Integrated transitions toward sustainability: the case of water and energy in Israel

Na'ama Teschner

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The candidate confirms that the work submitted is her own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

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Abstract

Water and energy sectors encompass large infrastructural systems, face increased scarcities and have been argued to have locked-in structures. Questions of how technological breakthroughs occur and how the underlying policies and institutional structures change are therefore important for responding to socio-economic pressures and to improve environmental sustainability. This thesis aims to re-theorise the interplay of technology, policies and discourses within sociotechnical regimes and to examine the merits of these relations from an inter-sectoral perspective. This dissertation combines insights from the literature on science and technology studies, policy dynamics and policy integration and uses the integrated approach to examine parallel and interrelated dynamics in the Israeli water and energy regimes, making use of the interpretative policy analysis methodology and a range of qualitative methods. The dissertation makes three analytical contributions.

Firstly, the dissertation highlights how the power of technology in shaping and transforming policy regimes has been underestimated in the current literature about policy dynamics. The dissertation exemplifies this by the case of desalination technology, which had the capacity to transform the Israeli water sector. I suggest that technological breakthroughs that rendered seawater desalination economically feasible, undermined long-lasting hydro-ideological support for agriculture, introduced new ideas about water abundance, and engendered changes in paradigms, institutional structures and constellation of actors. Desalination technology contributed to this shift by destabilizing the existing structure through re-framing and dis-placing important issues, such as environmental externalities, economic costs and hard political choices, to other policy sectors and levels of governance as well as reallocated them between politicians, bureaucrats and water professionals.

Secondly, the dissertation argues that the focus of the sociotechnical transitions literature has been on structural changes with predefined objectives and suggests that a more fluid and agency-based ideas about discourses – as presented by discursive institutionalism – can provide contrast and complement. The dissertation exemplifies the usefulness of this cross-fertilisation by analysing the

rise of four technological alternatives to current Israel's coal-based energy regime. I suggest that the regime is shifting away from the traditional scarcity discourse towards a new discourse on energy abundance. The new energy abundance discourse was created by policy networks, who promote natural gas, oil shale, nuclear energy and solar energy as energy alternatives although their mainstreaming still faces formidable uncertainties and various constraints. The findings also support the premise that a change from constructed scarcity of energy resources to their abundance potentially reconstructs socio-technical transitions, future pathways or technological trajectories and institutional arrangements at large.

Thirdly, the dissertation examines how sectoral transitions may be coupled and technological regimes may co-evolve. The dissertation demonstrates that while transition management literature examines how long-term structural changes could be directed toward greater sustainability, it has, however, mostly taken a sectoral approach which neglects the potential interdependencies between sociotechnical changes and policy dynamics in different sectors. The thesis examines the water-energy nexus in Israel and suggests that transitions of the water and energy sectors in Israel are physically, spatially and financially coupled. Yet, inter-sectoral institutional structures, management apparatus and niche-induced innovations were found to be lacking integrative capacities, driven by an inherent strategy of supply-side management and around the unaltered, implicit, core belief in the need to secure independent and ultimately unlimited sources of water and energy.

In practice, integrated transitions management could therefore play a crucial role in re-orienting trajectories in the water and energy sectors, re-designing transition arenas and articulating transition pathways. This could encourage technology-mediated policy realignments on the basis of more comprehensive and longer-term problem solving rather than on the opportunities technologies offer for problem avoidance or postponement. Further policy recommendations highlight the merits and pitfalls of greater cohesion in the policy arena, including the effectiveness of procedural tools such as the regulatory impact assessment.

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Acronyms and Abbreviations

ANT	Actor - Network theory
BOO	Built-Operate-Own
BOT	Build - Operate – Transfer
DI	Discursive institutionalism
HI	Historical institutionalism
EIA	Environmental impact assessment
eNGO	Environmental non-governmental organization
EPI	Environmental policy integration
EU	European Union
GHG	greenhouse gases
IEC	Israel Electricity Corporation
IPCC	Intergovernmental panel on climate change
ITM	Integrated transitions management
IWA	Israel Water Authority
IWRM	Integrated water resources management
kWh	Kilowatt per hour
MCM	million cubic meter
MSF	multi-stage flash
MED	multi-effect distillation
MW	Mega watt
NGO	Non-governmental organization
PA	Palestinian Authority
PPP	Public-private partnership
PUA	Public utility authority
RIA	Regulatory impact assessment
RO	Reverse osmosis
SCOT	Social construction of technology
SI	Sociological institutionalism
SSK	Sociology of scientific knowledge
SST	Social studies of technology
TM	Transition management

1. Introduction: the key dimensions of the problem

"Are choices trade-offs?" (Holland, 2003:17)

1.1. Introduction

Socio-technical restructuring worldwide has been influential in advancing significant changes in social and natural environments. Concurrently, environmental concerns have been increasingly incorporated into decision-making processes. Yet, as will be shown in this thesis, policy regime changes are advanced primarily through technological-pushes and shifting discourses, and less by a careful consideration of the long-term sustainability of policies and practices. Additionally, while cross-regime dynamics - manifested as interdependencies of environmental, economic and socio-political problems - present even greater challenge, they have been rarely acknowledged by policy-makers. The analysis presented here is therefore taking an integrative outlook, specifically at the water and energy policy regimes. It will directly address the complex spaces and contexts where interdependent socio-technical transitions are formulated or constrained.

In studying socio-technical transitions, the focus in this research will be on developed countries, with Israel as a location based case-study. Israel, a semi-arid region, has had to battle water and other resources scarcity from its early days of formation. It is a relatively small country with high population density. While its democratic political culture and egalitarian society have enabled the creation of a modern state and western life-style for its citizens, its geopolitical continuous isolation, tensional borders and unstable status among parts of the international community, have posed many challenges on the state's ability to secure resources' availability, mainly water and energy. Moreover, there is a greater consent today that any attempt to address the acute water problem in Israel, cannot be made solely within an independent national system, as was the case for the last few decades, but will have to

include the needs of the surrounding countries, including the Palestinian Authority and to promote mutual collaborations. I will argue here that Israel's water and energy regimes present an optimal terrain for the study because they are simultaneously undergoing a complex, yet definite, transitional process.

This introductory chapter covers the conceptual and empirical justifications for the research, the research aim and specific questions, and provides a road map for the rest of this thesis. The conceptual motivation for the research is based on identified gaps in the literature, which are discussed in chapter 2 in greater detail. From a policy perspective, the empirical justification for the research is rooted in a growing concern about what was termed the *water-energy nexus* and the correlated problem of *integration* in national policy and decision-making processes. The theoretical background for the nexus and the particular context in which this phenomenon is examined are also spelled-out here.

1.2. Integrated transitions toward sustainability: conceptual novelty

From a conceptual perspective, there has been a good deal of work on how decisions are made in the policy arena. The study of environmental decision-making or *environmental governance*, to use the more inclusive term, is particularly flourishing. However, while decision-making theories and dominant models can significantly contribute to our understanding of existing structures and patterns of policymaking, they are limited in their explanation of policy dynamics (i.e. continuation and change) under growing environmental uncertainty and complexity (Kemp et al., 2005). This limitation partially stems from the prevalence of various social perceptions about the capacity of technology to solve or at least mitigate the most permanent environmental problems communities are facing worldwide, and it is one dimension of what was conceptualised as "ecological modernization" or "technological optimism", which "identified modern science and

technology as central institutions for ecological reform" (Mol, 1996:313; Huesemann, 2003).

Technologies and technological systems are therefore the focus of much research, as are their interactions with politics, policy-making, and governance. Technological intake is a key-interest also in studies on *socio-technical transitions*, which are largely occupied by questions regarding structural, co-evolving changes in societal and natural constitutes (i.e. actors/agents, institutions, policy, science, technology, economy, discourse, culture and ecology) in distinctive sectors – water, energy, transportation - visualised by cogwheels in Figure 1. A question remains open to whether socio-technical constitutes always take the same size and role in this complex socio-technical system. An instinctive answer would most probably be that no, as every transition is necessarily a context, location and time-based phenomenon. Yet, I argue in this thesis that current conceptualisation of socio-technical transitions assumes fixed, circular relations between different constitutes, where in fact some forces are ignored or downsized. I hope to present in this thesis a threefold contribution to the socio-technical transitions literature and to the refinement and characterisation of the relationships between major sociotechnical components: policy, technology and discourse. I will highlight the interchangeable role of technologies, discourses and interdependent transitions in policy dynamics, by challenging three voids in the literature:

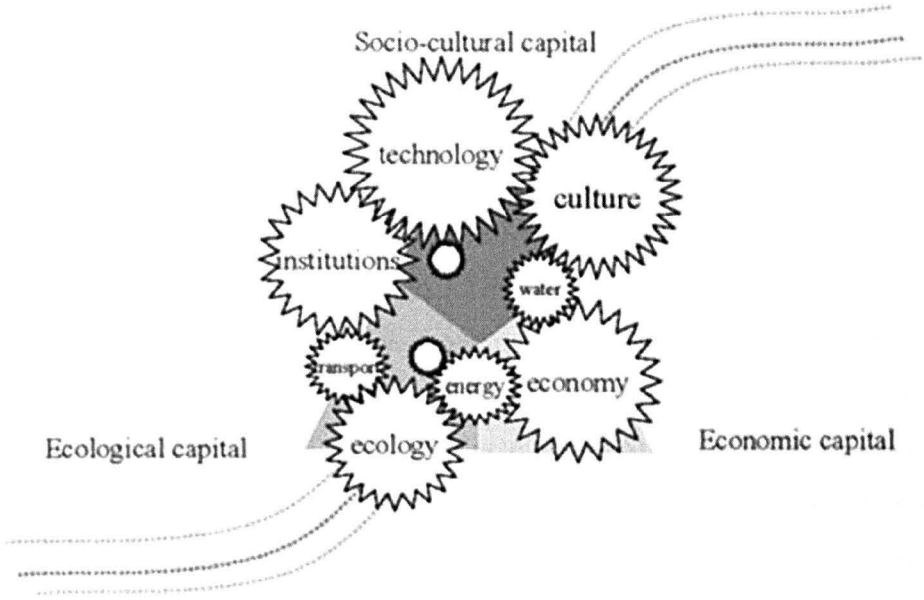

Figure 1: Cogwheels in transition. Image from: van der Brugge (2005:166)

First, many studies about either policy or technology, usually conceive policy a lever that is shaped and manipulated in order to influence technological trajectories and escape unsustainable paths. A reverse causal relationship, in which technology has the potential of transforming decisions and policies, had been advocated, for example, in the work of Latour (e.g. 2000)[1]. I would also build on Sabatier (1988), who claimed early on as well, that technology plays as an external pressure on policies and institutions and Lovell (2007), who emphasised the importance of materials and technologies. The water policy regime case-study in chapter 4, therefore prepares the way for unfolding the transitions management approach so as to consider a wide range of interdependencies. I will take the understanding of technology as an actant in the policy arena forward, and ask here *how* does technology influence policy and institutions under conditions of interdependent change and how negative consequences can be mitigated?

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[1]B. Latour is talking about systems broader than policy and on the "capacity of artefacts to construct, literally and not metaphorically, social order" (Latour, 2000:113).

Second, I will use in this thesis the socio-technical transitions theory in conjunction with discursive institutionalism theory. In chapter 2, I will make the point that the focus of socio technical transitions literature is on structural changes with predefined objectives, whereas more fluid and agency-based ideas about discourses – as presented by Discursive Institutionalism – can provide contrast and complement. Discourses will therefore be found to influence not only policies and technological trajectories but also more general social arrangements. In chapter 5 I therefore look at the energy regime, in order to find out how the socio-technical literature can be enriched by refreshing its largely structural orientation with discursive institutionalism and its ability to bring-in actor-centered considerations.

Lastly, on the basis of the literature review in chapter 2, it can be claimed that the sectoral handling of transitions has to a large extent missed the connections and interdependencies between distinct sectors. As will be showed here, a transition in one sphere is likely to influence or be influenced by another transition. The premise of this thesis, therefore, is that a more integrative approach to socio-technical transitions can highlight issues that are essential to our understanding of transitions and their implications on sustainability. In chapter 6 I therefore put to use a proposed broader approach to policy dynamics in the form of Integrated Transition Management.

With respect to the forthcoming analysis, three notions merit a preliminary definition here: 'governance', 'institutions' and 'sustainability'. With respect to the former, I usually choose to refer to processes of governing as decision-making or policy-making, rather than to deal in-depth with the theoretical aspects of the term *governance*. Particularly, with relation to the study of water management, I prefer the concept of water policy regime that is used in recent research (Pahl-Wostl et al., 2007; Huitema and Meijerink, 2010b) rather than water governance. Nevertheless, since this term has gained a growing popularity during the last decade and because it encompasses also the useful term 'networks', it is unwarranted to completely disregard it. Briefly, in the term governance, I refer to networks of governing structures and methods beyond the government – the traditional sole player. It is

through governance that socio-technical transitions are crystallised and potentially managed. Depending on the strength of laws and regulations, effectiveness of implementation, types of actors involved, market structures and more (Treib et al., 2007), different modes of governance (e.g. statism, pluralism, corporatism, network governance) will fundamentally determine the nature and pace of a transition. Policy dynamics can largely be explained by different modes of governance. The overarching governance concept is embedded in every aspect of our lives. Water management, for example, is a governance concept (Brooks, 2007). The academic community of water policy professionals promotes the idea of "adaptive governance" as "integrated and collaborative approaches to resource management (which) support a process of collective learning and the resulting institutional changes needed to shift management operations for improved water management" (Fischhendler and Heikkila, 2007:4).

This term is important because the socio-technical transition in the Israeli water sector, for example, has altered several components of governance through which the system has historically guaranteed water supply. These include changes in power distribution between ministries and authorities, responsibility for water production, rising involvement of eNGOs in the communication of water related issues to the public, ownership and market structures. Changes in governance have in turn accelerated policy dynamics and transformative processes. I chose not to use the governance terminology in the thesis because I felt that this ubiquitous term could, for the purpose of this thesis, be reduced into particular terms where these are needed such as polity or management. Yet, governance is a thread running behind or sometimes beside the conceptual language used here and therefore should not be completely ignored.

The second notion that may require a brief notice is *institutions*. It is used here as the formal and informal organizations, associations and procedures in a society, that is, the substance of which governance is made up from. Within the environmental governance framework then, "resource management institutions are the laws, policies, rules, norms and customs by which

resources are governed" (Bakker, 2007:434). It is argued that moving toward more sustainable practices essentially entails institutional change (Frank and Hajer, 1999; Connor and Dovers, 2004). The effort to offer an account for the dynamics, of both modes of governance and institutions, is enhanced by an ability to demonstrate the interdependency of the social and technological systems (see Paavola, 2010). The cases in this thesis demonstrate such interdependencies throughout.

A third term that requires concise attention here is *sustainability*. Promotion of sustainability pursues changes in governance, institutions, technologies, and social/individual behaviour, for the purposes of maintaining the maximum functioning of ecological systems in a way that is socially just and economically feasible. Following from this definition, is that socio-technical transitions' commitment to the goal of sustainability, is an indicator of the degree to which a sector's managers undertake directive that is protective of natural resources without risking continuous supply, access and safety of services - in our case of water and electricity. The environmental sustainability dimension of the interaction of governance mechanisms and institutions, even if sometimes implicit, comprises the core foci of the analysis undertaken in this thesis.

The sustainability discourse is not dominant at state level institutions in Israel. Most governmental ministries promote development rather than sustainable development, especially in important sectors, such as transportation. A national plan to reduce the impacts of GHG emission and to combat climate change, for example, has not yet been approved or adopted by either a governmental decision or any of the individual ministries. What did receive the support of the government was a national plan for "green growth" (Governmental decision no. 3768, 23.10.2011) that emphasises the creation of new "green jobs". This goes in line with a recent report on the Israeli environmental movement and organisations (in the non-profit sector), which concluded that successful oppositions to unsustainable initiatives was, and will increasingly depend in the future, on the extent to which environmental organizations are able to "talk" in economic language. In turn,

the industrial sector in Israel can be considered a passive player, as it only recently and slowly adopted voluntary regulations related to export, and in order to stand-up to European standards. Finally, even with growing awareness, especially to health-related environmental issues, the general public does not prioritize environmental sustainability issues; security and well-fare concerns remain on the top of the public agenda. The environmental context of this research is further elaborated in chapter 3.

Between the three-fold conceptual motivation for the research, as depicted in the beginning of this sub-section, and the research's empirical justification (section 1.5 below), it is reasonable to bring the academic point of view on the interface of two particular policy regimes: water and energy, the two case-studies in this thesis. The water-energy interface is embedded in two complementary concepts: scarcity and abundance, which I deal with in the next subsection. Further exploration is incorporated in chapters 4 and 5.

1.3. Constructions of scarcity and abundance

Water may be one of the most valuable yet vulnerable resources in relation to sustaining life. It is generally acknowledged that it is mostly as a result of human actions that the depletion and contamination of water resources are making water scarcity an issue of major international environmental problem (Pearce, 2006). Clean drinking water is in particular an issue of enormous anxiety. Traditionally, societies in developing countries and arid regions are considered to be the most affected by the shortage of freshwater as well as by mismanagement of water resources (Lipchin, 2005). Several concepts indicate different magnitude of or sources for the problem. For example, the internationally accepted Falkenmark indicator sets 1000 m3 per person as a minimum annual level below which countries encounter 'water stress' (Tal, 2006). In turn, water scarcity is defined by Bakker (2002:770) as "a generalised phenomenon in humid as well as arid countries, resulting from increasing pressure on water resources in terms of quality (increasing pollution) as well as quantity (increasing demand for water)".

The essence of the problem is therefore considered not always to be a problem of the amount of water available, but the inability to make it adequate to use and available to consumers. In addition to inadequate storage and delivery systems, competition among users (agriculture, industry and cities) accelerates the problem (Hannigan, 2006). A 'water crisis' is either defined simply by the lack of access to safe and affordable water, or serves as an overall concept to describe the resulting situation from water shortage, stress or scarcity.

Researchers have focused on the various drivers behind definitions of and coping-strategies with water crises across nations. According to Allan (1997), for example, global economic processes, such as 'virtual water' trading play much greater role in policy decisions than any professional, "objective" hydrological analysis. The concept of 'virtual water', i.e. the water embedded in exported/imported grain, highlights one way among others to identify and assess policy choices and political-economic decisions in regard to a precious resource like water.

Such an analysis is compatible with the social constructivism approach, which emphasises historical events, social forces and ideology, as the sources for the emergences of 'facts' and 'problems' (Hacking, 2000). In this line, intellectuals have questioned the mere existence, in several dry areas, of what is termed a 'water crisis', interpreting it as a discursive construction within a particular socio-political arena (Aguilera-Klink et al., 2000; Hannigan, 2006; Trottier, 2008). It was critically argued, for example, that "nature is never 'short' of water...water is short only when social actors have decided it is so for a variety of reasons" (Trottier, 2008:198).

Trottier (2006) has stressed that different stakeholders within and outside the scientific community, hold different interests and put forward contradictory definitions of a 'water crisis', reflecting the inherently political nature of any scientific exertion. In some cases scarcity can be seen as the lack of enough resources to satisfy insatiable wants, as opposed to human 'basic needs'

(Meerganz Von Medeazza, 2008). In addition to "demand-induced scarcity", Meerganz von Medeazza (2008) differentiates between two other types of "anthropogenic" scarcities and claims, for instance, that the deficit in the supply system of Gaza Strip is mainly caused (and maintained) by the geopolitical situation, and that the deficit of water availability in the slums of Chennai is essentially a result of the ill-suited and, above all, inequitable water governance schemes.

Another target for researchers' critique in regard to water mismanagement is the global tendency toward the privatization of water infrastructures and provision. Privatization is depicted in theory as the neo-liberal state's reaction to problems of scarcity or difficulties in management. Briefly, processes of privatization of environmental assets, natural resources (including water) and national schemes that directly or indirectly involve impacts upon the environment are already prevailing in countries around the world, with growing problems and concerns for quality, quantity and justice, involvement of multi-corporations and marketization (Saurí and Del Moral, 2001; Haughton, 2002; Pretty, 2003; Bakker, 2007). In her research about water management practices in Spain, Bakker (2002) explained that the underlying assumption behind privatization is that the market is more efficient than governments at providing basic services and that public utilities services are better be outsourced in order to cover the failure of the state to manage them efficiently.

Privatization, which involves the transfer of some or all the resources or systems of operation from public hands to private ownership or control, is explained as the outcome of the "hollowing–out" of the neoliberal state (Rhodes, 1997). Otherwise, it is seen as a process in which the capitalist economy forces us to value everything in terms of the market, thus transforming users into consumers (Bakker, 2001; Swyngedouw, 2005). The first western country to fully privatize its water services was England. At that time (the year 1989) other utilities such as oil and telecommunication were already managed by the private sector. But the full privatization that took place in England as part of its national economic policy had been partly

transformed into public-private partnerships, when several water companies have realized that not all parts of water management are profitable (Bakker, 2003b). Water is thus depicted as an "uncooperative" commodity (Bakker, 2007).

The social impacts of such socio-economic restructuring vary from place to place. It is argued that water prices can often be expected to rise and level of quality to fall (Hannigan, 2006). In many 'Southern' countries such as South Africa, Bolivia, Argentina and Ghana, water privatization is an on-going source of major conflicts, which have worsened the problem of access to clean water and growing inequalities between communities (i.e. Loftus and Mcdonald, 2001).

Whether a natural problem or a socio-economic construction, the increasing negative implications have encouraged the search for more sustainable decisions, policies and plans for water management, such as the Integrated Water Resource Management framework (IWRM)[2] and "soft-water paths" (Gleick et al., 2002). The increasing anxiety from severe global water shortage has also prompted a greater chase after scientific and technological

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[2] IWRM is an approach that aims at increasing sustainability of water resources, management, uses and treatment, by different types of integrations within the natural system (quantity and quality, surface water and groundwater, upstream and downstream etc.) and the human system (different users' needs, development policies in other sectors, different scales of management) (Jønch-Clausen and Fugl, 2001). Although extensive body of work is done to promote IWRM around the world, diverse voices against the approach are recorded in the last couple of years. Trottier (2008), at the critical constructivist edge has criticised the mere adoption of the IWRM concept as an inevitable solution of centralized states, disempowering local social institutions and reinforcing a "global water crisis paradigm". Even from a more pragmatic stance, however, researchers have claimed that similar to other forms of integration, the IWRM approach, despite its presumed popularity, has largely stayed in the realm of theory and rhetoric and that it might be impossible to successfully address all the issues it is concurrently attempts to integrate (Biswas, 2004; Jeffrey and Gearey, 2006).

solutions for water scarcity (Aguilera-Klink et al., 2000), such as seawater desalination (Wangnick, 2002).

The construction of scarcity is similar across managing sectors of other natural resources. Energy scarcity can also be seen as either demand-induced, the result of inadequate management practices or a symptom for global ill-politics. Indeed, to a large extent, the concern over scarcity of primary energy sources and particularly oil has shaped current energy regimes. Bridge and Wood (2010:567) consider for example that "scarcity is oil's meta-narrative, the core storyline in the unfolding drama of the hydrocarbon economy since the late 19th century".

Similar to cases of other natural resources, physical and socially constructed scarcity of energy resources serves different and sometimes contradictory interests, such as the oil industry's interest in high price of energy and the environmentalists' advocacy of low carbon economy and society. Although some commentators have challenged pessimistic elements of the scarcity discourse such as oil's geophysical limits, the "peak oil" and "the end of the era of cheap oil" (Clarke, 2007), its role and power in shaping energy regimes has hardly been questioned, particularly as a driving force and central theme in international relations (Haas, 2002).

Studies of natural resources scarcity and crises typically trace their socio-political sources and implications (Bakker, 2000; Mehta, 2003). For example, Aguilera-Klink *et al.*'s study (2000) highlights how socially constructed scarcity of water supported power relations and economic structures in the island of Tenerife. However, less attention has been paid to abundance as a constructed category and a factor shaping energy and resource regimes. Alatout (2009:367) suggests that water abundance was constructed to advance hydro-political goals in the pre-state Israel. Sen (1977) in turn highlights how food abundance might not prevent hunger because it is crucially linked to unequal incomes and access to food. Similarly, Dewees (1989) has demonstrated how the physical abundance of wood does not solve fuel wood crisis in developing economies because of differential access and

resulting resource allocation. Finally, critical geographers have sometimes examined the links between the availability of natural resources and socio-political order, demonstrating how abundant natural resources may help to construct "imaginative geographies" and reproduce ideas about nation-building, national identity, citizenship and territory (Perreault and Valdivia, 2010).

While much work has been done on natural resources scarcity and crises, much less attention has been paid to abundance. The concern over the less visible or sometimes unknown implications of the notion of abundance has begged the need to examine abundance as a "...constructed category by itself, rather than the hidden, other side of scarcity" (Alatout, 2009:367). I intend to focus on abundance in chapters 4 and 5.

In what follows, I turn to the water-energy interface. This inter-sectoral interface first and foremost derives from the constructed scarcity and vulnerability of the two resources, without which the interface would have surely become less of an interest for researchers and policymakers alike.

1.4. The water-energy interface

The primary nature of the water-energy interconnection is physical. Generally, the construction and operational stages of water delivering (pumping, transport, use and treatment), in that they require substantial amounts of energy (see Figure 2)[3] - is a central dimension of what recently has come to be termed the water-energy nexus (Lofman *et al.*, 2002; Stillwell *et al.*, 2009). Research has highlighted the interconnectedness of the two systems for end-user individuals (Malik, 2002), in municipal or regional

[3] This model treats desalination as a treatment procedure. I disagree with this choice and will treat desalination under a separate category of water production. Moreover, the energy use in desalination is much greater than in the other treatment techniques.

levels, and at national scales (NRDC, 2004; Kenway *et al.*, 2008). In particular, energy cost of agricultural irrigation is a subject of concern, especially in developing countries (Shah et al., 2004). Achieving certain water quality standards also depends on growing energy input for the process of treatment (Rothausen and Conway, 2011).

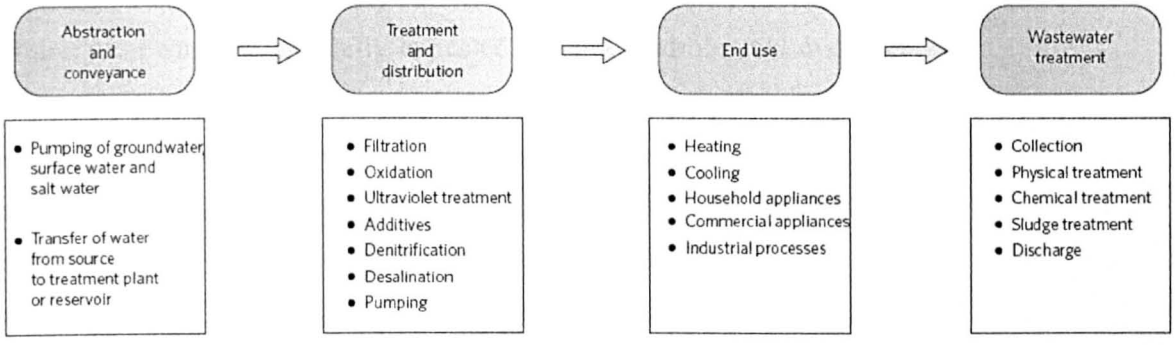

Figure 2: A life-cycle model of the water sector and processes involving energy use. From: Rothausen and Conway (2011:211).

One of the most obvious juxtapositions of water and energy, for example, is hydroelectric power generation. With massive reliance on dams (for irrigation, energy, water supply and flood control), the Californian experience of the years 2000-2001, has demonstrated how an energy crisis soon became a water crisis and how droughts and lack of precipitation may only exacerbate an already difficult energy situation (Lofman et al., 2002). Ultimately, according to the authors, management and policy intended to improve the supply or use of one resource can negatively impact the management/supply of other resources.

Beside 'energy for water', large amount of water is needed for thermoelectric power generation. The amount of water needed to produce energy varies with the type of facility and the characteristics of the fuel in use. Fossil-fuel, nuclear, and geothermal power plants require much water for fuel excavation (hydraulic fracturing, oil and gas drilling, coal mining), processing and cooling (Gleick, 1994). Some renewable energy technologies are water intensive as well, such as geothermal plants and solar panel fields.

Alternative energy sources, however, such as biodiesel and ethanol are prime consumers, requiring enormous amounts of water for soy and corn irrigation and are claimed to worsen water pollution (Service, 2009).

While water and energy systems are intertwined in several ways, their convergent points are strained by the effects of climate change. In particular, although the range of impacts of climate change on water resources is not yet entirely known, it is generally expected that the hydrological cycle will be dramatically influenced. For example, changes of the intensity and distribution of precipitation, of sea-levels, stream-flows and snowmelt seasons, were already recorded in different locations (IPCC, 2008). The effort to reduce GHG emission has promoted an industrial interest in decarbonizing the water sector and reducing embodied and operational energy in water services provision by several means, such as: reduced consumer demand and water heating; looking at total system carbon including treatment; biogas production and use; gravity feed standards; leakage reductions; heat recovery and more (Schiffler, 2004; Semiat, 2008; Ainger et al., 2009). Technology is seen as a particular key-factor in climate change adaptation (IPCC, 2008). However, certain techno-institutional adaptation measures to particular impacts of climate change could in fact increase vulnerability; for example, whereas seawater desalination is a demand-side solution to water scarcity, it is claimed to be also an energy-intensive technology and therefore inconsistent with efforts to mitigate climate change (Schiffler, 2004; Semiat, 2008).

Nevertheless, despite of ample dimensions of these multiple linkages (physical, institutional, geographical and financial) only in very few cases, in specific locations (mainly Australia and California or Texas, US), researchers have pointed to the inseparability of water issues from energy issues as highly significant for both markets and policy-makers. Furthermore, the current structures of resource managerial bodies are still far from addressing the issue in an optimal manner, as is described by Biswas (2004:249):

> The current and the foreseeable trends indicate that water problems of the future will continue to become increasingly more and more complex, and will become more and more intertwined with other development sectors like agriculture, energy, industry, transportation, and communication, and with social sectors like education, environment, health, and rural or regional development. The time is fast approaching when water can no longer be viewed in isolation by one institution or any one group of professionals without explicit and simultaneous consideration of other related sectors and issues and vice versa. In fact, it can be successfully argued that the time has already come when water policies and major water-related issues should be assessed, analyzed, reviewed, and resolved within an overall societal and development context.

Existing physical, operational or managerial approaches may not be equipped to deal with the social, economic and environmental consequences of the nexus. When several parts or elements of the systems are in need to complement each other so that the systems would operate more efficiently, integration capacities may be required (Givoni and Banister, 2010). Integration, however, may be found hard to achieve at the policy level, as Webber (2008:4) has noted:

> Although the two resources are highly interdependent, energy and water regulators operate separately, with different funding streams, accountability mechanisms, government oversight and legislative committees. Instead of water planners assuming they will have all the energy they need and energy planners assuming they will have all the water they need, we must get them in the same room to make decisions.

Policy integration is therefore a key-interest of this thesis. Whether integration is possible, what kind(s) of integration are needed, what should be integrated and what are the mechanisms for integration, are questions further dealt with in chapters two, six and seven.

1.5. The water-energy nexus in Israel: empirical justification for research

It has been argued that "governments and people in severely water scarce regions are in denial about their water resources and their policy options" (Allan, 2006, 132) and that water scarcity is "both real and

constructed...through political and policy process" (Mehta, 2003:5066). Merely a perfect manifestation of these statements, Israel's current water trends are claimed to be the legacy of many years of neglect and disregard of continuous water problems by governments, policymakers and authorities. During the first two decades of the state's existence, water shortages were perceived in terms of a problem of accessibility, and not of quantity, congruent with the Zionist ideology of settling the land of Israel, securing food sources and the first Prime Minister's vision of "Blooming the desert" (Menahem, 2001; Alatout, 2008). But even when shortage of water became apparent, lack of long-term planning and unrealistic optimism have prevented the transition to a more sustainable water management (Tal, 2002).

Following several clusters of dry years, the Israeli Water Authority had launched a master plan in 2002, which deals with the need to develop, independent of precipitation, sources of fresh water supplies, among them desalination plants (IWA, 2002). The plan set a target of approximately 400 million cubic meters (MCM) per year of desalinated seawater to be produced not later than 2004 and 540 MCM/yr. by 2010 (44% of the total annual production). The basic concern of the 2002-2010 water management strategic plan was the need to replace the problematic historical assumption that ruled water management strategy. Since for decades decision-makers and regulators have been "walking on the edge" of water sources (for the water map of Israel see Figure 3 below), utilizing them as much as possible, devastating consequences are now increasingly apparent, such as the drying out of natural flows in streams; the salinization of the coastal aquifer; severe pollution of wells; and the perturbing drop in the levels of the Dead Sea,

Figure 3: The water map of Israel consists of main attributes of the water system: the two largest aquifers, the national carrier and the four operating desalination plants along the coast-line.

to name only few (Tal, 2002). The newer approach, however, had sought to increase supply "only" to meet demand. Although already quite behind schedule, governmental decisions have by now raised the targets even more and it is now expected that the four new plants will produce 750 MCM/yr. to supply all domestic needs of the country by 2020 (Governmental decision no. 3533 from 1.6.2008). Meanwhile, the Water Commissioner had explicitly declared a state of emergency with respect to water and initiated new regulations for agricultural and domestic sectors, along with public campaigns to promote water saving. But the question of what will be the best strategy for sustainable management of water resources in the country remains a burning public controversy, with scientists, policymakers, politicians, environmentalists, journalists and members of the general public all engaged. Moreover, the way in which desalination technology has contributed to a major transition in the water system bares the question of its hidden costs and its subsequent implications on both the natural and the social systems.

Simultaneously, new discoveries of natural gas deposits in Israel's sea territory are accelerating a transition from coal-based electricity generation, which was based on 100% imported fuels, to approximately 40% local, self-supplied natural-gas based production. The new discoveries along with three other emerging technologically-based alternative sources of "local" energy: nuclear, solar and oil-shale have induced a discursive shift and a social construction of an unlimited energy supply, which eventually feed-back to the on-going transition. These developments echo in many respects the transitional constitutes of the Israeli water regime: both water and energy are scarce resources which the State has had to secure since its incipient years; both are still controlled by governmental or semi-governmental monopolistic bodies in which the public is hardly ever involved; while still, in both sectors, partial privatization or profit-induced changes influence strategic decision-making and policies, regulations, technological choices and efficiency measures.

Previous research supports the claim that the implications of a policy decision to embrace a certain technology are embedded in wider economic and social contexts (such as privatization schemes) and reflects certain values which societies may hold. Marsh and Sharma (2007) have undertaken an exceptional attempt to develop an input-output model assessing a range of technological options for the New South Wales region in Australia, in the context of the water-energy nexus. They have developed four scenarios, which describe different existing options to meet future water needs considering their energy footprint. Their findings concentrated on the socio-economic and institutional conditions under which desalination technology would fit the most. They suggested that desalination is accepted as the most favourable technological solution, when policy makers' technological preferences are based on consumerist values and affiliated with the notions of world markets and international trade. In contrast, when global sustainability trends, stable political environments, international cooperation and maximization of regional resources are prevailing characteristics in peoples' worldviews, they would tend to support water strategies that include demand reduction, water recycling and water harvesting, rather than desalination. This research has several limitations. First, it assumed the sustainability of an integrated approach to the management of water and energy, rather than proved it. Furthermore, it did not establish a direct connection with stakeholders; rather the scenarios were created by the authors based on existing international scenarios such as IPCC studies. Lastly, their scenarios are limited by a lack of a vision, in which significant socio-technological innovation might play a great role and influence a certain course of development. Despite these limitations, the research's findings are interesting and might reflect some tendencies behind the choice to support desalination in the Israeli polity.

Decision-making in Israel was historically concentrated at national levels. Especially in regard to the environment, the founders of Israel have created a highly centralised system of controlling its resources, designing and implementing policies (Menahem, 1998; Tal, 2002). The Israeli Ministry of Energy and Water Resources is in charge of both water and energy sectors;

the National Water Authority and the Israeli Electric Corporation (IEC) operate under its direct authority. Principally, the government, the relevant Ministries and Inter-Ministerial Committees are responsible for setting the agenda and formulating national strategies. In practice, however, the national Water Authority controls most aspects of water, as well as the design of long term strategic plans (as the aforementioned master plan), short-term policies (such as water allocations) and regulations (such as a "drought tax"). The national electric company, as the sole company in the country, has historically established a dominant position within the energy sector, thus allowing itself to have a major influence also in the policy domain.

Currently, any move attempting to address the issue of water or energy scarcity, especially at the backdrop of advanced technologies (such as Reverse Osmosis membrane desalination or solar PV panels), is closely linked to wider changes in socio-economic arrangements and governance as well as institutional trajectories at both the national and international scales. This thesis argues, as will be elaborated later, that transitions of the Israeli water and energy policy regimes are motivated not only by technological breakthrough and discursive shifts in each sector independently, but also by inherent interdependencies between the two sectors. It argues that these two socio-technical transitions are coupled and therefore, that any sectoral analysis of policy transitions contributes only partial explanation for such dynamics.

This research is therefore interested also in these wider processes within Israel's national governance and institutions that make certain alternatives attractive upon other mechanisms governing supply and demand of natural resources, such as efficiency and conservation policies. Alternative approaches could have lower economic, environmental and social costs or higher benefits in terms of availability and security of supply, especially in the face of coupled transitions.

1.6. Aims and questions

The aim of the thesis is to examine interdependencies, essentially environmental, of policy dynamics. More precisely, this thesis aims to re-theorise the interplay of technology, policies and discourses within sociotechnical regimes and to examine the merits of these relations from an inter-sectoral perspective. The study applies an integrative approach (new-institutional, co-evolutionary) to the empirical understanding of the complex and dynamic processes shaping the water-energy nexus, as this interface defines the nature and scale of these two sectors coupled transitions. This study identifies three specific conceptual questions that stem from the quest after a better understanding of the relationships between these sociotechnical components, as follows:

i. ***How does technological change affect policy in sociotechnical transitions?***

ii. ***What is the role of discourses in policy dynamics of sociotechnical transitions?***

iii. ***What does the interdependency of socio-technical regimes mean for their transition? How can coupled transitions be directed toward greater sustainability?***

The first conceptual key-question which this thesis addresses is that of providing an additional account of the relationship between policy change and technologies in socio-technical systems during transition. While theories of policy change can be classified as either problem centred, actor centred, or external crisis based, the water regime case-study provides a fruitful ground to examine the ways and mechanisms by which technologies may affect policy dynamics and contribute to either change or continuation. At the empirical level, the investigation focuses on the question of how technological improvement of seawater desalination technology has

contributed to a shift in the Israeli water regime, altering infrastructures and institutions through the mechanism of displacement.

The second crucial question in this study considers the effect of a discursive shift on technologies, policies and social arrangements in socio-technical transitions. The Israeli energy regime serves as an interesting case to examine the emergence of a new discourse on energy abundance which is replacing an earlier discourse on energy scarcity, and the ways by which moving away from traditional conceptions of the scarcity of energy resources has constrained socio-technical transitions, delimited future pathways or technological trajectories and influenced social capacities.

Finally, The two parallel transitions in the Israeli water and energy policy regimes, as outlined above and analysed in depth in chapters 4 and 5, have led to the objective of showing the inter-linkages in the unfolding of policies in these two transitions over the past several decades (in chapter 6). With question three in mind, this thesis further examines (theoretically, not empirically) the ability of current models and theorisations of decision-making processes and the transition management approach to deal with cross-sectorial transitions. The analysis also begged a preliminary conceptual discussion on whether and how these policy transitions may be oriented towards greater sustainability and the merits and pitfalls of a more integrative transition management model.

These three questions are general in nature. I will use them as a starting point and their broadness will allow me to focus on particular details at a later stage. The motivation for these research questions is primarily conceptual in nature, thus justifying their broad form and generality. I will go back to reflect on this choice of questions and its implications in the concluding chapter of the thesis (chapter 8).

1.7. Outline of chapters

This thesis is divided into eight chapters. **Chapter 1** introduced the key-dimensions of the research problem, the empirical and theoretical justifications for the research and the research overall aim and specific questions. **Chapter 2** contains the conceptual material of the research. There I develop the theoretical basis for the analysis of the data presented in the three main empirical chapters (chapters 4, 5 and 6) and identify gaps in the literature.

Chapter 3 sets the methodological stance of the research. I specify the methods used and raise methodological challenges in interpretive policy analysis. This chapter also set the socio-economic, political and environmental contexts of the case-study. Following, chapters 4 to 6 describe the two selected case studies. Whilst each chapter presents a separate topic, they share similar structure. Each chapter contains: brief introduction, outline of the setting in which the research took place, a crystallized and focused literature review; a section of discussion that contains the analysis of data, and a short conclusion part.

Chapter 4 introduces the institutional setting of the Israeli water policy regime, the main characteristic of water infrastructures, supply and demand as well as a short presentation of issues that were not considered central but nevertheless are relevant and important as background information for this thesis, such as the Dead-Sea, the Red-Dead Canal and The Palestinian water situation. I continue with the presentation of a theoretical framework against which the first research question was formed. The empirical analysis is based on a case study of Israel's water regime, particularly the dynamics which surround the expansion and diffusion of desalination technology, as a panacea to water scarcity in the country. I discuss its origins and implications and close the chapter with a few intermediate conclusions.

Chapter 5 introduces the institutional setting of the Israeli energy policy regime, the main actors in the policy arena and the main patterns of supply

and demand. I present the theoretical framework that links STS with Discursive Institutionalism and empirically show how discourses affect socio-technical transitions. I move on to discuss the implications of the shift on energy pathways and conclude with a few remarks on the long-term sustainability of Israel's energy policy regime.

The principal conceptual contribution of the thesis can be found in **chapter 6**, linking chapters 4 and 5 and addressing the interdependencies and the co-evolvement of Israel's water and the energy regimes. After a short presentation of the conceptual framework, the chapter focuses on the expression of the water-energy interface in the Israeli context. The discussion and the following conclusion subsections deal with the question of how these policy processes may be oriented towards greater ecological sustainability and lay the ground for a new integrative model for transitions management.

Chapter 7 presents a coherent discussion and an account of the links between theory (chapter 2) and empirical findings (chapters 4-6). It suggests the merits of a more integrated transitions management model and further highlights the main theoretical contributions of this thesis.

Chapter 8 concludes and details implications for policy and recommendations for further research. There I also reflect on the choice of methodology and raise key challenges in conducting this study.

2. A review of conceptual approaches to policy dynamics

> *"Technology constitutes a new human environment that is unsuited to human symbolization; technology has turned into its own symbolic transformation" (Ellul, 1978:216).*

2.1. Introduction: conceptualising environmental policy dynamics

The assumption, that addressing only the social dimension of environmental issues (such as management and impacts) without an appreciation of resource and ecosystem dynamics will not be sufficient to move society toward sustainable future, is now widely accepted (Folke et al., 2005). Key-questions are therefore reciprocal, interested in what ways ecological phenomena extort human responses, and in return, how do human practices influence ecosystems (Dietz *et al.*, 2003). Systematic interconnectedness elicits integrative lookout at the coupling of the socio-environmental systems. A theoretical recognition of the complexities involved in this coupling of systems has produced a set of both implicit and explicit interpretations of sustainability, all with various implications for policymaking. As I noted earlier, the core element in the various interpretations reflects the need to reconcile the points of friction and tension where the two systems interact. Accordingly, the most widely accepted definition of sustainability places its principle on three interconnected building blocks: environmental integrity, societal equality, and economic security, while recognizing that each system carries its own complexity and vulnerability (Sneddon *et al.*, 2006). Despite ample possible critiques of this concept, developing models of sustainability in recent decades are indeed appreciated mainly for their integrative promise: "as the study of complex adaptive systems continues to inform our understanding of socio-ecological interactions, models of sustainable development will likely continue to integrate this knowledge" (Newman, 2006:633).

Yet, integration has also become a key-problem as policy making in general and utility companies in practice, are now required to deliver solutions in what is appreciated as a highly interdependent world. This is why this thesis has set the target of studying several aspects in what is manifested as, at the bottom line, a problem of integration. In order to study this phenomenon, this chapter reviews key-literatures that provide ingredients to the analysis in chapters 4-6, and more precisely, the strands of the literature that are most equipped to deal with changing policies in an interdependent world. I will outline the way classic public policy approaches have dealt with dynamics, providing the important starting point for any study; how institutional approaches and especially the institution of discourses have provided useful insights to the study of change and continuation; and how combining socio-technical approaches with policy dynamics complements the aspect of technology, a crucial constitute in almost any socio-environmental relation.

Since the 1960s, environmental policymaking[4] has been commonly based on the integration of Costs and Benefits (CBA) associated with alternatives for action into a quantitative decision-making calculus, including the analysis of environmental considerations, which are not conventionally valued in term of money (Easter *et al.*, 1999). It has been also occupied with standards setting, monitoring, enforcement and assessment at the level of one environmental media or natural resource. Two developments have drastically changed the way environmental policy is theorised and practiced. First, in spite of the fact that environmental decisions are still determined within the polity arena, in the face of current environmental degradation, there is a dual pressure on decision-makers to make decisions less on the base of CBA and more based on the integration of scientific expertise, while making sure that the process is at the same time deliberative, democratic and transparent and that private

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[4]A broad term, here refers to the course of state's actions with the aim of promoting sustainability by finding a solution to what is jointly perceived and defined as an environmental problem.

and public stakeholders are also involved (Drori *et al.*, 2003; Irwin and Michael, 2003; Jasanoff, 2004).

Second, considering the range of environmental issues, the possible number of alternative management strategies, and the cumbersome structure of governing institutions, the policy process in this field is expected to be far from one, coherent or consistent activity (French and Geldermann, 2005). Environmental problems are many times transboundary in nature and therefore require cross-national cooperation (Chechile, 1991). Environmental intervention is risky, often irreversible and inevitably involves making trade-offs between several concerns, which are often competing over attention and funds (Kemp *et al.*, 2005). Above all, policymakers hold inexplicit responsibility - in the spirit of The Brundtland Report - to consider, in any environmental decision-making process, the needs and rights of "the next generations". Because environmental problems tend to be inseparable from problems in other times, places and environmental media (Dryzek, 1987), or from other aspects of life, environmental policymaking is increasingly treated only as a function in the broader framework of environmental governance (Adger *et al.*, 2003). Nevertheless, despite the many facets of interdependencies, in reality, policy fields still focus independently on discrete problems in specific environmental media, and those policies usually deliver narrowly defined solutions.

