cycle and which were not adequately scrutinised prior to being implemented. Recent examples include decisions made to construct desalination plants in Sydney and on the Gold Coast, as a well as a significant proportion of so-called 'water grid' transmission piping."* (Academy of Social Sciences Australia)
	"Governance arrangements relating to water supply planning should be varied to provide for an open, transparent and public process undertaken by an independent party." (IPART, Sydney)
	"The second problem that must be overcome is the institutional structure of urban water planning. There are many weaknesses in current arrangements because urban water planning is largely undertaken by existing water utilities resulting in the perpetuation of status quo practices and methodologies and serious conflict of interest. Engineers Australia believes that urban water planning and the procurement of water solutions should be undertaken by an independent agency in each jurisdiction and that water planning and the delivery of water operations should be separated." (Engineers Australia)