This complex and multi-faceted nature of common policy processes is dealt with by a large number of literatures in public policy, political science and organizational theories, and from various perspectives, aiming at understanding how the multipart entity of the state, political actors and other players interact and produce public action in discrete sectors or policy regimes (John 1998). Studies also revolve around questions of change and continuation of these actions.

The mechanism behind sectorial handling of problems can be better understood in light of the policy regimes concept, which encompasses institutional, organizational, and regulatory arrangements for governing an

established issue area (such as the environment), driven by certain policy paradigms (Vogler, 2000; Young, 2002; Menahem, 2008)[5]. The literature often considers international environmental policy regimes explanatory structures of multi-scale changes and continuities underlining the interplay of international institutions, policy-making and cross-national cooperation. Scholars are also increasingly applying the concept of a policy regime to national policy domains (Jochim and May, 2010), as will be used here, to examine three main questions: (i) why certain policies and policy regimes are more stable or resistant to change than others; (ii) what exogenous factors and internal forces are affecting the process of decision-making and the life-cycle of one policy or an entire policy regime and; (iii) what is the relative ascendancy of structural verses actor-centred explanations of policy regime dynamics. To begin with, a quick comparison between international policy regime and national policy regime research suggests that also in the latter, changes are understood to be driven by (local) actors' maximization of power, status or autonomy, and/or by the aspiration of the rational actors to achieve the most efficient allocation of resources (cf. with Young, 1994). They compare in another aspect as well; dynamics in a national policy regime cannot be explained solely by political processes since social, economic or natural forces also play a role in complex structural changes.

The cycle of policymaking in any policy regime necessitates interaction between many entities, actors and/or institutions. One might therefore expect that policy regime dynamics - especially environmentally-related and that are aimed at delivering sustainability - necessitate cooperation, coordination or integration of some sort and level, and that such mechanisms would lie at the

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[5] Policy regimes are analytically differentiated from socio-technical regimes. Although in both instances the term indicates on the assembly of various constitutes in space and time, in the first case the concept is used to point solely on governing arrangements at some scale (national, international). Sociotechnical regimes as will be further discussed include a particular state of policy regime as well as other constitutes (technologies, cultural norms and so forth).

heart of any intact policymaking process (Peters, 1998). In practice, however, empirical evidence alerts that policy regime changes in governing systems are rather, to a great extent, "sources of causation, feedback, and the sheer complexity of what is going on" (John, 2003:483).

A prominent practical challenge to greater cohesion at the national level, for example, is *departmentalism*: a sectoral rivalry over resources, media coverage and political capital that renders coordinated decision-making impossible (Kavanagh and Richards, 2001). A counter effort against sectoral interests is the attempt to promote horizontal integration, that is, an intra-sectoral policymaking or in British terms - a "joined-up government" and what Dery (1998) calls "overall policy formulation", which is the attempt of different sections within one department or different governmental entities to create synergies between policies and use the same goals to formulate it (Geerlings and Stead, 2003).

However, given the relatively short tenures of politicians and the ad-hoc nature of political activity (Pierson, 2000), it is not surprising that some problems, tensions or costs are intentionally ignored or reframed as the responsibility of someone else. Moreover, studies are often informed by cases in which even the most authentic attempt to practice policymaking (e.g. forming solutions to problems) inevitably meet the challenge of interdependencies. The term *'displacement'*, for example, is sometimes used to describe situations where decision-makers avoid the treatment of messy (or "wicked") problems, especially when these traverse the technocratic exercise of policy-making and involve or require political attention (Dryzek, 1987). As will be further illustrated in chapter 4, from an environmental point of view, displacement can have a physical manifestation. Dryzek (1987:428) argued, for example, that "any improvement on a single indicator... may mask problem displacement to another medium or location". That is, environmental problems and impacts can travel spatially and be transferred to other environmental media (e.g. water, air, or soil). For Dryzek (2009:4), the combination of short-term political thinking as of Pierson, and environmental

problem displacement, are manifestations of the "ecological irrationality" that characterises contemporary liberal-democrat states.

Given the amplifying cases of policy interdependencies and problem displacement between times, places or from one media to another - such as in the case of water and energy interdependencies - the problem of integration thus becomes a key-concern. Yet, much of existing academic research in this field concentrates on "greening" sectoral policy regimes, by the integration of environmental concerns into decision-making in distinct non-environmental sectors (Baker, 2006) (see appendix 1 for a summary of literatures). Lafferty and Hovden (2003:2) have argued that the merit of environmental policy integration entails "...a revision of the traditional hierarchy of policy objectives, with the portrayal of environmental objectives as central, if not principal". Environmental policy integration (EPI) might be crucial in offsetting what is perceived as the trade-off between economic growth and environmental integrity in line with the principles of sustainability. Yet, it remains confused and vague regarding the meaning of the notion itself and undetermined regarding ideas about what should be integrated, why, how and by whom (Nilsson and Persson, 2003; Scarce and Sheate, 2002; Pollitt, 2003; Hertin and Berkhout, 2003; Bammer, 2005).

Regarding how policy side-effects or externalities could be reduced, there are some insights already in the existing literature. Among the strategies of Beck and his co-authors (2003) for overcoming side effects is the suggestion to always expect the unexpected. Grunwald (2007) advises that governments and policymakers should reflect more about decisions and interactions among actors in order "to gain knowledge about interests, perspectives and capacities and to learn about the character of social/environmental linkages" (Meadowcroft, 2007:309). Researchers often propose that greater cohesion, cooperation and greater integration between sectors and policies could help prevent some of the spills-over, undesirable outcomes of policies, which are otherwise postponed or dislocated (Meijers and Stead, 2004; Bammer, 2005). Horizontal institutional interplay potentially generates incentives to manage cooperation that can yield joint gains or prevent losses (Young, 2002). Policy

integration, however, is not easily achieved and transaction costs may still be high (Geerlings and Stead, 2003; Fischhendler and Heikkila, 2010).

It appears that beside a general agreement that environmental policy integration is a way to encourage the rationality and effectiveness of policy-making and implementation, studies do not engage too profoundly with challenging interdependencies. As examples to interdependencies, one may consider how policy dynamics becomes more complex with the growing integrative capacity of physical and biological elements in each policy regime, such as utility infrastructures. Dynamics are also exacerbated by the greater amount of individual actors and policy networks that are involved and the greater "organizational inputs" (funding mechanisms, stakeholders feedback and evaluation procedures) that need to be integrated into the policymaking process.

With the water-energy nexus in mind, the aim of this thesis is therefore to engage with the question of the ways to deal in theory and in practice with policy dynamics in an interdependent, complex world. As mentioned above, I would study this question of cross-sectoral dynamics in the water and energy policy regimes, through three theoretical lenses that deal with policy dynamics: traditional models of decision making, institutional approaches to policy and the sociotechnical transitions scholarship.

I will argue, however, that although traditional models of policy dynamics and institutional, structural-based approaches, are a good starting point, they are both largely unequipped to deal with complex policy dynamics that cannot be understood independently but through their interaction with other policies. This is because most often, these approaches' unit of analysis pertains to the level of one sector. While socio-technical transitions studies are complementary, adding to the complexity the technology factors and technological change, they are nevertheless also lacking a focus on the interdependencies of large technology-based, infrastructural sectors (such as water and energy). Furthermore, it is in my intention to show how, in our contemporary complex technology-driven world, these various policy

dynamics literatures on their own cannot explain substantive changes of systems from one state to another, beyond the policy terrain (hereafter '*transition*'). Thus, the interplay of policies, technologies, and discourses, as central constitutes in dynamics and transitions, is insufficiently conceptualized.

To move a step forward, I present the Transition Management model as an alternative to more traditional models of environmentally-related decision and policy making, especially those concerning long term sustainability. The model is also an intriguing platform to deal with cross-sectoral interdependencies and coupled transitions, a task which I undertake in chapter 7.

The present chapter helps to retheorise the interplay between policymaking and technology, and the shifting roles of actors, networks, paradigms and discourses. It will also provide the ingredients to developing an analytical framework in chapter 6 for cross-sectoral dynamics, such as in the case of the water-energy interface. For the sake of clarity and flow of argumentation, a selection of state-of-the-art literatures has been incorporated within the empirical chapters four, five and six rather than here. Hence, the reader is directed to the relevant chapter when appropriate. This chapter will present a more general conceptual base; will point to its weaknesses; and will identify research gaps.

This chapter is organised as follows: section 2.2.1 introduces traditional approaches to the study of policy dynamics. It explores traditional models of agenda-setting, procedures of decision-making and triggers for dynamics. Section 2.2.2 delves into less actor-based and more structural-based approach to policy dynamics through the focus on institutions. Understanding the relative importance of both actors and institutions is important to shading light on the interplay between policy, technology and discourses. Section 2.2.3 reviews key-components in Social Studies of Technology (SST) literature, including the system, co-evolution and transition approaches to socio-technical dynamics. It highlights the role of technology and the co-

evolutionary manner of policy changes, thus contributes to a more profound explanation of systems' interdependencies. The final section numbered 2.3 concludes this chapter.

2.2. Competing approaches to policy dynamics

2.2.1. Classic public policy approach to policy dynamics

Models mostly describe a chaotic, unpredictable, sometimes arbitrary procedure of making policies. Even when stages of the process can be defined and identified, such as problem framing, establishing alternatives and implementation (English et al., 1999), it is often agreed that any mechanistic, linear and distinct model cannot explain what initially had generated the process and usually fails to tell us about the interfaces of politics and power, and the interests, conflicts and social networks at play in real-life policy arenas (Lindblom, 1959; Fischer, 2003). Decision-making processes might be better depicted as 'garbage cans', into which various kinds of problems and solutions are dumped by participants as they are generated (Cohen et al., 1972) and the policymaking procedure as a 'primeval soup' (Kingdon, 1995). From an actor-based perspective to policymaking, the process is understood in light of the interactions of actors participating. Yet, while rational-perspective models of decision-making have portrayed an individualist process of agents who make decisions as if they hold perfect information on which to ground their decision and that it is possible to predict, consider and know all possible future outcomes (Simon, 1976; Faucheux and Froger, 1995), critics have challenged this great emphasis on rationalism and portrayed it as too ideal, but not real ("bounded rationality"). Alternatively, decision-making is argued to be made without any fixed goals in the policy-makers' mind, but through an incremental process in which problems may be defined and redefined in light of the available means to solve them and through negotiations and coalitions among the participating agents (Lindblom and Woodhouse, 1993). Decision-making at the polity is therefore everything but organized; it is rather the science of "muddling through".

The incremental approach to decision-making may indeed explain how alternatives to a certain decision are evolved based on mutual adjustments of individual interests of participants in the process (Lindblom, 1959). Nevertheless, the model is limited to explaining gradual processes of bargaining and can hardly account for abrupt changes in decisions or policies (Kingdon, 1995), or "punctuations" in policy (True et al., 1999). Baumgartner and Jones (1993) therefore suggest that public policy-making is characterised by stable periods, which are interrupted by punctuations. Pempel (1998 in Streeck and Thelen, 2005:7) similarly argued that path dependencies - inherited and entrenched systems of governing - are "periodically ruptured by radical change, making for sudden bends in the path of history". Policy changes, like radical political-economic shifts (a popular example is the 1970s' transition from Keynesianism to monetary capitalism in Britain), are a particular subject for theorization. Prominent American political scientists, such as John W. Kingdon, Paul A. Sabatier and Frank Baumgartner put the initial stage of agenda setting at the focus of investigation of policy change. Others, such as Aaron Wildavsky, have put greater emphasis on the stage of policy implementation.

For example, with a strong explanatory power, Stone's (1989) study has offered that decision-makers' choice to push forward particular issues is much depended on the kind of 'causal story' which they were able to draw. In order to target an issue, it usually needs to be defined as a problem that can be explained in terms of human intention or conscientiousness. In order to put a problem high on the agenda, decision makers and political actors will therefore try to push their casual story out of the realm of accident or natural disaster into the realm of human intent and responsibility. Alternatively, according to Kingdon (1995), certain issues can be abruptly pushed forward, if the right "window of opportunity" is formed. Policy is made through three parallel streams: recognition of problems, generation of solutions, and deployment of political interest. External shocks, such as environmental or monetary crises can also be seen an alternative trigger for punctuation in policymaking; these interact with internal competition between 'advocacy

coalitions' over different ideas and values - termed by Sabatier and Jenkins-Smith (1984) 'policy core beliefs'. Advocacy coalitions attempt to translate their policy core beliefs into policy decisions through the utilization of 'guidance instruments' such as changes in rules, budgets, personnel or information (Sabatier and Jenkins-Smith, 1993).

Several ways to typify policy regimes dynamics and classify their triggers have therefore been proposed. Jochim and May (2010) have classified the triggers of policy regime changes into crisis-driven and coalition-driven. Policy change and continuity are often explained by the consolidation of an identified problem, solution and a political gain which may open up a "policy window" (Kingdon, 1995); by external crises such as an economic downturn, war or droughts (Sabatier and Jenkins-Smith, 1993; Jones, 1994); or by an endogenous reconsolidation of policy networks, epistemic communities, interest groups, or policy entrepreneurs (Atkinson and Coleman, 1992; Haas, 1992; Hall, 1993).

A core perspective that emphasises dynamics, by focusing the analysis on networks, can be found in:

> ... *a decentralized concept of social organization and governance*: society is no longer exclusively controlled by a central intelligence (e.g. the State); rather, controlling devices are dispersed and intelligence is distributed among a multiplicity of action (or 'processing') units. The coordination of these action units is no longer the result of 'central steering', or some kind of 'prestabilized harmony' but emerges through the purposeful interactions of individual actors, who themselves are enabled for parallel action by exchanging information and other relevant resources (Kenis and Schneider, 1991:26 emphasis in the origin).

Rhodes (1997:426) identified already some time ago the cross-scale interactions in the polity arena as a process of "self-steering inter-organizational networks" and policy networks as "sets of formal and informal linkages between governmental and other actors structured around shared if endlessly negotiated beliefs and interests in public policymaking and implementation".

The constellation of policy networks provides an arena for mediation and negotiation, communication and coordination of interests of either a single actor or a cluster of actors, built up around traditional ministerial policy sectors. The notion of policy networks, which provides a useful model to map and describe the relations between actors in a specific policy domain and explains a decision-making process or outcome, is commonly used for policy analysis in the EU context (Peterson, 2004), with an emphasis on the continuous leading position of formal government. The structure of a policy network is to a great extent defined by the strength of links between its members: a 'policy community' would be capable of steering or controlling the policy process while 'issue networks' are more loosely-affiliated (ideologically, politically, financially) and would find it harder to exercise a collective goal (Rhodes, 1997). Both concepts are based on the assumption that the individual resources of an agent will influence his relations with the other agents and thus the scale of dynamics. Nevertheless, networks function also in a similar manner to structures (see section 2.2.2), as implied by Wasserman (1994:xiii): "network models focusing on individuals view the network structural environment as providing opportunities for or constraints on individual action".

By providing a bridge between the micro (actors) – and the macro (structures) orders, the policy network model certainly fills a void here. Stone (1989) herself pointed to the weakness of the agent-based description; her story misses institutional/structural patterns of individual and social behaviours that are needed in order to give a broader explanation for why issues are constructed as "problems" in the first place and are then subjected to policy intervention. Indeed, while studies have given agent-centred analysis to processes of decision-making, research in these fields has increasingly shifted emphasis toward structural explanations, assuming that individuals are constrained by larger entities, and that their actions are only a vessel through which these entities essentially affect policy outcome (Hall and Taylor, 1996), as will be further discussed below.

2.2.2. Institutional approaches to policy dynamics

The structural-based approach to policy dynamics suggests that political institutions (the parliament, the courts, the bureaucracy) structure policymaking processes, outputs and outcomes. Constraining the behaviour of individuals, institutions enforced the "government of laws and not of men", articulating clear, context-based norms, values, habits and customs for societies (John, 1998; Peters, 2005), but maybe unrealistically leaving state officials' interests and societal groups, for example, out of the realm of influence and power. Neo-institutionalism, has therefore moved away from only describing institutions, to paying particular notice to the institutional environment in which social action takes place.

2.2.2.1. Neo-institutionalism

According to neoinstitutionalism, institutions are no longer narrowly defined as formal structures in which aspects of activities (administrative, legal and political) are evolved, formed and governed (North, 1991; Hay and Wincott, 1998). Rather, institutions, in a much broader sense, "incorporates informal and formal procedures, practices, actor relationships, costumes, norms and traditions" (Jones and Clark, 2001:6) that structure, constrain and stabilise behaviour in the polity (Peters, 2005). In their influential paper, Hall and Taylor (1996) have depicted three fundamental analytical streams: historical institutionalism, rational choice institutionalism and sociological institutionalism. Recently, the role of ideas and knowledge production in institutional dynamics is increasingly recognised as an additional stream (Frank (Frank and Hajer, 1999; Schmidt, 2008). While all agree that institutions matter, the streams differ in the form, scope and extent to which institutions are attributed with significance.

In short, similar to rational-perspective models of decision-making, *rational choice institutionalism* (RI) suggests that actors achieve their policy objectives in a self-interest manner. Similar to the 'bounded rationality' thesis, however, it claims that actors' rationality is bounded, but this time not

confined to physical limitation, but to an agreed set of institutions that provide them with the rules of the game and impose restrictions equally upon all. In turn, *historical institutionalism* (HI) asserts that policy choices are hard to change because once policy is initiated future actors will play according to its given arrangements. *Sociological institutionalism* holds that actors behave according to a set of cultural frames, including values and symbols. Their policy choices heavily depend on their normative perception of the situation (Hall and Taylor, 1996; Jones and Clark, 2001). The three neo-institutional streams share the assumptions, that a particular institutional design would therefore favour one policy network above others, affect actors' strategies and define the range of potential policy changes that can be brought about.

For the study of environmental decision-making, and particularly questions related to the relation between participation, knowledge and sustainability, rational choice institutionalism for example, had offered a significant contribution. Institutions, as definers of rules, control who has the access to a resource, for what use and to what extent, as well as who is eligible to participate in decisions about these issues. According to rational choice institutionalism, many types of formal and informal institutional arrangements are able to reduce problems of overuse or misuse of common-pool resources, despite the traditional pessimism regarding the ability of communities to sustainably manage them (Dietz et al., 2003). The neo-institutionalism wave has inspired many more studies related to socio-environmental issues, in regard for instance, to environmental management and protection of collective resources (Mccay, 2002; Dietz et al., 2003; Paavola and Adger, 2005), environmental planning (Rydin, 2003) and environmental performance of businesses (Prakash, 1999). It was pointed out, however, that these studies are largely disregarding an important type of player, that is, discourses.

2.2.2.2. Critical neo-institutionalism

A fairly new strand of neo-institutionalism is based on the Foucauldian legacy of discourse and the critical policy analysis disposition. *Discursive*

institutionalism (DI) uses discourse not only in its common sense of a shared form of speech entangled within a particular context, but "...a complex entity that extends into the realms of ideology, strategy, language and practice, and is shaped by the relations between power and knowledge" (Sharp and Richardson, 2001:195).

Its main arguments are based on the assertion that rational choice institutionalism, historical institutionalism and sociological institutionalism provide mainly a static approach to institutions, which describe stable policy regimes, but are limited in their ability to explain dynamics (Schmidt, 2010). For instance, RI pinpoints the logic behind policy changes on the interaction among rational actors that depend to a large extent on fixed preferences and regularity of their institutional setting and therefore relies on external forces such as economic crisis to explain changes inside the polity. In turn, HI analysis is based on the assertion that policy change and institutional restructuring are path-dependent. Institutions are thus rather known to have "a continuing and largely determinate influence over the policy far into the future" (Peters, 2005:71).

Discursive institutionalists argue in turn that ideas (Hall, 1993; Hay, 1999), narratives (Mcbeth et al., 2007), and discourses (Campbell, 1998; Rydin, 2003; Raven and Verbong, 2007; Schmidt, 2008) may provide a more critical explanation of institutional and policy dynamics. DI suggests that discourses pattern interests, preferences and strategies of actors (Schmidt, 2010) and explain how they are embedded in their choices and actions. While there is a wide agreement that discourses or narratives alone do not cause institutional change, they nevertheless may be a part of a powerful causal explanation (Blyth, 1997; Schmidt, 2010)[6]. Schmidt (2008; 2010) has therefore suggested

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[6] In order to make sense, discourses have to be analytically distinguished from the institutions they ought to change. When discourses are not merely shared ideas but rather can be attributed with a deliberative intention of their "owners" to extract change, they should be referred to as an analytical category by itself (Arts and Buizer, 2009).

to call attention to the ways "foreground discursive abilities" (including ideas, narratives, paradigms, frames etc.) of politicians and policymakers about societal, cultural or economic goods, reshape institutions, forcing them to change, adapt or even disperse by actively restructuring actual preferences, strategies, and normative orientations of actors.

Central to the approach of discursive institutionalism is the concept of *power* and therefore it will be discussed here in brief. The connection between power and the role of ideas, particularly in politics, is well-established (Béland, 2010). Discourse, in the Foucauldian sense, is power. The Foucauldian emphasis of power-relations and political conflicts as shaping and reshaping meaning is expressed, for example, in Escobar's definition of discourse, as the "articulation of knowledge and power, of statements and visibilities, of the visible and the expressible" (Escobar 1996: 326). Moreover, understanding discourses as institutions means accepting them as structuring people thoughts, acts and speaking. Therefore, discourses are not only a device by which power can be individually or institutionally exerted, but rather a distinct force behind societal processes (e.g. Arts and Buizer, 2009). This understanding of discourses supports several claims I will be making this thesis, including the focus on the hegemonic discourse (and paradigm) in the water and energy sectors, even as the discourse simultaneously suppresses and marginalise others (cf. with Palmer, 2010; see also section 5.4.3 and footnote 9 within); as Arts and Buizer (2009:342, my emphasis) have asserted, studying "policy from a Foucauldian angle *means* identifying the hegemonic discourses that structure this domain...", and analysing its historical evolution and its implications (i.e. the ability to produce an effect) for the behaviour of actors and institutions.

Some critique the prepositions of DI and its self-coronation as a fourth new-institutional stream. Bell (2011), for example asserted that a more constructivist approach to HI that accounts also for interpretive agents and their interaction with wider structural contexts can engage with core elements of constructivism (discursive approaches) and explain institutional change. According to this criticism, agents, institutions, structures and ideas "holds

each to be mutually constitutive in a dialectic manner" without giving primacy to either (Bell, 2011:891). Nevertheless, discursive institutionalism is gaining an increasing attention from critical policy analysts with different interests in urban governance (Fuller, 2010); political feminism and gender (e.g. Kulawik, 2009) and; environmental-related policymaking (i.e. Palmer's (2010) analysis of renewable transport fuel policy in the UK and Lynggaard's (2007) research on changes in common agricultural policy in the EU) (see more in chapter 5).

To sum, scholars have claimed that any change (regardless of the way it comes about), any recreation or reaffirmation of policies and institutional arrangements (between actors or organization at the same level of governance or at different scales of governance), bears an effect for coupled systems and can either hinder or foster sustainable management of environmental resources, resolutions to environmental dilemmas, and the implementation of environmental policies (Young, 2002; Paavola et al., 2009). Insights from neo-institutionalism theories therefore should also be useful for studying dynamics and transitions (socio-technical dynamics). It appears that certain institutional arrangements could encourage transitions while others might prevent them. As will be further discussed, transitional processes are explained by different mechanisms (system innovation, co-evolution, external forces at the macro level and regime shifts), other than sustainability concerns. Yet, Transition Management, as a perspective, normative model to guide transitions, assumes (as will be elaborated in section 2.2.3.5.) that there is a way to control and direct these forces in a certain way, which would lead to greater sustainability, a claim which is not explicitly made by neo-institutionalists. Ideally, an understanding of the challenges behind transitions toward sustainability, can contribute to better understanding of dynamics and maybe most importantly, the ways to guide or manage them.

The neoinstitutional approach to policy dynamics contributes a more intricate explanation to the problem of integration because it reflects the complexity of the polity and human interaction (internal and external) in general, more realistically. Discursive institutionalism provides useful commentary on the

role of discourses in such interdependencies that result from different types of interactions. Furthermore, discursive institutionalism helps to bridge the gap between an agency-oriented vs. structural conceptualisation of discourses.

At the heart of the question of the best approach to analyse real-life political situations as they unfold in practice, lies the classical problem of explaining the weight of actors versus institutions in processes of change. However, considering the impossibility of disconnecting actors from their social environment, social and political scientists attempt to bridge the gaps between individual agency and conditioning of well-rooted social structures (Giddens, 1984 in Arts and Buizer, 2009:343). This effort is mirrored by models such as 'policy networks' on the one hand (see section2.2.1) and 'discursive institutionalism' on the other. DI approach was even accused for running the risk of taking institutions 'back out' from structural-based analysis (Bell, 2011). A mediated approach, which identifies discourses with neoinstituionalist, structural explanations of change and continuation, while simultaneously recognises the agency of individual actants (human and non-human) in promoting discursive constructions, seems valuable for the analysis undertaken in this thesis.

2.2.3.SST approach to policy dynamics

Up until now I focused on different models of and approaches to policy dynamics. In what follows I turn to discuss a set of literatures, broadly entitled Social Studies of Technology (SST), which are emphasising the role of technology, thus providing a genuine approach to the study of dynamics. These studies originate in the Sociology of Scientific Knowledge (SSK) scholarship, which battled to overcome the barrier preventing social scientists from studying the realm of natural and scientific facts (Shapin, 1995). A major contribution to SST was the growing acceptance of previously scientific "facts" as social constructions and technological artifact as "social constitutes", so as the rejection of technological determinism (Pinch and

Bijker, 1984). This socio-technical framework does not confine itself to one definition, conceptual framework or domain. Broadly, it contextualises technological change and its interplay with wider societal dynamics in evolutionary economics terms, through the lenses of three central notions: systems, co-evolution and technological lock-in.

2.2.3.1. Technological systems

A system approach to the subject of study is desirable when linkages between elements can be analysed in what else would be a complex phenomenon. This chapter began with a brief introduction to the coupled socio-environmental system. In the same line, the technological systems approach asserts that technology does not operate in a vacuum; neither is it exogenously designed, developed, or replaced. A technological system is rather embedded with matters of design, economy and politics (Hughes, 1994), channels of communication, social structures and social values or cultures (Katz, 1999). Hence, the development of technological artifacts should be interpreted within an analysis of the battling growth of 'systems' or 'networks'. In line with the Actor-Network Theory (ANT), Latour (2005) rejects the traditional view of society and technology as separate systems by his treatment of both humans and non-humans as actants. He also rejects the idea of a stable 'society' and argues that the social is about artifacts, institutions, procedures and concepts and their reassembly. Birkenholtz (2009) has stressed along the same lines in a study of water technologies in India the capacity of artifacts to form sweeping, unpredicted new production-relations, institutions and social networks – a process he termed "reverse adaptation". Technology, it is argued, not only results from many interacting actors and artifacts creating a complex system with its own emergent attributes, but also poses transformative powers (see chapter 4).

The view that technology can cause and has caused substantial material and immaterial changes is in no way new. Technology has often been considered the driving force of human progress and not less than a social agent of institutional and environmental change (Marx, 1994; Murphy, 2007). New

technologies may have emerged within existing networks of spare parts, infrastructures, markets, and old technologies (compiling systems), but these new technologies also serve as catalysts for social change, patterns of behaviour, preferences and order. In addition, Katz (1999) asserted that "altogether, (technological – NT) diffusion research is (or at least was) a way of describing, maybe even explaining, social and cultural change".

Early studies of technological systems used functionalist terms to explain innovation, diffusion, transfer and application of technological systems, which were conditioned in providing its function and in a 'fit' between the technology's attributes and its adopter. In the functionalist perspective, the technological system acts as an organism that can adapt its performance to external conditions (the societal environments) and adjust accordingly (Hård, 1993). However, critics have argued that the functions provided now by a specific technology cannot indicate the reason it was invented or even the purpose for its development and diffusion. Critical neo-Marxist and feminist studies have further used their terminology to assert that technology is shaped by hegemonic groups and used for particular social interests, contributing to an explanation for why innovation processes are seen as contradictory and uncertain and why the scientific superiority of a particular technological solution will not necessarily guarantee its success (Howcroft et al., 2004).

Such an analysis follows the well-established principles that firstly, technology is too easily dismissed as a tool and its effects are too easily attributed to the good or bad intentions of its users (Weinstein, 1981) and secondly, that technology embodies forms of power and authority, and indeed 'politics' (Winner, 1986).

2.2.3.2. Co-evolution

As mentioned above, the SST tradition has rejected two basic prevalent assumptions: that technological development and adoption is an independent process; and that social change is predetermined exclusively by technological development (Pinch and Bijker, 1984). The coevolutionary approach to

society and technology is in many respects also a critical response to these two premises. It can be traced back to Norgaard's (1984) book, in which he argued that an ever-increasing feedback between the social system and the ecosystem can be seen as a co-evolutionary process, wherein nature, knowledge, institutions and technology are all interrelated and a change in one sphere involves a change in others. The mutual and interdependent development of systems, such as the social and the environmental (Norgaard, 1984; Holling *et al.*, 2002), the scientific and the technological (Barnes, 1982; Fransman, 2001), the social and the technical (Rip and Kemp, 1998; Geels, 2005) or the cultural and the scientific (Irwin and Michael, 2003), is sometimes described in biological terms; systems are always responding to each other, or coevolving. Co-evolution in socio-technical systems therefore exists between technical components and social actors or networks. Co-evolution is the counter-deterministic force behind innovative technological artifacts, depicted by Rip and Kemp (1998:330) as "configuration(s) that works" (see chapter 4).

Earlier than ANT, the Social Construction of Technology (SCOT) theory is a well-cited example of the co-construction of society and technology. It is based on the assumptions that the design of a technological artifact is the product of "flexible interpretation" and intergroup negotiation of its users, and that different social groups impart distinctive meanings and objectives to it. This process thus overweighs straightforward considerations of efficiency or cost. Through a co-constructive process, users and social institutions (such as political, cultural, economic and gender rules, preferences and meanings, asymmetry of power relations and so forth) shape and reshape a newly technology's design, development and adoptions (Klein and Kleinman, 2002). Pinch and Bijker (1984) further argued that technological development is underpinned by different "relevant social groups", each with its own interpretation of sociotechnical problems and accepted definition of successful solutions.

2.2.3.3. Technological lock-in

A relatively recent development of a co-evolutionary approach is applied to dynamics that involve technologies and institutions, and is, broadly speaking, a conceptual effort to explain both changes (i.e. economic growth) and stabilization (i.e. technological locks-in) (Foxon, 2006; Paavola, 2010). Notions such as lock-in and path-dependency emphasise the link between past occurrences and limited choices and changes available for present decision-makers (Cowan and Gunby, 1996; Mahoney, 2000; Berkhout, 2002). Socio-technological lock-ins originate from formal and informal institutional systems of infrastructure, finance, insurance, supplier networks, customer preference, embedded training routines, and policy and regulative contexts, which make incumbent technologies difficult to replace and innovation to breakthrough (Hoogma and Kemp, 2002; Meadowcroft, 2009). Increasing returns from early adoption of a technology often result in that technology, not necessarily the economically or technical superior one, dominating the market (Cowan, 1990). As will be strongly evident in chapter 5, there are various factors contributing to the lock- in of socio-technical regimes, for example:

Constraint	
Technological	New technology is immature and expensive while existing technology benefits existing infrastructure, maintenance and manufacturing facilities, as well as complementary technologies (Kemp *et al.,* 1998; Hoogma and Kemp, 2002). New technologies compete not only with existing technology, but also with the socio-economic system in which it is embedded (Foxon and Pearson, 2008).
Economic	Existing technology benefits from scale economics and increasing returns (e.g. Pierson, 2000).
Environmental	New technology might have undesirable or unknown impacts. High scientific uncertainty involves taking high risks (Walker, 2000).
Social	The "coordination barrier" - a given technology will become more attractive as more people use it (Pierson, 2000). Existing technologies already carry symbolic and cultural meanings, and require specific expertise, knowledge, skills and habits, which actors would be reluctant to lose control over (Barnes, 1982; Hoogma and Kemp, 2002).
Governmental	New technologies require legal framework (in the form of

policy and regulatory	contracts), organisational capacity (involving producers, users and financiers) and political commitments of various state actors (e.g. Walker, 2000).

Table 1: Constraints of socio-technical change

In general, as noted above, a socio-technical regime will remain stable or 'locked-in', as a result of positive feedbacks or 'increasing returns' to the adoption of dominant technologies, institutions and practices, which make the adoption of new alternatives less and less probable (Mahoney, 2000; Unruh, 2000; Berkhout and Gouldson, 2003). The difficulty of moving from one system-state to another lies, among other things, in the rules, practices, skills and cognitive routines of engineers and designers, embedded in an existing socio-technical regime (Rip and Kemp, 1998). In socio-technical systems "technologies and their institutional context... interact to guide change along preferred channels and form barriers preventing switching to alternative regimes" (Berkhout and Gouldson, 2003:3).

But despite many constraints (the above list is only partial and it is usually the combined effect of a few factors that alternative technologies have to compete with) and numerous instances of technological fixation, societies constantly face sociotechnical changes, shifts and transitions that dramatically affect both the natural environment and the way people perceive it. The next sub-section is devoted to the idea of such dynamics.

2.2.3.4. Socio-technical transitions

A growing body of literature examines dynamics in and transitions of socio-technological systems (for example, from horse carriages to automobiles, from energy production based on coal to gas, or from technocratic to adaptive water management). A fresh understanding of society-technology relations is therefore developed by this growing body of literature. Entrenched within the neo-institutional and co-evolutionary traditions, it portrays policies and technologies as two cogwheels within a complex set of other societal cogwheels – culture, economy, ecology (Van Der Brugge et al., 2005; Tabara

and Ilhan, 2008; Foxon, 2010) (see Figure 1 in chapter 1). These components reinforce each other to form an interlock, a sign for a full completion of a transitional cycle (Loorbach, 2007). While stability emanates from aligned linkages between different socio-technical elements, a transition would be manifested from disrupting forces (see Figure 4 below). A disruption in the system - that results in a new 'architecture' or system structure (Lawhon and Murphy, 2012) - could be of different type and scale, including for example: a real or perceived significant damage from existing technology, such as ozone depletion (Glynn, 2002) or ideological changes in governmental functions, which occurred, for example, with the changing role of public authorities in the Netherlands from liberal avoidance to more active intervention. In the latter case, a change in perception of local authorities, have created a feeling that something had to be done by the central government to improve hygienic conditions, thus contributing to the transition to a sewer system (Geels and Kemp, 2007).

The scales of dynamics are explained by the interaction of three functional levels, sometimes referred to as the Multi-Level Perspective (MLP) (Verbong and Geels, 2007; Kern and Smith, 2008):

- **Niches** at the micro-level: where local practices create technological innovations. Especially the more radical technological breakthroughs are emerged, tested and defused within technological niches, protected from market forces.

- The undergoing physical and immaterial structuring changes at the meso-level of the **regime**, composed of societal constitutes (culture, policy, technology, science, discourses, industry and the market).

- The macro-level of the **landscape**, where wider economic, cultural and natural processes take place. The landscape conditions delimit and direct changes that take place at the lower levels.

A transition is therefore depicted as a four-phase[7] evolutionary process that has resulted in a significant transformation. These interactions and flows between the three levels are well portrayed by Geels and Kemp (2007) in Figure 4 below.

To conclude, according to studies, a transition is not simply a period of abrupt change following a crisis, as has been explained by Sabatier (1994) and it does not necessarily take place to solve a pre-identified problem, a characteristic of policy change albeit Kingdon (1995). Transition is better defined as a long, multi-stage period of structural, institutional and organizational changes from one system-state to another (Rip and Kemp, 1998; Geels and Schot, 2007), a view which blurs the distinction between radical and incremental change and therefore can also be depicted as a process of "gradual transformation". In order to identify these cases of gradual transformation (particularly of institutions), Streeck and Thelen (2005) have offered to make a distinction between the process of change - which can be either incremental or abrupt, and the outcomes of change that can be resulted either in continuity or discontinuity of the previous course (see table 2 below). In order to be depicted as a transition, a socio-technical system would experience an incremental process, which will result in a significant change:

		Result of change	
		Continuity	*Discontinuity*
Process of change	*Incremental*	Reproduction by adaptation	Gradual transformation: Transition
	Abrupt	Survival and return	Breakdown and replacement

Table 2: Types of change: processes and results. In Streeck and Thelen, 2005:104 (with my addition)

[7] Loorbach (2007) distinguishes four phases in a transition: predevelopment (the stage of experimentations), take off (the state of system starts to shift), acceleration (the transition become visible and changes are diffused within the system) and stabilization (the final stage during which the state of system returns to some temporal equilibrium).

One of the challenging critiques of any attempt to define transition was made by (Meadowcroft, 2005), who argued that compared to policies or institutions, transitions are even less definite, definable units neither in time nor space; old technologies do not completely vanish, several transitions can concurrently start, and delineating regimes might be impossible.

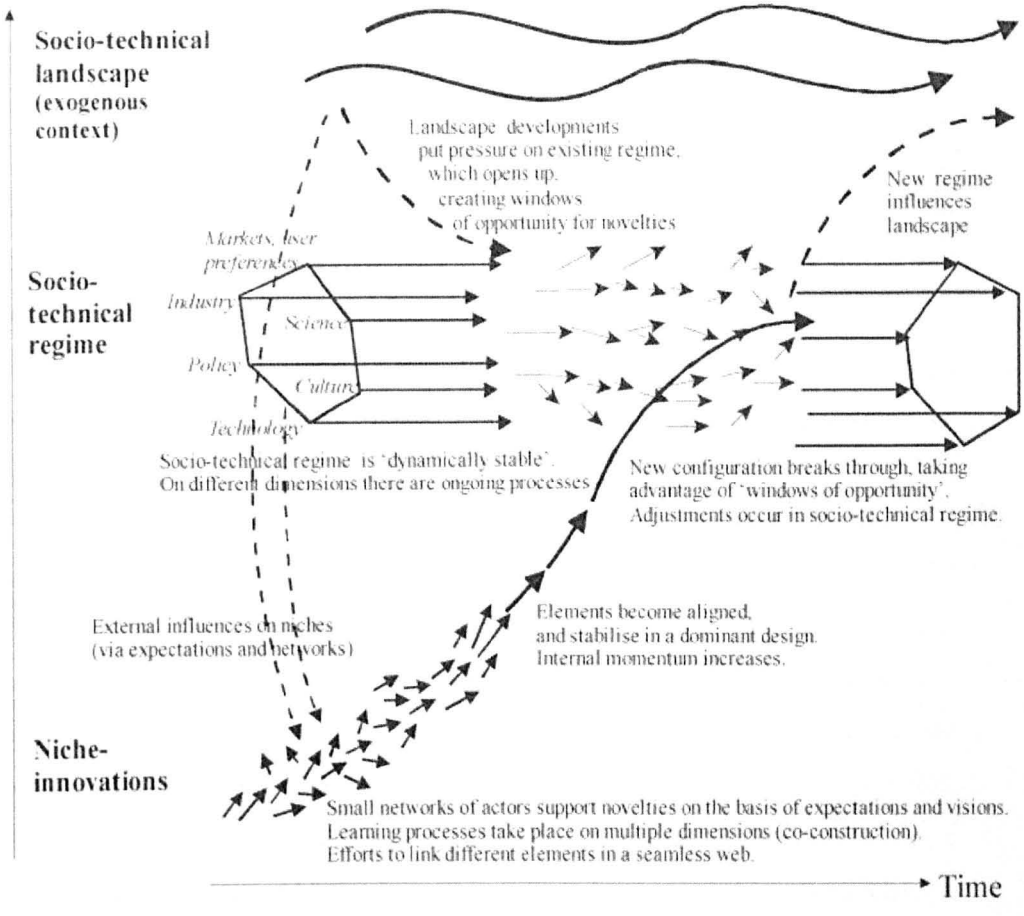

Figure 4: Illustration of the interaction between scales from the Multi-Level Perspective (Geels and Kemp, 2007:1263).

The important contribution of the sociotechnical analysis nevertheless is its strengthened observation that despite the fact that technological change is often correlated with progress, it is rather a messy, ambiguous process that increasingly requires intentional steering especially at the regime and niche levels. Notwithstanding, the need for an overall guidance is not obvious. Recently, a meta-steering of the whole transitional process is advocated by scholars who are engaged with the transition management model, as will

further be elaborated. Yet, studying the role of actors in transitions has been mostly confined to niche-managers - i.e. actors wanting to foster new technologies through information sharing, network-building or legitimising new technology (see e.g. Haxeltine and Seyfang, 2009). On top of who should be involved, there is a lacuna in these studies regarding the interests, abilities and ways in which actors could be engaged in the management process. In chapter 5, I will undertake the task of linking discursive institutionalism approach to dynamics with the socio-technical framework in order to gain a more actors-centred perspective to fill this gap.

The final part of this chapter presents the transition management model in most general lines. Since this research could not test the applicability of the model to the particular case-study, the model was rather used as a conceptual and analytical frame to study policymaking. In return, the case-study could have informed the model, as will be shown in chapters 6 and 7, by pointing to its current udertheorisation of interdependent policy dynamics.

2.2.3.5. Transition Management

Transition management (TM) is a conceptual model of a policymaking process. It is based on the assumption that socio-technical transitions that took place in the past did not necessarily result in a desirable way and that in order to achieve the goal of sustainability, however it is defined, a deliberate effort is needed. The TM model aims at long-term desirable social change and development, which could be achieved by the use of social actors and the alignment of their interactions; co-evolutionary processes of societal institutions and technologies and; a modulation of collective chosen goals (Hoogma and Kemp, 2002). Its multi-actor nature means that different stakeholders (policymakers, scientists, politicians, NGOs, businessmen, interest-groups, industries etc.) are expected to play different roles in different phases of the process (Rotmans et al., 2000). Transition management is therefore first and foremost based on dynamics integration and the coordination of "...multi-actor processes at different levels, aiming at

long-term sustainability, through the creation of long-term vision, innovation networks and experimental playgrounds" (Van Der Brugge et al., 2005:167).

The genuine belief of the TM model's developers is that some transitions, though complex processes occurring in complex environments, can and should be managed (Rotmans et al., 2000; Kemp and Rotmans, 2005; Loorbach, 2007), whereas for now questions of who is to manage them and under which mandate remain open. Based on the literature, I dissect four major operative stages along the process. First, transition managers need to establish 'transition arenas' – where actors can interact, express and exchange their agendas and prospects. At the same time, this forum should create joint images to guide a desirable vision along with indicative targets (Meadowcroft, 2005). Second, 'transition routes' or 'pathways' - directed by the vision - should be identified while the industrial/business sectors continue to explore potential innovations ('transition technologies') and the public sector continues to invest in research and development. Finally, it is the stage of 'institutional transition', where reform and restructuring are needed in policies and regulations, infrastructures and public behaviour, to promote the preferred pathways.

Transition pathways are of particular interest here. While they are developed naturally and sometimes even unintentionally, without a steering hand, they nevertheless often suffers from technological fix, a static view of the transition process or a narrow view of endogenous dynamics that could have crucial impact on transitions (Verbong and Geels, 2010). In contrast, managed pathways may stimulate learning from key-elements in current and historical regimes, identify the diverse range of actors and networks and encourage the inclusion of wider landscape and focused niche factors (see Foxon *et al.*, 2010 and further in chapter 5).

In more practical terms, transition pathways are the range of possible futures. As such, they are usually developed using scenario-building techniques, however, not necessarily quantitative. Studies have pointed to the usefulness of backcasting method for managing transitions. As opposed to qualitative

predictive and explorative forecasts, the results of backcasting are innovative images of the future, which represent long-term solutions to the social problem in question (Quist and Vergragt, 2006). The desired scenario, however, does not have to be pre-determined, but should be produced along the process. Backcasting is therefore unique in that its products are desired, normative scenarios rather than descriptive and optimal.

According to Rotmans et al. (2000), TM process should include the following core properties:

- Using long-term thinking for short-term policy;
- Thinking in multi scales terms; considering diversity of stakeholders at different governance levels;
- The use of participatory decision-making;
- Aiming for learning-by-doing and doing-by-learning;
- Bringing about system innovation besides system improvement and;
- Flexibility, meaning keeping open a range of options.

It is anticipated that a successful transition will necessarily depend on a wide support from existing governance structures and different institutional arrangements, such as well-established policy networks and technological enterprises (Jacobsson and Lauber, 2006). Yet, a TM process is also expected to act as a force of its own which will bring about socio-cultural, institutional and economic changes, and will not be depended on the good will of any particular actors.

The TM model has attracted various responses, as will be further discussed in chapters 5 and 6. While the Dutch government has undertaken several means to implement the TM model, gaining some real-life experience with the concepts (Kemp et al., 2006), there is still much to discover on how does TM work in practice; what operative stages are required; according to which indicators can we evaluate transition management's success or failure; and eventually, what problems can TM expect to encounter. A critical analysis has pointed out that the TM model cannot avoid the faults of present

deliberative policy approaches, in which who participates, who wins and who loses from a chosen direction (or 'pathway'), are contested issues (Shove and Walker, 2007). It is therefore not clear how the process of TM could elevate power relations, strategic behaviour and hiding interests, all current obstacles to greater deliberation and coordination in policymaking. In addition, the forces behind certain technologies and regimes lock-in might be too powerful and it is not obvious whether and how TM can in fact transform existing institutions, policies and political reality (Shove and Walker, 2007).

Finally, Kemp et al. (2006) have noted that TM is being practiced in the Netherlands for managing transition toward sustainability in distinctive sectors: energy, agriculture, mobility, biodiversity and more. I will be arguing in this thesis that TM could benefit from a more integrative approach. As part of the objectives of this research, chapter 6 will therefore examine the role of a largely neglected integrative dimension of TM, that is, integration of inter-sectoral policies and specifically as in the case of water and energy dynamics.

2.3. Conclusions: moving policy dynamics theory forward

When policymakers make decisions and design policies they set off a process which is conceptualised as policy dynamics. Since policymaking takes place in a setting of constant interactions (between actors, actants, networks, institutions and the environment), the attempts themselves to uphold or hinder integration inaugurate dynamics. This chapter has undertaken a novel attempt to combine different approaches to such policy dynamics in order to lay down the theoretical foundation for an examination of the thesis's key-question regarding the interplay between sociotechnical components and interdependent regimes during transitional processes. For the purpose of exploring this, the literature review crossed decision-making models with the newer approach of transition management.

While these literatures provide valuable insights into various aspects of the dynamics of sociotechnical components, changing policy in an interdependent world is nevertheless undertheorised and insufficiently explained. Three original conceptual claims can therefore be drawn from this chapter's literature compilation:

I. Recent studies may have focused on dynamics of large infrastructural systems from the transition perspective and have highlighted the entrenched and interrelated nature of large systems of infrastructures within a system web of policies, economies, institutions, technologies and behaviours (Frantzeskaki and Loorbach, 2010). Yet, these contributions cover distinctive areas, such as energy, mobility and water and there is an absence of reference exactly to the crucial phenomenon of interdependency, such as of cross-cutting environmental issues. While the scientific community has widely recognized by now the complexity of the environmental system itself and its interconnectedness to the social system; and environmental scientists are looking on the interactions across sectors (water quality, rivers, soil, energy, air and biodiversity, for instance) from numerous angles - policy, as opposed to that, is still lagging behind and policy studies are still lacking some crucial evidences for what is estimated to be the current level of intra-sectoral environmental interdependency; whether different kinds of integrative ideas and tools can in fact promote sustainability and; how these can be implemented in certain contexts. The important questions of how and why policymaking differs between sectors (John, 1998:12) should therefore be followed by questions on how policy subsectors correlate and co-depend. I intend to fill this gap in chapter 6.

II. Dynamics in any particular sector, such as water, energy and mobility can be expected to derive from a technological change. Yet, the role of technology has not been adequately addressed in the literature on policy regime change and we are therefore left with one-sided causal explanation of sociotechnical transitions. I have mentioned earlier in

this chapter that policy dynamics theories put the policymaking component at the centre of their analysis, through which socio-technical transition can be explained. They miss, however, the role of technology, especially within environmental policy regimes, as an explanatory variable to transitional processes. The sociotechnical transition literature, only partly fill this void by treating technology as an actant. Yet, often it treats technology as dependent variable that is usually constrained or promoted by policy dynamics. The classical, institutional and sociotechnical approaches to dynamics are offering, each by itself, an incomplete explanation of policy change. Together, however, they will provide the base to explain, in chapter 4, *how* technology caused dynamics that manifested essentially as interdependencies of the water and energy regimes.

III. Finally, the sociotechnical transition literature may provide a heuristic framework and analytical concepts to studies of policy change. Yet, while policy change is seen as a tool, rather than the outcome (see the previous point), policy and decision makers are absent in the conceptual language, and transition processes are analysed separately from the policies, management or steering approaches that are to influence them (De Haan and Rotmans, 2011). Therefore, the role of agents in transitions is to a large extent ignored. I suggest that bringing discourses – ultimate mirrors of power-relations and interests - back in, could have the potential to bridge this gap. This will be done in chapter 5, by linking the discursive institutional approaches to the socio-technical transition framework.

A principal rationale for this thesis is, therefore, to offer the contribution of an integrative lookout to the study of socio-technical transitions. This is particularly worthwhile, as the studies of transitions have tended to focus on one policy regime in distinctive sectors (e.g. energy, water, communication, transportation etc.). Such studies have generally examined, through case-studies approach, transition of utility provision, such as the transfer from coal to natural gas (Rip and Kemp, 1998; Monstadt, 2007). Others have looked on

water management transition processes (Van Der Brugge et al., 2005; Pahl-Wostl, 2007) or specific niche-innovation trajectories (Hoogma and Kemp, 2002; Verbong and Geels, 2007). Interestingly, not much has progressed in the subfield of policy dynamics and integration since Underdal (1980:159) has observed that "interaction systems characterized by significant exchange of 'externalities' are likely to generate proposals for some kind of coordination and attempts to reach joint decisions regarding the conduct of interdependent activities".

3. Methodology, materials & methods

"Objectivity is not measured by procedures that assure an accurate mapping of the world but by the growth of knowledge". (Burawoy, 1998:5)

3.1. Introduction

The previous chapter outlined the conceptual framework that have been guiding the theoretical prepositions for the study and has opened-up the analysis of various aspects in the water and energy sectors, for each sector independently and for both interdependently. In light of the complex and dynamic nature of policy and decision-making processes such an analysis is required to be grounded in convincing methodology and empirical approach. This chapter is therefore devoted to a more detailed presentation of the general methodological framework and specific methods that were employed. Specifically it focuses on the Interpretive Policy Analysis framework, which is perceived as merely a tool but rather a general, critical methodological approach to the field of public policy, as well as on a few of the difficulties it may present to researchers. Thereafter, the material and methods used in this thesis are detailed.

3.2. What is policy

To begin with, the term policy cannot be easily defined. Generally, a policy is "any output of any decision maker, whether it be an individual or a collectivity, a small collectivity or a large one, a government or a nongovernment" (Lowi, 1970:317). A policy also necessarily involves a normative angle as it is produced by some kind of an authorized entity to

satisfy some sort of a public need (Pierson, 2005). Although definitions have varied, it still might be possible to push these into roughly two categories. First, scholars equated policy with an intended solution to a perceived problem (Dery, 1998; Sabatier, 2007). This is, according to Pierson (2005) a functionalist explanation of public policy. The problems with understanding policy this way is that first, in many cases, the act of making a decision and crafting a policy precedes the perception of an actual need or problem (Kingdon, 1995). Second, taking into consideration the "sizable time lag" between policy-making and its consequences, rarely policies embody the goals of social actors but rather are much often by-products of social processes. These critical observations have shown the way to an alternative interpretation according to which policy is understood as an arena of conflicting interests, an outcome, sometimes arbitrary, of a process, rather than an intentional output. The latter view is based on the observation that policy arenas are composed of numerous stakeholders which are, or at least can be expected to be involved (Kiker et al., 2005), and that they constantly negotiate, "puzzle", or in fact "power" (Hugh Heclo, 1974 in Hall, 1993).

This view of policy directs us to think of it indeed not merely as the output of policymaking, but as an essentially contested and bewildering process (see Colebatch, 2006). The policy analysis in this thesis therefore tries to do justice with both approaches to policy. As will be deliberated upon in the following sections, policy has been methodologically conceived both as text (meaning a pure product) and a discourse, that is, a negotiated and contested process on meaning and interpretation. The political arena in which policy is made can therefore partially explain policy dynamics; why policies are sometimes hard to change, while in other times the speed of their change is hard to catch-up with.

3.3. Competing methodological approaches to policy analysis

The mainstream positivist approach to policy analysis relies on quantitative data, replicable experiments, causal generalization and objective hypothesis-

testing to accumulate valid scientific knowledge that can be considered as facts and provide policymakers with rigid solutions to problems (Fischer, 1998). Its accompanied methods – cost benefit analysis, input-output modelling or survey studies – are being increasingly criticised by post-positivists, however, following the argumentative turn in policy analysis (Fischer and Forester, 1993; Hajer, 1995).

The post-positivism stream, according to which scientists produce discursive and contextual understanding of societal problems, necessitates certain assumptions about the nature of these problems. In this line, constructivists argue that the problems themselves are scientifically or more generally socially constructed (Hill, 2005) and that certain "conditions come to be defined as problems, and have better chance of rising on the agenda, when we come to believe that we should do something to change them" (Kingdon, 1995:198). The rationale behind the claim that our understanding of the conditions around us, of social and in particular environmental problems and their scientific solutions, are socially constructed - is twofold. At the epistemological level, truths about the natural world were observed to be falsehoods so many times along history that it will therefore be unreasonable to easily dismiss calls for "relative truths" in any human activity such as policymaking or scientific observations (Bird, 1987). Relative truths or "changing conceptions of nature" are also uncovered among different societies (Latour, 2004:4). At the ontological level, the potential number of "truths" about nature, environment or scientific inquiry, and the amount of possible "problems" in particular, are at any given time much bigger than the actual issues that receive attention by politicians, scientists, public, media or any other societal actor. Therefore, the realms in which problems are dealt with and the level of coverage a topic receives indicate an active process of problem's construction (Yearley, 2002). Hence, the constructivist approach also assumes reality is always particular, dependent on subjective framing, moment in time and place specific representations, metaphors, symbols, and experiences. For example, the scientific consensus that humans face a severe crisis with respect to water quality and quantity serves as an underlying

assumption for most social studies on water. Yet, when taking into account the particular context in which problems are formulated and certain ideas and technologies are adopted, the approach that sees water scarcity as 'socially constructed' has the potential to provide multiple layers to the analysis.

An established methodology for a constructive analysis of policy dynamics is the interpretive policy analysis framework, which treats policymaking as a social interaction on its various implications (linguistic constructions of discourses and hegemonic concepts, composition of networks and coalitions, existence of power-relations and interests), rather than a technical process. For example, interpretative studies of water policy and management have shown how different epistemic communities promoted each a very specific understanding of what is a 'water crisis', which has resulted in a limited capacity to ask questions and determine the manner they formulate their solutions (Trottier, 2008); how some understandings of 'water crisis' or 'water wars' tend to obscure issues concerning unequal access to and control over water (Mehta, 2003); and how different discourses of water (such as treating water as an economic good vs. basic right) influence *de facto* different (and sometimes contradictory) trends like decentralization, centralization, and privatization (Sangameswaran, 2006).

3.4. The interpretive policy analysis framework

Interpretative Policy Analysis (IPA) as a methodology (i.e. a way of seeing the world/social reality), suggests post-positivist phenomenological, epistemological and ontological stances about meanings, knowledge(s), practices, ideas and discourses in the policy-making arena (Yanow, 2000). As mentioned above, policymaking is regarded not merely as a technical, objective or rational process but a complex one, involving multiple stakeholders (including politicians, practitioners, managers, scientists and the public), with multiple perspectives, interests and mentalities.

From an interpretive point of view, policy processes are constrained by subjective, geographic/political/socio-cultural context-based and situated articulations (rather than facts) by policy actors who are constituted in frames of language and subject to power relations, regarding institutes that are not objectively relevant but yet are often framed as such (Gottweis, 2003; Yanow and Schwartz-Shea, 2006). The goal of the interpretive policy analysis approach is therefore to underline the roles of these subjective, actor-based ideas or frames in the policy arena and especially in processes of policy change and continuation (Rydin, 2003), and by that to give rise to diversity of voices, choices, interests and understandings. A second and third layer of interpretations which are of interest to the analyst materialise during the stage of policy implementation, by the executers and then by the subjects of the policy. The policy analyst is therefore required to examine the policy problem from the situated perspectives of the actors involved, taking into consideration also the fourth layer of interpretation, that is, of the researcher himself, as was put by Yanow (1993): "...much of their (i.e. policies –NT) meaning can only be elicited by an act of interpretation on the part of the researcher (1993:42).

Interpretations are entangled with questions of meaning, as any policy in itself. The interpretative turn has sought to identify policymaking with the generation of meaning and the ways those different meanings are communicated, as was suggested also by Dryzek (2006:90): "Policy analysis encompasses a variety of activities concerned with the creation, compilation and application of evidence, testimony, argument and interpretation in order to examine, evaluate and improve the content and process of public policy".

Fischer and Forester (1993) as well as Majone (1989) were essentially referring to policymakers as producers of arguments, while Stone (1989) and Roe (1994:3) portrayed them as storytellers. Colebatch (2006:10) argued that the view of the policymaker as storyteller or argumentator entails the understanding that "much of the policy process is about managing overlapping and conflicting interpretations of the subject of concern".

In order to understand the various meanings, which are the products of stakeholders' views, the analyst should study the process within its specific context and against the participant's own system of values and motives, for example by analysing discourses. This is further stressed by Fischer (2003:68): "A socially relevant approach to policy inquiry has to include the subjectively oriented goals, motives, and intentions of the policy actors. As such it has to be grounded in an interpretive analysis."

The idea that policies are embedded with values is fundamental to the understanding of what policy is and how it could be interpreted. In that respect, Ball's (1993:3) assertion, that "policies project images of an ideal society", provides a good demonstration of the usefulness of the interpretive approach to policy analysis because it brings subjectivity, values and interests (different systems of values define 'ideal society' significantly different) to the core-definition of what policy is. Nevertheless, as aforementioned in chapter 2, the term 'policy' itself is challenging since it is being used to describe different "things", "units" of references, processes or outcomes. For Ball (1993), "much rests on the meaning or possible meanings that we give to policy; it affects 'how' we research and how we interpret what we find".

Ball (1993) differentiates between two types of policy: policy as text and policy as discourse. At the first instance, policies are expressed in documents, which are written by multiple authors and read by multiple readers in a variety of settings, which already explain why policymaking cannot be treated a one linear, coherent process. Policy documents are a result of compromises and contestation that are "coded" into text, and therefore indicators of different meanings. Moreover, policies are "textual interventions into practice" (Ball, 1993:12) in that they have transformative effect. Ultimately, both authors and readers are active agents over the course of policy development in their act of interpretation. At the wider lever, however, policies are discourses within the social system, in that they are understood to be exercising power in the Foucauldian sense, as the producers

of 'truth' and 'knowledge'. Policies are enacted with politics and structure what can be said and thought. Gradually, certain interpretations become more probable and legitimate than others as well as the possible forms of solutions and implementation.

Ball's distinction provides useful methodological input to the analysis in this thesis that is constantly weaving between the roles of particular actants (humans and nonhumans) and institutional structures in policy change and continuation. As a departure point, there is no one coherent or official policy, neither of water nor of energy that the analysis had looked at, but rather a process of negotiation, contest responses and attempts to representing solutions to perceived problems of natural resources scarcity and management. In other words, an underpinning assumption of this thesis is that interpretive approach would be the most suitable to examine different dimensions of policy dynamics. This is because the unit of analysis was not consider to be a definitive, final policy outcome summarised in a text, but the discursive world that lies within and around target-issues in the water and energy policy regimes. This discursive world, according to Fischer (2003) may be expressed as a policy, but is in fact a set of arguments, favouring different ways of looking at the world.

Yanow (1993:41) suggests that an interpretative policy study should be occupied with the questions of how policy "makes" meanings. That is: "...how a policy accrues meaning; where meaning resides; how they are transmitted to and among various policy stakeholders; how they come to be shared or not shared; how they may be destroyed". Interpretative policy studies reveal multiple understandings of the actors involved in processes along the policy cycle, how these understandings are created and importantly, how they are manipulated as part of political strategies. Actors' multiple understandings of problems and solutions create the challenge of understanding and explaining these disparities without ending up with the

conclusion that no real problem in fact exists. By showing that behind the variation of policy alternatives promoted by different policy networks[8] to solve the problems of water and energy scarcities, lies only one powerful shared paradigm or discourse (that is of the "more is better" – chapter 4 or the "discourse of abundance" – chapter 5), I meet this challenge. It thus suggests that the plurality of interpretations in some stages of the policy cycle could be more limited than proposed above by previous studies. It also suggests that various interpretations would not necessarily result in different understandings of which of the policy alternatives should be implemented.

It is important to note here, however, that alternative voices to the shared discourse of plenty do exist. Environmental NGOs, mainly the Society for the Protection of Nature in Israel (see section 5.4.3 for elaboration) have advocated the need to reconsider the excessive use of desalination through studies and reports, and called for greater emphasis on demand-side solutions to the water crisis. They also campaigned with relation to energy issues, against, for example, drilling oil-shale (also see chapter 5). Significant alternative voices to the hegemonic discourse of plenty, however, both in the water and energy sector, as well as with respect to their nexus, are apparently absent. This can be explained by the attractive environmental benefits of abundance, such as the ability to restore dry streams and salinised aquifers with the additional amount of available water, benefits which cannot be disregarded by environmental NGOs. Similarly, socio-environmental NGOs did not emerge as a significant opponent to energy abundance, as they too recognise the importance of energy for economic development and the social benefits national income from natural gas could foster.

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[8] Devora Yanow's conceptualisation of policy networks is based on an older idea, the one of "interpretive communities". These groups are composed by members of a community (not necessarily geographically determined) that share a set of values, beliefs, feelings and similar cognitive and linguistic characteristics (Yanow, 2000).

To sum, stakeholders' conflicting interpretations of a problem, discursive struggles on the production of shared social meanings, and discrepancies between will and deed, are, according to the interpretative framework, the main drivers of change, rather than policy itself. Interpretive analysis is therefore a dynamic process, with shifts of values and interests throughout, making new interpretations relevant constantly (Colebatch, 2006; Fischer, 2007). The act of interpretation taken by the analyst seeks to better explain the world of policymakers. It does, however, also hold the normative goal of pointing toward possible solutions in a more deliberate and just ways.

3.5. Research design

The two main accounts for the linkages between theory, as a set of abstract categories, assumptions and models (Colebatch, 2007), and (qualitative) data, as a collection of both content (of research's participants and documents) and the way it is represented by participants and actors, are known as 'theory-testing approach' and 'grounded theory'. The theory-testing approach treats theory as a guide to research (i.e. data gathering, analysis and presentation), while research can be a means of testing the efficacy of the theory. It often begins with theoretical assumptions and propositions. As a methodological issue, the theory-testing approach takes, to a large extent, an empiricist point of view of the world. Grounded theory, on the other hand, advocates the idea that theory must reflect people's experiences, meaning and understanding, rather than identify 'empirical' variables that 'externally' influence behaviour (Layder, 1998). Concepts and hypotheses must emerge from the data by means of a process of mutual feedback between theory and data.

This research has employed these two approaches to research design. The research was motivated simultaneously by strong theoretical propositions derived from a pre-identified specific gaps in the literature (i.e. the ways technology affect policy, the lack of agency in socio-technical analysis and the lack of account for inter-sectoral interdependencies in the transition

management model) and by real-life experiences and perceived problems that may alter current theoretical assumptions and are reflected in the case-studies (that is the issue of water-energy scarcity, technological alternatives and institutional change). Therefore, while the first stage of research conducted with line with 'theory-testing approach', the following steps, including field work, analysis and writing-up were guided by principles of 'grounded theory' and were more inductive in nature. It required a continuous interplay between theory and data. The conceptual combination between "theory-driven" and "practice-driven" offers a clear articulation of aims and questions prior to the empirical work on the one hand, while on the other hand it encourages flexibility and reflexivity of data gathering and analysis. Naturally, too much flexibility in a long-term research can become a disadvantage in terms of losing focus and wasting resources. Keeping in mind the time and budgetary limits for the research was therefore important.

The Interpretative Policy Analysis framework essentially involves questioning the relationships between research elements: theory, methodology, data and analysis. A fluid course of research as a result of blurred boundaries and overlaps between these concepts has consequently led to a call for "on-site flexibility and less step-wise research design" (Yanow, 2003). In order to capsulate the empirical part in the most organised way, the research has taken the case-study approach, as will be next elaborated.

3.6. Case-study approach

The case-based research might only produce context-dependent knowledge which is hard to be generalised, yet it ultimately describes, reflects and tests views and understandings of a situation as they unfold in practice. Thus, by focusing on real-life situations and examination of particular cases some sort of proximity to something "real" might be best achieved (Flyvbjerg, 2006). However, the use of empirical methods and case-studies in a theory-driven and conceptual research is not obvious. Replicability and the ability to make

generalisations – two prerequisites of a theory – are not (and should not be, as some will argue) goals to be achieved in a social research. In his exploration of the extended case method, Burawoy (1998:14) has proposed the premises of reflexive science to deal with the presumable gap between "...participant and observer, knowledge and social situation, situation and its field of location, folk theory and academic theory".

Reflexive science is guided by four assumptions. First, intervention of the interviewer in the experience of the interviewee is desired and not something to avoid. Second, the reliability of the research steams from a process of aggregation of 'situational knowledge' into social process, that is, the ability of the researcher to explain participants' 'data points' in term of social dynamics. Third, an underlying assumption is that everyday life situations are never the same and that there is a need to account for changes across time. This is termed by Burawoy (1998) the "structuration of social forces", meaning the external and structural powers that delimit the sort of things that happen in multiple different 'locales'. Finally, the goal of research analysis should be the reconstruction of a theory, not by generalisation, but by increasing its 'empirical content'. In developing the extended case methods M. Burawoy does not take a deep interpretive point of view. His goal is rather to find a third way wherein positivism means something despite its flaws. He also does not take a grounded approach to research because the extended case method necessitates the pre-existence of a theory: "we cannot see social world without a theory, just as we cannot see the physical world without our eyes" (Burawoy, 2009:xiii).

What reflexive science contributes for the design of this thesis is the claims about the importance of contextuality and the conceptual connection between the micro (i.e. detailed analysis of internal social process) and the macro (i.e. account of external social forces); in other words, the supposition that case study can be used to extend an existing theory. It helps in thinking about the relations between empirical data and theory and in rationalising the modulation of the data back into theory.

Case-studies, however, should be carefully chosen in order to be able to provide a rich data against which the research questions could be tested and theory expended. As can be seen in section 1.2 the study went back and forth between several layers of theorising: at the first layer, the study concerns the socio-technological relation with policy changes and continuation, in the second, it looks at the interacting forces within environmental decision-making processes and their effects on sustainability. A third layer concentrates on natural resources scarcity and abundance. By way of investigating these issues, I have selected two national policy regimes affected by the availability and management of natural resources; wherein new technologies are becoming increasingly prominent; and the sustainability of environmental decision-making is questioned (see further section 3.5.2. in this chapter). While the cases supporting my research served different goals and were of a different nature, it can be argued in fact that the two policy regimes do not only follow a similar pattern or reflect similar tendencies, but they are also complementary to each other, together providing a more holistic account of socio-technical developments.

The two case studies dealt with are the transition of the water policy regime and the role of desalination technology (chapter 4) and the transition of the energy regime and the role of discourses (chapter 5). The two case-studies were then compared and combined in chapter 6. The choice of two complementing case studies – similar infrastructural systems in which one is undergoing a transition led by one technology and the second is driven by four major alternatives - enabled this analysis to capture a broad range of socio-technical dynamics occurring in both sectors both separately and jointly.

The cases differ in terms of the number of technological alternatives involved in the dynamics but compare in alternate ways. First, the case-studies do not differ in terms of their geographical location. The identical space in which the two policy regimes are crafted allowed me to focus on the discursive level

without spending a considerable effort in the attempt to bridge over formative differences in cultural, political and regulative systems of different countries. Second, they basically share similar drivers of dynamics because in both the water and energy sector, as will be further demonstrated, policy is driven by large-scale technological choices based on their promise to solve perceived scarcity. Third, policy in both sectors emerges through coalitions of policy networks. Theoretically, these networks vary in composition from sector to sector, but in practice, in the Israeli context they consist of the same governmental/policy agencies (primarily the Ministry of Water and Energy the Ministry Environment and the Ministry of Finance and to a lesser degree in our case-studies the Ministry of Health and the Ministry of Interior); the same key legislators in these ministries as well as in the Public Utility Authority; some identical relevant business and industry representatives (the same company could be dealing both with desalinated water production and gas drilling); almost the same pressure groups and environmental NGOs and; a few prominent journalists and media reporters that covers both sectors. Consultants and policy analysts, being specialists to specific subjects are expected to differ from domain to domain but also this is not always the case, especially when international consultant companies (McKinsey, RAND) are involved in national strategic planning and sector-specific consulting at the same time.

Policy regimes have to be evaluated against the context in which policy is shaped and acted upon, that is the particular case-studies. Also the Interpretative Policy Analysis approach anchors the validity of interpretation in the wider context in which the events are taking place (Wagenaar, 2011). For this purpose, in the following sections I bring a brief introduction to the Israeli socio-political and environmental settings and go back to explain the choice of focusing on the water and energy sectors.

3.6.1. The Israeli setting

Located in the Middle East region by the Mediterranean shore, Israel is geographically and strategically situated as a continental bridge between Asia, Africa and Europe. Modern Jewish settlement in the land of Palestine began under Ottoman rule at the end of the 19th century and continued under the British mandate, against the backdrop of regional and global geopolitical events. Current borders (Syria in the northeast, Lebanon in the north, Jordan in the east and Egypt in the southwest) were delineated in several wars with its neighbouring countries following the establishment of State of Israel in 1948. Despite a few decades of peace negotiations and several agreements, regional stability is yet far from achieved.

On the eve of the day of the declaration of independence the county counted approximately 800,000 Jewish residents. Waves of immigration have resulted in rapid population growth, which is still kept today due to high birth rate (3.5%) and very high life expectancy. Population growth is an important factor in the context of natural resources and environmental issues, especially when considering the relatively small size of the country, which may become even smaller in a future agreement with the Palestinians, and its high population density. In 2011 there were 7.7 million citizens, approximately 2 million of which are non-Jewish. More than 90% are living in an urban form of life and are concentrated along the coast. While the Southern region of Israel occupies 12,900 km^2, or 62% of Israel's territory (in the pre-1967 borders, i.e. excluding the West bank and Gaza strip), it is a scarcely-populated desert. A large proportion of the population is therefore concentrated along the very short coastline of 206km.

Economically, Israel is rated by the UNDP in the "very high category" of the Human Development Index, between Denmark and Belgium and in the 39 place of the nominal gross domestic product (GDP) list of countries of the World Bank. In 2010 it has joined the OECD. The political-economic ideology of all Israeli governments since the 1980s, with no major difference

between right-wing and left-wing parties, is essentially a neo-liberal, market-based economy, which is accompanied by an intensive privatization schemes across sectors, including health, social welfare, education, communication and public housing. Market liberalisation also encompasses governmental companies and operations; natural resources and environmental-related services such as the privatization of the Dead Sea Works LTD (that makes profit from a public asset and contributes to its disappearance (Sherwood, 2010)); a recent bill to privatize the ownership and management of natural reserves; and privatization of water production and treatment as well as of electricity production (further elaborated in chapters 4 and 5). These are only few relevant examples among many.

As a representative democracy, the Israeli polity arena is divided into three authorities – the Knesset (the parliament with its 120 members, the legislative body that is elected every four years), the government (the executive authority) and the judiciary. The number of seats assign to each party in the Knesset is proportional to its share in the total national vote. The head of the largest party becomes the Prime Minister and is granted the assignment of building a coalition. Local government include dozens of municipalities and more than 140 local councils. The major arena of interaction between local and state authorities is state services, principally in the areas of education and welfare. The legal basis for the present system of local government in Israel, as other laws, is based on British Mandate system in Palestine (Ministry of Foreign Affairs website, 2011). Israel does not have a formal document identified as a constitution. Instead, the Knesset decided to enact a list of Basic Laws, which define and protect several human rights. Primary legislation is composed of laws that are initiated by the government, with very few private bills, which must gain governmental approval. Since 1989, the 'Arrangements Law', originally aimed at supporting the political-economic systems in the 1985's economic crisis, has been serving governments to pass a bundle of legislation without a separate, focused debate. Secondary legislation consist of regulations and rules under the supervision of ministerial offices and various statutory authorities.

The relatively short existence of the national institutional arrangements of the state might explain the lack of well-established, stable and effective administration both at the national and regional levels, especially in comparison to other developed countries in North America and Western Europe. Still, a transition from "government to governance" can be depicted also in the Israeli pluralist political sphere, with the decreasing power of political parties and the growing dominance of other actors such as interest groups, the bureaucratic system, the media and the third sector (Nachmias and Sened, 2002).

The social, economic and political conditions in Israel affect the behaviour of actors, the emergence and character of policy networks and consequently, policy itself. For example, the growing economic interests of private companies in energy sources exploration, which are encouraged by low state's revenues and poor taxation, have changed the balance of players in the energy regime, by reducing the centrality of the traditional state's players and by making private companies quite influential in the economic and political spheres. Concurrently, the increasing role of environmental non-governmental organizations in the policy arena and growing public awareness to environmental issues (Tal, 2002; Hananel, 2010), have created room for public influence on policies and regulation related to energy. An example for the latter is the legislation in 2008 of a Clean Air Act, which was considered an unprecedented achievement of the Israeli environmental camp[9].

Secured drinking water and energy availability, the two main fields considered here, are essentially environmental problems. Not only because precious natural resources are sometimes at stake, but also because water and

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[9]nrg (2011) For the breathers: Clean Air Act has came into force. *nrg*,. http://www.nrg.co.il/online/1/ART2/195/855.html Last Accessed: 2.1.2011. (Hebrew).

energy are extensively exploited by human and their continuing unsustainable management have resulted in wide-reaching negative environmental consequences, at local and global scales, and generated new environmental problems, such as soil salinization and air pollution. It is therefore important take a focused look at the environmental setting against which water and energy policies are crafted.

3.6.2. Environmental context

The scarcity of resources in Israel, mainly of water, energy and land has a tremendous effect on the quality of the environment. Coupled with population growth and tendencies of construction, sprawl and development, the state of air quality, aquifers, open spaces and biodiversity is in constant decline. To this list one can join more "natural" environmental problems that stem from Israel's geographic conditions, such as droughts, desertification and air pollution from natural particles. Among the various environmental challenges that the Ministry of Environment has reported about extensively during the time frame of this research are: domestic and industrial solid waste, streams and marine pollution, drinking water quality, soil pollution, noise pollution, and GHG emission (Ministry of Environment website, 2008-2011).

There are a number of laws related to specific environmental issue (such as the Water Law), several inter-sectoral laws that deal also with environmental issues (such as the Planning and Building Law) and a wide range of legislative instruments that include environmental provisions. Whereas local and regional municipalities hold the responsibility for environmental protection but in practice have a very limited authority, Ministerial officers and particularly the Ministry of Environment are occupied with many environmental issues, big and small alike. This has often led to the inefficient use of human resources and budget (OECD, 2011). Another impediment to effective environmental governance is fragmentation of responsibilities and the distribution of environmentally related functions between many sectoral

ministries (elaboration with examples in chapter 4). Environmental legislation, however, is improving. Important additions since 2008 include the Clean Air Act, the Polluter Pays Law, the Packaging Law and the Environmental Enforcement Law.

The Israeli planning system is an important mechanism through which environmental policy and regulation are crafted and implemented. Although currently under a massive reform, it is still a highly centralised, hierarchical statutory planning system; within it six regional planning committees are in charge of the planning, inspection and judicial aspects of building, development and land-use in the local committees of their jurisdiction (Ministry of Foreign Affairs website, 2011; Tal, 2002). Land development proposals and projects are approved or rejected based on the restrictions explicitly mentioned in the national, regional and local levels. The Israeli National Planning and Building Council, under the supervision of the Ministry of Interior, initiates the preparation of national land-use and development plans: dozens of domain-specific national Master-plans set aside lands for power plants, nature reserves, forests, tourist facilities, mining, desalination plans and so forth. My choice of interviewees included the head of Infrastructures Planning Unit within the National Planning Council and a member of the special Planning Committee on Sea Protection because the planning system does more than regulating land-use; it is an active actor in the policy-making process and an important arena in which strategic details of policies are negotiated. For example, in the preparation process of the desalination plants Master-plan, the planning committee required from the Water Authority to make a convincing argument to support its projections of water demand and consequently the amount of desalinated water needed. One of the interviewees explained why:

> If the water Authority came and said 'we know what to do, we know all the details, we have a plan from now until forever, and we have the exact data and projections and here is the bottom line: the water system needs five more desalination plants', then the National Planning Committee would have designated five locations. But it does not work like that. Why? Because the Water Authority might have the responsibility for the water sector and the

> general view of the water sector, but the planning institution bring together many more conflicts and issues and interests that are important for us to keep at the policy rather than the technical level (Interview, The Planning Authority)

Notwithstanding, institutional actors which have little to do with environmental protection are prominently involved in environmental decisions due to a highly political nature of environmental management, especially of water and energy resources. For example, the Ministry of Foreign Affairs is involved in decisions concerning annual water allocations to neighbouring countries according to bio-national agreements and regardless of the mere availability of water. Indeed, both water and energy are natural resources in conflict. Thus, very often the political reality in the Middle East constrains the ability to promote a more sustainable management of natural resources.

Environmental challenges require a strategic, long term and comprehensive planning with respect to development and conservation. In 2003 the government of Israel adopted a "Strategic Plan for Sustainable Development", which seeks to integrate environmental considerations within future activities at the national level, based on the Johannesburg Conference of the United Nations in 2002 and the country's historic commitment to implement Agenda 21. This decision determined that "each ministry will prepare a strategic sustainable development plan with rules for implementation and funding, measurable objectives and timetables" (Governmental decision no. 246, Israel parliament, 2003, 14 May). Years later and no ministry, governmental office or other statutory authority, had yet seriously complied with this commitment (State of Israel Comptroller Annual Report, 2006). Recently, the OECD report on environmental performance in Israel determined that strategic planning and implementation capacities in Israeli ministries are very low and mechanisms for enforcement and evaluation are almost completely absent. A lack of strong data base on the economic aspects and range of possible economic tools of environmental policy is also considered an impediment to more sustainable decision-making by the ministries (OECD, 2011).

The institutional point of departure for this thesis is the water and the energy sectors. This does not suggest that policy dynamics or transitional processes are limited to these sectors. However, several factors contributed to making these particular sectors the most relevant for a focused inquiry on the relations between policies, technology and shifting discourses in sociotechnical transitions. Firstly, water and energy are vital resources. Water especially is a vital element of the Israeli nation-building and rural landscape. Israeli water discourse, however, is diverse and increasingly fragmented (Feitelson, 2002). Similarly, Israeli energy discourse revolves, more than anywhere, around state security and foreign relations. Secondly, although technological innovations offer to tap the massive oceans and employ the infinite sun, the ability to directly intervene in natural cycles and artificially supplement availability of resources entails its own consequences. The water and energy sectors in Israel best reflect the international quest for technological innovations in these fields and they further mirror national political-economic tendencies of market liberalisation. Finally, intricate interdependencies which link the two sectors provide rich fora to examine coupled transitions. Until now policies in the water and energy sectors have evolved separately with none or little consideration of the impact of socio-ecological changes for interdependent systems. However, the two sectors are intertwined, as problems are displaced from one media to another.

3.7. Time frame

The research undertaken in this dissertation took place during the years 2008 -2011. However, the study is not confined to these four years. A rather wide and detailed historical setting on the development of the water and energy sectors in Israel is given in sections 4.3, 5.3 and 6.3, which paves the way for looking more intensively on a shorter and much more recent period (the last 10 years). The year 2001 signals the point of policy change in the water regime when the Israeli government made a decision to desalinate non-

negligible amounts of water. I use earlier studies for insight into the period that preceded this point of change: they have established the adherence of the water policy regime to ideological and political support for agriculture and its water needs. Although desalination targets have been changed several times (see section 4.3.7), three large desalination plants have been constructed and integrated into the system since 2007, making the year 2008 a dawn for a new period. In the energy regime, discoveries of natural gas in Israel's claimed economic waters only came about for the first time in the year 1999, while only in 2004 it began to feed the State's power stations. The transition to desalinated water and natural gas based- electricity is the two major dynamics in the Israeli water and energy regimes respectively. I therefore treat these events as punctuations and analyse more in-depth policy dynamics just beforehand and immediately afterward, while the historical review established the claim that in general, both sectors have been presenting path dependency and locked-in tendencies prior to these developments. I reflect back on some of the implications of studying on-going policy dynamics in the concluding chapter.

3.8. Materials and data validation

The research combined two main complementary qualitative research strategies: documents analysis and in depth, semi-structured interviews. Information obtained in one strategy could therefore be validated or refuted by the alternative source in a kind of triangulation. The Interpretative Policy Analysis approach, however, gives the requirement for data validation a different meaning from the one assumed by more traditional approaches to research, such as triangulation. That is, since post-positivist's epistemology captures research as "a product of the very social world it seeks to explain" (Fischer and Forester, 1993:333), interpretive research does not differentiate, as opposed to Wolcott's (1994) observation, between "undeniable" analysis and interpretation. To promote the validity of analysis and interpretation, as interchangeable activities, it has been offered to give a "thick description"

(Adger et al., 2003 after Cliford Geertz) that is placed in "a proper context" (Wagenaar, 2011), as set above.

3.8.1. Documents

A variety of written sources has been explored. This secondary data was obtained from archival work as well as published and unpublished documents divided into two types of written documentation: official minutes and news media.

I. Over 60 minutes of "Parliamentary Committee of inquiry to examine Israel's water management and crisis" including transcripts of interviews with more than 100 central actors in the water sector. Among interviewees are: two ministers of Energy and Water Resources (current and former), the minister of Environment, dozens of governmental officials, including ministerial directors, representatives from the Ministry of Finance and the Ministry of Agriculture, the entire leading team of the Water Authority, the managers of *Mekorot*, dozens of scientists and academicians in universities and research institutes (specialists of water engineering, water chemistry, hydrology, environmental policy and public policy), directors of major industries, including desalination plants, sewage corporations and the agricultural union and representatives of major environmental non-governmental organizations. The interviewees were asked to elaborate on the experience in decision-making processes within the Israeli water sector including the alternative considerations, budget, responsibility, authority, power, accountability, coordination and implementation. Specific questions also addressed the issue of desalination, its social, economic, political and environmental costs.

II. Major type of policy document used here is transcriptions of parliamentary committees, including, among others, meetings of the

Interior and Environment Committee, Economic Committee, and Science and Technology Committee (selected list below). These committees, which are composed by 15-19 MPs, are the operative mechanism within the Knesset (the Israeli parliament) in which specific topics are discussed in greater detail and rules or regulations are crafted and modified. Discussions involve a wide range of invited parliamentary, public and private stakeholders, while non-invited citizens can usually observe (see a selected list of minutes). Additional documents included official parliamentary reports, minutes and summaries of parliamentary meetings (such as the inter-ministerial committee for climate change) and planning committees available on-line. Unpublished minutes included meetings summary of the National Planning Committee working on a national Master Plan of desalination sites.

III. Newspaper articles and press releases published in national media between 2008 and 2011. Media coverage as a source of data was considered particularly significant because it is considered not only to reflect discursive constructions but also to produce and frame them (Pan and Kosicki, 1993 for one example among many). News media published online were used frequently by means of keywords (water, desalination, energy etc.) to identify relevant actors, developments and key-events.

The Water Authority, 2002. Strategic plan for the water sector 2002-2010.
The Ministry of Energy and Water Resources, 2010. National Plan for Energy Efficiency 2010-2020.
The Ministry of Energy and Water Resources, 2010. Renewable Energy Policy.
Parliamentary minutes, 2008. Readiness for emergency time of the water and energy infrastructures, State Comptroller Committee
Parliamentary minutes, 2009. Issues in solar energy. Economic Committee, 30.12.09
Parliamentary minutes, 2009. Failures in energy supply and the IEC energy demands plan. Economic Committee

Parliamentary minutes, 2010. Exploration of oil and natural gas, Economic Committee
Parliamentary minutes, 2011. National plan for alternative car-fuel. Economic Committee
Parliamentary minutes, 2011. Oil shale technology for the production of fuel - challenges related to development and production. Science and Technology Committee
Parliamentary minutes, 2011. Caps and licences for solar energy facilities. Economic Committee, 21.6.11. http://oknesset.org/committee/meeting/4214/.
Parliamentary minutes, 2011. Environmental protection of NG drills in the sea. Joint Committee for Health and Environment
Parliamentary minutes, 2011. Energy sources, law in preparation (energy efficiency standards). Interior and Environment Committee

Table 3: A partial list of parliamentary official documentation reviewed (all in Hebrew)

3.8.2. In-depth semi-structured interviews

Primary data was obtained from twenty-six interviews undertaken during seven months field work during 2009-2010. Generally, target institutions in which I was looking for suitable interviewees were chosen based on their appearing relevance to decision-making processes in the water and energy sectors. Specific interviewees were then identified based on the analysis of documents, and especially based on the protocols of the "Parliamentary Committee of inquiry to examine Israel's water management and crisis". The simple selection criterion suggested by Stake (1995), according to which the best interviewees will be the people who can provide an opportunity to learn something new about the subject, has guided the process of identifying the most relevant actors within these target institutions.

While one document can only teach us something on a particular time in a particular moment, one interview can reveal a whole process and hint on significant institutional as well as ideational changes. Interviews are the place to investigate the actors' perceptions about the phenomenon in question in greater depth. The selected interviewees therefore included persons from

both the water and energy sectors and at different scale of governance, and can be seen as representatives of their collective institutions. These "institutions" included the following organizations: The Water Authority, the Israeli Electricity Corporation, *Mekorot* (the National Water Company) The Ministry of Environment, The Ministry of Energy and Water Resources, the National Planning Committee, the special Planning Committee on Sea Protection, The Israeli Energy Forum (NGO), Israel's Society for the Protection of Nature (NGO), Israeli academicians and scientists, TAHAL (water technologies and planning company), private environmental consultant companies, and a carbon-trade business company. I intended, however, to capture, not only the formal actors but also those who make an attempt to influence the process informally, or without a formal position.

Interviews were intended first to provide general data on both historical and contemporary events and processes that may clarify the current state of affairs and the issue at stake through questions such as: how processes of making decisions in regard to resources management are carried out in practice; what were the mechanisms by which interrelated concerns were addressed; how were trade-offs balanced; and more (A list of questions in Appendix 2). Second, to elicit stakeholders' experiences, views and interpretations on specific topics, by asking for instance what the interviewees think about the way interrelated issues are being dealt with by decision-makers; what is their interpretation to this course of events; etc. Distillation of physical data from situated views was proved hard to achieve, although not necessarily desirable, because what people perceive as "ought" to be (their normative perceptions) is what drives change (Swart et al., 2004) and therefore can be used by the researcher to explain it. In that, interviews are also best to reflect complexity, "discovering and portraying the multiple views of the case" (Stake, 1995:64). One prominent example for such "multiple realities" in my research and selective use of scientific data is Figure 15 provided to me by the Hydrological Service (the Water Authority). The graph shows the percentage of annual rainfall in compare to the annual average for a period of the last 15 years. According to this graph, a sharp

decline in average precipitation in the last few years can be traced. While the quantitative data presented in this particular graph underpins the Water Authority's stand regarding the need to rapidly promote large-scale desalination policy, there are several researchers who claim that presenting annual rainfall at the national scale is essentially misleading since regional variation is significant, and while some regions in Israel do experience decline in rainfall, others have in fact received much larger amounts in recent years (Hydrological Service report, 2011). When I asked my Water Authority interviewee about the competing theories regarding annual average precipitation in Israel, he answered in certainty: "there is no such a thing as scientific controversy about it". Such discrepancies in the interpretation and presentation of scientific hydrological data is a well-researched phenomenon, related to the constructive nature of environmental problems, to different interests and to the way certain issue are set on the agenda and choices are selected among different alternatives.

A third purpose of interviewing, as suggested by Weiss (1994), was to provide a more holistic picture of the institutional system, the many actors of such a multipart entity and their inner interactions. Lastly, interviews were used to scrutinize and refine issues and interesting directions that could later support the design of a more focused discourse analysis.

Interviewing as a method is not faultless. Difficulties related to differences in language use and word meanings[10], accuracy of answers, "messiness" of data, and the basic expectation that the interviewee will talk about the chosen topics at all. These challenges were underlying assumptions that accompanied the interviews and taken into account in the process of data analysis.

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[10] While in this particular case difference between scientific and lay languages is quite apparent, the chance of misunderstandings based on cultural difference was relatively minimal because both the researcher and the participants share the same cultural setting.

Initials	Position / affiliation	Date + location
	The Water Authority	
AG	Coordinator, energy in water team in strategic planning department, The Hydrological Service, IWA	3.2.2010, Jerusalem
YD	Former manager, Planning Unit, IWA. Currently external advisor to IWA.	25.4.2010, Ra'anana
AT	Manager, Desalination Department, IWA	24.2.2010, Tel-Aviv
MZ	Manager, Planning Unit, IWA	21.7.2010, Tel-Aviv
AP	External environmental advisor to the IWA and head of the Water and Energy planning team	12.4.2010, Tel-Aviv
	Water Company -Mekorot	
YK	Head, Energy Department, *Mekorot* National Water Company	13.1.2010, Tel-Aviv
	Company - TAHAL	
SN	Environmental economist, TAHAL water engineering company	10.5.2010 Tel-Aviv
	Electricity Corporation	
ZL	Deputy director-general, Planning and Environmental Unit, Israel Electricity Corporation	17.1.2010, Haifa. 25.1 completed by phone
	The Ministry of Energy and Water Resources	
SV	Chief scientist	4.1.2010, Jerusalem
AK	Former manager, Sewage and wastewater department, IWA. Currently head, water and energy infrastructures	9.5.2010, Jerusalem
	The Ministry of Environmental Protection	
MH	former CEO, The Ministry of Environmental Protection	3.1.2010, Kiryat Uno
NK	Former Economist, The Ministry of Environmental Protection	4.2.2010, Jerusalem
VB	Former Deputy director, The Ministry of Environmental Protection	9.11.09, Jerusalem
RA	Head, Sea and Seashores Department, The Ministry of Environmental Protection	14.12.09, Haifa
	National Planning Committee, Ministry of Interior	
MK	Member, Planning Committee for marine environment and water pollution	14.12.09, Haifa

ME	Head of Infrastructures planning unit, National Planning and Building Council, The Ministry of Interior	9.4.2010, Jerusalem
	Academia and research institutes	
DAG	Environmental Sociology, Tel-Aviv University	19.8.09, Tel-Aviv
JG	Desalination Scientist, Ben-Gurion University	5.8.09, Sde-Boker
OA	Coordinator, Energy in water forum, Samuel Neaman Research Institute	4.8.09, by phone
DNK	Political Geography, Haifa University	7.9.09, Haifa
	Non-Governmental Organisations	
IH	Deputy director, Open Landscape Institute, NGO	16.8.09, by phone
MP	Marine and Coastal Environment, The Society for Protection of Nature in Israel (SPNI), NGO	31.1.2010, Tel-Aviv
YCF	The Israeli Energy Forum, NGO	11.11.09, Tel-Aviv
NS	The Israeli Energy Forum, NGO	3.5.2010, Tel-Aviv
ALT	Founder, Israel's Environmental Defence, NGO and member, the Jewish National Fund (JNF/KKL) management board.	27.4.2010, Sde-Boker
	Energy business	
AD	Founder and CEO, *EcoTrade*, Israeli carbon emission trading company	30.5.2011, Sde-Boker

Table 4: List of interviewees

3.8.3. Public appearances

Another type of data was generated in public appearances and speeches of governmental policymakers and regulators taking place in several conferences and various forums (academic and public). This type of data can be classified somewhere on the line between primary and secondary since it often involved both speeches prepared in advance and read from text, as well as personal communication with the researcher.

Name	Organizers & location	Date
Water Wisdom: a New Menu for Palestinian and Israeli Cooperation in Water Management	Ben-Gurion University + Arab Association for Quality Development and Improvement, Bethlehem Branch, Palestine, held in Amman, Jordan	9-11.4.2008
The Feasibility of Nuclear Energy in Israel	Israeli Institute for energy & Environment, Tel-Aviv	30.11.2009
A moment before Copenhagen: The Israeli perspective	The Interdisciplinary Center (IDC), Hertzelia	2.12.2009
Planning along the sea shore: The annual Israeli Planning Association Conference	University of Haifa, Haifa	18.3.2010
Israel's readiness to climate change – implications on the water sector	Bloomfield Science Museum & Friends of Earth Middle-East, Jerusalem	21.4.2010
The Israeli Association of Ecology and Environment Conference	University of Ben-Gurion in the Negev, Beer-Sheva	21-22.6.2010
Jerusalem Conference for Environment and Society: crafting sustainable energy policy for Israel	The Society for the Protection of Nature in Israeli, Jerusalem	7.11.2011
Energy and Business Conference	EcoEnergy Company, Ramat-Gan	28-29.11.2011

Table 5: List of forums and conferences attended

3.9. Data analysis

Discourses analysis is often treated as a "whole package" of theory and methodology, guiding a critical research, that is, a research that investigates and reveals power-relations by highlighting the role of language in societal transformations (Hajer, 1995; Jørgensen and Phillips, 2002). For example to its use as a theory, Discursive Institutionalism, a building block in the theoretical framework of chapter 5 in this thesis, has extended neo-institutional analysis to include ideas, language, and discourses in its account of organisational or institutional change. Whereas discourse analysis functions also as a tool or a method in interpretive research, the exact way of

conducting such an analysis is very often obscured, generally consists of several stages; from transcription, through sorting and reducing, reorganising the data in light of the purpose of the research and finally abstracting conceptual claims that link the data with the theory.

The coding of written documents was a multi-stages process. Initially, key-words and key-issues were identified, by using *Nvivo* program. In Appendix 4, I have highlighted the key-words that have relatively high number of references in the sample of interviews and documents, to show how these key-issues emerged quite early in the research as central and how more findings and later analysis reinforced their prominence. The interviewing process has started only after key-themes emerged and the interviewees were selected accordingly. For the purpose of the second stage of analysis of data in this thesis, fourteen interviews were tape-recorded after granting permission from interviewees and later transcribed. The rest of the interviews were hand-recorded and typed into the computer immediately after. The interviews were transcribed in Hebrew and remained in their original language during the analysis. Selected quotes have been translated into English only at the last stage of writing the chapters. Public appearances were also transcribed. All documents, including transcripts were subject to thematic coding.

Thirdly, key-issues (of now all written material) were used to create a conceptual map by using *Freemind* program (example in Appendix 3). At the third stage, key-words and issues were gathered into main themes (thematic coding) and identified as constitutes of the hegemonic discourse, which may be regarded as the rules of practice or "the game". Finally, words or issues that seemed to be marginal were then brought back to the analysis as the counter-discourses or at least as complementary. The combination of central and marginal (or in fact marginalised) discourses allowed for the creation of new claims about the Israeli water regime (chapter 4), the Israeli energy regime (chapter 5) and the interlinkages between the two (chapter 6). No less

important it is hoped that the analysis went beyond the data to inform theory, as is elaborated in chapter 7.

3.10. Reflection of methodology

The methodology was built based on understanding of my interests and the knowledge that was gained in the first and second chapters. The methods then chosen were consistent with this methodology, and were devised to test the theoretical puzzle developed in the previous chapter, with the aim of answering the research questions, by means empirical study of the technological configuration dominating the water and energy sectors in Israel. The research uses different methods for exploring the material data (interviewing, documents and public appearance analysis), but rooted in the approach to knowledge and knowledge claims, as socially constructed, mediated and interpretative.

3.10.1. The position of the researcher and more research ethics

I was born in Israel and grew-up there. While there are advantages in being familiar with the local setting under study, first and foremost in terms of familiarity with the local language and culturally accepted norms, several specific challenges potentially face the researcher studying the context of his or her day-to-day life. First, authors have called attention to the meaning of social relations whilst conducting research. Differences between researchers and researched based on gender, age, position, social-status, power or others (Christians, 2000), could not have been eliminated also in my own locale. Gender and age differences were particularly apparent whilst interviewing decision-makers in the field of energy, which is dominated by veteran men, although this was not expected to have a major effect on research results.

Additionally, elite interviewing involves both issues of validity and reliability (Berry, 2002). Even though I did not interview politicians, many of the participants in this research are public Figures that speak with the press and in front of large audiences. They are used to being publicity quoted and being identified with their positions, and consider this an essential part of their official duties. Despite the advantage of being able to easily guarantee their participation and to schedule a meeting and to usually receive full cooperation during the interview, quite often elite's answers to questions remain at the level of statement (or 'politics') and can hardly move beyond the official standpoint toward the interviewee's personal observation or interpretation of the issue at stake. Sometimes it was hard to explain that I am interested in more than mere technical details, and wish to engage with them in a dialogue to hear what they *think*, rather than *know*, about the policy. In any case, there were no issues regarding interaction with vulnerable people and I often expressed myself in a straightforward manner.

One way to overcome this difficulty and gain interviewee's personal perspective is by keeping the anonymity of informants and avoiding from quoting interviewees by their names. Notably, none of my participants expressed any concern regarding having their name going forward with their quotes. Furthermore, considering the small amount of key-actors in the Israeli environmental arena, complete anonymity is impossible and people in the field would probably be able to identify the source. In order to mitigate possible implications, participants were first, notified verbally, in the beginning of the interview that what they say can be used in a direct way in the research (i.e. quoted) unless they specifically ask to say something "not for citation". Only one interviewee did not want to be recorded but he, also, permitted me to freely report my understanding of what he has said. Second, I decided that direct quotes will not include a specification of the interviewee's initials and usually will not include also his or her affiliation in the organization, such as head of department or general manager, in order to keep a distance between their sayings and a definite identification of who they are. These issues were pre-recognized and clarified during an ethical

review process undertaken in the university, and approved by a research ethics committee.

Not less substantially, in attempting to reify discourses, I was making claims and identifying discourses that have no substantive form beyond my own research. I was therefore engaged in the joint production of these discourses. Being a member of the society under investigation meant even a closer engagement within this shared discursive sphere. However, because my interest from the beginning was establishing the conditions of processes rather than to evaluate any specific policy output, when actors from different sectors argued the same point - I could get a unique overview of the construction of discourse, albeit without being really external to it.

4. Water: the role of technology in paradigms, politics and policy transitions

> *"First modern societies have a particular* ***concept of nature*** *founded on its exploitation. Nature is simultaneously central to society and marginalized. It appears as the 'outside' of society. Nature is conceived of as a neutral resource, which can and must be made available without limitation. This is the prerequisite of an industrial dynamic of affluence which regards its normal state as one of endless growth, and which succeeds in displacing its negative effects so that they seem to originate elsewhere" (Beck et al., 2003:4).*

4.1. Introduction

As part of the general aim of this thesis to reconceptualise technology-policy dynamics in sociotechnical transition, the goal of this chapter is to contribute to the on-going discussions on policy dynamics. As mentioned in the literature review, the role of technology has not been adequately addressed in the literature on policy change. Sabatier (1988:136) did claim early on that the role of technology is similar to that of a crisis as an external pressure on policies and institutions, while Lovell (2007) emphasised the importance of construction material and low-energy technologies in the housing sector's policy process in the UK. But apart from these exceptions, much of the policy dynamics literature conceives of policy as a lever that is shaped and manipulated in order to influence technological trajectories and escape unsustainable lock-ins (Rip and Kemp, 1998; Elzen *et al.*, 2004; Geels, 2005; Hekkert *et al.*, 2007; Foxon *et al.*, 2010), downsizing the important reverse causal relationship in which technology has the potential for transforming policy regimes.

In what follows it is demonstrated *how* a technological breakthrough can reshape policy paradigms and subsequent policy dynamics through the case-study of desalination technology and its influence on Israel's water policy. The water regime in Israel was static for decades, anchored to a hydro-ideological support of water-intensive agricultural production and characterised by a kind of environmental brinkmanship, and a muddling through periods of crises and political manoeuvring. As will be emphasised in this chapter, while several factors had contributed pressure toward a socio-technical transition of the Israeli water regime for some time, these were not sufficient to engender a significant change in existing policies and institutions before technical improvements in desalination process made desalination an economically feasible alternative.

Though techniques for transforming seawater into drinking water had been known and practised in water-scarce regions such as Israel for decades and the technology was promoted vigorously as a large scale solution for Israel by some actors, it was deemed unfeasible by the Ministries of Finance and Agriculture. A parliamentary decision to increase desalination capacity made little progress due to political impasse (Feitelson, 2005). Recent scientific and technological breakthroughs have significantly reduced the cost of water desalination per cubic meter. Thus, whilst multiple factors laid the basis for a shift (as will be discussed below), technological advancement in the end made desalination a panacea for water scarcity. As has been introduced in chapter 1, desalination technology and large scale water infrastructures will dominate Israel's water management strategy in the next couples of decades, planned to supply all domestic usages (approximately 750 million cubic meters) by the year 2020 (Tenne, 2010).

On a theoretical level, this chapter is interested in the relationship between technology and policy change and specifically in the causal power of the former over the latter. It is asking *how* the technology was able to cause policy dynamics. Whilst it has been suggested that supply-side technological solutions such as desalination do not address entrenched underlying political

and social paradigms and arrangements (for example Meerganz Von Medeazza, 2005, 2008; De Châtel, 2007), it has not been explained how and why the technology allows underlying issues regarding desalination to be bypassed. In this chapter, I shed light on how desalination, both as an actant and as a discourse, has displaced growing costs and tensions into new and less visible realms and avoided direct confrontation with existing power arrangements. I argue that this kind of displacement is a structural mechanism in which a new technology can shift a policy regime in socio-technical transitions more generally and that it is important to make displacements more visible in order to ensure that the regime will change in a positive direction. The findings call for greater integration and reflexivity in the policy regime arena, thus providing another evidence for an already established assertion in policy integration studies (see chapter 7).

This chapter is consists of four main sections. I will first recall a few of the theoretical prepositions for understanding technology as an explanatory variable for paradigm and policy regime changes. I will then describe the setting in which the study took place: the water sector in Israel, institutional context, infrastructures development, current water allocations, wastewater reclamation and desalination production. A few acute issues such as the declining of the Dead Sea and the Palestinians' water situation are also noted. Section 4.5 focuses on the emergence of desalination policy. In section 4.6 I will discuss the mechanism of displacement by which desalination technology was capable of inducing radical change. Section 4.7 concludes that an integrative and reflexive structure for public policy and management (could be in the form of integrated transition management – see chapter 7) could better handle the consequences of "problem displacement" by technology.

4.2. Policy regime change and the role of technology

Even with its objection to technological determinism, much of the SST literature reviewed in section 2.3 assigned transformative powers to

technology. As opposed to these studies, many scholars are reluctant to consider technologies as driving social change. For example, Nye (2006) resists the view that something embedded in technology could make its dominance over society inevitable. Similarly, Geels (2005b:1) argues that "...technologies do not fulfil societal functions on their own. Artefacts by themselves have no power".

In order to resolve this, I suggest that contrary to Nye's (2006:28) lament, accepting the possibility of technological causation does not rule out the "importance of particular individuals, accidents, chance, and local circumstances" and does not necessitate "technological determinism". Also, it does not preclude the role of institutions, agency, values, perceptions or social construction. Marx and Smith (1994:xiii) suggest that "...the history of technology is a history of human action"; technology can offer something that enables and promotes change at a certain point of time and in specific circumstances and environments. In this light, concerns about technological inevitability are misplaced. This is especially true if we accept an intermediate view of a "dialectical relationship between the social shaping of technology and the technical shaping of society" (Wyatt, 2008:176) or the view of "technological momentum" which highlights technology's dual role as both cause and effect (Hughes, 1994).

While socio-technical transition necessarily entails policy changes as part of a wider institutional evolution, these have seldom been the focus of research. Instead, the research on socio-technical transitions primarily aims at reconstructing a narrative of regime change in a way that allows the emergence of new transitional paths. Policy change is seen as a tool, rather than as an outcome. Policy and decision-makers are largely absent from the conceptual language, and transition processes are analysed separately from the policies, management or steering approaches that are to influence them (De Haan and Rotmans, 2011).

The literature may contribute an important understanding of the power of technological development to form a new sociotechnical regime around that technology (Foxon et al., 2010; Nye et al., 2010). Yet, public policy researchers and theorists of policy change have not taken Sabatier's (1988) early claim - that new technology's effect is similar to the role of external crises or a "policy window" - much further. The assertion that technological solutions to what are identified by policy-makers as problems can shift policy regimes – is supported by only a few case-studies (e.g. Lovell, 2007)[11].

I therefore argue that technological breakthrough can play a pivotal role in policy dynamics and socio-technical transitions although it is usually treated as a dependent variable in the policy dynamics literature, with its development and diffusion aligned or co-evolving with policies and regulations[12]. In what follows, I will demonstrate this claim by investigating the Israeli water policy regime and take one step further to ask how the technology was able to play such a role. I will first provide a short reminder of the empirical materials used. I then set the background to the water policy regime and its sociotechnical landscape, including the emergence of desalination policy. Finally, I will focus on the displacement mechanism by which this new technology was able to shift a locked-in policy regime.

4.3. Empirical materials

The following analysis of the Israeli water regime and particularly of policy dynamics revolving around desalination, is based on an extensive documents analysis and interviews with key actors. Dozens of minutes generated by a

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[11] Exceptions to this are studies that focus on the circular relation between resources, prices and the adoption of technological devices (for a review see Jaffe et al., 2003).

[12] This is especially true of the research on green technologies and environmental policies (see e.g. Foxon, 2010; Kemp, 2000).

Parliamentary Investigation Committee provided a rich source of written material that was subjected to close reading, thematic coding and selected quoting. It included internal dialogues of a wide range of stakeholders from the public and private sectors. The work of the committee aimed at tracking down the chain of events that led to what was acknowledged by the government to be a severe water crisis and at the process of work many related issues had surfaced: the role of agriculture, the divided responsibility of managers and legislators, the role of science versus politics in making decision and so forth. Among these issues, participants in the process highlighted the water-energy interface with respect to desalination. On the basis of this reading I have chosen key-actors in the water regime that are actively involved in making those decisions (heads of departments in the Water Authority and *Mekorot* national company, representatives of ministries, planners in the Planning Authority, scientists, and water companies) I was interested in. Together with additional official documents and public appearances of stakeholders, these materials constitute the source on the base of which the first research questions can be answered. But first thing first.

4.4. Water infrastructures in Israel: a brief history and current setting

A wide range of studies has examined Israel's water policy and management. The studies emphasised the role of the Zionist-agrarian ideological movement in determining the development of water infrastructure and centralised institutions (Alatout, 2008; Feitelson, 2005; Feitelson et al., 2007); the geo-political situation of both conflict and cooperation between Israel and neighboring nations regarding water resources (Tal and Abed Rabbo, 2010; Wolf, 1995); and the spatial and physical integration of the water system, based on a "national water carrier" (see picture 1) that transfers water 130km from the Sea of Galilee in the north to the south (Fischhendler, 2008). Improper practices, such as over-pumping, neglect and pollution, are

highlighted simultaneously with innovation and best practices that Israel has demonstrated for instance in combating desertification (Portnov and Safriel, 2004). In this section I describe the water policy regime from historical perspective and set its institutional context.

4.4.1. Geographical conditions and the pre-state period

Israel is a land of water scarcity, with 60% desert and eight dry months a year. Annual precipitation averages from more than 700mm in the north to less than 35mm in its Southern strip (Kislev, 2001). In ancient times, water has been collected in cisterns and wells, and transported from springs, streams and groundwater to settlements by aqueducts, e.g. to Jerusalem and to Caesarea. Later, the Arab inhabitants of the land watered their fields and orchards by open canals, taking advantage of gravitation (Sitton, 2002).

Water infrastructure started to change dramatically in the first half of the 20th century, developed in parallel by the British Mandate and the new Zionist settlers, who came predominantly from Europe and included engineers who had a vision of cultivating the land. In his futurist book Altneuland, Theodor Herzl, "the visionary of the State of the Jews", described fields of wheat and barley, corn, poppy seeds and tobacco, which are high water consuming crops. The first person to envision a national water plan in 1920 was Pinchas Rotenberg, one of the leaders of the Yishuv, the Jewish Zionist settlement in the land that preceded the State of Israel. Nevertheless, the expert delegation of the US Federal Bureau of Reclamation that visited Israel in the mid 1920's, invited by Zionist leader Haim Weitzman, still concentrated only on the coastal aquifer (ignoring the Sea of Galilee and the mountain aquifer). It was not before the late 1930's that Dr. Walter Laudermilk outlined the plan that is considered today the initial vision for developing the national water system (Schwarz, 1990). By then the senior water managers at the time agreed that the strategy should be to transfer water from where it is plentiful to where it is not, to supply water during the dry season, to convey water

under pressure in pipes in order to overcome topographical barriers and reduce leakage, and finally to take an integrative approach and supply water throughout the country, particularly to the arid Negev desert (Sitton, 2002).

In 1937, in rare cooperation, all the central development agencies of the Yishuv established one company, in order to found, operate and manage hydrological projects for irrigation and domestic consumption - *Mekorot* ("Resources") (Tal, 2002), which was registered in the British Mandate government. Its first head was Levi Eshkol (later the third Prime Minister of Israel), and his professional partner was Eng. Simha Blass. Eshkol and Blass conducted the first water infrastructure initiative two years earlier, water drilling for agriculture in the Yizrael Valley in the North of the country. During its first decade, *Mekorot* executed drilling and pumping facilities, placed water pipes and supplied water to settlements in the North and Centre of Israel as well as the North-Western Negev. However, one of its main aims was to provide water to the Negev desert at large (Mekorot, 2010). Blass was in charge of planning this infrastructure. He submitted the first plan in 1939, and it included three stages: 1. transport water from nearby drills, 2. transport water from the Yarkon river in Central Israel, and 3. transport water from the North (Blass, 1973). After a pilot transport effort in 1947, the first major stage, the Yarkon-Negev pipeline became operational during the 1950s. Blass's plans were the basis for a national water carrier that was executed after the establishment of Israel in 1948, as further described below. All plans were inspired by the Zionist mission to create a large Jewish settlement based on agricultural activity and the soon to be first Prime Minister David Ben-Gurion's vision of "making the desert bloom". Ben-Gurion, like other European Zionists, thought that the desert will be a blessing only if it will no longer be a desert. He wrote that "the state of Israel cannot stand a desert within it" (Ben-Gurion, personal diaries, 1955). However, the new infrastructure created a non-realistic thirst for water, and blinded decision-makers regarding the long-term implications of the pressure on such a delicate resource (Tal, 2002).

4.4.2. Early years after national independence: Institutions, regulations and major projects

Most of the water-related infrastructures and institutions in Israel are a result of the Water Law. Enacted in 1959, this comprehensive law reflects to a great extent its creators' ideology and perception of water. Its first concern was with the nationalization of all sources of water. Its opening section therefore expropriated all private water resources and all types of water (including rainfall and wastewater), and fixed the control over collection, storage and distribution of water under the authority of the Ministry of Agriculture (later the Ministry of Energy and Water Resources) and three operational bodies: the Water Commission, the national water utility *Mekorot* and *Tahal*, the national water planning company (which was later privatized in the 1990's).

The Water Law is the most significant mechanism that supported a completion of the shift from communal (especially of Arab communities, which used to collect and divert rain water for drinking and irrigation purposes) or regional scales of management, toward an integrative, centralised and statist water management (Feitelson and Fischhendler, 2009). The Water Commission (later 'Authority') determined the abstractions from all water resources, allocates the water to the different users (now all metered) and following a recent structural reform in the sector, the renewed Water Authority is also responsible for setting water tariffs (until recently fiscal decisions were made by parliamentary committees). A Public Committee of Water Management that is mainly composed of members of the agrarian sector, and a "water court" that deals with any claims of a person or organization that sees itself as damaged by the commissioner's decisions, were also established as part of the centralised water institutions.

The hydrological map of the country consists of a few main natural sources of fresh water. The Sea of Galilee, which receives most of its water from the Upper Jordan River, used to provide more than a quarter of the country's total demand. However, the average of 400 MCM annually pumped by

Mekorot from the lake dropped to merely 133 in 2009, an indication of the severe water deficit and the water levels decreasing below the "red line", which was set as an indicator of the minimum water level that the lake can reach without severe consequences to the quality of the water. Already in 1990 deficiency of the water resources reached 1.6 billion MCM (Tal, 2002). The second major water resource is the Western Mountain aquifer in the east and the Coastal aquifer in the west, providing approximately 350 MCM annually.

Picture 1 The National Carrier (Northern open section)

The sources of water that flows to the Sea of Galilee are partly situated in Syria and Lebanon, which for decades meant that any activity related to water diversion in either side of the border was a source of contention and agitated conflict. These geographical and geopolitical conditions have served an additional reason for an integrative system of water management and use that

could foster large scale hydrological projects (Fischhendler and Heikkila, 2010). Prices as well, were set at a single, uniform level across the country (Tal, 2008). Physical integration was achieved by the National Water Carrier that connects the three major sources, with a huge cost for the young state that reached 175 million dollars. Pushed by enormous pumps, massive pipes bring water from the Sea of Galilee, at 213 meters below sea level, to 44 meters above sea levels. The water is then carried along 130 Kilometers. Its northern section is an open canal while its southern sections conveys in large pipes underground, transporting about 400 MCM of water a year. Today, with the introduction of desalinated water to the integrative water system (see water map Figure 3 in chapter 1), the National Carrier has to be reconstructed in a way that will allow water to also be moved from desalination plants in the west coast to other parts of the country in the east, south and north. Additionally, population growth requires a new pipe line from the west to Jerusalem, a massive infrastructure project that is currently carried out by *Mekorot*.

The original water salinity in the Sea of Galilee was, however, too high for agriculture. Upon establishing the supply, a diversion of saline sources via a special canal to the lower Jordan River decreased the salinity of the lake by almost 50%. Still, regulations of drinking water quality had to be set in the early days by the Ministry of Health. These measures were, by any means, neither sufficient nor significantly capable of protecting the quality of the sources themselves. For example, during the 1950s and 1960s urban sewage systems as well as industrial waste were directed into near-by streams with little or no treatment. However, the drafters of the Water Law did not mention the word 'pollution' in any of its 150 sections (Tal, 2002). Parallel to the development of environmental legislation in the US during the 1970s, a new section was later added to the Israeli Water Law with the objective of regulating and preventing water resources pollution, especially of groundwater, wells and streams. Yet, although the amendments to the law determined that the Water Authority can also initiate enforcement actions and force polluters of water to repair damage, enforcement capacity - and

consequently the ability to deter heavy polluters - remains relatively weak (Tal, 2007a).

4.4.3. Water allocations

During the first decades of the State of Israel, water was allocated generously. Rapid population growth and rising standards of living, the Zionist visions of agriculture, the desire to attain food-independence, and the aggressive development of industry, were seen much more urgent than addressing the long-term effects of over-pumping. Moreover, the real Figures of water availability were not agreed upon in the early stages. In 1948 hydrologists estimated that the 248 MCM utilized that year was only a fraction of the potential refill of the water resources, but in reality it was about a quarter of it (Schwarz, 1990; Tal, 2002). Nevertheless, by 2009 water consumption increased to 1910 MCM, for all usages (including allocations to Jordan and the Palestinians), and from all sources, including desalinated and reclaimed water (Water Authority, 2010). Figure 5 shows that while overall water supply in Israel has been fairly steady over the last two decades, fresh water supply to agriculture decreases, reclaimed water usage in agriculture increases, and domestic and industrial supply remains relatively constant. The overall water for agriculture per capita was reduced by about half from the 1960's to today (but productivity per capita increased), with water productivity three times better today (Kislev, 2001).

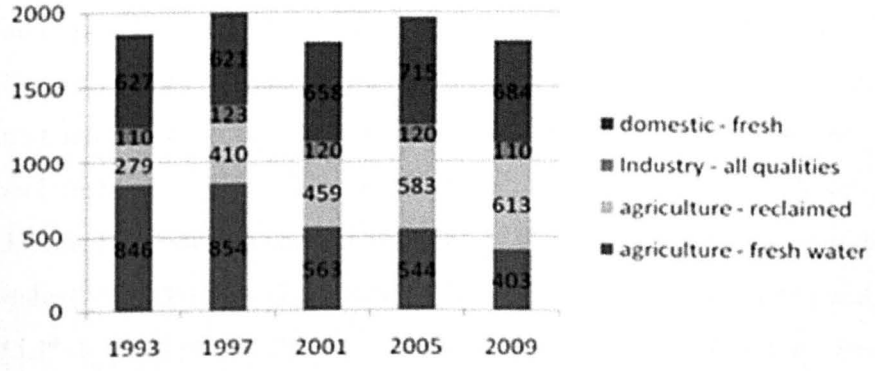

Figure 5: Water consumption (MCM) in Israel by sector and type of water. Source: Water Authority, 2010

In the past, the association of the Water Commissioner with the agricultural lobby often resulted in decisions which mirrored the Commissioners' personal values, favoring the farming sector in national water allocation (Feitelson et al., 2007). The generous allocations to agriculture that characterized Israel's water management strategy, enabled farmers to grow high water consuming crops such as cotton. The policy came at the expense of over-pumping of ground and surface water, with severe hydrological implications. This general approach was stopped by a new water commissioner, appointed from Israel's academic sector in 1991, soon after he took over (Tal, 2002). As an emergent measure allocation to agriculture was cut by 70% inter alia through use of economic tools, such as raising water prices and reducing subsidies. After paying less than a third of the cost of water for many years, by the mid 2000's farmers paid 88% of the actual cost with little effect on their profits. Adaptive measures, such as changing crops to more water-efficient ones such as peas and sunflowers, helped make this transition possible (Tal, 2007a).

In recent years, severe water shortages led to water saving campaigns and the introduction of the "drought tax", a politically contested measure designed to reduce water demand. Nevertheless, these actions reduced water usage by 11% in the domestic sector and 9% in the agriculture sector during 2009 relative to the previous year (Water Authority, 2010), and 13% reduction in total consumption of local authorities, including domestic, public gardening, education facilities, hotels and retail (Central Bureau of Statistics, 2009). Figure 6 shows the current water consumption in Israel by sectors, indicating that out of the total 1910 MCM (1267 MCM freshwater and 643 MCM reclaimed and saline), the agriculture sector is still the largest consumer with 53.2%, the domestic sector consumes 35.8%, and the rest is divided between industry (5.8%) and allocations to the Palestinian Authority (PA) and Jordan (5.1%) (Water Authority, 2010). When one considers freshwater consumption alone, however, (Figure 7), the equation changes: of a total 1267 MCM, the domestic sector is the largest consumer with 54%, the

agriculture sector receives only 32%, Jordan and PA 8% and the industry 6%. In other words, the domestic sector has overtaken the agriculture sector in consumption of freshwater, a recent and increasing trend. The domestic consumption of freshwater range is between 100 and 230 litter per person per day (*Mekorot* web site, 2011). The average water consumption per capita in April 2009, however, has been reduced by 18% compared to the same month a year earlier, following a water saving campaign[13].

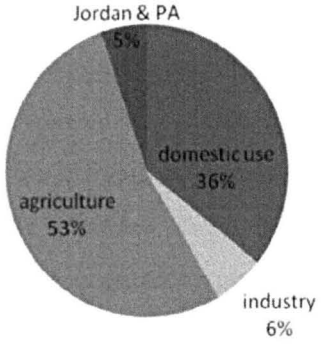

Figure 6: All water consumption in Israel in 2009

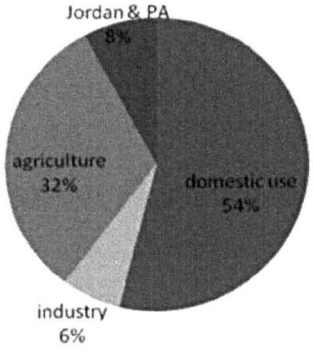

Figure 7: Freshwater consumption in Israel in 2009

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[13] Bar-Eli, A. (2009, 7 September). *Mekorot*: following Bar Refaeli's Campaign, water consumption reduced by 18%. *The Marker*. http://www.themarker.com/misc/1.532993 (Hebrew). Last Accessed: 14 April, 2012.

4.4.4. Waste-water reclamation

Many efforts were made in Israel to advance the transformation of sewage from a hazard and a primary source of pollution, to an additional reliable source of usable water, thus reducing pressure on natural water resources. In 2011, 95% of the population is connected to a sewage system and 75% of domestic effluent is reused for irrigation, industrial or recreational purposes. The Dan Region Reclamation Project (*Shafdan*) which operates since 1987 is the largest wastewater reclamation facility in the country. It treats 130 MCM of wastewater annually from the heavily populated Tel-Aviv Metropolitan area. Most of the effluent is treated to a secondary level, through a biological process. In the *Shafdan* there is also use of a Soil Aquifer Treatment technique (originally implemented in Arizona). Here, a sandy aquifer serves as both an additional treatment and a seasonal/multi-annual storage, and the high quality effluents delivered 100km south to agricultural purposes in the Negev desert. As part of the integrative water infrastructures system, reclaimed wastewater is also discharged upstream in several rivers in order to help restore dried and polluted streams. The water is later recaptured downstream for irrigation of parks or agriculture crops (Friedler, 2001).

However, extensive use of recycled wastewater poses health, economic and environmental risks, resulting from residual chemical or biological contaminants such as high concentrations of nutrients, salts that are toxic to plants including sodium, chloride and boron. While some nutrients were found to be beneficial to crops, others cause soil degradation and groundwater pollution (Ben-Gal *et al.*, 2006). In 2010, after a decade of negotiations, the Interior and Environmental Protection Committee of the Israeli parliament finally approved new standards set by the "Inbar Committee". These recommended values for reused wastewater quality - for thirty-seven parameters - are designed to minimize potential damage to water sources and to cultivated soil, while protecting public health.

A major part of an institutional reform in the water sector is the effort to manage the resource in a closed fiscal system in order to improve efficiency and to promise that any economic surplus from the water sector is invested back in the system. Until recently, water management was based on a divided jurisdiction between government and local municipalities: the latter responsible for delivering water within its jurisdiction, collecting water bills and providing sewage services. The result was often severe neglect of urban sewage infrastructures and untreated leakages in water pipes. Local councils were tempted not to pay *Mekorot* for the water and instead to use the money for other purposes. Therefore, the Water Authority is leading a transition toward the establishment of sewage corporations within local and regional councils, an intermediate step toward the possible privatization of sewage services (Tal, 2007a).

4.4.5. The Dead Sea and the Red-Dead Canal

The name "Dead Sea" originates from the absence of flora and fauna life in this lake, the result of its extreme salinity (approximately 30% - ten times more than the Mediterranean Sea). The Dead Sea is a terminal lake situated in the lowest place on earth, currently 424 meters below sea level. This constitutes a 34 meter decrease since the beginning of the 20th century. During the last two decades, the sea has been shrinking rapidly; from a surface area of 940km2 to 637km2 due to a reduction from 1,500 MCM refill annually to a current 400 MCM (Abu Qdais, 2008). The reasons for the decline are the diversion of water from the Sea of Galilee to the Israeli National Carrier and also to Jordan and Syria, preventing the natural flow through the Yarmouk stream and the Southern Jordan river to the Dead Sea. In addition, the pumping to the chemical industries in Israel and Jordan, natural evaporation and the general drop in precipitation (often attributed to climate change) lead to the steady drop in water level of one meter a year, with attendant costs estimated in 90 million dollar annually in Israel alone (Gavrieli et al., 2005; Tikva, 2006).

The shrinkage of the Dead Sea has severe consequences: with the dramatic drop in underground water levels, sinkholes are created unexpectedly in the vicinity, including under roads, settlements and agricultural land. The drop in the sea level and at the same time the artificial increase of the level of the industrial pools, have severe economic (mainly on tourism), environmental and safety impacts on all riparians. The Dead Sea constitutes the border between Israel, Jordan and the Palestinian Authority. Israel and Jordan developed significant tourist industries along the Dead Sea which are threatened by the disappearing sea. This situation led to international and regional efforts to find a solution that will stop the decrease in the sea level and mitigate some of the massive anthropogenic interruptions.

Perhaps the most popular and most examined solution to the shrinkage of the Dead Sea is the Red-Dead Canal, or the Peace Conduit. According to this proposal, 2,000 MCM/yr. water will be transported from the Gulf of Aqaba to the Dead Sea. Using gravity, 1,200 MCM will be dropped to the Dead Sea in order to create electricity that will enable desalinating the remaining 800 MCM (Tikva, 2006). This will enable supplying the severely water stressed Jordan and increasing the Dead Sea water levels, supposedly benefitting all parties and the environment. The cost of the project is estimated at two billion dollars. The current feasibility study initiated by the World Bank alone have already reached a cost of fifteen million dollar[14]. Experts warn about significant downsides, including leakage of sea water to the underground water along the way, vulnerability to earthquakes, change of landscape, mixing Red Sea water with the brine of desalinated water, (including the chemical used in the process) with Dead Sea Water. It is postulated that this might lead to creation of gypsum, making mineral mining more difficult and changing the color of the water to white, possibly leading also to growth of algae. Finally there is a concern about the consequences to

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[14]Tal, D. (2006b) $15m Red-Dead canal feasibility study mooted. *Globes*. Available on-line: http://www.globes.co.il/serveen/globes/docview.asp?did=1000102704.

the Red Sea from pumping such quantities, including harm to the coral reef (Asmar, 2003; Gavrieli *et al.*, 2005). Several experts suggest that while the deteriorating state of the Dead Sea should be addressed, the urgency still does not call for magic bullet mega-solutions such as the conduit, which may have irreversible effects.

4.4.6. The Palestinian water situation

I present here a brief account of the Palestinian water situation, as it can hardly be disconnected from water infrastructure in Israel, while more thorough accounts of the Palestinian water situation can be found in the literature. Water is a major issue at stake in the conflict between the Palestinians and Israelis, in this water scarce region. Notwithstanding improvements in the water infrastructure and allocations, Palestinians suffer severe scarcity of water, especially in Gaza, and frequently their ability to manage their water sources is constrained by Israeli authorities. The largest water source in The Palestinian Authority is the Eastern Mountain Aquifer, while the Western Aquifer is a main water source for Israel within the green line, where downstream flow from the aquifer is utilized, and for limited Palestinian communities. Concurrently, the Jewish settlements in the West Bank get their water supply from the Israeli National System (Aliewi, 2010).

Israel and the Palestinians share additional water resources and hazards. These include the Mediterranean Sea, a source for desalination, mainly in Israel but with a potential to rescue Gaza from its severe water scarcity; the Dead Sea, which is a source for tourism, and may be a source of desalinized water, should the Red-Dead canal materialize; and finally, sewage, which needs to change from a hazard to a water resource, but still flows from the West Bank to Israel, polluting its streams and causing a major environmental health hazard. At present, only 6-7% of Palestinian sewage is fully treated (Tal and Abed Rabbo, 2010). This severe lack of sewage systems and constant leakage in water pipes, characterize both Palestinian towns and Israeli settlements, and are a major hazard to public health, to groundwater

and to ecosystems. Another major hazard to the groundwater is the unauthorised drilling of wells by Palestinians that lower the water table and can pollute the aquifer. Major water projects such as desalination in Gaza or water reclamation in the West Bank have made little progress due to a variety of factors, including Palestinian internal considerations, Israeli security and bureaucracy agencies or the suspending of funding from international funders, recently due to the rise of Hamas in Gaza (Reuters news agency, 2010).

The Oslo Agreements between Israel and the PA included the establishment of several joint commissions. The one commission that continued to function and meet for over a decade, including during the violent days of the second Intifada, is the Joint Water Commission. While the two sides have different views regarding the functioning of the committee and the efficacy of meetings, it is agreed that the commission has contributed to some improvements in the Palestinian water infrastructure, but at the same time may be responsible for lack of progress in other essential water projects. Yet, the Committee proved that both sides can cooperate and solve problems jointly, which is a promising outcome (Jayousi, 2010; Kerret, 2010).

Regarding Palestinian allocations, the estimated water use is as follows (Figure 8): municipal and industrial: 112 MCM/yr. (59 in the West Bank, 53 in Gaza) and irrigation: 174 MCM/yr. (89 in the West Bank, 85 in Gaza). Therefore the total water usage in The Palestinian Authority annually is 286 MCM/yr.

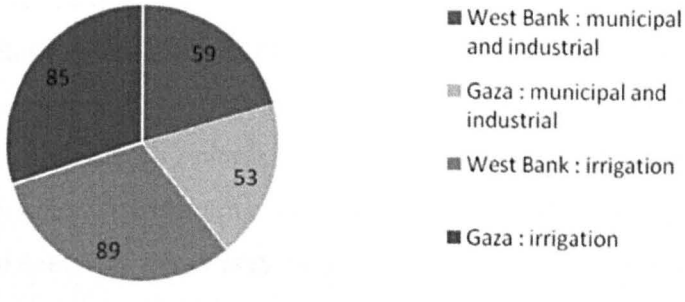

Figure 8: Estimated water use in the West Bank and Gaza

The estimated needs of the Palestinian population, however, are much greater, estimated in 2010 at 723 MCM, which is 437 MCM beyond the current supplies. Similarly, while according to both Israel's Water Authority and the Palestinian Water Authority the potential freshwater for domestic use in the West Bank is approximately 110 l/c/d (litter per capita per day), due to severe leakages and unauthorized water abstractions, the actual allocation is estimated in no more than 73.7 l/c/d. Since this Figure does not include those who are not connected to the water infrastructure at all, it is argued that a realistic Figure is 50 l/c/d (Aliewi, 2010; Water Authority, 2008). The water situation in Gaza is much more severe and allocations are estimated at 13 l/c/d (Aliewi, 2010).

4.4.7. Desalination: water for now and the future

In some regions around the world communities rely on desalinated water for their supply. The largest installed capacity is of Saudi Arabia, which is then followed by Spain and the USA. Rest of the largest capacities are within the Middle East (see Figure 9). Desalination is a process of removing salt and other substances from water. Over the past decade desalination plants and their total capacity worldwide have almost doubled. There is a range of desalination techniques. The most common techniques are the thermal and the membrane processes. The thermal process is based on distillation and heat transfer. Main thermal technologies are the multi-stage flash (MSF) and multi-effect distillation (MED). The membrane process involves water filtration through a membrane. Today the most efficient membrane technology is based on reverse osmosis (RO), in which pressure is used to force seawater to move through a membrane to obtain fresh water and separate the salt. RO plants are considered to have low capital cost but high maintenance and running cost due to the high cost of the membrane replacement and the energy requirements to operate the plant. The process also requires intensive post-treatment of the water, including re-mineralization, Boron and chloride removal and disinfection.

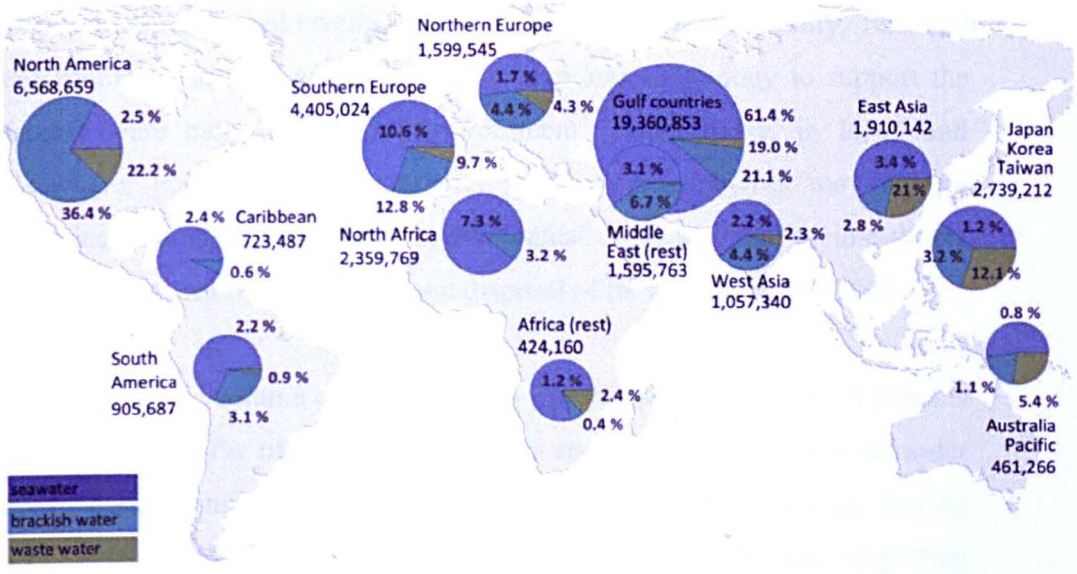

Figure 9: Global desalination capacities in cubic meter per day. From: Lattemann et al., 2010

In Israeli, experiments with desalination technology have started in already in the 60s, based on a feasible breakthrough made by Eng. Alexsander Zarchin, a new immigrant to Israel in 1947. Zarchin was a founder of the governmental owned company IDE Technologies, which later would be fully privatized and become a multinational group of desalination technologies. First seawater desalination plants (in Multi-Stage Flush technique) were constructed by *Mekorot* in dry and relatively remote areas, such as the city of Eilat (in the country's southern tip), desalinating water in the Gulf of Aquba. This and other settlements were too far to be connected to the national water system. Few years later it was revealed that a cheaper production is possible through a mix use of brackish water and seawater and by using the RO technology (Gvirtzman 2002). An interesting attempt to construct a seawater desalination plant that is powered by nuclear energy was made in the year 1964. Unpredicted support for the project was given by President L. Johnson of the United States, and a joint Israeli-American team received a green light to examine the economic and technological feasibility of such a facility. This

mega-project to generate 600 MW and 100 MCM/yr. of desalinated water, was considered megalomania even in American terms[15]. Finally, financial commitments, as well as nuclear knowledge and technology to support the facility were not given by US government. Even today, in Israel and elsewhere, nuclear desalination with its economic benefits may not be sufficient enough to overcome technological risks and the socio-political resistance against nuclear power and disposal of its wastes (Wang, 2009).

As for 2012, the volume of approximately 300 MCM/yr. produced in Israel is equivalent to 40% of its domestic water requirements. All five seawater desalination plans (see table 3 below) apply the RO technology. During 1999-2008 the Israeli government has made several decisions regarding desalination. The first governmental decision (no. 4895) was made in 1999. It stated that the water sector should promote seawater desalination. This decision was made in contrast to the official standpoint of the budgetary department in the Ministry of Finance (for the reasons behind its objection, see this chapter, section 4.5). Following this decision, some organisational changes took place, and a special supervisory committee in the Water Authority had been appointed, to oversee the bidding process of desalination plants. Concurrently, the Water Authority initiated a strategic plan for the years 2002-2010, in which it recommended to produce 400 MCM/yr. of desalinated water. In 2002, the government adopted this target in a governmental decision (no. 1682). However, since the introduction of the desalination program in 1999, there have been several changes in governmental decisions regarding the targets of annual quantities to be produced, from various reasons: the initial target capacity of 50 MCM/yr. was raised in 2002, to 400 MCM/yr., but reduced in 2003 to 230 MCM/yr. in response to an unprecedented large amount of rainfall in 2002. In 2007, after

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[15] The source for this story can be found in Natan Arad's memoir. He described it in his blog: http://www.nathanarad.com (in Hebrew). Arad was a leading *Mekorot* engineer in this project, as well as involved in many others, including the Red-Dead Canal, Oil-Shells exploitation and more.

several dry years, the target was re-set to 500 MCM/yr. to be reached by the year 2013. The year after further increase was set to 750 MCM/yr. to be reached by the year 2020.

In July 2000, therefore, the first bid was published and the contract with the winning company was sighed 14 months afterwards. The facility, with 100 MCM/yr. capacity started producing desalinated water in August 2005. Parallel to unsuccessful attempts to promote small-scale facilities, preparations were made for another bid of a large-scale plant. It took, however, almost two years to agree on a suitable location and the facility was ready to go only in 2009. With the growing recognition of the water deficit levels, the actions to promote desalination intensified, and two more bids for large scale facilities (above 100 MCM/yr.) were opened. Additionally, it was agreed that small scale plants will expend their operation capacity. The latter decision has not came easily, as meanwhile desalination prices dropped and desalination companies were reluctant to expend production based on current market prices.

It is envisioned that any supplementary desalinated water that becomes available between 2010 and 2050 will be infiltrated to aid in replenishing Israel's aquifers (Water Authority website, 2012). Smaller desalination facilities desalinate brackish water from groundwater wells. Such facilities exist in Eilat, the Arava, and the northern coastal plain (Gvirtzman, 2002). At present, total production of desalinated water from brackish sources is 30 MCM/yr., and planned production is planned to reach 80-90 MCM/yr. by the year 2020. Desalination facilities follow a similar procedure of public tendering and bids by the private sector for the construction and operation of each facility[16] (Water Authority website, 2012).

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[16] Small plants are built under BOO agreement (Built-Own-Operate), while bigger plants are based on BOT (Built-Operate-Transfer). Consider also footnote 20.

	2007	2008	2009	2010	2011	2012	2014 (projected)
Ashkelon	105	111	115	119	120	120	**120**
Palmahim	19	30	35	42	45	45	**90**
Hadera			10	115	127	127	**145**
Sorek							**150**
Ashdod							**100**
Total	**124**	**141**	**160**	**275**	**292**	**292**	**605**

Table 6: Seawater desalinated water production in Israel 2007-2014 (MCM/yr.)

The future of expansion of desalination use in Israel depends on several factors. Desalination presents new challenges to water professionals and planners, especially in a geographically small country such as Israel. It requires major adjustments in current water infrastructures since the major production is shifted from the northern source of the Sea of Galilee to the central and southern coast of the county. Additionally, while desalination technology carries the benefits of introducing a new and theoretically unlimited source of water and therefore securing water supply for all usages, it entails long-term environmental disadvantages. (Schiffler, 2004). Among the major concerns are the high energy needs and associated GHG emissions, waste (brine) discharges and the occupation of valuable coastal areas. The government and the Water Authority's intentions to base water management strategy primarily on desalination have drawn some criticism, primarily from environmental NGOs, which demand that greater attention be given to water saving campaigns and reclamation of polluted wells. They also expressed the concern that desalination plants would turn out to be white elephants in the anticipated energy-constrained era.

4.5. Socio-technical transition in the water sector and desalination policy

There is a wide agreement that water management in Israel has historically been based on hydro-ideological support of agricultural production, and that it has been characterised by "walking on the edge" of water sources, utilizing them to a degree of environmental compromise (Fischhendler, 2008; Parliamentary Investigation Committee, 2010). These two features have contributed to equilibrium in the water regime and to its long-term stability. Some authors have suggested, however, that various recent socio-technical developments such as water cuts and price increases, water re-allocations, and the weakening of the agricultural policy network have already contributed to a transition which is manifested as:

- Innovative *irrigation technologies* and advanced wastewater reclamation facilities, which have allowed more efficient water use and released additional water for non-domestic usage.

- Reduced contribution of *agriculture* to the state's economy – it has fallen below 2% of the country's GDP over the recent decades. Following an economic crisis during the 80s, a new paradigm supported the shifting of resources from agriculture to other sectors. The "agricultural myth" that established untouch-ability of agriculture and policies related to that sector (Brown, 1992 in Feindt, 2008) has faded away the more dependent Israel became on global food markets.

- Growing public interest in health and *environmental matters* has led to the emergence of a new policy network with actors such as environmental NGOs (Menahem, 1998; 2001). The inclusion of environmental values in laws and regulations embedded environmental groups to new "issue networks". Israeli environmental movements have campaigned, for example, for nature's right to water,

which was encoded in law in 2004. New paradigms such as these have challenged the alleged contribution of agriculture to society and nature, or the view of agriculture as a "public good", and have therefore contributed to shifting the focus away from it.

- Joint meetings of the King of Jordan and leaders of the Israeli government conducted in secret since the 1960s. Water was among the contentious issues in these negotiations. In the *peace treaty* of 1994, Israel committed to allocating a fixed amount of fresh water to Jordan annually. Parallel "water talks" between the Palestinian Authority and Israel took place as part of the Oslo interim agreement in 1995 and resulted in one of the most important parts of the agreement - "Article 40: Water and Sewage". Despite current problems of implementation and various critics, this agreement recognises the Palestinians' immediate water needs and lays the foundation for cooperation in developing new sources and protection against water pollution (Kerret, 2010). As a part of geopolitical negotiations with neighbouring nations these "water talks" have underlined that drinking water demand would increase on each side of the border (Feitelson, 2002; Kartin, 2000) and have highlighted the concerns over potable water rather than water-intensive crops.

- Transformation of water in Israel, by means of pricing, from an ideological, symbolic scarce resource, to a *commodity*, the scarcity or abundance of which would be determined solely by the market and regulatory mechanisms (cf. Bakker, 2003a; 2003b). According to Alatout (forthcoming), this transition includes the construction of a new Jewish identity as the "citizen of the world", replacing the old identity of "immigrant and settler". A neo-liberal, global perception of Israeli society therefore also contributes to changes that are taking place in the water sector.

These multiple processes in the technological, cultural, economic and geopolitical realms, have laid down the groundwork for a transition. Yet, none of these changes in itself has been able to induce transformation in the Israeli water policy regime. Decision-makers, mainly in the political sphere, have continued to ignore continuous depletion of water resources and evidence of changes in rainfall quantities and distribution (Feitelson and Fischhendler, 2009; Parliamentary Investigation Committee, 2010; Shuval, 2010)[17].

Desalination did not appear spontaneously. As has been noted earlier, it had been used at experimental and small scales for example in oil-rich countries as well as in the southern region of Israel since the 1960s. The first seawater desalination plants were constructed by *Mekorot* (the national water utility) in dry and relatively remote areas, such as the city of Eilat (in the Gulf of Aquba) to desalinate a mix of sea and brackish water (Gvirtzman, 2002). Large scale water production, however, still remained impossible though as the technology was immature and costs were too high (Tal, 2006). Attempts by water professionals (water commissioners, water engineers or government and academic hydrologists and scientists) to promote desalination during the mid-1990s were rejected by the Ministry of Finance economists (Personal communication, Planning Department, IWA, 2010) who claimed that postponing desalination would be economically and strategically justified (Unpublished letter from the Ministry of Finance, 1999). Nonetheless, in order to compensate for a growing overdraft in the country's main fresh water reservoirs - two large aquifers and the Sea of Galilee - the Israeli Government adopted an unprecedented target in 2001 to desalinate 400 million cubic meters of water.

One major impediment to desalination was the Ministry of Agriculture and the agricultural lobby. They were active opponents of desalination, fearing

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[17] I present such an evidence in chapter 6.

that the increase in the price of water will fall on the farmers (Feitelson, 2005). However, when the Minister of Agriculture was questioned about the Ministry's role in installing desalination, he preferred to put the blame on someone else, claiming that: "all that is happening today can be traced back to the year of 2000...the Ministry of finance's bureaucrats have never agreed with those decisions"[18]. Indeed, the Ministry of Finance also objected to these expensive public projects without guarantees of a full cost recovery by an increase in the price of water[19]. Furthermore, the Ministry of Finance did not support the idea that *Mekorot*, the National Water Company, which is already heavily subsided by the state, will be responsible for constructing such an expensive project as a desalination plant. The political window of opportunity for desalination had opened in 1999-2000 because it was the same person that had been appointed as both the Minister of Finance and the Minister of Water and Energy, and past political controversies became almost irrelevant.

Implementation has still lagged behind, and it was only in 2005 when the first large desalination plant (100 MCM/yr.) was constructed. As has been told by interviewees, delays in meeting the new target have three, institutionally-based, key reasons. Firstly, rainy winters in 2002-2003 masked the sense of urgency of desalination for unprofessional eyes. Secondly, finding suitable land in the already over-crowded coastal strip was slow and difficult process[20]. Thirdly, the construction of desalination plants involved private

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[18] S. Simhon, Minister of Agriculture during 2001-2002, 2006-2009 and 2009-2011, in Investigation Committee, protocols, 2009.

[19] References to this claim can be found in the Investigation Committee's protocols. For example, one interviewee claimed that he can "see the main reason for this water crisis in the Ministry of Finance actions. The Ministry announces every now and then that there is no need to desalinate. And by that they have overthrown governmental decisions" (Prof. R. Samiet, a desalination engineer, protocols, 2008, in Hebrew).

[20] According to a report, written in 2009 by G. Rozental and submitted to the Investigation Committee (in Hebrew), the government decided that a BOO (Built-Own-Operate) tender can be found more appropriate, considering that bureaucratic procedures and inherent

companies and capital. The procedure of adapting the water sector to the new era of private-public partnerships (PPP) required the establishment of new arrangements and institutions, such as the Water Desalination Authority (Interview, AT).

Meanwhile, the cost of supplying water rose as water shortages required emergency production from marginal water sources. In the agricultural and water sectors it was realised that treated, inexpensive effluent (whose quality could be even improved if desalinated drinking water was used and recycled) could be used as water substitute. This alleviated conflict of interests in water resources and avoided the need for painful cuts in water allocations.

Cost of desalination decreased dramatically from about $2.50 per cubic meter in the 1970s to only $0.53 in 2003 (Becker et al., 2010; Greenlee et al., 2009). This key technical achievement triggered a major shift in water paradigm, policy and politics. Garb and Lee (forthcoming) suggest that once decision-makers realised that desalination could free Israel from the constraints of natural water supply and ever-lasting crises, they shifted their weight on promoting desalination instead of resisting it. As a result, desalination targets sky-rocketed: at the time of writing the long-term national plan (in preparation), is to increase desalination annual capacity target to 1.5 billion MCM by 2040 (Interview, MZ).

There is therefore an important reason why it was desalination technology that contributed to a major policy shift, which will also inevitably result in

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constrains of the planning system have considerably slowed down the first bidding process. In a BOO procedure, the private initiator comes with his own designated site for the facility, instead of a pre-located public land. However, according to one of the interviewees in this thesis, who participated the design process of the bids, the BOO has no advantage in that respect. The initiator has to go through the same planning committees' approval process anyway (NK, interview, 2010). The BOO approach was therefore left for only small sites with a maximum capacity of 50 MCM/y.

environmental and social changes: it was able to give each of the key involved actors the thing they needed to realize their interests with no or only minor compromise. In the next section I will elaborate, and give concrete examples, to the ways different interests were satisfied and policy goals realigned.

4.6. "Displacement" as a mechanism of technologically-induced policy regime change

4.6.1. How technology causes policy regime change and further implications

While several political and other factors contributed to incremental changes in the Israeli water regime, the role of technology was key, demanding more theoretical attention than currently awarded in the policy dynamic literature. Desalination provides an example of the potential agency of technological innovations. In what follows, I will explain how technology can exert its agency and how desalination was able to transform a locked-in regime. It will be shown how desalination functioned as a "solution" to persistent water problems through displacing externalities, costs, tensions and hard choices in a way which aligned with the interests of key actors and embedded institutional structures.

Although problem displacement cannot always be attributed to deliberate intentions of any actor, my case study suggests that displacement can be regarded as a mechanism that reorganizes the outputs of a new regime. In this case example, advances in desalination technology allowed an appearance of water abundance to emerge as a new water paradigm, replacing the old paradigm of water scarcity and repetitive crises, which reinforced a locked-in regime. By offering "limitless product whose price and quantity produced are governed by market forces" (Garb and Lee, forthcoming), environmental externalities, economic costs and hard political choices were first masked and

later displaced. In what follows, I will discuss different forms of involved displacements in greater detail.

4.6.2. Cases of displacement

Environmental problem and risks displacement. The most obvious displacement involved was that of problems across environmental media. Environmental risks related to water resources were displaced by transforming them to other risks requiring attention of planners and policymakers alike, related, for example, to "the scarcity of available coastal zones, energy use and climate change" (Interview, MP). On the manifestation of the water problem as a problem of available land, one of the interviewees noted that

> The locating team of the first desalination plant in Ashkelon had so much difficulty to find a place for it, and this is not the centre of the country we are talking about (Interview, Ministry of Water and Energy).

Additionally, there is no scientific agreement, for instance, on long-term effects of brine and salt discharges from desalination facilities to the marine environment, and once drinking water problem is solved, sea water is at risk:

> We went to the Water Authority and said: 'ladies and gentlemen, until today there was only one very limited research that has been performed during one limited season and a small budget, something like 80,000 shekels. And after all you are the body that provides the water, that produces it, you are with the responsibility to make sure to rule-out future harm'. But no one took a decision to force the Water Authority to carry out a monitoring study (Interview, eNGO).

While environmental externalities and future implications of desalination are sometimes brought up by scientists and environmental groups, other forms of displacement remain less apparent. Yet they do exist in the political/technical, managerial, economic and geopolitical realms as I discuss below.

Displacement of fundamental political choices to technical details. Perhaps the greatest tension in the Israeli water regime has been in the political realm. Authority and responsibility over water has been shared by at least five ministries, which has resulted in confrontations over water allocations, quality and pricing (Fischhendler and Heikkila, 2010). The water allocation process was considered lacking democratic representation of affected groups and long-term, strategic thinking (Fischhendler, 2008). Specifically, as Menahem's (2001) research has shown, a strong agricultural lobby reinforced a prioritisation of the agricultural sector in water production, allocation and pricing. It was therefore a political impasse, first and foremost, which postponed desalination by over a decade (Feitelson, 2005; Parliamentary Investigation Committee, 2010). The mainstreaming of desalination became feasible only when innovative development brought about a paradigm shift. The new paradigm is centred on the appearance of abundance, rather than entranced scarcity. By creating the impression of water abundance at the acceptable level of costs, the technology has gained support from a broad range of political actors such as environmentalists, Ministers of finance and Water and Energy, heads of municipalities, the water management authority, and even the members of the agricultural policy network. Each actor has its own view of potential uses of additional water. A veteran Israeli environmental scientist, for example, considered that

> In some circles there was an almost blind faith that scientific and technological progress was unlimited in its ability and that it was only a matter of a few more years until there would be a dramatic breakthrough in desalination technology and the goal of cheap desalination would be a reality. Thus some agricultural and water planners believed that there would eventually be almost unlimited water supplies available for the vast expansion of agriculture in Israel. (Shuval 1999, p.8)

However, it took several years before the awareness of the potential of desalination became ingrained and was able to offer what policymakers conceived as a competitive cost compared to natural water pumping.

Once this occurred, the technology unravelled the equilibrium of vested interests in water management. Yet, the new wider coalition favouring

desalination did not resolve all political tensions. Rather, these were shifted to technical details, displaced across sectors and environmental media and reframed as someone else's problems. For example, decision makers might no longer face the uncertainty of rain, nitrate and pollutant concentrations in aquifers, or the declining water level in the Sea of Galilee, because these uncertainties have been displaced. Instead, there are new technical questions: who will win the tenders and operate the plants, what would be a sufficient depth for the brine discharge pipes from the plants, or where natural gas powering the plants would come from.

Thus, the responsibility, power and decision-making capacities related to these technical issues have been displaced from politicians to hydro-bureaucrats and water professionals. In other words, the hard choices over the management of scarce water resources are displaced. But political decisions of course do not disappear: they just rematerialize in other settings. When water professionals are asked why the future water supply has been pegged on desalination, they express a wish not to have to depend on other countries as sources for water, food or energy because

> It is very easy to build a coalition against us (the State of Israel)...and this can happen in minutes and the water source will disappear, and this is why we cannot trust such sources... (Interview, Water Authority)

This is clearly a political concern. Yet, there was no need for any governmental policy to address the concern since water professionals are aware that there is politics in everything. The perception of key-actors in the Israeli Water Authority is that

> Israel is a highly political country, which needs to be left with enough water so that politics can play its role (Interview, Water Authority).

Desalination has allowed the politics of power relations between ministries and political negotiation to be modified as a politic of technical details, where water and planning professionals negotiate the needed amounts of desalinated water, the location of the plants, and the source of energy for these plants.

But, as Nelkin (1979, in Murphy, 2007) has pointed out, the use of technology to solve problems could sometimes evoke objection aimed less against of science and more of the use of scientific rationality and technical expertise to indeed mask political choices.

Displacement of uncertainties in water quantity and quality. First, in the agricultural and water sectors it was realised that treated, inexpensive effluent, whose quality would actually be improved by inputs of desalinated drinking water , could be used as an irrigation water substitute. This alleviated conflict of interests in water resources and avoided the need for painful cuts in water allocations, albeit with an economic dislocation of costs, as further discussed below. Second, the choice of desalination displaced concern from water quantity to water quality and risks for human health. In a desalination process, the water is filtered through membranes, removing salts and impurities. In order to make desalinated water suitable for drinking, there is a need to supplement the water back with its essential minerals, especially magnesium, calcium, iodine and fluoride. Despite recent recommendation published in 2009 by the WHO[21] and Israeli water professionals[22], there is a growing controversy between the Ministry of Health and the Water Authority regarding the need, if at all, to add magnesium to desalinated water, with the latter objecting to this act (Parliamentary minutes, the Labour, Welfare and Health Committee, 11.1.2011). This also has an economic displacement dimension, since the costs involved are considered significant, estimated in 5-11 million US dollars per year in current desalination production amounts and in 0.5 cents per cubic meter (The Knesset Research and Information Centre, 2011).

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[21] World Health Organization (WHO) (2009). Calcium and Magnesium in Drinking-Water: Public Health Significance. http://whqlibdoc.who.int/publications/2009/9789241563550_eng.pdf

[22] Dan Even (2012, March 2). Health Ministry: lack of magnesium in the water would cause death of hundreds every year. *Haaretz* (in Hebrew).

Fiscal costs and subsidies displacement. A fourth major displacement relates to the cost of water production. In principle, desalination can ease the tensions related to historical subsidisation of water for agricultural uses because it creates additional water for domestic use. This leaves more natural – that is "cheaper" - water available to the agricultural sector. Domestic water can also be recycled as cheaper water (treated sewage) for agriculture. Thus, the cost of water has been displaced to the sewage regime, where pricing and ownership of grey and black water will have to be renegotiated and clarified. Policies which prioritised agricultural water use in the past will not need to change because, as suggested by the former Head of the Water Authority,

> ...governmental subsidies would reappear in one way or another (Uri Shani, public talk, 2010).

Therefore, "cheap water for agriculture" remains an underlying directive of any water policy, with the full cost of both desalinated water and sewage treatment being gradually displaced onto the general public. Prices of domestic affluent treatment for households have already undergone accumulative increase of 32% between January 2010 and January 2011 (Water Authority website, 2012).

Displacement of geopolitical strategic and economic tensions. The fifth displacement takes place in the geopolitical realm. Actors have also embraced desalination on the basis of its promise to solve tensions over water resources at the regional scale. Early on, desalination was opposed as undermining Israeli claims to water resources such as the Eastern Mountain Aquifer underneath the West Bank:

> A major unknown Figure in the future projection of water needs in 2010 is the one derived by Israel agreements with the Palestinians, maybe even the Syrians. However, the government policy in the water sector could bare an effect on the results of such political negotiations. The Palestinians will discuss with us, among other issues, their water rights in the Mountain Aquifer. In case we push the water sector into the desalination era too soon and before the agreements, the Palestinians would argue that Israel controls an unlimited amount of water (produced by desalination) and then they, who don't have another sources and are economically inferior society, ought to

> receive a bigger share of water rights in the Mountain Aquifer. Similar claimes can be made by the Syrians (Unpublished letter by the Ministry of Finance, 1999:3, My translation).

But later, the official Israeli standpoint changed. Now water abundance is seen to allow more flexibility in geopolitical negotiations with the Palestinian Authority and neighboring countries (Garb 2010), easing what has been termed the "hydro-hysteria". There is an Israeli support for the construction of a desalination plant on the Israeli coast to provide 150 million cubic meters of water to the Palestinian population in the West Bank[23], though Palestinians expressed reservations about this plan: desalination displaces security risks from Israel to Palestinians, making the latter dependent on Israel and international donors for water sources as well as in their limited ability to pay for desalinated water for domestic and particularly agricultural activities (Ghbn, 2010). Having a desalination plant under Israeli control as a solution to the Palestinian water scarcity problems also displaces the familiar Israeli-Palestinian disagreement on "water rights" onto more technical lines. Having plenty of water with no recognition of rights to specific sources for either party may move the negotiations forward, but may still be considered ideologically problematic and strategically unwise by both sides.

4.7. Conclusions

The hydrological mission of Israel's establishment has largely achieved its goal. Today, reasonable quality water is provided to consumers with a relative high level of reliability regardless of pervasive drought conditions. This was made possible in a relatively short time period, through the projects outlined in this chapter, as well as technological innovations, such as drip

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[23] Horesh, S. (2008, 30 December). Desalination plant will be built for the Palestinian Authority. *Globes*. http://www.globes.co.il/news/article.aspx?did=1000412097 (Hebrew). Last accessed: 14.4.2011.

irrigation, and the local water industry's large investments in R&D of high-tech water technologies. Another important achievement is the unprecedented percentage of recycled wastewater (75%) in Israel, which compares favourably with similar semi-arid countries such as Spain (12%) or Australia (9%) (Keremane and Mckay, 2007; Iglesias Esteban and Ortega De Miguel, 2008).

From an environmental point of view, current water infrastructures, regulations and practices require greater attention from politicians, policymakers and water managers if these are to become more sustainable. For example, 110 MCM of non-reused domestic and industrial effluent are still discharged without treatment. Many streams and wells are polluted and the aquifers suffer from rapid salinization and seawater intrusion. Streams are drying up and aquatic ecosystems are under threat as a result of over-pumping and "drought-induced water pumping". Finally, the externalities of desalination are not fully known and in order to keep the price of water from skyrocketing, there is a possibility that the full environmental costs of desalinated water (that includes the energy externalities and long-term effects on the marine environment) will not be internalised in future water prices.

Traditional and current institutional structures pose additional challenges. It has been argued for instance that there are inadequate mechanisms in place to allow for the participation of different stakeholders, particularly the general public in decision-making processes (Interview, MP). In addition, as will be further argued in chapter 6, the integrated physical infrastructure does not necessarily indicate an integrated institutional capacity. In fact, it might be that authorities and responsibilities for water resources and management are distributed among too many ministries and bodies, who have interests that sometimes overlap, and at other times compete. This has posed difficulties in the past, for example in the enforcement of the Water Law against polluters (Fischhendler and Heikkila, 2010).

In term of sustainability of water resources, in the near future, additional attention should be given to demand-side management, to water conservation techniques and to innovative best-practices to manage water use at different scales beyond the national (such as community management schemes and cross border ones). Rain harvesting and grey water installations, to name a few, are being advocated by civil-society actors, and should receive a greater attention from water managers and legislators as well. Mega intervention projects such as the Red-Dead Canal require an in-depth, careful assessment that considers previous experiences both in Israel and worldwide. Finally, but crucially, a solution to the Palestinians' acute water shortages needs to be advanced. Even thou this depends on political will on both sides as well as on the international community, it cannot be a substitute for interim, pragmatic strategies for alleviating water scarcity in the region.

The policy of large-scale desalination, as depicted in this chapter, represents a regime shift and sociotechnical transition: policy makers consider desalination to solve the problem of water scarcity and unreliability in the region. The goals of the new policy, and the nature of policy problems and their possible instrumental solutions, as discussed below, were changed after a breakthrough in technology. This fits well with Hall's explanation (1993) for a paradigm shift. However, desalination technology did not appear spontaneously; it relates to existing networks of known technologies and large-scale integrative systems of water production and distribution. Immaterial structures of technocratic routines and technological optimism are already embodied within it. Moreover, desalination fits and reinforces traditional view of utilities according to which "bigger is better" when economies of scale are present. Desalination is also compatible with the neo-liberal ideology of privatization. Alternative ways to combat water scarcity, such as conservation, domestic water reuse, recycling or collection, and cleaning of polluted sources require regulative and physical decentralisation and greater public investment of funds.

I have therefore suggested in the chapter that technological change can be a key driver that shifts policy paradigms, political frictions and consequently an entire policy regime. I have also explained how technology exerts its agency through the mechanism of displacement, illustrating these claims with examples of changes in the Israeli water policy regime. Desalination dislocated environmental externalities across sectors and environmental mediums; political choices were displaced as water came to be seen a neutral product, governed by scientific, technocratic and the market rationality; water-related economic costs and subsidies were displaced by transferring them to the sewage subsector and; water quality problems remerged as desalinated water may carry a risk to public health. Finally, geopolitical tensions over limited water resources have shifted to less visible and prominent economic and strategic tensions such as the ability to pay for water and whose hand is on the tap.

Studies reviewed in chapter 2 suggest that in most instances, policy dynamics are explained by power relations and conflicts on redistribution (Dietz et al. 2003), rather than pure sustainability concerns (Mccay 2002). As is also evident here, the whole process of environmental decision-making is based on contest rather than consent mainly because environmental issues are inherently political (Dryzek 2005; Mollinga 2008). But, similar to science-based policy, technological adoption is embedded with political meanings of societal order and goals, particularly because it involves the framing of specific technology as a solution to a specific policy problem. Thus, a technology that is able to manifest itself as a solution, would be able also to rise above the political contest and to create a presumable consent and cooperation among the participating actors. The next chapter demonstrates the other case, where, a political quarrel is created around different technological paths, each portrayed as the solution to the problem of scarcity.

5. Energy: discourses and policy transitions

"There are concomitant notions of responsibility that go along with conceptions of choice" (Purcell et al., 2000:62).

5.1. Introduction

In the previous chapter I examined the relations between policy dynamics and technological change through the mechanism of displacement in the context of Israel's water transition. In this chapter I examine Israel's energy regime. Again, policy and technological dynamics are under investigation, but this time the mechanism in operation is discourses. The analysis here congregates an institutional-based approach to policy dynamics with an agent-based approach through the focus on discourses and issue networks.

Energy regimes all over the world are large-scale socio-technical, infrastructural systems, which encompass the provision and use of energy for transportation and electricity. While parts of the chain of energy production, transportation and distribution have been privatized in different parts of the world, over 70% of global oil and gas reserves remain state-owned and centrally managed (Shaffer, 2009). But although the state is still centrally involved in ownership and regulation and despite the greater awareness of politicians and policymakers of the problematic dependency on oil and imported fossil fuels, as well as of climate change and other environmental problems related to energy use (Unruh, 2000; Bang, 2010), national policies and institutional arrangements for energy are considered very hard to change. No wonder energy regimes are frequently considered locked-in and path-dependent (Verbong and Geels, 2007). Initiatives to promote renewable energy in EU states for example have not resulted in a significant transition

toward sustainability or in the 'greening' of the electricity sector (Verbong and Geels, 2007; Kern and Smith, 2008).

Israel's energy regime is not different and attempts to promote sustainable practices have been usually hampered by demand-side management and energy sources constrains. However, at large, the conflict between economic interests and environmental concerns has been subdued because energy has been considered first and foremost as an issue of national security and because of the lack of significant domestic energy sources; in Israel, notions of 'energy scarcity', "security of supply", "energy island", and "modern lifestyle" have centrally shaped the way Israeli policymakers perceive the country's energy regime and understand its possible future pathways.

Given the working assumption of scarcity of domestic energy sources, an appearance of energy abundance would therefore strike significant. Studies suggest, however, that abundance is not necessarily good or not even the antonym of scarcity (Alatout, 2009). There is substantial evidence to support this claim. Sachs and Warner (1995) showed that resources-rich economies have grown less rapidly than economies not dependent on natural resources – a phenomenon called the "resource curse". "Dutch disease" is a related and well-documented phenomenon: large natural gas discoveries in the Netherlands shifted factors of production out from other sectors such as agriculture and manufacturing and was followed by an economic crisis (Brahmbhatt et al., 2010). Natural resource abundance is also often associated with rent-seeking behavior by actors who resist changes to status quo, and sometimes also with corruption (e.g. Repetto and Institute, 1986; Carney and Farrington, 1998). Moreover, it has been suggested that the greater availability of resources could amplify their demand (Meerganz Von Medeazza, 2005). However, these findings have not undermined the popular belief that "more is better".

In this chapter I examine Israel's energy regime and a discursive shift from scarcity to abundance as a case study of the potential role of discourses in socio-technical energy transitions. During the time frame of this study, large

discoveries of natural gas in Israel's claimed economic waters and the emergence of three additional technological alternatives to current coal-based electricity have given rise to new policy networks, each hold a different storyline to promote different alternative. I concentrate on how latent aspects and implications of such a discursive shift have influenced the energy regime at the national level and examine (1) the sources of this new discourse on energy abundance, which is replacing an earlier discourse on energy scarcity, and (2) how a change from constructed scarcity of energy resources to their abundance potentially reconstructs socio-technical transitions, future pathways or technological trajectories and institutional arrangements at large.

In order to answer the second research question regarding the interplay of technology and discourse in transitions, I combine in this chapter insights from earlier studies of socio-technical transitions in infrastructure systems and discursive institutionalism (see chapter 2). Transition studies have rarely studied in depth the role of discourses in transitions[24]. In what follows, I will remind the reader of the material data used here and outline the theoretical framework in greater detail.

5.2. Empirical materials

The empirical material included policy documents published during the recent decade, which depict promising new sources of energy. The major type of policy documents investigated was transcriptions of parliamentary committees, including, among others, meetings of the Interior and Environment Committee, Economic Committee, and Science and

[24] Exceptionally, Smith (2009) has examined the evolvement and institutionalisation of "transitions" as a storyline that was adopted by the Dutch government. I am, however, taking another approach, in line with Lovell's course of investigation (2008), in which she concentrated on the mutual influence of discourses on innovations and policy in the UK's housing sector.

Technology Committee. Additional types of policy documents included ministerial published plans relevant to the issue of energy, such as the National Plan for Energy Efficiency, 2010-2020 and Renewable Energy Policy, both published by the Ministry of Infrastructures in 2010. The second type of data was generated by discursive analysis of transcripted public appearances and speeches of governmental policymakers and regulators in several conferences and various forums (a full list can be found in the methodological chapter). The last type of documents included few dozens of newspaper articles that were published in various on-line editions of Israeli newspapers. 'Energy' was served as the key-word to identify those articles published on the internet, with no time limitation. Finally, the data was complimented by twelve semi-structured interviews with actors representing policy-makers (from the Ministry of Environment, The Ministry of Energy & Water and the Infrastructure planning division within the National Planning Committee), academia and experts, energy-related business organizations, the Israeli Electricity Corporation and environmental non-governmental organizations (eNGOs). Participants were chosen based on their active and public role in the local energy regime.

5.3. Institutions, discourses and socio-technical change

The neo-institutional approach introduced an influential conceptualisation of political and policy arenas (Hay and Wincott, 1998). According to neo-institutionalism, the behaviour of individuals in politics is only in part based on individual volition: actors are embedded in the structures, regularities, routines and behavioural standards, which also influence their behaviour (Peters, 1992). The understanding of institutions as associations, interrelationships or "networks of connection", which simultaneously generate and constrain actors and actions (North, 1991; Peters and Pierre, 1998) herald a systematic investigation of dynamics – of both change and continuation – as one of the key interests of political science and public policy studies. This approach treats institutions as "political actors in their

own right" (March and Olsen, 1984:738), "structuring the play of power" (Fischer, 2003:29) and delineating the 'working practices' in the policy arenas, as well as in other, more general social decision-making processes (Peters, 1992; Rydin, 2003). As I discussed in chapter 2, institutional change is recently interpreted by critical policy analysts to be the result of ideational and discursive communication between actors in the polity (Schmidt, 2010).

The notion of a transition originates from the Science and Technology Studies (STS) and it provides a useful framework for examining institutional changes. A transition reflects a structural-institutional dynamic which is longer-term and strategic in nature (Rip and Kemp, 1998; Van Der Brugge et al., 2005). A transition includes a multi-level alteration of (a) physical infrastructures and policy procedures at the level of the regime, (b) niche-technological innovations and (c) economic, political or environmental changes at the landscape level (Geels and Schot, 2007).

Interactions of dynamics at different levels, such as landscape pressure on a regime, are directed through "transition pathways" (Foxon *et al.*, 2010), and can produce a wide range of outcomes. "Sociotechnical imaginaries", as descriptions of attainable futures and prescriptions of futures that states believe ought to be attained (Jasanoff and Kim, 2009) play a similar role. From a normative point of view, the goal of governance institutions and policymaking is to direct transitions toward more sustainable outcomes by means of steering and management (Meadowcroft, 2008; Frantzeskaki and Loorbach, 2010).

I have been arguing here that in socio-technical studies, institutions, policies, technologies and discourses do not play an exclusive role on their own. Rather, they are all perceived to be intertwined components of regimes and landscapes (Martens and Rotmans, 2005). For this reason, using discourses to explain socio-technical transitions (or highlighting their role in transitions) translates to focusing on the ways in which discourses have influenced institutional arrangements, altered policies, contributed to the adoption of

certain technologies, or on how discourses are likely to bring about these impacts in the future (cf. with Lovell, 2008). More generally, there is a need to examine the role of paradigms and discourses in shaping and defining the range of possible future pathways in a specific transitional process.

A discursive approach to sociotechnical transitions may alter our understanding of both changes and non-changes: that is, incumbent regimes, path-dependency and lock-ins in large socio-technical systems. Discourses and ideas are powerful constraints of action, framing and setting the limits of what can be perceived as possible solutions to societal problems (Arts and Buizer, 2009). On the one hand, discourses can explain lock-in alongside infrastructural networks and vested interests: they do maintain specific "rules of the game". Hajer (1995) has also suggested that discourses are passed from one generation of policy makers to the next one. Discourses can thus contribute to path dependencies, exclusion of alternatives during strategic decision-making processes, and masking of unconventional future pathways, because they constrain ways of thinking and acting. But on the other hand, discourses can also foster change by realigning actors into discourse coalitions or policy networks that "can be used to undermine and disrupt existing policy practices, and to generate and legitimize new approaches" (Smith and Kern, 2009:4).

Discursive Institutionalism (DI) can thus clearly contribute to the socio-technical transitions literature by highlighting that institutions are not only constraints of action, but also actively constructed by actors (Schmidt, 2010). DI helps to link an agent-centered approach with institutional change, a neglected perspective in the transition literature as well as in the wider STS literature (Walker and Shove, 2007; Smith *et al.*, 2003). Although recent literature has acknowledged the role of actors and front-runners in influencing transition pathways (Verbong and Geels, 2010; Foxon *et al.*, 2010), most studies have treated structural processes as objective, and have missed the potential role of values, tactics of persuasion, and power relations in creating and reinforcing transitions.

Shove and Walker (2007) have called for an explicit recognition of the 'dark side' of the transitions arena, the acknowledgement of the power and political dynamics in sociotechnical transitions and specifically in the attempts to steer or manage them (see also Jasanoff and Kim, 2009). Since the way in which "discursive strategies" are used in the political and policy arenas is considered a crucial part of the way in which actors achieve their goals and exercise power (Rydin, 2003:53; Schmidt and Radaelli, 2004), DI may be well equipped to reveal those less visible layers of policy dynamics.

The theoretical framework outlined above is based on the contribution of discursive institutionalism to socio-technical transitions literature, and on the assumption that certain ideas and forms of speech reflected in discourses might encourage or discourage transitions toward sustainability. The growing body of this kind of discursive studies highlights the significance of both formal (e.g. electoral or regulative systems) and informal institutions (e.g. discourses) in managing and governing environmental resources. In this chapter I examine Israel's energy regime and the emerging notion of energy abundance in Israel as a case study of the potential role of discourses in socio-technical transitions. In the next subsection I set the case-specific background for the analysis.

5.4. Israel's energy regime: institutional setting and actors

Although located in the oil-rich Middle East, Israel was considered for long to have no fossil fuels (Coxon and Greenfield, 1985; Bahgat, 2010). Attempts to find them were made from the early 20th century by Turkish, British and Israeli governments and most prominently private investors, but the small discoveries were not economically viable to extract. During statehood, exploration and production of fossil fuels have been regulated by the Ministry of Energy (later the Ministry of Energy and Water Resources) on

the basis of the Petroleum Law (1952) inherited from the period of the British Mandate.

The Israeli energy sector has been dependent on imported fuels in the absence of domestic energy sources. Petroleum (crude oil) and mazut (diesel) imported from West Africa and Northern Europe were the primary energy sources for electricity generation and industry until the 1970s. The Yom Kipur War and the oil crises of the 1970s and 1980s made coal the preferred energy source, partly because it offered security of supply[25]: Israel could import it from friendly sources such as former countries of the Soviet Union (e.g. the Republic of Azerbaijan and Russia), as well as from South Africa and the United Kingdom.

Israel has historically considered itself an "energy island" (Shaffer, 2011). Israel's geopolitical situation and security considerations have left it isolated and led the state to build an independent, integrative and centralised-managed electricity grid system. This means that any fault in production or transmission can cause serious disturbances, which cannot be remedied by importation of electricity from neighbouring countries. Another important feature of the Israeli energy regime is rapid growth of energy production and consumption due to high population growth and car-dependent, energy-intensive lifestyles. In 2010, the electricity sector had 5% reserve capacity. This small difference between the total generating capacity and actual level of electricity generation (see Figure 10) again makes the grid sensitive to faults. For comparison, the Netherlands had a reserve margin of 22% in

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[25] According to Shaffer (2009) the concept "energy security" includes three components: reliability, affordability and environmental sustainability. The term "security of supply" is used here rather loosely without getting into its more complicated technical and normative meanings or implications. In fact, there is no one accepted definition (see for example Helm, 2002).

domestic generation in 2002 and the possibility to import electricity (International Energy Agency, 2004).

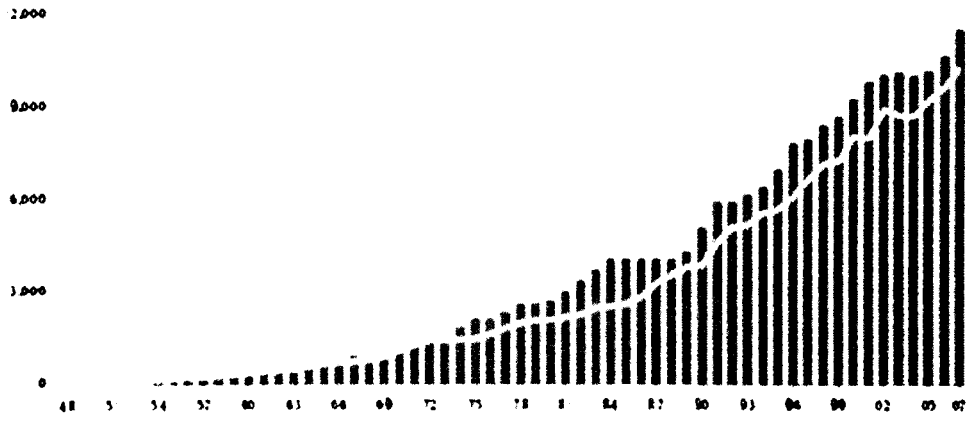

Figure 10: Total production (grey columns) and peak demand (light line) (in MW) in 1948-2007. Source: IEC statistical report for 2007.

Electricity generation is responsible for 11% of the primary energy consumption in Israel – it is the third largest sector in this regard after transportation (43%) and industry (35%). The storytelling of electricity generation in Israel often begins with the construction, in 1923 (24 years before the establishment of the state), of the first two power plants, on the banks of the Jordan Valley and a smaller one adjacent to the Yarkon Stream (which today flows at the heart of the city of Tel-Aviv). Maybe somewhat ironically, there was no conceptual separation at that point between the functionality of water and energy resources. On the contrary, the first power plants were built by the new Israeli Electricity Corporation (IEC) and produced hydroelectric power. Moreover, the British Mandate has gave Pinhas Rotenberg, the Zionist IEC's founder, a concession over all surface water sources in the country - for the purpose of electricity production - for a time period of 70 years.

It was not long, however, before Rotenberg had realized that in a tensional region such as the land of Palestine, reliable energy supply should not be

located far from the central urban and industrial activities (along the Mediterranean seashore) because the grid cannot pass via hostile territory. In addition, shorter lines could save a lot of energy. With major waves of immigrants during the 30s and the 40s and rapid growth in commercial, industrial and quality of life, demand of energy was exponentially increasing. Two main power plants were constructed in Tel-Aviv and Haifa, operating on steam. Still, during the next few decades, there was a need to defend the power plants from possible attacks from land or air (Naor, 2003).

Forecasted demand to the period after the establishment of the State had required mega investments which the IEC could not raise by its own. In 1945, after a long negotiation process and in order to avoid a total energy crisis, the government bought 95% of the Company's shares and the IEC was nationalized. With the legislation of National Companies Law in 1975, the IEC had officially gained monopoly restricted by governmental regulation. Along with price caps, it is subject to approval of investments in infrastructure, the structure and level of employees' wages, and fuels mixture and maintenance procedures (Tishler *et al.*, 2002). Various power-plants were additionally built initially generating 20-75 MW and later up to 230 MW each. Environmental concerns were not late to follow. The first Environmental Impact Assessment (EIA) in Israel, for example, was made for a planned coal power plant in the beginning of the 80s. A second large coal plant was concurrently advanced, as a result of 7% annual growth in demands.

5.4.1. The IEC in brief: reform and regulations

The national electricity company currently generates most electricity in the country, and it is also responsible for transmission through the national grid and distribution to customers. When the 70-years British concession had expired, the government put in force a renewed Electricity Law-1996, according to which the IEC will be given an operation quota for ten years. A complementary decision was taken by the Israeli government in 2003 to

initiate a major reform in the national electricity industry. It called for deregulation and privatization of both power generation and customer services. Transmission and distribution (T&D) services will remain regulated but will be available to all T&D users under mandatory open access. Tishler and Woo (2006:349) asserted that "as in the UK case, the Israeli government's action was motivated by the notion of using market reform to weaken IEC's labour unions and to reduce its labour costs".

Therefore, the government formed a Public Utilities Authority (PUA) with two main goals in mind: to tighten the regulatory supervision and control on IEC's tariffs and the quality of its service and to introduce competition in electricity production. Although reform efforts have managed to increase the market share of privately generated electricity in the grid only marginally (currently only 1% of total production)[26], the 1996 electricity law and later reform had opened the market to private producers. This can be expected have a major influence on the energy sector in the future.

5.4.2. Electricity production and consumption

As for 2010, the IEC's total electricity generation capacity was 12,987 MW and 56,147 million kWh were produced, while the peak electricity demand was 10,950MW. Actual consumption in 2010 was equal to 51,979 million kWh or 6,322 kWh in average per person (Central Borough of Statistics, 2011). For comparison with European countries see Figure 11 below.

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[26] Ten years after the new Electricity Law was presented to the market (and onward), the government chooses to renew the IEC permit annually with almost no changes from its original British concession. In Segal, N. & Sherman, A. (2009) Two decades to the reform in the electricity sector: a refreshed thinking - first draft Available online: www.kibbutz.org.il/hazan/hafrata/noam_-3_8_09.doc (Hebrew).

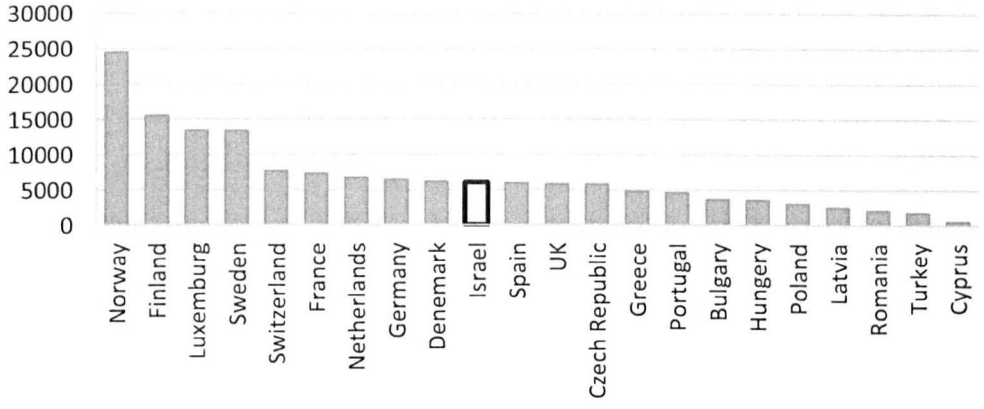

Figure 11: Electricity consumption per person (kW per year) 2005/2006 .Date source: IEC statistical report for 2007

Private and public buildings are the largest consumers of electricity, with a total demand of 22,750 MK/h true for the year 2008. The industry accounts for approximately another third of this number (Figure 12). For domestic use, electricity prices in Israel are low, in comparing to European countries such as the UK and the Netherlands, but similar to those in the US. Different prices for peak and low demand times (e.g. daytime vs. night) exist, but mainly for industrial users. Differential tariff, in which users pay extra beyond a certain amount, is not implemented in order to reduce demand (Segal, 2010).

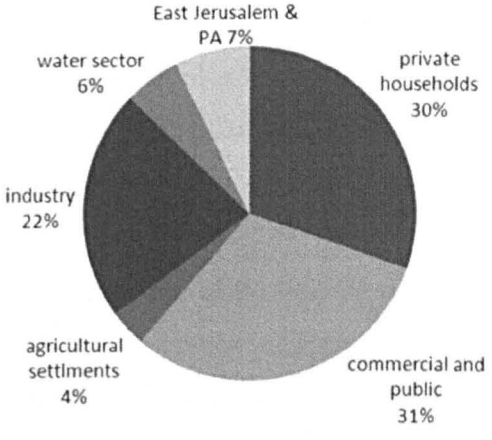

Figure 12: Annual electricity consumption by users' type in 2008. PA=Palestinian Authority. Source: IEC statistical report for 2008

Whereas in 1997 the main sources of energy were coal (73.7%), diesel (1.1%) and mazut (25.2%), in 2008 the mixture had drastically changed as a result of a new contract with Egypt to deliver natural gas. In 2010 the share of natural gas had been raised to 40% and it is estimated to reach above 50% of total energy sources for electricity production (Lavie, 2010).

5.4.3. Central actors

A limited number of prominent actors manage Israel's centralised energy regime and influence decisions made in it. I hereby focus on the actors relevant to the state of agenda-building and policy formulation. These include state actors, non-governmental actors, and business/industrial actors but exclude the courts (which may play a role at other stages of policy making such as enforcement of regulations) and international players such as the OECD.

The IEC is regulated by the Public Utility (Electricity) Authority (PUA) within the Ministry of Energy and Water Resources. The Ministry of Energy and Water Resources is a key-actor actor in the regime. It is responsible for electricity, natural gas, and fuels but also for water, wastewater, mining, quarrying and earthquakes. It regulates state-owned enterprises related to natural resources such the national water company *Mekorot* and the Israeli Electricity Corporation. It also has authority over research centres and other organisations such as Public Utility Authorities for Water and Electricity, and the Water Authority.

With this control over the utilization of natural resources, the Ministry of Energy and Water Resources influences environmental policy in Israel significantly. All decisions made have a direct impact on water and air quality, waste treatment and future reserves of natural resources. However, as previous research had indicated, as well as participants in this research, the Ministry of Energy and Water Resources have no real control over its subordinated institutions. The IEC for example is termed "a company with a

governmental ministry" (Parag, 2005). Participants in this research have pointed to its dependency for pre-policy calculations (like scenarios) on the IEC, and the lack of skills and expertise of the ministerial professional staff. For instance, a former vice-director in the Ministry of Environment has noted:

> The Ministry of Energy and Water Resources is totally controlled by the Electricity Company. There is no such a thing that the Ministry of Energy and Water Resources is in control. No, its decisions are dictated by actors in the market (Interview, Ministry of Environment).

The director of a non-governmental organization has also noted that:

> The Ministry has no data, no ability to produce any analysis. So they lately even come to us, to write them plans and I'm very happy to promote my plans and ideas but this is not the way it should work...do I work for them?" (Interview, eNGO)

Few interviewees even added that the IEC determines policy decisions *de facto*. In addition, with the establishment of the new inner-ministerial regulative authority (the PUA), the ability of the minister to influence decisions regarding electricity prices, has been impaired. With a central role of managing Israel's natural resources, the Ministry is therefore under a constant political pressure from many directions, both public and private interests.

The Ministry of Finance is another key actor because it is responsible for financial restructuring, approves all large public investments and allocates funding for them. In the energy sector, it is implementing decisions on energy efficiency, driving reforms in the fuel sector, promoting the role of private electricity generation under the Electricity Law-1996, and promoting renewable energy to meet a 10% target by 2020. As has been pointed earlier, one of the major areas of disagreements between the Ministry of Finance and the IEC is the control of its labour union over their own tenure, salaries and benefits, which have resulted before in sanctions and strikes (Goldstein, 2007).

Considering that electricity generation facilities and energy use are a major source of risk to the natural environment, human health and the stability of the climatic system, a third political actor to do with the energy regime is the Ministry of Environment. Before the introduction of natural gas to the sector, the power plants in Israel were responsible to 75% of total SOx emission, 40% of Nox and 37% of PM10/PM2.5 (IUED website). The Ministry establishes and enforces ambient air quality standards under the Hazards Prevention Law of 1961, its 1992 amendments and the Clean Air Act of 2008. The establishment of the Environmental Unit in 1972 and later the Ministry of Environment in 1989 was not a response to recognised environmental problems - it was rather an outcome of strategic bargaining by key coalitions at the time (Tal, 2002). It continues to have limited resources: its budget is only about 1% of government expenditure (Parag, 2005). Nevertheless, the ministry has voice in most important forums and can use its enforcement powers when required. The minister can also influence the "fuel mix" through regulations that require the Israeli Electricity Corporation to use more expensive but less polluting fuels.

With air quality in mind, the Ministry plays a role in the areas of energy efficiency, renewable energy and climate change policies, but mainly through education, voluntary agreements and political advocacy. When it comes to national energy policies, including renewable energy targets, the Ministry of Energy and Water Resources is in charge, and not the Ministry of Environment. As in the water sector, the distribution of authority and responsibilities and lack of inter-ministerial integration leave too much space for political intercession on the expense of environmental considerations. Similar to the Ministry of Energy and Water Resources, the Ministry of Environment is, too, often lacking the knowledge, data and high level of expertise to plan large-scale initiatives, to study in-depth the potential of more progressive regulations or to stand in front of heavy polluters more professionally (Parag, 2005).

Environmental NGOs (eNGOs), on the other hand, are a rising star in the socio-political sphere of Israel. The Society for the Protection of Nature (SPNI), the first environmental NGO, was established already in 1953 and is still dominant especially at environmental campaigns and educational projects. The Israel Union for Environmental Defence (IUED), which was established in 1990, uses legal tools to promote environmental legislation and to protect the public interest from environmental hazards, lack of environmental enforcement and destructive economic interests. The role of eNGOs in Israel is out of the scope here, but just to mention a research made by Parag (2005), in which she analysed the complex interaction of networks and actors in Israel's industrial emission policy. Her findings indicate multi-dimensional relations between ENGOs and other actors, even the Ministry of Environment. To point only one example: on the one hand, they shared information and supported one another in activities that promote social and governmental awareness to the problem of air pollution. On the other hand, when it came to selecting policy tools, they were in a disagreement; the ENGOs required tough legislation, while the Ministry of Environment, as an inferior political actor, preferred voluntary treaties as a way to avoid direct confrontations with the industry.

It is widely agreed that in relation to both energy and water issues in Israel, social and environmental groups essentially feel excluded from the decision-making process (Interviews, MP, YCF). The National Planning and Building Committee – the uppermost planning authority - as well as subsequent planning committees, are the only arena where ENGOs can have an official representative. Other than that, in places where more strategic decisions are taken, ENGOs can sometimes be present, but have no statutory role. Therefore, in a coalesced objection during the last decade to the IEC's plan to build two coal-fired units (of 1260MW) at the Rutenberg "D" power plant in Ashkelon, non-governmental organisations could have only conscript the more 'traditional' tools, such as protests, petitions and letters of objection.

Other non-governmental actors are constituted by private producers of electricity (renewables and non-renewables), natural gas companies and some major industries such as the Oil Distillation Company. Clearly all have different interests in promoting certain regulations and laws or preventing them from being endorsed and each has its own level of political power. The constellation of actors and policy networks in the energy regime play an important role in the case ahead of us. These will be the focus of the next subsections.

5.5. Emerging energy abundance discourse

The main assertion is the following: despite several decades of relative stability in terms of energy sources, technologies and actor constellation, the energy regime is currently undergoing a rapid socio-technical transition driven by (1) government efforts to end the monopoly of the national Electricity Corporation and (2) increasing use of natural gas from the Mediterranean Sea and natural gas imports from Egypt which changes the "fuel mix" substantially. The new non-negligible offshore natural gas discoveries have made it a realistic alternative to the current coal-based regime. The share of natural gas as a fuel in electricity generation has rocketed to 40%, significantly reducing the share of coal. Natural gas, together with oil shale, nuclear energy and solar energy, are potentially opening up the previously locked-in, isolated and on-the-verge-of-a-crisis energy regime and creating an appearance of energy abundance. The four alternative sources of energy will be examined below in greater detail.

The natural gas alternative has been boosted by recent natural gas discoveries (the last one named 'Leviathan', whale in Hebrew) by private consortia. With estimated gas reserves of 16 trillion cubic feet, Leviathan is the largest discovery in deep waters globally in a decade (Aharoni, 2010). It was made possible by new technology that can map geological formations under deep water and equipment that remains reliable in corrosive environments and

extreme pressure and temperature. The discoveries have contributed to a new discourse, according to which Israel will be able to not only supply its own energy needs, and to enhance its energy independency, but also to become an exporter of natural gas. The abundance discourse fosters the creation of a policy network composed of diverse actors that favor the transition of the energy system from coal to natural gas, which has been so far prevented by the Ministry of Energy and Water Resources despite several governmental decisions to promote it (State Comptroller Report, 2005). Protagonists of the transition, such as current chairman of the Natural Gas Lines Company consider that "Israel could become a leading regional gas power" (O. Marani, chairman of the Natural Gas Lines Company in the Energy and Business Conference, 2011), thus actively contributing to social construction of energy abundance. But while the transition has now already been set in motion, its risks and uncertainties are only beginning to surface (see table 7).

Oil shale, the second energy alternative, has been used in the Southern region of Israel already since the 1980s. Policymakers considered oil shale extraction desirable for the long-term (Coxon and Greenfield, 1985) although it was not economically viable and had serious environmental implications (see table 7). A private company has been given a license recently for exploring oil shale fields in the Adolam region. They are confident that experimental drilling will prove the reserves economically worthwhile to extract.

The company envisions "bringing energy relief and independency to Israel by means of sustainable and environmentally friendly use of oil shale in its territory" (IEI Company Website, 2011). The chief scientist of the Ministry of Energy and Water Resources also promoted the project by suggesting that the

> Adolam region is an area with amount of oil that is equal to Saudi Arabia's (S. Vald, in Parliamentary minutes, 2011b:28).

New technologies may offer extraction of oil *in situ* by extreme heating of the ground instead of mining and processing the shale. Leading environmental NGOs have opposed the project, arguing that it could undermine other strategic decisions and obligations made by the government regarding climate change, reducing dependency on fossil fuels, and its general commitment to sustainable development (Parliamentary minutes, 2011b).

The director general of the Interior Ministry considered already in 1977 that nuclear energy will become a major source of energy in Israel within a decade (Winn and Peranio, 1980). While this never happened, nuclear energy - the third alternative - is again portrayed as necessary and inevitable in Israel by a policy network composed of the Ministry of Energy and Water Resources and the IEC:

> At the long-term there won't be any other choice but producing electricity with nuclear energy, because renewable energy could never supply more than third of the needs (Landao, U., Minister of Energy and Water Resources[27]).

I return to discuss this emerging discourse on the feasibility of nuclear energy in chapter 6. But for nuclear energy to be realised in the Israeli context, in both short and long terms, it will also have to overcome numerous challenges, as depicted in table 7.

Renewable energy is the fourth energy alternative promising abundance because of infinite sources such as the sun and wind. In semi-arid Israel, solar (thermal) energy has been used for water heating for some time. The Planning and Building Law (regulation no. 1.09, 1970) requires that all residential buildings up to nine floors in height must have solar collectors installed. But solar photovoltaic (PV) electricity is still produced only in a small scale. The current government has not taken major steps to promote

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[27] Quoted in Morgenstein (2010, 2 March). Israel Electric Corporation is making arrangements for nuclear energy. *nrg*. (Hebrew).

renewable energy apart from some investments in R&D, in one PV array based on a feed-in-tariff, and providing limited public support for PV instalments on private roofs (Parliamentary minutes, 2011d). The government's target is that renewable energy should make up 5% of the total energy use by 2015 and 10% by 2020. In comparison, UK renewable energy target for 2015 is 15% and that of the Netherlands is 10%. Nevertheless, for some actors the abundance of renewable energy is real and promises a revolution. For example, Shimon Peres, Israel's President considers that

> From Israel's perspective, it's better to hang on the sun than the oil producing countries. The sun is more permanent, objective, not a member of the Arab League, we have straight connections. We have plenty of it. This is our future, the sooner we enter it. (S. Peres, at Dan David award ceremony for Al Gore, Tel-Aviv University, 2008).

These four energy alternatives share in common an alleged potential to secure Israel's energy needs for several decades. Yet, this potential is still largely rhetoric. Each of the alternatives would need to overcome several challenges before becoming successfully mainstreamed. These challenges include technological feasibility; scientific uncertainties; profitability; environmental risks; public acceptability; international acceptance; geopolitical security; and institutional reformulation. Table 7 explains each constraint in more detail and provides examples of them.

To conclude, these technological-based energy alternatives are portrayed as ultimate solutions offering inexpensive and secure energy. They are all promoted because of their promise of energy abundance, although they clearly are not in a position to deliver as indicated in the table. The following section examines first whom does this new discourse of energy abundance serve? Secondly, it discusses how the abundance discourse is changing the "rules of the game"; or, in other words, how does the discursive shift restructure current socio-technical transitions, future pathways of the Israeli energy regime and institutional arrangements more generally.

Constrain	Natural-gas (NG)	Oil-Shale	Nuclear	Solar Thermal/PV
Technological	Challenges of identification & production in deep-waters	Unproved technology that has never been tested anywhere	Conditioned in the use of not yet developed 4th generation reactors	Technologies exist but efficiency is very low (about 20%) and storage is challenging
Scientific	Uncertainty and disagreements over the actual available amounts	Unknown implications (ground warming, toxic emission and more)	N/A	N/A
Economic	Profitable for companies and may lower electricity prices. But prices depend on regulation and Ministry of Finance prevented transition to NG arguing that coal is still cheaper	Profitability of fuel produced from oil shale depends on the fluctuating cost of oil barrels	N/A	Solar PV panels can be cost-effective only if the price per kW is set high enough
Environmental and human health	Deep-water drilling affects the marine environment. Risk is greater when lower strata contain oil. Concerns deepened after the Gulf of Mexico oil spill. On-shore processing plants and pipelines pose risk on human and nature	No environmental advantages such as a reduction in GHG (which can be attributed to NG, nuclear and solar). Direct environmental implications include: air, soil, groundwater pollution; landscape destruction; etc	Radioactive waste and pollution of the environment in case of a hazard. Although GHG emission is low during electricity production, a life-cycle of a power-plant including construction is considered energy-intensive	Solar and other renewable energies are not without trade-offs; environ. implications include loss of open-spaces and consequently decrease in biodiversity, accumulation of unrecyclable batteries, etc.
Social	For example, a delay in liquefied natural gas (LNG) supply to Israel was caused by local residents, whom objected to the construction of a processing plant on the base of NIMBI claim	Petition against the project was submitted to the high court by local residents and environ. NGOs in an attempt to prevent the government from licensing the drills	As a result of growing public awareness and capacity to influence policymaking, a construction of a nuclear power-plant will necessitate public support	N/A
Institutional, legislative and regulative	Licensing of excavation is made according to the Petroleum Law (1952). The law itself is not a constraint; on the contrary, its goal is to encourage private exploration of oil and gas. However, institutional constrain arises when the		IEC does not have the know-how, materials and operation capacities for nuclear power-plant, so construction must be outsourced	For solar technology to take-off there is a need to change regulative structures, implement

	validity of existing laws, regulation of taxation systems are questioned (more details in the discussion section). Additionally, the law does not contain any environmental requirement from such projects.			targets, remove bureaucratic impediments and invest in R&D. Also, targets should be set higher
International	N/A	Commitments of GHG reduction or industrial competition in international markets are hard to realise with oil in Israel's fuel mix	Israel might have to bypass the Nuclear Non-proliferation Treaty to construct a nuclear power-plant.	N/A
Geopolitical	NG already evoked a maritime border's dispute between Israel and Lebanon. Pipeline between Egypt and Israel was sabotaged	N/A	Heavy security risks especially in case of a terror attack or war	N/A

Table 7: Summary of constraints to future energy pathways

5.6.A discourse in transition: discussion

The Israeli electricity sector is on the verge of a crisis due to growing demands and delays in the implementation of measures to increase generation capacity. Officials warn about an "electricity drought" but these physical and discursive scarcities have not induced a movement toward more sustainable energy use: domestic electricity prices remain low compared with western-European countries (IEC, 2007); electricity reserves are almost fully utilised and construction of new power plants is currently at standstill; there is a lack of long-term, strategic planning and national plan for the sector (Interview, MP). Also, despite several governmental decisions to promote energy efficiency and alternative energy sources, little has actually been done to foster them (Parliamentary Minutes, 2009). This raises questions on the forces behind and the implications of the newly emerged abundance discourse.

5.6.1. Who and what the discursive shift serves?

The discursive shift from scarcity to abundance was constructed through the promotion, by different policy networks, of four energy futures, each with a promise to solve Israel's energy problems. This is generally reflected in the words of the chief scientist in the Ministry of Energy and Water: "everything is measured by energy... we need to make available and abundant energy so we can have everything else, including water" (Interview, Ministry of Energy and Water). The various actors promote the appearance of abundance, based on different storylines - organizing narration of the reality that simplify and influence environmental policy (Hajer, 1995) - such as national security, ecological concern, economic rationale (see Teravainen, 2010), and general political strategy. The policy networks that evolved in favor of each energy alternative, however, are not driven by one unifying storyline beside the perception of abundance.

Ecological concern. For environmental groups, abundant natural gas provides tailwind for their ten-year struggle against the construction of additional coal power plant. It is also compatible with the discourse on climate change and mitigation strategies they are interested in forwarding. The Ministry of Environment also finds the discursive shift beneficial. Certainly at this point, to hold back the entrance of natural gas would mean to devastatingly hinder recent improvements in air quality. With all its limitations, natural gas and its products could be used as fuel in public transportation in the future, as well as substitute current imported ammonia supplies (S. Nezer, Air quality department, the Environment Ministry in Jerusalem Conference for Environment and Society, 2011).

National security. The above quote of Shimon Peres (in previous section) suggests a linkage between energy abundance and national security discourses (see also Shaffer, 2011). Peres's faith in solar energy is underpinned by a meta-narrative of "technological optimism" (Alpert and Michaels, 2011) on the one hand, and a deep-rooted cultural framing of Israel as a global leader and proponent of innovative technologies on the other (Tal, 2007; Verbong and Geels, 2010). Policy-makers and experts combine the two:

> ...only technology will save us. The technology that Israel needs to develop will change the world and lead a change in the struggle against climate change (Dr. Y. Berzin, in Conference, 2009b).

The motivation behind this declaration is not only to promote Israel's international relations, but to emphasize that if the country was sufficiently energy independent, the impact and threat of Iran and the other oil-rich Muslim countries would be reduced. The head of the Israeli National Economic Council expressed this in the following way:

> Compared to other places in the world, the oil shale field in Israel is not big. But across the world, oil shale is located in places different from places of oil. Our plan is to distribute our energy dependency between states, not necessarily between sources...this is winning. This is why it is so important

> that the oil-shale production technology will be tested (E. Kandel, Head of National Economic Council, in Parliamentary Protocol, 2011a:3).

Political strategy and economic rationale. In the political sphere, decision-makers could use the perception of abundance to justify their "business as usual" approach to energy policy. Regardless of the environmental benefits of a transition to natural gas, solar energy or even nuclear-based electricity generation - especially in terms of reducing air pollution and greenhouse gas emission, policymakers employ the sense of abundance to avoid energy efficiency and demand reduction pathways, which according to a critical environmental activist in the field of energy, are considered to subsume much less political prestige (Interview, YCF).

With respect to natural gas and oil shale discoveries multiple actors and political, environmental and economic interests were involved in their construction as abundant. For example, Abundance gives political leverage to opponents of electricity price increases because domestic availability of fossil fuel may entail lower costs than imported coal and oil (MPs in Parliamentary Minutes, 2011c). Private gas companies have in turn been able to increase the value of their shares by presenting optimistic expectations about their discoveries. They also portrayed abundance of natural gas as a precious gift to the country and themselves as its generous benefactors:

> This is a day of celebration for the entire State of Israel (Y. Tshuva, owner of the gas company Delek Group Ltd.)[28].

This supported their efforts to maintain a positive image among the general public. Another example for an economic interest in abundance can be found in the following, presented by a director of a company developing methanol-based fuel for vehicles:

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[28] Morgenstain, R. (2009, 18 January). Every Israeli citizen should be happy from the discoveries of natural gas because he will feel it in his pocket. *nrg*.(Hebrew).

> One can produce methanol from anything that omits CO_2... IEC's power-plants for electricity production from coal or from gas could produce methanol. Dump-sites can. The oil shale, that we all hope that would soon be used, can produce methanol (Emesh Technologies, in Parliamentary Protocol, 2011a:11).

Here, the discourse supports an incumbent technology, yet to be developed. This kind of co-evolution of discourses and technological innovations (Lovell, 2007) can lead to a change of locked-in regimes and initiate and promote sociotechnical transitions (Raven and Verbong, 2007), yet not automatically toward greener future.

Finally, in the case of nuclear energy, the most suggestive actors in the policy network today include the Israeli electric company and the Minister of Energy and Water, which already announced his personal commitment to promote it (see chapter 6) and has offered a new scholarship scheme for students to study energy-related engineering and particularly nuclear engineering (Ministry of Energy and Water website, 2011). The times in which various stakeholders doubting the new paradigm of abundance are when they wish to highlight the disadvantages of their less favorite alternative. For example, when the CEO of the IEC has spoken about nuclear energy, he noted that the natural gas revolution, which brought the Israeli electricity sector to depend on 40% natural gas in the blinking of an eye, is a

> ...danger to the reliability of supply. In contrast, nuclear energy successfully combines all the positive elements in term of price, GHG emission reduction, reliability, etc. (A. Lesker, IEC, in Israeli Association of Ecology and Environment Conference, 2010).

Other actors in the polity use the sense of abundance created specifically by nuclear energy at the stage when there is still no need to actually cope with its implications; the Ministry of Environment official considered in that respect, for example, that

> ...sustainability is all nice and good, but we consume energy, and it is impossible to say 'no' to everything (Y. Inbar, Ministry of Environment general-director, in Nuclear energy conference, 2009).

5.6.2. Implications of the discourse of abundance

Despite the unifying discourse used by the different policy networks to promote particular energy alternatives, the discourse of abundance is not a panacea for resolving conflicts between actors but rather a source of further tensions. For example, with respect to natural gas, policymakers and regulators in the Ministry of Environment argues that without appropriate legislation, drilling of natural gas can pose severe risk to marine and coastal environments and should therefore be treated with extreme caution. Similarly, the scarcity of land and constant threat to biodiversity from loss of open space pose a challenge to solar energy fields, dividing environmentalists to the pro-clean energy and the pro-biodiversity camps (Interview, VB). This kind of conflict that stems from contrasting values has been documented elsewhere as well (Barry *et al.*, 2008; Jessup, 2010). Conflicting agenda is an interesting consequence of the effort of actors to construct a sense of abundance, as reflected in this very dynamic discursive shift.

The discursive shift also implies changes in the roles of key actors, including the state. A socio-technical trajectory involving the oil shale alternative is represented as being in the "national interest". As Jasanoff and Kim (2009:121) have suggested, this imagery is stabilized by the particular political culture in which other pathways are unlikely to develop:

> I am not against the State. If the state needs to produce energy we need to sit down and *explore the options*. But I know how it goes, we all know what happens when a pilot project only partially succeeds; I can stand in front of all the governmental ministries, I can tell here about *all the pressures* that the ministries have put on me even before the project was examined: *everybody are already in favor, before they even checked.* (emphasis added, M. Dadon, Head of regional council, Adolam region, on the oil-shale project, in Parliamentary Minutes 2011c:15).

In such a political culture that approves short-term management strategies and quick "results", the discursive shift to abundance may mask questions regarding what is desirable by restricting the nature of possible future pathways. Policymakers will probably tend to see only the alternatives that can achieve such political conditions. It might also increase uncertainty and make future predictions and strategic planning harder, especially when the promise of abundance is made under unstable regulatory and institutional regimes.

Restricted pathways and incertitudes inherent in the energy regime are also likely to influence interdependent regimes, such as the transportation sector and climate change policy. For instance, a transition to a more sustainable transportation system is likely to become discounted if Israel's energy sector becomes self-sufficient (MP D. Hanin, in Parliamentary Minutes, 2011b). With respect to climate change policy, Israel was categorized as a non-Annex 1 or "developing" country in the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Fittingly, Israel's policy makers have done little to promote the de-carbonization of the energy sector, although electricity generation and vehicle use are responsible for 83% of the country's CO_2 emissions (Central Bureau of Statistics, 2008; Alpert and Michaels, 2010).

Although a transition from coal to natural gas in electricity generation would reduce the sector's GHG emissions substantially (Mckinsey & Company, 2009; Alpert and Michaels, 2010), greater availability of energy is less likely to encourage a change in perceptions of climate change and in patterns of consumption, two central determinants of effective carbon reduction (Michaelis, 2007; Semenza et al., 2008). Discourse of abundance may not only lead to growth in demand but also weaken core social values. For example, when reflecting on the discourse on 'hydrogen economy', Brossmann (2009) considers that:

> ...if it is true that fantasies relating to energy consumption and abundance have become publicly standardized community values, they will continue to

> mediate the experience of individuals until they are identified and critically examined. If taken to the extreme, values antithetical to consumption and abundance, such as conservation and environmental stewardship, could become socially unacceptable (Brossmann, 2009:5).

Finally, implications of the discursive shift are manifested as overarching institutional changes. This can be understood in light of Phillips et al.'s (2004:635) statement that "...institutions...can be understood as products of the discursive activity that influences actions". Despite the public opposition of the oil shale alternative and concerns over the nuclear one, the most extensive controversy was not about energy sources, but about fiscal policy regarding revenues and their distribution between the state and private gas companies (Bar-Eli, 2010; Stoil, 2011). A committee was appointed by the Parliament to re-evaluate the fiscal policies on revenues and taxation. Politicians and committee members found themselves under pressure from groups that demanded increase in the state's share in the revenue from the discoveries. In turn, rent seeking by gas exploration companies was aimed at keeping the gas and oil royalties to the State at 12.5 percent and avoiding any further taxation.

The public concern for the exploitation of energy resources such as natural gas and oil shale focused on the legal base of licensing, extraction and revenue distribution, that is, on the Petroleum Law of 1952. Critics sought to highlight the law's archaic nature, which provides free access to exploration of energy sources. This could have been fitting for a time when the State's energy security was one of its top priorities in the context of multiple threats. From an environmental perspective it was argued that giving a drilling permission on the basis of the Petroleum Law contradicts the formal procedure for large-scale projects, which requires the approval of the Planning Committees on the basis of the Planning and Building Law (1965) (Parliamentary Minutes, 2011c). Unlike the Petroleum Law, the Planning and Construction Law requires an environmental impact assessment and invites public comments on the project. The drillings, however, were not subjected to such requirements.

Public campaign and experts' warnings about the threat of the "Dutch disease" have helped to pass in the parliament in April 2011, a new law that increases the state's revenue from natural gas and oil production (Book of Laws, The State of Israel, 2011). The Minister of Finance has announced that the State's revenue from the discoveries will be directed to a designated public fund to avoid the Dutch disease or resource curse (Wolfson, 2011). These socio-economic concerns thus became integrated into the abundance discourse and helped to reduce public opposition to development of new energy resources by the relatively moderate changes to the law and revenue sharing.

The public debate about energy alternatives is therefore remarkable considering that environmental matters such as climate change and air pollution rarely make headlines in the Israeli news. Energy issues are seldom framed in terms of social or ecological sustainability. As the Ministry of Environment notes, "we cannot yet talk about making *sustainable energy policy*. We first need to talk about making *energy policy*". However, the discursive shift may point at the institutionalization of a new public sphere in places where it was excluded from/salient about. Traditionally, energy has been an issue for experts. Yet, other actors were able to exert some influence on decision makers in the debate by reframing energy-related issues as issues of social justice and economic equity.

5.7. Conclusions

This chapter aimed at showing how discursive institutionalism can reveal and highlight the less visible side of socio-technical transitions – that of how different ideas and interests of actors simultaneously drive and explain transitional processes. That is, discursive institutionalism can help to complement the mostly structural approach of transition studies with an agent-based, actor-centred approach.

It was suggested in the introduction of this thesis that the discourse of abundance is in some ways similar to the more common discourse of scarcity in providing socio-political explanations of policy dynamics. International relations, global markets and national politics have been shaped by ideas of energy crisis and "peak oil". Nevertheless, the findings in this chapter suggest that the Israeli energy regime is shifting away from the traditional scarcity discourse towards a new discourse on energy abundance.

The new energy abundance discourse was created by storylines, which depicted natural gas, oil shale, nuclear energy and solar energy as energy alternatives although their mainstreaming still faces formidable uncertainties. Some of them are also constrained by current geopolitical order and political relations in the region. Others depend on technological innovation and efficiency improvements, which in turn depend on reformulation of existing policies and regulations. That is, feasibility of all alternatives would require the creation of new institutional arrangements, regulative mechanisms and the change of existing law governing the energy regime. Yet, the findings highlight how discursive constructions, which actors use to promote their interests, can play an important role in socio-technical transitions, such as those of energy regimes. In the case of Israel's energy regime, the discourse of energy abundance can risk a transition toward greater sustainability by restricting possible pathways and masking alternative ways to achieve energy security.

I have shown that discursive institutionalism can reveal and highlight the less visible side of socio-technical transitions – that of how different ideas and interests of actors simultaneously drive and explain transitional processes. That is, discursive institutionalism and policy networks analysis can help to complement the mostly structural approach of transition studies with an agent-based explanation. Since the discourse of abundance produces new conflicts (such as within the environmental camp), it is important, however, to warn against a linear projection of policy networks, meaning that the fact that several actors share similar ideas and interests behind their support in

particular alternative does not means we can make any assumptions regarding future constellation of actors into a policy network and transition pathways.

Finally, in this chapter I also highlighted important implications of this discursive shift for contemporary socio-technical and institutional settings which have to do with conflicting environmental agendas; Israel's energy security; the ability to make future sectoral predictions and strategic long-term planning; Israel's international relations; its climate change policy; embedded values related to consumption and sustainability; and the capacity of the public to influence policy-making on energy issues. A new "hydrocarbon governance" (Perreault and Valdivia, 2010:689) is needed, one which clearly maps future pathways and involves a wide range of actors while being aware of the problematic nature of a discourse on resources abundance.

6. The water-energy interface: coupled policy transitions

> *"A crisis occurs when an ecosystem behaves in a surprising manner or when observations of a system are qualitatively different from people's expectations of that system." (Holling et al., 2002:415)*

6.1. Introduction

This chapter examines the inter-linkages in the unfolding of water and energy policies in Israel over the past several decades, and how these policy processes may be oriented towards greater ecological sustainability. The sectoral analysis of the water and energy transitions in chapters 4 and 5 has pointed to the many spills-over generated by the interplay of policies, technologies and discourses. The aim of this chapter is therefore to spell-out further inter-sectoral dependencies and their implications for sustainable sociotechnical transitions.

Policy dynamics such as that of water and energy policies have been conceptualized by numerous theories in various disciplines such as public policy, political sciences and organizational management. As discussed in chapter 2, the literature on socio-technical transitions offers a promising approach to the refinement of policy dynamics (Huitema and Meijerink, 2010a, 2010b). Particularly, Transition Management is regarded as a promising policy approach and practice that could help to step out from the messy policy-making process portrayed by other various theories of agenda-setting and environmental decision-making. Despite recent criticisms that it neglects the influence of power relations, transition management proposes a rational, incremental process and offers adaptive, strategic and participatory tools.

However, research on socio-technical transitions has mostly had "sectoral" focus. For instance, studies have examined transitions in national energy sectors, such as the switch from coal to natural gas (Rip and Kemp, 1998; Monstadt, 2007) and the transition to hydrogen economy. Van Der Brugge *et al.* (2005), Hisschemöller *et al.* (2006) and Pahl-Wostl (2007) have in turn focused on transitions in water management. Multi-regime interactions (in a single sector) between Dutch electricity and gas regimes were examined by Raven and Verbong (2007). Kemp et al. (2006) have suggested that transition management will increasingly be applied in the energy, agriculture, mobility and biodiversity sectors in the Netherlands.

This chapter draws on co-evolutionary ideas as a source of insights for a more integrated approach and uses it to understand how the transitions of Israel's water and energy regimes have been and are intertwined. Socio-technical transitions are indeed already conceptualized in co-evolutionary terms. Scholars have depicted processes of variation, inheritance and selection, entangling technical components and social actors or networks (see chapter 2). Technology, however, is not exogenously designed, developed or replaced in a vacuum of single sector regime. Rather, technology is formed within a wider context of the social system that goes beyond its particular function, which can be a transformation of energy into electricity or seawater into drinking water. Technological solutions in different regimes do not only share similar features (size, materials, costs) but can also reinforce and legitimize their reciprocal development.

Integrated transitions management, as a form of cross-regimes perspective, is therefore of importance both analytically and instrumentally in environmental issues which are often interrelated and interconnected (Gunderson and Holling, 2002). That is, a transition in one sphere is likely to be related, influencing or influenced by another transition. While Smith *et al.* (2003:10) have already noted that "infrastructures supportive of the incumbent regime and the co-evolution of interdependencies with other regimes, can act to lock regime development deeper into historical trajectories" and while Shove

(2004), Geels (2007) and Raven and Verbong (2007) examine multi-regime interactions, this kind of analysis is still largely missing in the transition management literature. The premise of this thesis is that a more integrative approach to socio-technical transitions can highlight issues that are essential to a more comprehensive understanding of transitions, their implications for the environment, and their successful implementation. Likewise, the understanding of how co-evolutionary processes can lead to deep economic, institutional or technological changes, or alternatively to stabilization and stagnation trends (such as locks-in), could be enhanced by looking at coupled transitions and exploring the possibilities for more integrative management.

The interactions of water and energy regimes in Israel forms an interesting case study for examining these types of interactions, as both water and energy have been scarce resources since the foundation of the State and hence have been the focus of a great deal of policy and political attention. This chapter describes how the water and energy regimes have largely been developed under separate policy processes (see also chapters 4 and 5), so the interactions between them have largely been side-effects rather than strategically planned, for example as the result of environmental problem displacement. Recent plans for the widespread use of energy-intensive seawater desalination technology to provide fresh water and discussions about the adoption of nuclear power, which requires significant amounts of cooling water, highlight the increasing interactions between these two regimes. With traditional decision-making and policy implementation that is undertaken mainly within sectoral boundaries and lack of in-place integrative mechanisms, these physical, geographical, institutional and financial interdependencies will not necessarily contribute to long-term ecological sustainability. This chapter and chapter 7 that follows suggest a preliminary investigation of the potential of "integrated transitions management" to offer a more coherent, long-term and sustainable approach, not only for the water and energy sectors, but for other environmental-related regimes as well.

In what follows, the next section outlines the theoretical framework used to support the findings presented in this chapter. The following section focuses on the empirical case-study and highlights main trends in water and energy management in Israel. Because many of these were covered in previous chapters, I will only highlights the elements most relevant to the question of how do the interdependencies of socio-technical regimes affect their transition. The fourth section examines links between the two socio-technological regimes, and discusses the prospects and limitations of the transition management model to deal and direct these kinds of interdependencies. Further investigation of the TM model is undertaken in chapter 7.

6.2. Four-fold framework

Since governmental entities continue to play an important role in the governance and management of natural resources and particularly water (Bakker, 2003a; Huitema and Meijerink, 2010b), the polity continues to form the main arena in which crucial process are decided upon. Four complementary conceptual approaches to understanding the policy-making process have been proposed and will be further evaluated in this chapter: policy dynamics, socio-technical transition, policy integration and co-evolution. I suggest here that insights from each of these may be combined to produce a framework to better understand inter-sectoral dynamics.

6.2.1. Policy dynamics

Explanations of policy dynamics often revolve around the appearance of problems, or perceived problems to policy-makers as drivers of dynamics. When a problem is forced onto the macro-political agenda, or when viable solutions are more clearly perceived, the system would enter a state of disequilibrium, which bears a high potential for change (Baumgartner *et al.*,

2006). Sabatier and Jenkins-Smith had doubted, however, that minor problems can be enough to cause a policy change and claimed that dynamics are mainly induced by shocks or crises (Sabatier and Jenkins-Smith, 1993). These external events interact with internal competition between advocacy coalitions over different ideas and values (Jenkins-Smith and Sabatier, 1994). The role of problems in driving policy dynamics is also central to the 'primeval soup' model of the policy process. According to Kingdon (1995), certain issues come to the attention of policymakers and are put forward through three parallel streams: recognizing problems, generating solutions, and deploying political interest. However, for him, problems and solutions as carriers of change cannot always be distinguished, as policy entrepreneurs tend to construct problems to which solutions were pre-formulated.

6.2.2. Socio-technical transitions

Transition, as a long, multi-stage period of structural change from one system-state to another (Van Der Brugge *et al.*, 2005), embeds not only the alteration of policies, but co-evolutionary dynamics of infrastructures, regulations, institutions, networks, and users' perceptions and practices (Verbong and Geels, 2007). A Socio-technical transition framework adds a conceptual link between technology and technological artefacts, and the policy/change domains, by focusing on the forces behind innovative technologies. The transition management literature understands that, whilst previous changes of the system did not necessarily happen in a planned or desirable way, in order to achieve environmental sustainability, a deliberate steering of change is needed. An important contribution of the transition management model is that it argues that analysis of past transitions can be used to create typologies and analyse potential future transition pathways (Geels and Schot, 2007; Foxon *et al.*, 2010), in order to inform policies aiming to guide future transitions. Transition management therefore aims at a long-term desirable social change and development by the use and coordination of interactions between social actors, co-evolutionary processes and a modulation of collective chosen goals (Hoogma and Kemp, 2002).

6.2.3. Policy integration

A third body of work considers the prospects of policy integration in promoting policy coherence, successful implementation, and positive outcomes. Policy integration is defined as the attempt of different sections within one department or different governmental sectors to create synergies between policies and use the same goals to formulate it (Geerlings and Stead, 2003). Especially, the integration of environmental considerations into general policies was emphasised by researchers (Hertin and Berkhout, 2003; Lafferty and Hovden, 2003; Nilsson and Eckerberg, 2007). It is widely acknowledged that even in the 'crowded policy space', where policies will unavoidably interfere with others (Majone, 1989), some sort of national cohesion, cooperation and integrative policy-making would lie at the heart of any effective policy process. Yet, integration of information, actors, resources and goals between different sectors within the polity and organisational support that "transcends institutionally-defined policy fields" (Geerlings and Stead, 2003:194) is considered hard to find theoretically and practically, in traditional governmental structures (6, 2004).

6.2.4. Co-evolutionary theory

Finally, co-evolutionary theorising also helps to shed light on interlinked social transformation. The key ideas about the co-evolution of socio-ecological systems (as developed by Norgaard, 1984) can also be applied to co-evolution of interlinked social and technological systems vis-à-vis their ecological counterparts. Or, in other words, some of the key ideas of co-evolutionary thinking can be amalgamated with those of transitions management to shed light on parallel transitions.

6.2.5. Integrated approach

Most environmental policy-making studies narrowly assume that individual policies can be formulated, analysed or reified separately from other policies and their possible range of concomitant issues (Peters, 1992), although a few studies have debated the need for better environmental policy integration (Scrase and Sheate, 2002; Coffey and Major, 2005; Watson *et al.*, 2008). I propose that a more comprehensive analysis of policy dynamics (change or continuation) needs to recognize the multi-scales, multi-actors, interrelated and co-evolutionary relation between and across policy domains, and thus needs to take a more integrative perspective. The socio-technical transitions approach adds value here by examining how the interactions between social and technical elements can promote or hinder wider systems change. Examining co-evolution of interacting systems adds to this by investigating causal influences from one system to another system's evolutionary dynamics (Murmann, 2003). A combination of these approaches, with insights from policy dynamics and policy integration, leads to the observation that integrated transitions management could have potential to overcome short-term thinking in the policy arena as well as ease controversies between different networks of actors.

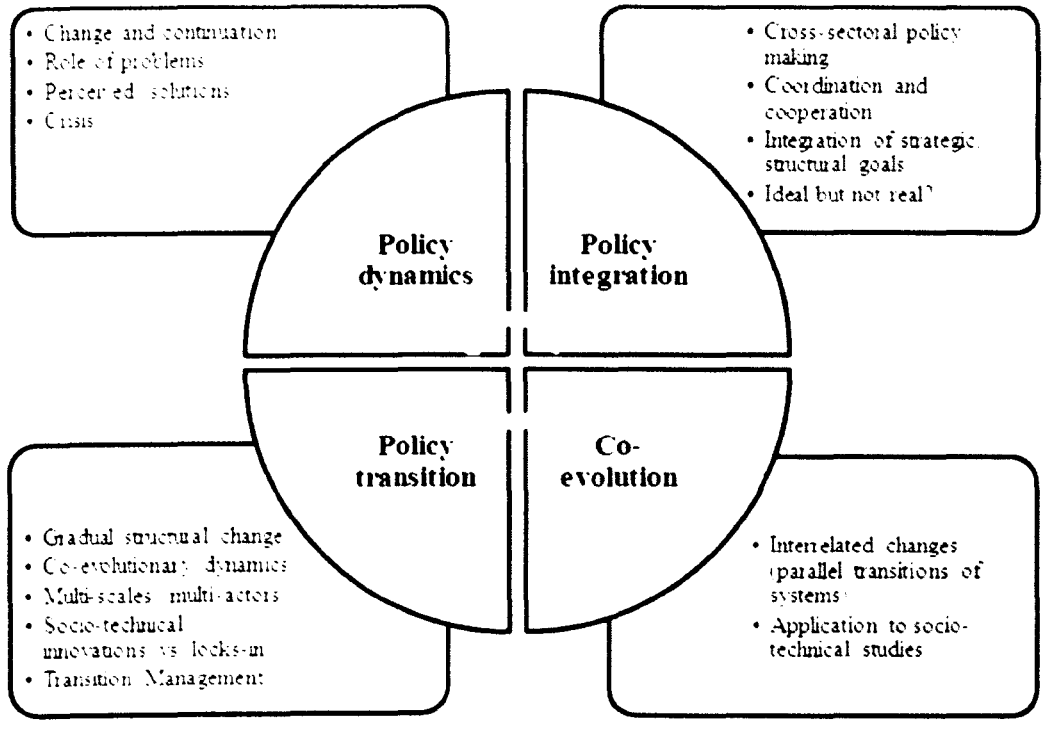


Figure 13: Four-fold framework connects dynamics, transitions, integration and co-evolution approaches to policy processes

The presented theories are complementary to each other and form a quarto-partite frame, as visualized in Figure 13 above. Reading horizontally, the top-half of the Figure links 'policy dynamics' and 'policy integration', two frameworks for analysing policy, and the bottom-half of the Figure links two frameworks for analysing socio-technical change: 'socio-technical transitions' and 'co-evolution'. Reading vertically, the left-half of the Figure links 'policy dynamics' with 'socio-technical transitions' which occur in a single sector, and the right-half of the Figure links 'policy integration' with 'co-evolution' which occur between sectors and between different systems and processes.

In what follows, I will apply this integrative approach to examine interrelated dynamics, with a focus on the meso-level of the regime, in water and energy sectors in Israel, drawing on insights from the above theoretical approaches. Section 6.3 reminds the reader of the key policy dynamics in water and

energy management, and sets out key elements of on-going socio-technical transitions. Section 6.4 examines policy dynamics, integration and co-evolutionary processes between the water and energy regimes and offers insights from integrating the four approaches to inform current policy dynamics.

6.3. Water and energy regimes in Israel

Strategies of natural resource management are constantly changing in Israel. Uncertainties and rapid changes that the State has faced in its short period of existence have required quick yet robust solutions for preserving and exploiting natural assets. The State has had to battle different degrees of water and energy scarcities from its formation. In the two previous chapters, I described how the Water Law was designed in order to maintain control over precious and sometimes disputed sources, and to support the agricultural vision of the State's founders and the reinforcement of national sovereignty over the environment. The Israeli electricity sector shares similar characteristics and is also centrally managed by the Israeli Electricity Corporation (Tishler et al., 2002). In terms of securing resources, and as a result of its geopolitical situation, Israel is depicted as an "energy island". Its economy depends on imported oil, coal, and natural gas. Recent years have witnessed more change, however. I also illustrated how market-oriented reforms have influenced policies, regulations, institutional structures, technological choices, supply sources and efficiency measures within these two sectors. Both water and energy sectors can therefore be considered as systems in transition, the long-term consequences of which are as of yet not known.

At the centre of these dynamics is the adoption of seawater desalination technology as the leading policy strategy in Israel to deal with what has been termed the "water crisis", thus advancing the creation of a new water regime. Crucially, however, seawater desalination, even with the best available

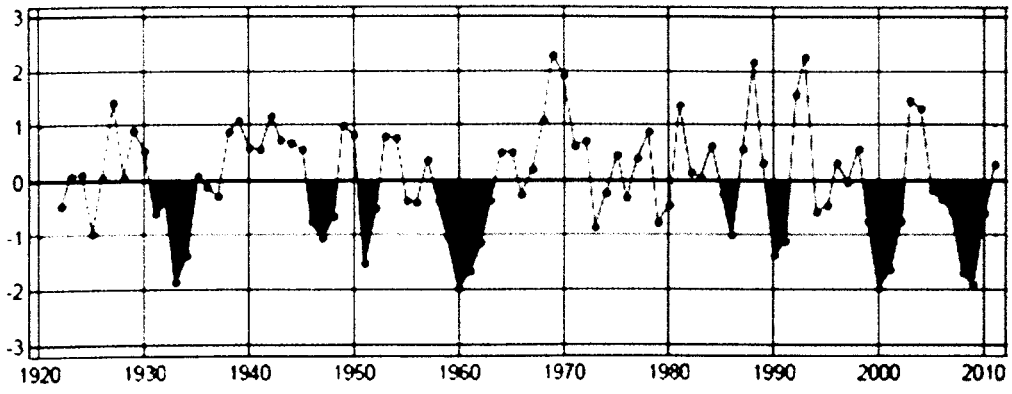
technology, is an energy-intensive water production mechanism and carbon emissions are consequently high, compared with other water supply solutions. Desalination, as a magical solution to water scarcity, is therefore a prominent example of the water-energy-climate nexus, with its various environmental manifestations. The coupled policy dynamics between these sectors, and the extent to which these are leading to co-evolving transitions towards or away from sustainability, is therefore at the focus of this chapter.

6.3.1. Dynamics in water management

A need to secure fresh water resources to fulfil increasing demands of the rapidly developing nation was clear to the founders and first water professionals in the pre-state period, and had fed what Molle *et al.* (2009) termed the 'hydraulic mission' and the emergence of 'water bureaucracies'. However, what has increasingly emerged as a social construction of water scarcity and later of a 'crisis' was the result of the high rate of population growth (the number of households in Israel for example increased from 1.2 million in 1990 to 2.1 million in 2009) and the chase after modern, western life-style, as well as a long legacy of neglect, mismanagement and disregard of continuous droughts, salinization and pollution of water sources. For instance, it was observed that already in the beginning of this century, nearly 20% of the coastal aquifer could not be utilized due to high salinity caused by seasonal over-pumping (Zaslavsky, 2000). Moreover, scarcity was considered to demand the creation of centralized, national water management institutions and technologies, which in turn have allowed the economic development of the State (see chapter 4).

Until recently, the agricultural sector was allocated more than half of total fresh water consumption and a strong agricultural lobby was undermining any attempts to lower the abstraction rate or to raise water prices (Feitelson, 2005). Water shortage in one reservoir was offset by a policy of overdraft in the other reservoirs, a policy which counted on subsequent wet years (Fischhendler and Heikkila, 2010). A series of dry years is not an exceptional

occurrence, however. A parliamentary document has recorded a regular pattern of significantly drier years than the long-term average in 1983-1986, 1988-1989 and 1998-2001 (Tal, 2010), as can be seen in Figure 14. According to the IWA, measurements also indicate a sharp decline in average precipitation in the last few years, as shown in Figure 15, most likely due to global climate change (Alpert *et al.*, 2008). Yet over-pumping has continued to lower Israel's water resources below the "red lines"[29].



[SPI (Standardized Precipitation Index) 2010-2011 = 0.30]

Figure 14: Streamflow Drought Index (SDI) for the Sea of Galilee (Lake Kinneret) hydrological basin. Source: A Report on the Annual Rainfall Season and its Main Hydrological Characteristics 2011. The Hydrological Service, Jerusalem.

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[29] The "red-lines" are hydrological indicators of the minimum water levels in the Sea of Galilee and Aquifers at which water should no longer be drawn from the lake. The line is arbitrary: water experts are in disagreements exactly where the line should be set. Also, it was lowered several times in order to continue pumping. There is also a "black line" set at 215 meters below sea levels, below which the lake will suffer irreversible ecological damages.

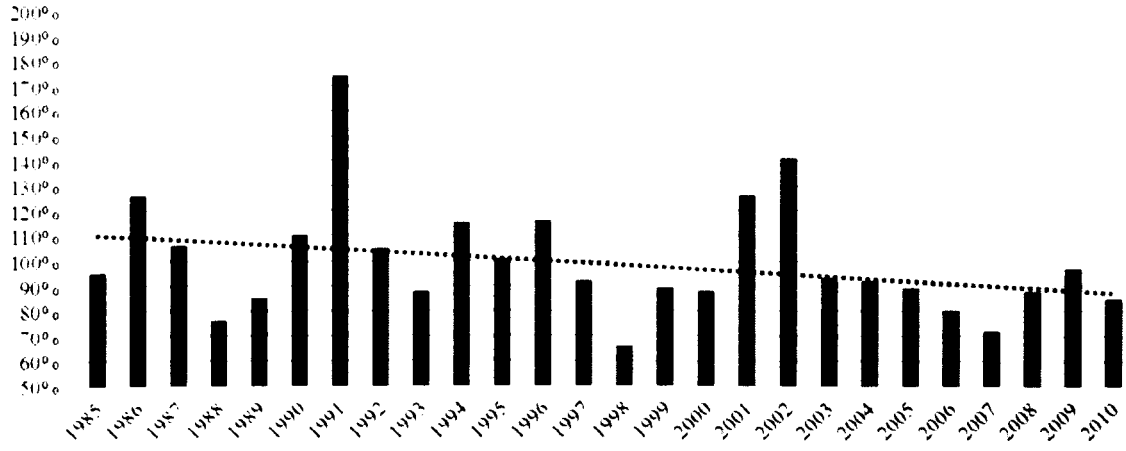

Figure 15: Percentage of annual rainfall in comparison with the annual average (national) 1985-2010. Source: A Report on the Annual Rainfall Season and its Main Hydrological Characteristics 2011. The Hydrological Service, Jerusalem.

As detailed in chapter 4, to address the severe shortage, the first large scale desalination plant (the biggest of its kind in the world) entered service in 2005 and two others have since been finished. A major impediment to their construction was the Ministry of Agriculture and the agricultural lobby. They were active opponents of desalination, fearing that the increase in the price of water will fall on the farmers (Feitelson, 2005). Ministry of Finance also objected to these expensive public projects[30] without guarantees of a full cost recovery by an increase in the price of water. Meanwhile, a major saving of freshwater was made by reuse of domestic sewage by farmers (Mekorot, 2010).

Past controversies between ministries over financing and budgeting of water projects became irrelevant with the breakthrough in desalination technology. At the same time, a special government department for Public-Private

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[30] Investigation committee minutes, 2010. For example: S. Simhon, Minister of Agriculture, minutes, 2009; Prof. R. Samiet, academic, desalination engineering, minutes, 2008. Available on-line at http: elyon1.court.gov.il/heb/protocol_1.htm (Hebrew). Last accessed: 19.9.2010.

Partnerships (PPP) was established. While the institutional apparatus of water management is still largely based on a divided tenure between municipalities (collection of water bills and wastewater treatment) and the state (abstractions, allocations and distribution), desalination plants are constructed through BOT (Build-Operate-Transfer) and BOO (Build-Own-Operate) agreements and are forming a new arena for public-private partnerships (Deane, 2003). Together with recent initiatives to increase the role of business in municipal sewage treatment, desalination plants exemplify the partial privatization of water management in Israel.

A review of parliament's decisions and future plans prepared by the Israeli Water Authority (IWA 2009a) on strategic decisions in water management indicates that a transition from fresh-water supply to desalinated sea-water supply for the urban sector (which in 2010 is the main water consumer) will be completed before the year 2020. Long-terms implications of this strategy are not clear. There are concerns for the impacts of desalination on marine environment, its energy costs and need of space at valuable seashore (Garb, 2010). Moreover, increased availability of water could amplify demand (Meerganz Von Medeazza, 2005). Yet, calls for demand-side management remain largely omitted. It seems that "everyone wants more water" and even environmentalists hardly challenge this prevailing paradigm:

> I would tell you something to sparkle your thesis; desalination is a necessity and it will also be good for the environment (Interview, a leading environmentalist).

6.3.2. Dynamics in energy management

As I already noted in the previous chapter, with a projected steady growth of required generation capacity per annum, a new 500MW plant would be required every year. Failure to do so could cause electricity shortages and economic losses. The last thing any minister would like to be responsible for is an electricity deficit. This concern is reflected in the principles guiding the sector's managers: 'robustness', 'non-regret' and 'safety', all aiming at

securing supply at any cost (Interview, SV). With a discovery of a large reservoir of natural gas in the Israel's Mediterranean territorial waters, some actors within the energy regime are currently pushing for the abandonment of coal and the transition to the use of natural gas. It was claimed that the IEC is not eager to do this because it would lose its monopoly of importing coal, would no longer need as many workers on the power-plants as before and because it would involve a cut in price of electricity for consumers. Most importantly, the IEC might have to abandon its plans for a new coal power-plant, it was promoted intensively for a decade. At the time of writing, it was therefore estimated that the fuel mix will not contain more than 40% of natural gas (Tal, 2009).

In the previous chapter I have also discussed the emergence of different energy alternatives to the current coal-based energy regime. Indeed, one of the latest developments in the energy sector is the emergence of discourse on nuclear energy. The origins of this discourse can be easily traced. Nuclear energy has experienced a revival in the developed world. For example, the United Kingdom published a White Paper in January 2008 stressing that the continuation of nuclear energy is of public interest as part of the UK's low carbon energy mix to help meet carbon reduction targets and to ensure energy supplies (International Atomic Energy Agency, 2009). A similar rhetoric is used to advocate nuclear energy in Israel:

> Bringing in atomic energy can improve our international position in terms of GHG emission and polluters...the Ministry of Environment would like to make a comprehensive assessment of the environmental impacts of atomic energy...it won't be right to reject it out of hand because of its potential environmental impacts (Chief Scientist, The Ministry of Environment. In: Feasibility of nuclear energy in Israel conference, 2009)

The general director of the IEC explained the advantages of nuclear energy:

> We think that nuclear plant is the ultimate solution in the next decade, after we solve the political barrier. We, in the IEC insist to be prepared for this issue, even if it is progressing at slow pace. And, if we could know today that preparation for nuclear will really start in 2014-2015, we could now turn to

> the government and say – cancel the planned coal power-plant. If we want to avoid building this power-plant, we have to start working today on nuclear energy at both political and technological levels (A. Lesker, A. General director, IEC at Feasibility of nuclear energy in Israel conference, 2009).

Another effective way to make nuclear energy look better is to contrast it with renewable energy:

> Incorporating renewable energy into the grid is too costly; to transmit from the southern region of Israel to the northern...and there is also the premium that is very expensive...while nuclear energy is the cheapest means to reduce GHG emission. (Elmakiyas, D. Director, Planning, Development & Technology Unit, IEC at Feasibility of nuclear energy in Israel conference, 2009).

The Israeli government and particularly the Minister of Water and Energy are also dominant proponents of nuclear energy and discuss it as an inevitable alternative; the Minister declared his personal commitment to examine the potential of nuclear energy for the Israeli electricity sector during a visit to France on March 2010[31].

Interestingly, the recent near-catastrophe events in Fukushima, Japan, have had no significant effect on the official positive attitude toward nuclear energy: this can be explained by the belief that future fourth generation power-plants can be riskless and by the general "technological optimism" approach that is held by many Israeli policy-makers (see for example Tal, 2008). The growing recognition of the feasibility of civil nuclear energy is clear in the light of numerous citations of nuclear energy in local media and scientific-public events on this topic, particularly during 2009-2010.

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[31] Sofer, R. and Darel, Y. (2010, March 7). Israel will announce: we will built nuclear power-plants. *ynet*, , http: www.ynet.co.il articles 0,7340,L-3859228,00.html, Last Accessed: 24.6.2010 (Hebrew).

6.4. Discussion: Policy and socio-technical interactions between water and energy regimes in Israel

6.4.1. Policy dynamics and policy integration between water and energy regimes

Transitions of the water and energy sectors in Israel are coupled in several ways. The first link between water and energy in the Israeli context is historical: the integrative system of water distribution required the transportation of water from the Sea of Galilee (as the central reservoir of freshwater) in the North to the other parts of the country. When this massive project of pumps and pipelines was completed in the end of the 1960s, it consumed almost ¼ of total electricity energy generation, because its operation involves lifting water from 209-213 meters below sea level to an elevation of 151 meters above sea level. Still today, the water sector is the largest industrial consumer of electricity and is responsible for 6% of the total energy consumption in the country, with oil distillation and the chemical and mining industries the closest behind (Grossman, 2007; Central Boreau of Statistics, 2009).

Desalination is a key example of the connections between the water system and the energy system (Schiffler, 2004). The Reverse Osmosis technique, which is more energy efficient than older technologies (Semiat, 2008), is still an energy-intensive water production solution (King *et al.*, 2008), even though technological improvements in recent years kept lowing the amount of energy needed in the process. Electricity consumption by the water sector is expected to be doubled, from 2.8 billion kW in 2006 to approx. 5.7 billion kW in 2015 (Figure 16) with full use of desalination, increasing in the short term the Israeli water sector's share of total energy consumption by approximately 2-4% (Position paper, water and energy team, IWA, 2009b). When fuelled by coal-based electricity, carbon emissions of desalination will be high. According to Australian calculations each desalination plant of 45 million cubic meter capacity would generate annual CO_2 emissions of

135,000 tonnes, if powered by coal-based electricity only (Proust *et al.*, 2007). To emphasise the water-energy nexus, (Meerganz Von Medeazza, 2008) suggests looking at desalination technology as a black box: turning saline water into freshwater involves seawater and energy as inputs and freshwater, greenhouse gases and concentrated brine as outputs.

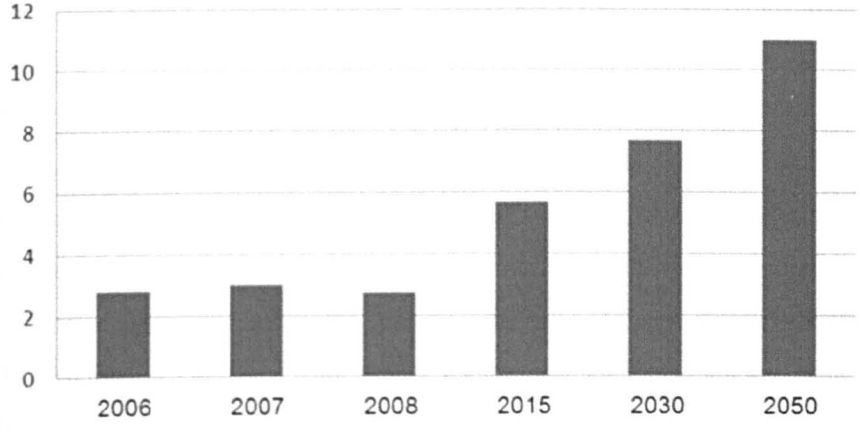

Figure 16: Current and future projections of total energy use (billion kW per year) by the water sector in Israel. Source: Position paper, water and energy team, IWA, 2009 (Hebrew).

Desalination has also a spatial manifestation of the water-energy nexus. Water plant tenders include the permission to build a natural gas based power plant to generate the about 75 mW required by desalination (at a capacity of 150 million cubic meters). It could therefore be expected that new natural gas plants would appear along the coast, beside the new sources of water. Yet, this link is not merely geographical but rather economic because the desalination company which have won three out of five tenders (with negotiations still continuing on the fourth desalination plant) has offered the lowest price for the production of water, mainly because it also drills natural gas that would power these desalination plants (as well as half of the

country's needs). This has already been tagged as the new monopoly, a private one cross-cutting water and energy sectors[32].

Another link is institutional. Here is where policy integration, which aims at creating synergies between policies and coordination between different actors and departments, is probably most needed to achieve greater implementation as well as better outcomes. It may be expected that the physical integration of infrastructures, as in the case of desalination, could give rise to high capacities of policy integration and inter-sectoral cooperation. This, however, was found not to be the case. The analysis of interviews with major stakeholders and minutes of governmental departments points to the fact that major issues, such as energy considerations, were raised and considered only at late stages and after the policy was already formulated. First formal discussion on energy requirements for large-scale desalination is found only in the National Planning Committee minutes, from the year 2010. This can be partially explained by the increased perception of urgency with respect to water deficit that masked any other consideration. In addition, there was a lack of integrative accounting for future carbon emissions and international commitments on their reduction as well as lack of involvement of, and coordination between, central stakeholders such as the Israeli Electricity Corporation, and the Water Authority (IWA, 2009b; Interview, ZL)

Many western countries are making efforts to reduce carbon emissions as a response to growing awareness of climate change and to commitments to address it (see for example DECC, 2009). The efforts to reduce CO_2 emissions will certainly impact the water sector as well, for example through technological improvements in water industries and household retrofitting of taps and toilet bowls. In a country such as the UK, where water is considered

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[32]Bar-Eli, A. (2010, 20 January). Israel becomes an energy emirate: who are the winners and how much money there is in the reserves?. *The Marker*. http://www.themarker.com markets 1.564259 (Hebrew). Last accessed: 14.4.2012.

"dirt cheap" because "one could not get a cubic meter of dirt delivered to the door for the £2 3 currently charged for that volume of water" (McDonald, 2007), climate change should be seen as a driving force for transition. However, if at all, climate change seems to drive Israeli transitions only in the energy sector, not in the water sector. Unsurprisingly, with a perception of severe water deficit, in the eyes of water professionals, reducing carbon emission is not a top priority (Kidar et al., 2010).

Finally, the water-energy nexus could be looked at as large amounts of water are needed to produce electricity in power-plants. According to the IEC data, the largest coal power plant in Israel uses as much as 330,000 ton seawater in one hour. Whilst nuclear power-plants use and consume significantly more water per kW than electricity generation powered by fossil fuels, the location for a future civil nuclear power plant in Israel was designated already years ago in the middle of the desert (Ministy of Interior, 1965). The questions of how and from where the water required will be sourced, have not yet received much attention[33], despite the evolving discourse around nuclear energy. It can be concluded, that the policy dynamics, revolves around the unaltered, implicit, core belief in the need to secure independent and unlimited sources of water and energy.

6.4.2. Socio-technical transitions and co-evolution in the water and energy regimes

I now examine the extent to which socio-technical transitions within, and co-evolution between, the water and energy regimes are occurring. Firstly, based on the analysis made in chapters 4 and 5 it can be determined that both regimes demonstrate transitional tendencies, which are manifested in the entrance of new actors, new rules, changing relationship of networks, and

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[33] Laster, Y. (2009, 17 August). Nuclear power plant in the Negev? And where would the water come from? Commentary published in *The Marker*. (Hebrew).

institutional reforms. The centralized, vertically integrated production-supply chain (by IEC in electricity and *Mekorot* in water) has been altered, with the appearance of partially privatized production solutions. Decentralization of production became increasingly viable with the growing acceptance of the potential of natural gas for electricity production and seawater for drinking water. The governmental intention, to reduce the power of the national water and energy utilities and their natural monopolies, has been a dominant force in each regime, as well as cross-regimes. This, however, may result in the creation of a new monopoly, because it had opened the possibility for desalination companies to generate their own electricity, thus strengthening their hold over both water and energy production.

Secondly, the unfolding transitions were largely caused by punctuations, rather than incremental developments. In the water sector it was the breakthrough in desalination that triggered a transition. The energy sector was punctuated by the unexpected discovery of natural gas in the Mediterranean, which is questioning the need to build a new coal power plant. The new situation, where the Minister of Water and Energy and the Israeli Electric Company feel that their influence on the current transitions is weakening, has fed an emerging discourse on nuclear energy. Yet, a cross-regime perspective reveals that the "vicious supply-demand cycle" (Kallis, 2010) is also inter-sectoral. This refers to mutual positive feedbacks as efforts to expand supply lead to potential for increases in demand and so forth.

Thirdly, processes of co-evolution have dominated both regimes. In the water sector, large hydraulic configurations were supported by narratives of development and exogenously determined demand. In the energy sector, anticipated increase of electricity demand was similarly reinforced by the strategy of supply-side management. Once all planned desalination works are in place and additional power plants are constructed, it might be harder to shift the paradigm; the government, as well as the private investors, would have economic and political interests that demand will not fall. This would

further hamper niche-innovations investments, in for example, renewable energy technology.

6.4.3. Integrated transitions management

This suggests that combining insights from co-evolution, transitions theory and policy integration could give rise to virtuous rather than vicious cycles, whereby efforts to move to renewable energy sources and to manage demand, for example, reduce the need for expansion of fossil fuel or nuclear power supply, thus reducing both ecological and political pressures. Integrated transitions management could therefore play a crucial role in re-orienting trajectories in the water and energy sectors. Transition arenas, where actors can interact, express and exchange their agendas and prospects (Meadowcroft, 2005), could be opened, at least in early stages of the process, to other networks actors. Here is where trade-offs and policy spills-over can be identified explicitly. A more careful design of the transition arena might reduce sectoral leverage, sectoral interests and transaction costs. Integration of actors from different sectors would encourage shared goals formulation, could have the power to create a paradigm shift and to support a transition from supply-side management to demand- side management, for example by the method of inter-sectoral scenarios or backcasting (see heuristic stages of TM Figure 17).

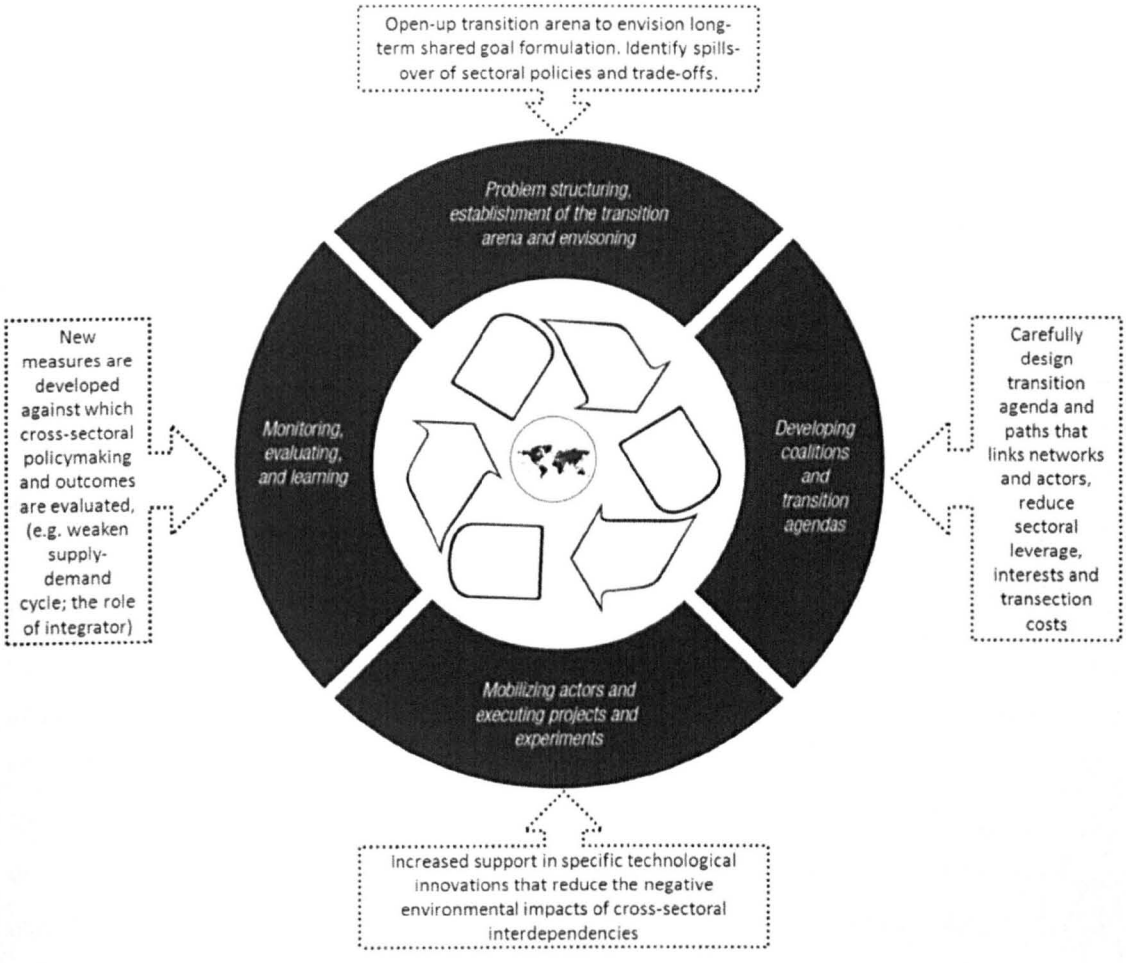

Figure 17: The integrative transition management cycle. My additions (in dashed line arrows) to the transition management cycle image in Loorbach (2007:115).

One possible outcome or what is termed as a transition pathway, from an integrative management, could be a decision to increase electricity prices for consumers, rather than water prices[34]; this might better reflect the true cost of desalinated water. This however, requires a cross-sectoral comprehensive management. The transition management model has highlighted how important it is to encourage industrial sector to continue exploring potential innovations. The added value of integrated transitions management would be

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[34] I thank Dr. Sinya Nethanyahu from TAHAL Group water consultant company for insightful comments on this issue.

in specific innovations that may support a resolution of the water-energy nexus, for example by advancing renewable energy technologies for desalination, the co-generation of water and energy, extra efficient desalination membranes, coupled centralisation of water and energy production and delivering systems, and more.

6.4.3.1.ITM and discursive institutionalism

To adopt this approach and achieve greater policy integration, as outlined above, would require significant institutional changes, which would likely to be resisted by key actors, such as relevant ministries (agriculture, infrastructures), water-related business companies and the Israeli Electricity Company, that are able to exert power under current institutional arrangements. Earlier on I have argued that discursive institutionalism contributes interesting insights regarding to the role of discourses in transitions: paradigms shifts and construction of storylines held by policy networks, reveal hidden sides and power-relations over the backstage of any transition. As much as Shove and Walker (2007) were right in warning against the masking of power-relations in transition management process, it is true that the assumption, about the ability of ITM approach to avoid the ills of politics by the creation of shared arenas, should also be treated with suspicion. Lawhon and Murphy (2012) accused mainstream transition management advocators in assuming, for example, that the 'right' group of elite people and the 'right' kind of collaboration, would be able to direct transitions toward optimal sustainable outcomes. The ITM approach might, however, be able to reduce elitism and technocrat-ism in transition management process by avoiding the regular setting of one individual sector, in which power-relations are already in their traditional form, and by joining together actors which have no established way of making decision. Finally, discourses that give rise to institutions, as happened in both the water and energy regimes, can be expected to be "coherent, structured and...supported by broader discourses and are not highly contested by competing discourses" (Phillips *et al.*, 2004:645). ITM cannot avoid 'winners' and 'losers', but it

should be able to cross-fertilise different discourses promoted by different actors that currently have no channels of communication.

6.5. Conclusions

The study of interactions and policy dynamics between the water and energy sectors in Israel exemplifies the value of integrating the four different theoretical approaches. The four-fold model examines how sectoral dynamics are coupled and technological regimes co-evolve. More than a decade after the observation that "the state has long sought to manage the environment based on the assumption that the 'environment' can be divided into discrete entities for management purposes" (Bryant and Wilson, 1998:323), policy oriented research, such as transition management, should not underestimate the consequences of such an approach.

The results of this analysis highlight the weaknesses of a single-sector approach to transitions. Niche-induced developments, in both the Israeli water and energy sector, are driven each by an inherent strategy of supply-side management. At the meso-level of the regime, abundance of water requires the abundance of energy. This supports my theoretical assertion that inter-sectoral "systems of production and consumption" (Hofman, 2005) are interlinked and intertwined. Ultimately, in an attempt to secure resources, a pattern is created wherein technological solutions co-evolve across different regimes. It is indeed important not to view integration as a panacea (Coffey and Major, 2005; Russel and Turnpenny, 2009). Nevertheless, integrated transitions management should be able to offer a more centripetal approach; long-term goal formulation in the transition management process should allow for more comprehensive transition pathways to emerge, and interactive arenas may encourage participation of inter-sectoral networks of actors. A more careful design of the transition arena might therefore reduce sectoral leverages, sectoral interests and transaction costs. Without the appreciation of interdependencies in technological regimes, sustainability goals might still be

lagging behind. This highlights how examining policy integration can inform policy dynamics, and how examining co-evolution between sectors can highlight drivers or barriers to sectoral socio-technical transitions.

To conclude, Fischhendler and Heikkila (2010) have argued that the Israeli water management institutions are "trapped" and face an embedded difficulty to adapt, reform and cope with changing water supply and demand conditions. They explained this to be a result of the extensive physical and institutional integration within the water system, an explanation which can be valid also for the energy sector. Notwithstanding, when looking at the policy dynamics, structural changes and choices in both sectors, supply management could be explained by the interdependency of the two technological regimes. The rise of large scale technological configurations in both sectors is hardly accidental, and cannot be explained solely by the "consumerist syndrome" (Bauman, 2005) nor the need to supply ever-lasting growth in demands. Rather, this interdependency is embedded in socio-technical systems and might be essential to their change.

7. Managing integrated transitions: a discussion

> ...And I try, oh my god do I try / I try all the time, in this institution / And I pray, oh my god do I pray / I pray every single day / For a revolution (4 Non Blondes)

7.1. Introduction

The goal of this research was to examine interdependent policy dynamics with relation to the challenge of socio-environmental sustainability. The particular research questions dealt each with the dynamics between technological, discursive and policy changes and further aspired to explore the merits of these relations from inter-sectoral perspective. Obviously, the nature of this relationship is neither quantifiable nor linear. It is rather interpretative, interactive and adaptive. In applying this theoretical postulate to the water-energy nexus in Israel, the intention of this thesis was to offer important empirical evidence to support and test academic debates surrounding the sources and implications of policy changes and continuation. Therefore, the various strands of the analysis in this thesis have taken forward the policy dynamic literature, by combining it with sociotechnical transitions and policy integration literatures.

The aim of this chapter is to critically reflect upon the empirical findings presented in chapters four, five and six, with an interest to linking my research questions with the wider academic debate. This chapter is divided into two major parts. The first section 7.2 provides a short summary of what has been done in the thesis up to this point and the main empirical findings. The second part, (sections 7.3 and 7.4) addresses my three research questions one by one.

7.2. Summary of findings

To achieve the goal of the thesis, several strands of the literature were reviewed including policy dynamics and sociotechnical transitions (as part of larger SST framework). Combining these two large and diverse bodies of literature, a theoretical void was identified. It was observed that existing approaches to policy dynamics do not sufficiently account for inter-sectoral interdependencies. It was further asserted that the causality force of technology is missing in the policy dynamics literature and that in turn, the socio-technical literature is left with a lack of agency oriented analysis. Therefore, the theoretical puzzle this thesis engaged with was how to re-theorise the interplay of technology, policies and discourses at the level of the sociotechnical regime; what are the implication of this interplay on cross-regimes dynamics and; what can be accomplished through more integrative lookout. In order to achieve this goal I have chosen an interdependent pair of problem areas, one in the water sector and the other in the energy regime and conducted three separated studies.

In the beginning of the thesis I pointed at the social construction of both scarcity and abundance and therefore on the accompanied postulation that these concepts are not purely dichotomous. I continued with the presentation of the water-energy interface, which stems primarily from the vulnerability of the two resources and the social quest to secure them. This introduction served to contextualise the empirical justification for the research and the theoretical interest in interdependencies.

By means of interviews and document analysis, the first study (chapter 4) depicted a socio-technical transition in the Israeli water sector. I have claimed that this transition succeeded a long period of continuation and path-dependency of policies. I described the inception and development of a new water policy, which advanced the use of desalination technology, thus initiating a sociotechnical transition of the regime. The new policy goals seek to move away from the traditional pattern of crisis-induced management to

having enough high quality water for all purposes at all times. Other features of the regime have changed as well – the geography of water shifted and water would now be flowing from west to east and from south to north (Feitelson and Rosenthal, 2012), economic arrangements promoted privatization along the chain of water production and sewage treatment and different types of displacements occurred between actors and subsectors in the system, pointing at the existence of various types of interdependencies. I have concluded that policy dynamics in the water sector followed a technological breakthrough in desalination and that the long-term implications of such a technology-induced transition may be unsustainable if cases of displacement would not be taken into account explicitly.

Via documents analysis, conference talks and complementary interviews, the second case-study concentrated on dynamics in the Israeli energy regime (chapter 5). I have found that the transition of the energy regime from coal to natural gas (exported from Egypt and discovered in the Mediterranean Sea) goes along with a growing notion of energy abundance. This new paradigm is fortified by three additional energy alternatives (oil shale, nuclear and solar) that have made headlines during the timeframe of the study. The findings in this chapter highlight the role of different policy networks in promoting each of these alternatives and the power of the discursive shift from scarcity to abundance on demarcating and delimiting future energy pathways.

Overall, in these two chapters I firstly established the assertion that both sectors are indeed undergoing a sociotechnical transition, expressed in multiple dynamics. While policy goals (which embody certain rules and routines and reinforce certain solutions to policy problems) (cf. Wilson, 2000) did not change, the transition took place at several dimensions: technologies and infrastructures (e.g. desalination, deep-see drilling); policy ideas and discourses (e.g. from scarcity to abundance in both sectors, nuclear energy); and the organization of institutions and actors as well as implementation measures (privatization, for example).

Secondly, it has been demonstrated how the transition of each sector involves inherent spills-over to other interdependent regimes, thus establishing a-priory the 'existence' of the presumed interface. In the first case it was the environmental problem and risks displacement from the water sector to the energy sector and in the second case it was restricted pathways and incertitude, which also spill over to other sectors, and if not directly to water - then indirectly via the climate-change regime (see section 5.5.2).

Finally, the findings suggest that technological configuration drives policy dynamics in both sectors. This is not the common observation of policy change studies, in which emphasis is usually given to policy as a driver to technological innovation and change. Advocating a reverse casual relation between technology and policy, strengthens the later use of the coevolutionary approach to the study of coupled dynamics (see Figure 18 below). In other words, as I asserted in the end of chapter 6, it is not by accident that large scale technological configurations such as desalination and nuclear energy plants are promoted in both sectors simultaneously.

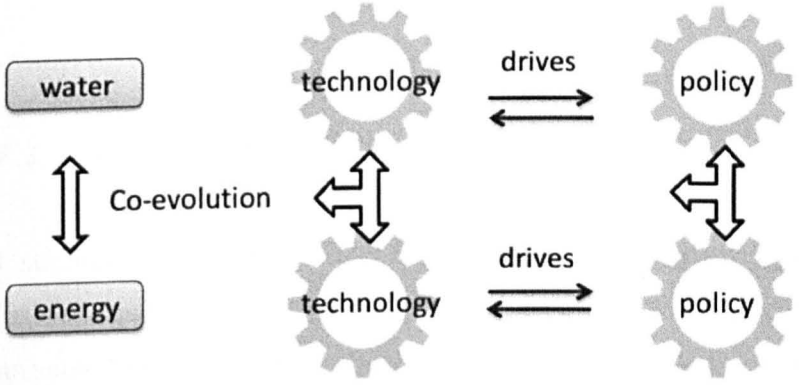

Figure 18: coevolution of dynamics in water and energy regimes

The findings of chapters four and five have therefore laid the ground for a comparative analysis of the water-energy interface. I have achieved the goal of examining cross-sectoral, interdependent policy dynamics with relation to question of sustainability by pointing at the connections between the water and energy regimes (in the physical, spatial, economic and institutional spheres) and at the implications of this interconnectedness on sustainability

(inter-sectoral vicious cycle of supply and demand, negative impacts on GHG emission, and more) and for transition managers (suggestions to open-up transition arenas, consider niche-innovation technologies with potential for solving the nexus, reformat transition pathways and specific regulations etc.).

In regard to the challenge of integration, among other results, findings suggest that one type of integrative capacity does not necessarily indicate its existence elsewhere. For example, the study in chapter 4 of how technological developments in water resource management and other realms can engender policy shifts through problem, cost, and tension displacement, suggests the need for greater horizontal and vertical policy integration and cross-sectoral cohesion. While Israel is practicing the idea of Integrated Water Resource Management (IWRM) (see footnote 1) maybe more successfully than any other county (Fischhendler, 2008), such cases of displacements are indication of the lack of other types of integration, as will be further discussed in this chapter. The overall result also suggests the need to supplement the transition process with integrative capacities in its management process, as a way of better dealing with the water-energy nexus.

7.3. Addressing research questions i - ii: a discussion

I summarise and discuss the research results by answering the first two research questions one by one in greater detail below. A synthesis would be presented the next section afterward (7.4) through looking more in-depth on research question number three.

i. How does technological change affect policy in sociotechnical transitions?

There is a central question in the context of debates about sustainability and this is: how technological innovative solutions emerge and become sufficiently powerful to challenge or even overthrow a dominant solution (i.e.

the prevailing 'regime' of production and consumption including institutional structures and actors constellation), resulting in an overall transition of the system (Haxeltine and Seyfang, 2009). This question is dealt with in the SST literature and has often met the multi-level explanation, according to which interdependencies between internal developments at the levels of a technological niche, the regime and landscape conditions, have produced the sufficient and necessary conditions for a significant transformation in sociotechnical systems in different sectors (agriculture, energy, water, transportation, etc.). Looking at the level of the regime, societal constitutes such as cultural attributes, policy intervention, artefacts (technological hardware and software), scientific knowledge, paradigms, or industrial and market-based activities, had proved by most research to determine the development and use of niche-induced technologies that are designated to fulfil socially determined functions (Smith *et al.*, 2003). A difficulty to delineate the borders of each level (niche / regime / landscape), which is sometimes pointed by critics, should not deter an attempt to make claims about its dynamism (change or continuation). It is useful at times to think about a regime as what it is not, mainly because the micro and macro levels can be more easily distinguished.

The motivation of many transitions studies emanates from the interest in questions regarding steering and governance of these multi-levels changes. The vast investigation of the challenging "governance of sustainable technologies" and "technological transitions" (Smith *et al.*, 2003; Murphy, 2007; Smith and Stirling, 2010), however, has not provided a comprehensive indication to the ways certain technological configurations drive policy dynamics. To be more precise, studies often depict policy as a tool to steer new technological configurations (by the allocation of resources to conducting research; developing public-private funding apparatus; creating markets; regulation of specific health and safety related issues; creating arenas for public participation and more). These studies rarely portray policy as the outcome of incremental or breakthrough improvement in existing or new technologies. Rather, policy change has been argued to be the result of

the "attempts by different coalitions of actors to set priorities and conceptualise the socio-technical system and its concomitant sustainability problems in different ways" (Smith and Stirling, 2006:11). In the literature, the understanding of policy is essentially of an interactive intervention:

> Existing technology governance arrangements tend to be considered as endogenous features of the socio-technical systems themselves. Yet when it comes to recommending how sociotechnical change might best be steered in more sustainable directions, analysis tends to step outside the system to objectify its workings, **with governance characterized in terms of exogenous 'mechanistic' interventions**. (Smith and Stirling, 2006:1, emphasis added)

In other words, technology is treated as an autonomous factor and an explanatory variable to policy change mainly by SST scholars such as Latour (2000), which takes a similar stand to the one Dosi (1982) took in his "technology push" approach in relation to economic growth.

Existing policy dynamics studies should more frequently turn the common causality of 'policy' → 'technology change' upside down by showing the ways in which "technology produces policies" to rephrase Pierson's (1993:597) statement that "policies produce politics". Chapter 4 was therefore driven by the theoretical inquiry about the relationship between socio-technical systems and policy dynamics and more precisely, about the ways and mechanism by which technologies could have the power to formulate a significant change in national policy, and consequently in the entire local sociotechnical system.

The results of the analysis of Israel's recently emerging national water policy, have pointed out at the ways advances in Reverse Osmosis desalination technology have contributed to a major change in the Israeli water system. This analysis contributes to the literature by drawing insights from the SST and the socio-technological transitions studies as reviewed in chapter 2, to show how technology can spur policy change, and suggest the mechanism by which it does so.

The analysis stemmed from the empirical assumptions (based on previous research of the Israeli water regime and my historical review) that past technological innovations, coupled with social, economic and geopolitical changes, have contributed to incremental changes in the regime without altering its path-dependency management strategy and basic core-beliefs, which in the course of action and in the face of growing demands, were translated onto the over-exploitation policy of fresh water sources. Similarly, networks of actors, in favour of historical choices of spatial distribution of infrastructures, sectoral allocations of fresh water and pricing structures, contributed to the lock-in of the regime while reinforcing its national and centralised character. However, I have suggested how the sheer technological breakthroughs that rendered seawater desalination economically feasible undermined this long-lasting hydro-ideological support for agriculture; how it introduced new ideas about water abundance; and how it engendered changes in paradigms, institutional structures and constellation of actors. I have empirically demonstrated how desalination technology contributed to this shift by destabilizing the existing structure through re-framing and displacing important issues, such as environmental externalities, economic costs and hard political choices, to other policy sectors and levels of governance as well as reallocated them between politicians, bureaucrats and water professionals. In a policy regime where technology drives change, by reframing the problem and consequently masking alternatives, the following opinion expressed by one of my interviewees is therefore not surprising:

> There is in fact no connection between the problem and the solution...a complete inauthenticity between *the problem* – i.e. the lack of water because current amounts are not enough to supply all demands – and *the solution*, which is desalination. (Interview, Water Company).

Scholars from different disciplines have made attempts to explain the mechanisms that operate behind the process of agenda-building, decision taking and policy making, processes which already at their most basic form aim at altering the current state of affairs. Political scientists have highlighted the fundamental mechanism that is based on the interaction between actors, either as an individual rational practice or as political bargaining inherently

structured by power-relations, conflicts, interests and social networks. Alternatively, geographers and environmental economists argue that formal and informal institutions are a mechanism by itself, playing a steering role by restructuring arrangements between actors – arrangements, which are able to reduce problems of overuse or misuse of common-pool resources, set parameters for environmental protection most efficiently and payments for ecosystem services. Emphasizing the mechanism of displacement is not to deny the importance of any of these processes. In fact, displacement is not a stand-by itself mechanism. Both agent-based and institutional-based processes are playing a key-role in realising any regime change. In the case-study discussed here, an emergence over-time of new issue networks (such as an environmental network, see section 4.4) or the new informal institutionalisation of neo-liberal social identity and water marketization (same section), indeed have prepared the ground for desalination and the water regime transition. Yet, by revealing hidden costs (environmental, economic) and frictions (managerial, political and geopolitical), displacement underpins a regime change when other explanations cannot be used exclusively to understand the process at work.

Policy and technology have often co-evolved, as argued by transition scholars. A closer look at the case of desalination in Israel, however, has shown that policy was very much passive and was not recruited to promote certain technological solution to the problem of water scarcity, pollution and mismanagement. Policy rather *reacted* inertly to the quite sudden appearance of the technology as (economically, technologically) feasible. The fact that this technology was known and available for many years (and practiced intensively in other countries) begs highlighting precisely its presumably "small" technological improvement. The empirical evidence supporting the answer to the first research question may now become clearer; *policymakers* could stop worrying about *policymaking*, because what was considered for many years unrealistic technological use, under long-lasting fiscal constraints, became feasible with the mere technological improvement. The point here is that the fiscal constraints are embedded with various important

challenges – such as energy sources and use, GHG emission, land use, marine pollution, escalating demands, increase in prices, political and geopolitical strategic manoeuvring and so forth. So only when the fiscal constraint of desalination was reduced, this thesis' analysis could have revealed their reappearance in other places.

ii. What is the role of discourses in policy dynamics of sociotechnical transitions?

Similar to the paradigm shift from a state of perceived scarcity of water resources to the perception of their limitless - the newly emerging discursive construction of abundance in Israel's energy regime has been dramatically shaping its sociotechnical transition in the last few years. Unlike the case of desalination and its promise of abundance, the discursive appearance of energy abundance does not settle political friction, but rather aggravates tensions around each technological alternative. The constellation of actors and policy networks in the energy regime plays an important role in our case-study. Each issue network promoted a different alternative energy pathway that is centred on a different technological configuration holding the promise to solve Israel's energy problems. The discursive shift from scarcity to abundance aggregated conflicts between energy values (e.g. general values of conservation vs. consumption; preservation of open-space vs. climate change mitigation in the case of solar; free-market ideology vs. social equity in the case of natural gas); it induced inner and inter-ministerial conflicts over the control and management of energy resources and; it changed the power balance of actors when, for example, the involvement of social or environmental organisations in the transition has become more institutionalised.

Since discursive institutionalism accepts the claim that any discourse is an "articulation of knowledge and power" (Escobar, 1996:326) and embodies explicit and implicit "narratives of authority" (Carver, 2002:52), it thus understands discourses as a form of structure setting informal rules for the

actors at the polity. It also relates a mere policy change to broader social change; policy change can be experienced through processes of shifting powers, ideologies or technologies in any given society (that is a community, a nation, or at international scale). Nevertheless, along the spectrum of agency-institutional explanation to policy changes, the position of discursive institutionalism is much less structural because once one assigns discourses with power, he or she necessarily brings vividly back agency to the front; actors who holds individual, multiple framing, meanings, and interests (Schmidt, 2010). In addition, as the analysis in chapter 5 has shown, different interests realign individual actors into policy networks that can be used to undermine and disrupt existing policy practices, and to generate and legitimize new approaches.

The focus of socio-technical transitions literature is on structural changes with predefined objectives. The contribution of the energy regime case-study is the linkage between Discursive Institutionalism with current conceptualisation of transitions, which may offer more fluid and agency-based ideas about discourses and therefore provide a contrast and complement. The subtle balance between agent-based, actor-centred and institutional approaches to policy dynamics was indeed at the focus of the analysis in chapter 5.

Discursive institutionalism contributes to transitions and TM studies in several ways (see also section 6.4.3.1). First, by bringing up to the front also the voices of actors who are neither energy experts, nor individuals directly involved in technical or economic decision-making (see for example Lawhon and Murphy, 2009, who criticized TM advocators for relating only to experts and high-profile actors). The discursive approach also reflected a bit of the general public's disposition; it pointed to the new institutionalisation of a public sphere, one which once formed, could be expected to increase its dominance and influence over the course of the transition.

Second, DI revealed the subtleness of power-relations and the existence of conflicting agendas, even within what presumably is a homogeneous policy network, like the environmental policy network. Finally, the empirical findings further demonstrate how a discursive institutionalist approach to policy change can highlight the potentially problematic aspects of socio-technical transitions: a socio-technical pathway may only be taken on the basis of its promise to provide unlimited supply regardless of its potential risks to social and environmental systems. For example, in the case of natural gas, it is not clear whether the export of natural gas would even contribute to long-term energy security or just fulfil short-term economic interests of business actors or multinational corporations (Shaffer, 2011). This is fortified by the resource curse literature, which highlights how difficult it is to successfully transform natural wealth into other forms of capital. The sustainability of the energy regime transition is therefore in jeopardy mainly because of the nature of these new "discursive commitments" to abundance.

7.4. Addressing research question iii: a synthesis

After discussing research questions i and ii separately, it is important to examine if and how did these answers achieve the goal of the study. By examining the role of desalination in water policy dynamics and discourses on energy policy, I have contributed theoretical insights regarding to the interplay of technology, policy and discourse, as three major constitutes of any sociotechnical system. I have aimed at explaining *how* technology affects policy dynamics, by combining different theoretical frameworks. It was offered that cases of displacement, allow technology to overcome policy path-dependency: after dislocating externalities, potential risks and costs to other regimes, the technology then becomes an optimal solution to the policy problem. Changes in discourses, resulting from technological advancements, were found to have a crucial effect on policy dynamics in a similar way. It was found that discursive constructions are strong enough to change policy

regimes even when technological configurations behind these discourse, are limited and constrained by multiple variables.

This analysis has prepared the way to examine the third question, which asks

iii. What does the interdependency of socio-technical regimes mean for their transition? How can coupled transitions be directed toward greater sustainability?

Looking across the two case-studies may have generated a new theoretical contribution regarding the dynamic of transitions. The cases may not comparable in all respects (different type and number of technologies at question, pace and nature of institutional change, water is consumed directly while the consumption of energy is mediated by the use of electricity for different purposes) but they do share similar characteristics (almost same state actors are involved, share similar policy goals, centralised management, etc.), as both clearly represent typical tendencies of large infrastructural systems in transition (from public utility-oriented toward 'liberalisation' and adoption of new innovative technological configurations). The water sector is in transition because the "basic premise of the water geography is altered" with fresh water coming from the sea rather the opposite way around (Feitelson and Rosenthal, 2012:272). Similarly, the energy sector is in transition because new sources promise independent and almost unlimited supply. A sectoral analysis of the water and energy policy regimes in chapters four and five revealed initially that the perception of abundance is a key to the understanding of these separate dynamics. Later it was found to be also significant in the co-evolution of the two regimes. Technologies in both cases served simultaneously as actants that steer policy and as a discourse that embeds individual interests and power-relations.

The main arguments in socio-technical transition research are drawn from co-evolution and SST theories (Grin et al., 2010). Co-evolution

conceptualisation of socio-technical systems is interested in radical technological changes more than in incremental improvements in existing technological systems and states of path-dependency. Accordingly, key-selection criteria (regulation, infrastructures or economic structure), selective pressures (resources scarcity, natural hazards, war) and feedback mechanisms, amalgamate to foster reciprocal abrupt changes in institutions and technologies (Kallis and Norgaard, 2010). A neo-institutionalist (sociological/organizational) approach, despite its relevance for socio-technical transitions analysis (because the sociological orientation of TM and because certain institutional arrangements could encourage transitions while others prevent them) is applied by Geels (2005), for example, mainly in terms of the conceptualisation of 'institution', but less in terms of change processes or agency. In general, neoinstitutionalism was criticised for its failure to address the process of change (Streeck and Thelen, 2005). Only a few researchers have met this two fold challenge. For example, Paavola (2010) has taken a new-institutional approach to the analysis of the co-evolution of institutions for water pollution control and sanitation technologies in the early 20th century's United State. In another study, Foxon (2010) has proposed that the significant roles of particular agents and their choices (particularly individual user choice, the development of business strategies, and the role of governments) should be incorporated in coevolutionary analysis of sociotechnical transitions in order to emphasis change rather than locks-in.

New-institutionalism in turn does not often lend toward making explicit normative assertions about technological/institutional change. When the neoinstitutional theory asks how social choices are constructed it usually does not go on to asking how they ought to be. This is in contrast to Transition Management, which is in its essence a perspective, normative model to guide transitions and that is based on the presumption that there has to be a way to control and direct dynamism in line with some sort of a an overarching socio-ecological interest, or the public's 'good'.

Therefore, a cross-sectoral analysis of the water and energy cases points to the usefulness of applying this integrative approach (new-institutional, co-evolutionary) to the study of cross-regime interactions. In order to accommodate the multiple forces in coupled transitions a four-fold theoretical framework was offered. Change - whether it is of discourses, technological artifacts, policy or institutions at the regime level within a socio-technical system – is always depended. Even if we would widen our analysis to encompass multi-level (niche, regime, landscape) perspectives on change, it is not possible to assume or treat it as an absolute, independent system. The question therefore concentrates on the implications of these, in our case - the geographical, physical, institutional, and economic interdependencies, for the process of change or continuation. At the bottom line, the empirical results of this thesis suggest that the coupling of the water and energy transitions allows the continuation of malpractices such as avoidance of problems (in quality and quantity of the resources) and reinforces traditional growth paradigms. This might be why several interviewees expressed a similar concern, as represented in the following quotation:

> Although structural, economic, social and political changes take place, still things continue as...no resources allocation...I mean, there are things that theoretically change but in practice there is some kind of continuation and you can see that the policy...the policy, even if it changes, its essence doesn't really change. (Interview, Water Company)

What are the sources and implication of coupled transitions? And is there something that the literature about cross-sectoral policy integration can contribute? Despite scientific acknowledgment of complexity and systematic linkages between environmental issues, Lafferty and Hovden (2003), as other EPI or inner-sectoral integration promoters, have rarely dealt with the question of horizontal integration that can account for the increasing collision between different environmental-related decisions across sectors. Exceptionally, integration between air pollution and land use in transportation planning is by now fairly acknowledged (e.g. Givoni and Banister, 2010). Instead, research has been focused mainly on the design of

tools to assess environmental regulation and performance in specific environmental sectors (Weale, 1992 in Toke, 2001). Yet, inherent trade-offs are exposed when a solution to one problem creates or fosters new or secondary problems, for example with the unforeseen implication of a technological developments. To date, also policy design and implementation occurs within specific departments. It fails, however to reflect the dynamic and interlinked nature of environmental subsystems, such as water, soil and air. The need for greater cross-secotral mechanisms, therefore, arises from the proliferation of dependencies and environmental trade-offs. An alternative approach should be able to ensure the flow of information, that decisions become transparent to the relevant policymakers and other stakeholders, and should reveal the processes behind the displacement of environmental problems from one media, time or place to another.

According to Stead (2010), the particular goals of inter-sectoral integration are: insuring better consistency between policies in different sectors and at different levels of governance; preventing duplication; providing conditions to achieve government's overall goals by reducing narrow, sectoral interests; promoting policy innovation and implementation and; encouraging a comprehensive understanding of the effects of policies on other sectors. As aforementioned, inter-sectoral integration is expected to involve the exchange of information and possibilities of interventions between different sectors; it necessitates the definition of the leading and participating authorities and their responsibilities; it calls for the definition of a governmental organisation to ensure integration and; it might require organisational restructuring, including manpower and budgets. The institutional base for inter-sectoral policymaking is therefore crucial and the lack of inter-sectoral integration is characterised by disconnect between levels of government and scattered responsibilities (Givoni and Banister, 2010). As noted in the beginning of chapter 2, departmentalism and sectoral rivalry, however, can be a major barrier, as is the case in the EU: "Battles for policy 'turf' are frequent and fierce, as are attempts to build high firewalls around policies in a given sector

so that they cannot be altered or undone by actors from other sectors" (Peterson, 2004:1)

In our case, inter-sectoral analysis reveals institutional fragmentation. Although in Israel water and energy issues are jointed together under the managerial authority of one ministry, no mechanism currently exists for co-operation, policy integration or cross-cutting policymaking between these two sectors:

> Water is an inter-disciplinary issue...but multi-dimensional planning is very rare in the Israeli system. Very weak. And it has several reasons. First, there are no professional administrators that can see the entire picture. Second, the political structure of the Israeli system of governance, which runs in a latifundia-manner, prevents any cross-sectoral planning. Each minister, except of the minister of finance, has an exclusive control over his office, sometime the prime minister may say a word. The unofficial collation agreement is 'don't interfere in mine, I won't interfere in yours'. Therefore, a cross-departmental cooperation is politically very hard to achieve. Third, there is no 'planning headquarter', except of the ministry of finance, but his perspective is limited to economic considerations (Prof. Zaslavsky, former water Commissioner, Minutes Investigation Committee, 2009).

Another example was given by my interviewee in the planning department of the Water Authority, who stated that:

> In the planning process we do not discuss energy problems and do not look for solution for the energy problem of Israel or energy consumption by the water sector, because the technical details are managed between the Water Authority and its utility company (*Mekorot*) and not the Israeli Electricity Corporation (Interview, Israel's Water Authority).

Stakeholders do not share consent as to what or who has the facilitating capacities to compete with the water-energy interface. Interviewees did not hide the fact that unofficial tunnels of communication between the IEC and the IWA, for example, are absent, and interactions between the networks range between non-existence and maybe even a traditional rivalry[35]. Most of the interviewees expressed loyalty to their own institutional affiliation when

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[35] Molle *et al.* (2009) discuss historical rivalries between "pure" hydrological actors and actors within the electric network in Mexico, especially around hydroelectric projects.

asked who is integrating water-energy considerations: the planning institutions i.e. Ministry of Interior (interview ME), the Ministry of Finance (interview MH), governmental decisions (interview RA), a joint ministerial committee for climate change (interviews YCF, NG) or the Ministry of Water and Energy (interviews AK, SV). The Water Authority, which has been working on a long-term plan for the water sector during the time frame of this study, considered energy issues in the plan (interviews AP, AG, AT, MZ), however, it took place *ex-ante* to decisions to increase desalination significantly. *Institutional ambiguity* (after Hajer and Versteeg, 2005), and unbridgeable gaps between actors that make strategic decisions and the executive institutions of these decisions[36], have therefore been impediment to lessen the impacts of the water-energy nexus, because there is no mechanism in place that promotes strategic, comprehensive consideration of the implications of this interplay.

Notwithstanding, the situation may not be much different in other places around the world. Indeed, developments in the water-energy interface would line-up with the goals of sustainability in no simple way. Policy integration still has to overcome not only the complex political, economic and environmental interdependencies which displace problems, costs and risks from one media and place to others but also its own inherent challenges.

Certainly, one of the most highlighted challenges of improving integration is the costs that are associated with more money, time or human resources spent in the policy arena. Transection costs exist when two or more parties make an exchange and sectoral bargaining, while different institutional structures imply different kinds of costs (Challen, 2000). The more parties involved the more complex the process become and the costs can be expected to be higher.

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[36] For example, there is no legal requirement to consult the IEC before initiating, planning, approving or constructing major industrial consumers of electricity, desalination plants included (GG, Attorney, IEC, personal communication, 2010).

Within the massive literature on governance, researchers distinguish three types of organizing mechanisms to reduce transaction costs – policy integration's most highlighted challenge - in the effort for greater coordination: competition; hierarchy; and communication (Jessop, 2000). I would like to note briefly that research on integration in practice counters the effectiveness of either. First, coordination that is based on *competition* assumes that exchange-based markets embed the idea of the invisible hand that stirs and guides individuals by means of attributing specific prices to the objects of transactions. Integration, however, has to make up for cases of market failure and the reality, according to research, is that markets are far from delivering optimal arrangements, especially in terms of information transparency and accounting for externalities (Givoni and Banister, 2010). The second mechanism for coordination is based on *hierarchy* and is generated by centrally organised decision-making processes and management structures, wherein all actors and institutions are equally constrained by the same rules and subjected to the same sanctions in case of noncompliance. A research undertaken by Feitelson and Gamlieli (2010) has shown that this does not always prove itself right. They expected that a centralised decision-making process in the planning and implementation stages of transportation policy in a new Israeli city (Modi'in) would decrease transaction costs of integration. They found that beside the Ministry of Housing responsible for the entire plan, no other agencies were integrated into the policymaking process. This resulted in a poor physical integration of the transportation system in the city. The third mechanism is based instead on the self-organisation of actors, and facilitated by *communication*. This arena provides a platform to solve common problems such as transaction costs through networks. Networks - conceptualised as the informal relationships between social agents or agencies based on common interests – can, for example, facilitate trust and information sharing. Again, according to studies, the reality is often that organisational separation leads to lack of interest or motivation to share information and to disseminate it (Givoni and Banister, 2010).

To conclude, the literature is quite short in providing any equivocal, simple answer as to how to overcome interdependencies along the chain, from policy-setting through policy implementation up to system operation. It does, however, share a common belief that policy integration has to be a means rather than the goal. The various studies imply that in order to overcome the governance barrier to integration, there might be a need to create a new level of institutions for joint interaction of policy networks specialised in integration. In new "modes of governance", hierarchies might need restructuring. For inter-sectoral integration to take place, a way to bring sectoral considerations into all other sectors that generate demand for its good or service - will have to be found. This calls attention back to Young's discussion (2002) on *polycentricity*, which affords opportunities for units of government to work together toward a particular end, while the individual units involved still maintain their own identities, rights, and authorities (Elazar, 1987 in Young, 2002:112). Young (2002) sees these institutional linkages as being exhibited through interactions and "functional interdependencies" between organizational actors at different scales, focusing on common substantive problems. As I stressed earlier, it is therefore interesting to examine the merits of the Transition Management model - a new form of decision-making - in coping with interdependencies, as a mean to achieve greater sustainability in managing the interplay of water-energy socio-technical systems (see section 6.4.3). I will discuss some of its merits below.

While TM builds on traditional participatory policymaking paradigms (Shove and Walker, 2007), it nonetheless allows competition, mutual adaptation and influence of actors' interests, rather than full binding coordination. A consensus requiring high integrative capacities is expected for only two elements in the process: problem definition and strategic goal articulation (Loorbach, 2007). Thus, in its four conceptual stages (see section 2.1.3.5), TM attractively employs the mechanisms best known for coordination (see above): competition coordinates economic decisions based on selective, market-induced innovations, which is restricted by protected niches;

coordination is further achieved by a centralised set of overall goals and hierarchal facilitating bodies; and communication achieved by the imposition of structure by informal institutions and networks within the transitional arenas. More pragmatically, I proposed a slight adjustment of the TM model (see Figure 17). Each conceptual stage of the TM process can therefore be supplemented by concrete measures that strengthen its integrative role:

TM conceptual stages	Integrated Transitions Management (ITM) objectives	Examples of ITM concrete measures
Transition arenas	Formulating the possible arenas, forums and actors for integrated environmental decision-making	⇨ short term and long-term integrated policies to achieve greater sustainability ⇨ shared goals formulation ⇨ power-relations and interests recognition (who wins? who loses?)
Transition agenda and paths	Identifying the social and institutional barriers and drivers for the realisation of integrated environmental decision-making	⇨ wide stakeholders participation ⇨ cross-sectoral spills-over and trade-offs identification ⇨ difficulties and barriers identification (for example: "crisis" management, geopolitical context, existing unsustainable policies)
Transition technologies	Spotting optimal technological as well as behavioural changes as solutions when integration is pursued	⇨ Technologies that better correlate with 'integration' (alternative technologies, co-generation technologies) ⇨ Mechanism for innovation
Institutional transition	Considering the potential role of Transition Management framework in facilitating further integration and system innovation	⇨ facilitators/managers of TM also act as integrators ⇨ Institutional setting (forums, actors, responsibilities and authorities) evaluation ⇨ government's role monitoring and learning process

Table 8: The links between concepts of TM, objectives of integrative TM and examples of concrete measures.

Rarely integration is being seriously addressed by practitioners. The reasons for that may be partly attributed to the lack of consistent definition or measures. Most profoundly, it is often argued that there is a need to avoid a message of 'integrating everything into everything' (Scrase and Sheate, 2002). Not surprisingly, attempts to increase policy integration encounter greater difficulty in current national and international governance structures, as will be further elaborated.

Following recent developments in the understanding of decision and policy making and particularly in relation to the management of resources and

nature, national central governments are no longer seen as the sole player in processes of policymaking or governing in general. Especially not when the severity of socio-ecological problems, such as biodiversity and climate change, is worsening and their scale grows, to a large extent due to globalization (Lemos and Agrawal, 2006; Young et al., 2006). The growing recognition of the role of non-governmental actors in the ruling and policymaking processes (Paavola, 2007) has drawn attention to the "governance", which further includes regional and local governments, scientific institutions, enterprises and civil actors, as well as international arrangements and trading systems (Young, 2002).

Decentralization of state power, traditional hierarchies, and "the reallocation of authority upward, downward, and sideways" (Hooghe and Marks, 2003:1) have led to further academic recognition in the need for multi-level governance, or cross-scale analysis in multiple disciplines (Young, 2002; Paavola, 2007). The challenge of governing - that is the craft, implementation and enforcement of policy, in an increasingly complex world and within multiplicity of actors, levels and modes - is indeed a key-interest in governance analysis (Stoker, 1998). Furthermore, it consequently entails high transaction costs, a key challenge to integration.

An example for the problematic price of integration can be found in Fischhendler and Heikkila (2010), which asserted that IWRM prevented institutional change and reduces adaptation capacities of the Israeli water regime. According to their research, the serious efforts to implement physical, organizational and innter-sectoral integration have led to institutional lock-in and stagnation. Additionally, Coffey and Major (2005) have noted that diversity, rather than homogeneity, promotes policy learning and therefore integration should be desirable only when it is clearly proved to support sustainability goals. Lastly, Scrase and Sheate (2002:288) reminded that "it is essential not to view integration unreflectively as a panacea or shortcut to sustainable development".

The integrated transition management approach was offered as an alternative to current routines of decision-making that can benefit from greater integration. According to Underdal (1980) to 'integrate' means

> ...to unify, to put parts together into a whole. Integrated policy, then, means a policy where the constituent elements are brought together and made subjects to a single, unifying conception (Underdal, 1980:195).

Here lies an important difference between ITM and policy integration. ITM is not aiming toward a unified, single policy. It is rather a process of collaboration with the aim of dealing with interdependencies. There is a good rationalisation of ITM in Heritier's (2002) statement that:

> No single actor, public or private, has sufficient potential for action and/or sufficient power to solve problems of interdependence on her own, nor has she all the knowledge and information required to solve complex, dynamic, and diversified problems (Heritier, 2002:185).

And therefore,

> Under conditions of problem interdependence across boundaries, collective action to provide common goods has to take place vertically across multiple levels of government and horizontally across multiple arenas involving public and private corporate actors (Heritier, 2002:185).

It can be expected that cross-sectoral integration, once TM is in place, would require only little effort and cost, compared with attempts to introduce integration in traditional decision-making arenas. Interdependencies of socio-technical regimes would thus be remediated through a more integrative management.

An additional difference between regular policy integration and ITM lies in the levels and scales at which integration is being pursued, as well as the types of indicators measuring it. Integration of policy, first, remains at the level of policy crafting and implementation. It could take place horizontally, between different governmental sectors, in which wide or narrow communication with other sectors and the ability to explicitly address trades-off and spills-over between sectors, are the major indicators of its effectiveness. Policy integration can be vertical, to include cooperation with

state actors at different levels, inner and inter-ministerial/inner and inter-department committees, and in which the history of cooperation and the levels of openness and trust are important determinants. Third type of policy integration would include stakeholders outside the polity, and the participation of actors external to civil service bureaucracy: interests groups, political parties, non-governmental organisations, local communities, industry, business companies and more. The stage of inclusion in the decision-making process and its statutory status are crucial to assess its integrative capacities. As TM offers an alternative to current policymaking, ITM is different from policy integration. First, because it goes much beyond the policy arena; trade-offs and cases of "problem displacement" by technology can be overseen already at the technological niche level, where its coherence is fostered by either governmental policy or entrepreneurs outside the government. Second, while policy integration is often seen as a tool for improving current policymaking, TM should not be seen as just a tool for system improvements (Nill and Kemp, 2009). Therefore, ITM is not only a mechanism for the greening of existing trajectories, but rather should be used to create new trajectories, ones which account also for interdependencies. Its quality refers to performance indicators. Even though sustainability is not easy to measure, the results of integration can be evaluated at each stage of the transition management cycle (arenas, agendas, experiments and monitoring). Coupled transitions could have negative implications for sustainability, but alternatively it could also mean that two problems can be addressed simultaneously.

I have already mentioned that similar to the transition management model, the ITM model should be treated with caution, and especially with respect to its "dark sides" such as the masking power-relations (see section 6.4.3.1). I have also discussed the problematic aspects of integration between policy agencies in general (this section, above). There is, however, another danger in the idea of dealing with coupled transitions through integrated transition management; institutionalising practices of integrative management of specific sectors that are lacking a strong reflexive process to come along with

them may result in the creation of a new locked-in, coupled regime. ITM of the energy and water sectors, for example, could create a situation were other interfaces are neglected, such as the water-agriculture of energy-agriculture nexuses. New co-evolutionary process can be not only an explanatory mechanism behind coupled regime, but theoretically also a side-effect of the institutional efforts to deal with coupled transitions. I sum up the main insights from this discussion in the following chapter.

8. Concluding remarks & reflections

> *"The gap between academic literature and the experience of participants in government is nowhere wider than at this point" (Allison, 1969:708)*

This chapter aims at making a few concluding comments (8.1). Next, section 8.2 presents policy recommendations, pin pointing specific policy and regulatory tools. Section 8.3 reflects on a few theoretical and empirical limitations of the research and 8.4 directs to further research needed in order to advance better theoretical understanding and practical implications of co-evolving sociotechnical regimes.

8.1. Concluding remarks

One result of the complexity facing analytical decision-making (Dryzek, 1987), is that the problem in question and the range of possible solutions, can rarely be analysed holistically. This means that a policy regime, often spans its own "sectoral" boundaries and encounters horizontal and vertical interdependencies (Pierson, 1993; Rayner et al., 2001; Jochim and May, 2010). The findings in this thesis support the view that displacements engendered by technical solutions, should be made more visible so as to avoid a transition from one inferior socio-technical regime to another, and to encourage that new regimes are built on genuinely sustainable solutions to problems.

The kinds of displacements I have described in chapters 4, 5 and 6, which mask the physical and social side-effects of technology and related policy changes, do enable policymakers to overcome tensions that have interlocked decision-making processes. Displacement therefore might not be the problem

per se but rather an indicator of the unresolved edges of public policies, especially but not only, of environmental ones. Indeed, the isolation of sectors in policy-making arenas should be questioned, especially when borders between policy levels and policy areas are transcended by inter-sectoral challenges. As part of the aim of this thesis and based on these evidences, chapter 6 explored inter-sectoral dynamics, some of which are the result of problem displacement from the water sector to the energy sector and vice versa.

The extensive literatures on policy dynamics exemplify altogether why integration is nevertheless so hard to achieve in contemporary governing structures: while integration may require central steering authority, current governance is decentralised and diffused, composed of multiple policy networks or coalitions, with different targets and interests. Governance theories present a crucial question as to the continuing capacity of central government to steer or control policy developments. Wilkinson (2007) even proposed that it might be necessary to consider a return back to a more hierarchical, top-down approach in the European Commission in order to advance environmental policy integration at the EU level.

In opposition to sociotechnical transition literature, which emphasises transformations, the analysis of entrenched technologies, such as large-scale water or energy infrastructure systems, often provides an explanation for the stability or stagnation of institutions and policy regimes, rather than for their change (c.f. Kay, 2005). The observations of path-dependencies of either technologies or institutions therefore underpin the normative view according to which sociotechnical transitions could and should be managed in order to prevent and overcome undesirable lock-ins (Meadowcroft, 2009). The question of how to better manage transition is dealt with by transition management studies. The transition management model offers an intriguing platform to avoid technological fixation and locks-in and to direct policy dynamics and transitions toward better socio-environmental outcome.

Technological fixation and lock-in analysis can contribute to an explanation of the way a certain technology or a scientific approach has evolved as the most favourable option while excluding alternatives from any decision-making process. Coupled transitions, on the other hand, imply that technological fixation in one sector can, to a large extent, be understood in light of development in an adjacent sector. Transition Management therefore offers important insights into the ways to increase integrative capacities of governments. Since the model is still lacking a reference to cross-cutting decision-making when it comes to off-setting different environmental requirements, in chapters 6 and 7 I relied on previous experience in order to suggest a slight adjustment of the model which might increase the potential to deal with inter-sectoral interdependencies.

Additionally, as already has been stated by transition management advocates, central governments have a significant role also in guiding transitions, steering their stakeholders and managing budgets. Governmental leadership in the water-energy nexus is even more needed in the Israeli case, with its, literally, very little room for mistakes. However, ambiguity was referred back to the integrated institutions where the necessary adjustments were expected to be made by informal communication. As discussed throughout the thesis, the mere idea of integrating traditionally separate policy sectors and creating arenas for dialogue and problem solving has its merits. Nevertheless, its challenging implementation also brings to the fore questions about the status, accountability and legitimacy of decisions made. A change from hierarchical orientation to a more coordinating "governance" oriented forms of steering, raise questions about whose capacities to influence are strengthened and whose are weakened.

Finally, since practice of TM is undertaken mainly in the Netherlands and most research does not usually go beyond west European countries, some of the ideas related to it are considered here and elsewhere at a very much theoretical level. Factors such as geopolitical tensions, repeated crises, and lack or weak participatory tradition in decision-making might be only a few

examples of hindrances to a wider use of the model. Hence, the transition model would need to be enhanced by analytical concepts from other policy approaches that explicitly incorporate power and political dynamics factors, instability of regimes and loose governance networks.

8.2. Implications for policy

The policy implications which can be drawn from this thesis are significant, exposing not only factors influencing specific decisions to promote a particular socio-technical pathway, but also providing critical insight into the processes likely to shape, more generally, natural resource management policies, especially those entangled with large infrastructures systems. What can be taken from this research with respect to policy is the call for greater horizontal and vertical policy cohesion. Indeed, the predominant appearances of governance dissonance at the water-energy interface have been an underlying hypothesis that motivated this study in the first place, and which was reinforced by the findings (mostly evident in chapter 6). Chapter 4 also identified lack of policy integration in terms of coherence and comprehensiveness, which has been resulting in problems, costs, and tensions displacement.

There seems to be a few central challenges to greater integration in the context of the water-energy interface. First and foremost, there is a need to integrate supply-demand considerations into the decision-making at different levels concerning the production and delivery of the two resources. Second, a wide but precise definition of integration is required to ensure policy alignment with sustainability goals. Water and energy transitions cannot be managed with the preposition that endless demand has to be met. Second, the juxtaposition of water and energy sectors should find an expression also at the institutional level by mechanism of integration between the managerial bodies of the two resources.

A number of key policy recommendations emanate from the analysis, which address the issue of displacement and policy integration and suggest an alternative agenda of action for governance institutions. The policy process, however, may require more than a superficial redirection to avoid an endless cycle of environmental problems displacement because political reality impinging on resource decision-making has developed in purely sectoral structure.

The first key-implication is the need to implement in Israel's bureaucracy some sort of assessment such as Regulatory Impact Assessment (RIA) or Strategic Environmental Assessment (SEA). Attempts in different countries to promote horizontal, vertical and environmental policy integrations are sometimes accompanied by Regulatory Impact Assessment (RIA). In Sweden, for example, based on a "joint drafting rule", any decision must be followed by such a report (Nilsson and Eckerberg, 2007). A central purpose of it is to facilitate and contemplate on the process of integration of socio-environmental consideration into sectoral policymaking. Even with its known limitations and weaknesses[37], the RIA was found to be an experienced-with tool or mechanism currently available to pre-coordinate post-policy outcomes. The need for such tools has also been articulated by an OECD report:

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[37] The assumption that RIA can promote sustainability of sectoral policies is being challenged. Studies in different national contexts have shown that insufficient training, time and resources, as well as political priorities and sectoral interests might, in fact, hamper attempts to increase levels of integration (Nilsson and Eckerberg, 2007). Additionally, it is already evident from RIA's practitioners that not all types of integration can be simultaneously achieved nor that one type that exists can necessarily generalize to others (see Watson *et al.*, 2008; and also my conclusions in chapter 6). The inference is that ultimately, while the RIA is prescriptively important, the procedure by itself has little impact on the level of integration and sustainability of policymaking in central governments and a questionable influence on existing political structures and processes (Russel and Turnpenny, 2009).

> A key challenge for regulators is **integration** of multiple policies that affect each other. As the world becomes more complex, regulators should be aware not only of their own objectives narrowly defined... Experience suggests that policy trade-offs can be better managed through a more thorough understanding of policy links and careful design of interactive regulatory policies... (OECD 1997:46)

This is not to say that every policy that is being crafted should be accompanied by a RIA because this would easily lead to waste of human and financial resources. Rather, RIA should be applied in long-term policies which are recognized as "path taking", that is, policies which include the choice of long-term interventional measures and involve large scale configurations (technologies or infrastructure). Furthermore, a careful design of a RIA would allow the process to be effective and little time-consuming. Even the implementation of emergency policy, which is how desalination policy was first described by policymakers, can start concurrently with identification of possible cases of friction or displacements. Similar to the role of Environmental Impact Assessment (EIA), such an RI assessment would not necessarily change or revoke the chosen policy, but it will force decision-makers to stop and rethink over the multiple consequences this policy might cause along each of the stages of its cycle. It is therefore a procedural tool, which could guarantee that certain considerations are not ignored: that trades-off between sectors are explicitly addressed in early stages; that channels of communication with stakeholders or actors within and between each relevant sector are kept open; and that external input is considered during decision-making from relevant authorities, scientist, the public and other specific stakeholders.

Second, further institutional changes are required. Maybe unexpectedly, better integration could be achieved also by a guided (physical) decentralisation of production. Smaller physical and geographical 'units' of production and consumption may encourage greater integration of planning, funding, and regulations across the currently segmented fields of management. Decentralized water technologies and designs include for example water-efficient appliances, rooftop rain gardens, and onsite

wastewater treatment and reuse. Decentralized energy system means that energy conversion units are situated close to energy consumers, and large units are substituted by smaller ones. It is mostly based on renewable energy sources and operates at lower kWh scales both in the presence and absence of grid (Kaundinya et al., 2009). While measures as such could have positive impacts, this is by no means an exclusive conclusion that the deployment of distributed generation is always the best option in terms of external costs and sustainability. First because some advantages of distributed system (such as gas-fired plants' lower GHG emission), are counterbalanced by, for example, higher discharged of other pollutants and second, because decentralised units of production may impose difficulties for the enforcement of environmental regulations (Interview, RA, in which he referred to small-scale portable desalination plants and the Ministry's worry about the difficulty to monitor their environmental impact).

Third, unlike integrative transport system wherein integration is seen as promoting a better travel experience for consumers, increased integration in the water-energy interface would not have automatically a positive benefit for end-users. Therefore, the political motivation to make any changes, whether institutional or infrastructural, is less straightforward and incentives are probably reduced to either economic efficiency or political capital that can be a gain of the institutional and physical systems, and less of the general public.

Fourth, it is clear that cross-sectoral niches would require a special restructuring, linking R&D companies with a different speciality subject and defining a new juxtaposition of the two areas of interests (water and energy technologies) for research grants, definition of research fields, training, room for experimentation, market introduction, complimentary technologies and infrastructures, incentives, regulation, national fiscal policies and so forth. New technologies would have to be evaluated according to their ability to mitigate this nexus and their alignment with wider sustainability goals.

Finally, the water-energy interface is essentially no different from interdependency of other regimes. The quest for integration might result in the need to ask hard questions also about other coupled regimes and adjacent sectors most naturally the agriculture, land-use and climate regimes. Framing of issues surrounding sustainable resources management is divided to efficiency versus conservation and therefore these two different approaches may guide this complexity. The first one assumes that the purpose of policy is to improve efficiency of use of natural resources (both physical and economic, in light of the assumption that making more from less is economically desirable). This is considered by the classical market-based approach as the best way (competition) to achieve cross-regime coordination. The second approach considers whether the concern of policy should be how much the overall amount of use and misuse can be decreased. Accordingly, cross-regimes interaction cannot be disconnected from (a) continuous efforts to incorporate sustainability concerns into decision-making processes and (b) to keep moving away from traditional supply management toward demand-side management practices.

8.3. Final reflections and research limitations

In this section I allow a space for reflection on the research questions and the choice of methodology: how adequate it was for answering the questions and how useful it was for analyzing the events at focus? My very initial curiosity was regarding the reasons and causes that led Israeli policymakers to adopt desalination technology at a large scale in response to their growing recognition of a "water crisis" and the decision-making processes within the polity that have allowed this choice to be materialized. I was also interested in the socio-environmental implications of this decision on a future transition toward sustainability of the Israel water system. After identifying the energy costs of desalination as a focal issue, I turned to the energy sector to find out that this sector as well faces significant socio-technological developments. It was in fact the coupling of the water and energy regimes that brought to the

surface the discursive constructions of abundance in both sectors and the transformative, causal powers of technology over policy. I therefore worked backwards to formulate the two first research questions on the relation between technologies and policy change, and the interplay between technologies and discourses. Looking back at the research questions, I found them to be very broad and explorative in nature. The results are respectively general and interpretative. It is possible that with more precise research questions and clearly defined aspects of the phenomenon under study, a more in-depth analysis could have been reached. However, in the absence of these initial general insights, it would have been difficult to identify these aspects and thus formulate the right questions a priori.

As one may expect, my empirical investigation of policy formulation often indicated its non-linar evolution and complexity. The interpretive policy analysis methodology used here allowed to take a next step to identify the actors' multiple understandings of the policy problems and their bias for different kinds of action; to examine how these understandings are created, promoted, manipulated and repressed as parts of political strategies and interactions; to discuss the values, beliefs, and feelings that were expressed by the stakeholders in the particular cases under study and; to pinpoint potential implications of these multiple interpretations. The interpretive approach of this thesis helped, for example, to reveal the role of discursive shifts in socio-technical transition processes. An important finding highlighted how discursive constructions, which actors use to promote their ideas and interests, can play an important role in socio-technical transitions, such as those of energy regimes. In the case of Israel's energy regime, the discourse of energy abundance can risk a transition toward greater sustainability by restricting possible pathways and masking alternative ways to achieve energy security.

The time frame of this study was unique in the sense that in a relatively short period of time both water and energy sociotechnical systems in Israel experienced dramatic events and shifts. Policy acted and reacted accordingly.

Desalination targets constantly rose and dropped by governmental decisions while posing continuous uncertainty on the water sector. At the time of writing these words, the Egyptian national gas company (EGAS) cancelled its agreement with the Israeli-Egyptian business natural gas company (EMG) and the energy sector is now experiencing difficulty to meet expected demands, especially in the coming summer months. These are only two examples of major developments that communicate with discourses and paradigms and affect transitional processes in terms of pace and nature. In retrospect, one limitation of the analysis in this thesis is therefore the choice of studying a policy that is still being formulated and a transition that is still on-going, instead of performing a post- implementation analysis as is being undertaken in most transitions studies. Nevertheless, the IPA provided the suitable framework exactly for such dynamics. As Wagenaar (2011:429) put it, the very essence of IPA is to characterise action in a "world of uncertainty that originates in complexity, irrepressible ambiguity and contingency and the inevitable conflict and incompatibility that spring forth from pluralistic practices and institutional positions".

Policy outcomes may be understood in various ways and studied at different levels. This study did not primarily aim at a conclusive assessment or evaluation of the outcomes in relation to specific policy objectives. Neither does it claim to disclose the particular causes of the observed outcomes. The goal was rather to offer an explanation for what the policy "means" in the eyes of different actors and essentially of the researcher. The choice of methods made possible the inclusion of actors' interpretations located at different administrational levels and in different organisational contexts. Although the amount of interviews undertaken was not big, these have made possible the analysis of the interactions between this broad variety of actors and helped to direct the focus of the analysis. A higher number of participants most likely would not have changed the overall picture of actors' interpretations although it could have allowed this study to get into variation and consistency among members of identified policy networks in greater detail. In turn, the analysis of documents and real-time public appearances

brought to the surface the actors' different capacities to influence the policy process. The large amount and wide range of documents also served as empirical information against which the interviews' discursive analysis could have been verified.

Finally, quantified data on the water-energy nexus, including a systematic examination of, for example, alternative measures to desalination (how much energy is invested in grey-water systems for example) is crucially absent from the analysis here. There was no comprehensive study on this subject that I could depend on as well. A quite predictable implication of this lacuna was revealed in the interviews. Actors, especially in the water sector had expressed a sense of support in desalination mainly based on their perception of its potential negative impacts, energy costs to be among the chief concerns. However, since quantitative data is limited and dispersed each actor produced his own numbers and used these to support his claims in favour or against this water sector's management policy. From my perspective as a researcher a lack of clear data also restricted the ability of this thesis to make direct policy recommendations for water and energy management regarding what practical measures can be considered more sustainable.

8.4. Future research

From the 1960s, environmental policy dealt with the side-effects of development and human activities and therefore has been producing end-of-pipe solutions to environmental pollution or degradation. The technocratic approach to environmental problems tended to overlook the underlying causes and consequently missed strategic options like pollution prevention (Weale, 1992 in Toke, 2001). Today's environmental research takes a very wide perspective on the effects of humans on nature that targets the sources of environmental problems. *Transition* is one way of conceptualising the human-nature interrelationship in the sense that it recognises a direct causal

link between socio-technical changes and environmental change. The *transition management* model is a framework that could serve as an alternative to traditional models of decision-making processes in the more complex and dynamic problems of our days, because it adds a strong normative directive. The relevant question here is therefore whether TM could form an alternative paradigm to dominant environmental decision-making frameworks for addressing cross-cutting sustainability challenges such as water and energy management.

Unfortunately, it was impossible to test this question empirically in the Israeli setting because the country may not be ready for transition management at all. Policy dynamics in the water and energy sectors are too chaotic, dominated by vested interests, inherited political stirring, and crises-based management. Nevertheless, the picture presented here may not be so different from water and energy policies in other countries, which have not diverted yet from the "statist developmental-ism" paradigm (Mercer et al., 2007) and therefore the potential of integrated transitions management (ITM) is a worthwhile agenda for further research.

Since much of this research had been focused at the level of the regime, additional research might look into particular technological niches which target the water energy nexus, and the way to support cross-sectoral experiments and innovation in, for example, water treatment technologies powered by renewable energy, co-generation of water and energy technologies, etc. Similarly, studies should also examine more in-depth the landscape conditions related to the nexus; among the most burning topics is the concept of technological transfer and the challenges facing poor countries in the process of adopting certain technological solution, such as desalination. Cases from Southern countries point, for example, on alternative ways to technologically deal with water scarcity, for example by the adoption of small, domestic desalination systems that can be more easily powered by renewables.

More theoretical work and practical trials are therefore needed to examine the capacity of greater integration in the transition management multi-level perspective model, its capability to promote sustainable resolution of long-term environmental challenges, and its applicability in different ecological, economical and geo-political contexts. Indeed, additional research outside the Netherlands might also reveal the degree to which the model could be applied in other polities. Policy integration and linking-up research is needed to reduce the risk that new technologies are adopted as a result of their ability to displace – rather than to solve – hard problems.

9. References

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Appendix 1: Integration in the literature

Levels of integration	Ideas & types of integration involved	Sectors, disciplines or frameworks	What for? Rational for integration	How? mechanisms & platforms	When? At which stage of policymaking	Where? Institutions involved	Examples from literature
Coupled socio-environmental systems (SES)	Conceptual integration – theorizing connections between the systems; Physical integration – between elements in the systems.	Earth sciences and social- sciences; System theory; Complexity theory; Co-evolution theory	Promote sustainability; account for interdependencies; Promote resilience and adaptability; Scientific inquiry	Acknowledge and conceptualize the interconnectedness of socio-environmental systems, and interactions between waters, soil, energy, air, biodiversity and the global human society	Usually not at the policy level. Pre-assumption of policymaking in relation to environmental issues	Mainly academia; Need to be acknowledged by policymakers	Young et al., 2006
Sustainable Development (SD)	Conceptual, procedural and horizontal, between the environmental, societal and economic considerations	All policy sectors. Building blocks of policymaking, decision-making and strategic or spatial planning	Growing inequalities and environmental degradation; Allowing development and economic growth to continue without compromising environmental and social integrity.	Wide range of policy tools: economic valuation of environmental systems, public participation, Environmental Impact Assessment (EIA); Preference for long-term interests	All stages of policymaking. From problem definition, through the design and implementation to evaluation and refinement of policies.	Government at all levels; Businesses and industries; Third sectors organisations; At local, regional, national and international levels	Hopwood et al., 2005
Environmental Policy Integration (EPI)	Integration of environmental concerns in non-environmental policies and plans	All non-environmental policy domains; directives	Promote principles of sustainability and preventing environmental side damages/externalities	EIA; Strategic Environmental Assessment (SEA); Regulatory Impact Assessment (RIA); HIA; Cost-Benefit Analysis	At all stages, especially at the stage of policy design	Sectorial ministries and governmental departments; EU institutions (i.e. Article 6: Amsterdam Treaty)	Lafferty and Hovden, 2003
Integration in planning and management	Substantive; Methodological; Procedural; Institutional; Policy; Stakeholders; integration between	Planning; Natural resource management; Deliberative planning; SD	Planning has major impact on human's living environment so making integration a key-principle in devising planning	Deliberate democracy; Alternatives assessment; SEA; Public participation;	At all stages	Relevant ministries; Planning authorities; Planning committees; Stakeholders; At local, regional	Eggengerger, 2000; Healey, 1999

	conflicting land-uses and related issues		and development approaches is crucial	Collaborative planning; Risk assessment; Multi-Criteria Analysis; GIS		and national levels	
Cross-sectoral integration/ ----- Linked-up policymaking/ ----- Joined-up policymaking	Horizontal; Vertical; Institutional; Stakeholders' integration; "Holistic government"	Organizational theories; Public policy; Environmental-assessment field; Sectors in all policy domains	It will be irrational and hard to implement a new policy that stands in conflict with other areas of interests; Promote effective and constructive cooperation, coordination and synergies between ministries, departments & policies	Inter-sectoral committees; Special coordination body (i.e. The Strategy Unit in the cabinet office, UK); Cost-Benefit Analysis; RIA	At different stages of policymaking: the sooner integration is thought of, the sooner trade-offs and future constraints can be detected	Governmental ministries; Authorities and managerial bodies; mainly national and regional levels	Scrase & Sheate, 2002
Integrated Natural Resource Management (INRM)	Technical; Policy; Stakeholders; Horizontal; Vertical;	Environment; Resource-management; Ecology; Planning; Land, forest, water sectors; Holistic systems approach; SD	Rationally balance the use and conversation of natural resources; Optimize the use of all resources for long term; Integrating community Involvement, technical knowledge, organizational structure, policy objectives	Joint decision-making of experts group; GIS as a databank; Adaptability and flexibility approaches	Mainly at the stage of physical planning	Government and, non-government management bodies; Industries; Communities; At all levels	Bellamy, 1999; Morisson, 2004;
Integrated chain management	Physical; logistic; Information flow	Materials and distribution management; Transportation; Industrial ecology; SD	Integrating operation, materials and logistics to improve efficiency and reduce environmental impacts; gain competitive advantage;	Life-cycle analysis; Risk and performance analysis; Materials flow analysis	Strategic levels	Industry; Firms; Companies; Supply chain actors; Relevant ministries (Trade, Industry, Environment)	Seuring, 2004
Examples by sectors	**Ideas & types of integration**	**Sectors, disciplines or frameworks**	**What for? Rational for integration**	**How? mechanisms & platforms**	**When? At which stage**	**Where? Institutions**	**Examples**

						involved	
Integrated Water Resource (IWRM)	Inner-sectorial but also inter-sectorial integration; Physical; Vertical Institutional; Administrative;	Resource management, Water (and related resources; River basin/ catchment management; SD	Increasing sustainability of water resources by integration of management, uses and treatment; balance between needs and availability of water	Multi -Stakeholder Platforms (MSP); Strategies and actions plans;	Requires institutional and legislative changes at policy level	National and regional water management authorities; River catchments authorities; Relevant ministries; local stakeholders	Biswas, 2004; Pahl-Wostl, 2007
Integrative Transport Policy	Physical; Technical; Institutional; Organizational; Vertical; Spatial;	Transportation; Land use; Environmental planning; Environmental assessment; SD	Traditional structure of government tends to limit information flows and impede coordinated action Need to integrate air quality & land use policies to promote SD	EIA; SEA; HIA; Ex-post evaluation; Statistics database; Spatial planning;	At all stages of policymaking, requires	EU committees Governmental ministries Planning committees Private planning companies and advisors; Users	Geerlings and Stead, 2003; Givoni and Banister, 2010
Integrative Waste Management	Physical; Vertical; Horizontal;	Resource management; Waste; SD	Pollution & deterioration of non-renewables and renewables (water, biodiversity etc); Reduce waste; Efficiency	Life-cycle analysis; End-of-pipe regulations	Strategic targets; Policy and implementation levels	Government; Ministry of Environment; Local government, Business; Public	McDougall and White, 2001

Appendix 2: Questions for interviews

Water, energy and climate:

- Within the water sector, in which forums where decisions in regard to energy issues are discussed and implemented? Which are the stakeholders?
- What tradeoffs can be expected in making decisions in regard to water scarcity and its alleviation?
- Where do you think issues of water and energy interact? Can you identify similar interplays between different resources or environmental sectors?
- What mechanisms to deal with those tradeoffs can you detail? Who is involved in related decisions? Can these be managed?
- When was the issue of desalination and related concerns first raised? What can you tell me about your involvement?
- Was the decision to race ahead with desalination involved thinking about energy costs? Implications of GHG emission? Other links to different environmental issues?
- What interests are involved in thinking over alternatives? Renewable energy/location sites? How these are justified?
- It is likely that carbon tax will be adopted in Israel as a mechanism to control GHG emission? And what about off-setting (example of Sydney desalination plant)

Technology and environment:

- How much do you believe in technological solutions to water scarcity problems? And to other environmental problems?
- What effects can we expect water-related technology will have on the social system in the future?
- What is being done today in order to minimize environmental impacts of desalination? Do you think these measures are enough?

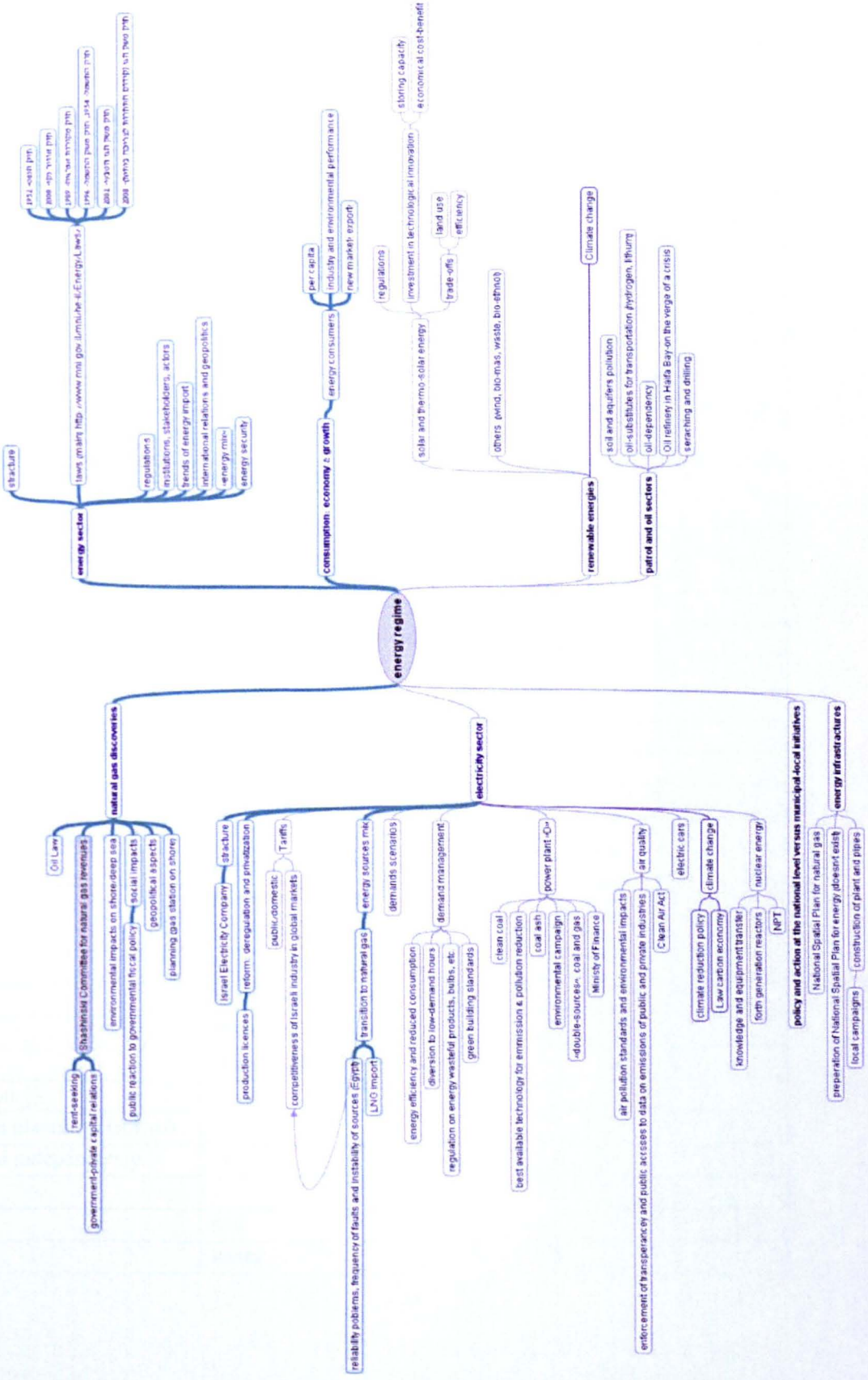
Integrated decision-making and planning:

- Where and when cross-cutting policies in relation to environmental issues are being made? Where do you think integrative considerations should be addressed (in governmental decisions/IWA decisions/planning committees/Ministry of Environment policy etc.)?
- Are there any difficulties in that? What do you feel are the barriers to cross-cutting policymaking?
- What institutional arrangements enable coordination and integration of the water and the energy sector (or specifically the IWA and the Israeli Electric Company)?
- How does the planning system affect decisions of water management and vice versa?
- What are the spatial implications of the still in planning TAMA 34/B/2 for desalination plants sites? What are the main issues discussed? Who these are addressed?

International and geopolitics:

- What is international/Mediterranean forum in which desalination and its environmental aspects (long-term impacts on the Mediterranean Sea) are discussed?
- Do Israel's desalination plants stand in international standards?
- In your opinion, how significant can be an external pressure on Israel in terms of its environmental performances?
- Is it being done differently in other places?

Appendix 3: Energy regime mind map



Appendix 4: Identified keywords and key-issues (a sample) in NVivo

Key-word/topic	sub-topic	Sources	References
agriculture	---	3	4
alternatives			
	importing water	1	3
	small or mobile desalination plant	3	4
	water sensitive planning	1	2
causes for delay			
	budget and budgeting	4	9
	information and data base	4	7
	professionalism (lack of)	1	1
	statutory	3	4
	waiting for approval	1	3
decision-making and impediments	---	7	14
	rapid personal turnover	4	5
desalination			
	and energy	7	8
	and related environmental issues	4	4
	polluted water desalination	1	1
	wastewater desalination	2	2
enforcement	---	1	1
excessive production	---	3	3
implementation (lack of)	---	6	9
Incentives			
	OECD	1	1
institutional structures		7	12
	Electricity Commission	1	1
	Mekorot Company	2	3
	Ministry of Environment	2	3
	Ministry of Finance	5	9
	Ministry of Infrastructures	1	2
	Hydrological Service	1	1
	Water Commission council	2	2
integration	---	4	7
long-term planning (lack of)	---	5	7
municipal independency	---	1	1
pollution		1	1
	soil	1	1
	water	2	2

power, authority and division			
	authority (lack of)	6	10
	division of power and authority	7	15
privatization	---	4	8
salty brine discharge	---	2	4
scientific controversy	---	3	4
sewage	---	2	2
social capital			
	public discourse	2	3
	transparency	4	6
technology	---	5	5
uncertainty (coping with)	---	2	2
vision	---	1	1
water and economy		1	1
	water prices	8	9
water and energy	---	3	4
water and geopolitics	---	2	4
water and politics	---	6	7
water crisis	---	6	8
water for nature	---	1	2
water law	---	1	1
water losses	---	1	1
water saving	---	4	5