GREENING THE GRID

The Ecological Modernisation of Network-bound Systems

Bas van Vliet

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Now that the thesis work is done, it is hard to date the start of it. It could be 1994, when I started a research project on the diffusion of water saving technologies in the Netherlands. At least it was the first time that I began to think about the environmental reform of a network-bound system. Besides, Gert Spaargaren was already involved in this project. I want to thank him and Tuur Mol for their continuing trust in this thesis work and their invaluable comments and support. I couldn't be in a better position than to have them both as promotors for this thesis, not the least because they may be considered the 'founding fathers' of ecological modernisation theory. I am also glad to be their first graduating PhD student, from a whole regiment to come.

Another start of this thesis work could be dated June 1997, when the European Commission acknowledged our proposal for a research project on utility services, domestic consumption and the environment. In a way, this was a spin-off of the study on water saving technologies, although it now included electricity and waste and, more importantly, the involvement of a group of researchers from Britain and Sweden. This thesis is very much indebted to the inspiring collaboration and exchange of ideas with Gert Spaargaren, Heather Chappells and Elizabeth Shove. Heather was a real companion in research and it is no coincidence that the term 'co-provision' was coined as a main theme in our collaborative papers. Besides Domus, as the project was called, I also worked together with them in a series of workshops and Summerschools on Consumption, Everyday Life and Sustainability. We presented collaborative papers on infrastructures of consumption and organised a number of bizarre everyday-life-and-sustainability exercises for academics. It was inspiring and great fun and I hope the collaboration with Heather, Elizabeth, Dale Southerton, Rolf Wüstenhagen and all others of this ESF network may continue in some way. I also thank Aad Correljé and David Goldblatt for reading and commenting on earlier versions of some chapters of this thesis.

I have been working at Wageningen University's environmental sociology / policy group since 1995 and have experienced several stages of re-organisation and development. The group survived and flourished due to its great enthusiasm in doing research and teaching students environmental sociology from all over the world. By now, the group has grown too big to name every-one: so thank you all! Yet, I still want to name a few apart from my promotors: my roommate Phong Thuy Phuong, for her company; Corry Rothuizen for all her help and her being there and Sander van den Burg, for his contribution to the inventory of environmental innovations. I very much appreciated that Joris Hogenboom was always on the same level when talking about and beyond our theses.

Thesis work is not only work: it is a way of living as well. I could share this with many friends but there is one special friend I wish to mention here. With Erik Heijmans I regularly run, eat, drink, discuss and laugh our ways through the world. And he also edited the main part of this thesis.

Talking about the start of this thesis work and everything besides that, I want to thank my parents: always supportive, always proud; and my brothers: I am pleased that Marc designed the cover of this book. Jeroen: your wonderful music supported many hours of my writing; and Gijs: thanks for always being anxious to know which chapter I was writing (and how many still to go).

As difficult it may be to date the start of this thesis work, the end of it couldn't be clearer. During the days before Christmas, I finalised the manuscript, just in time for the birth of our beautiful daughter Noor on Christmas day. Noor: thank you for waiting two weeks and Maaike: your strength is amazing. I'm so lucky you have accompanied me for so long already. I'm looking forward to share with you and Noor all the good things yet to come.

Utrecht, 12 February 2002

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List of Abbreviations

CHP	Combined Heat-Power
CTA	Constructive Technology Assessment
CoCoNut	Commissie Concentratie Nutsbedrijven
DSM	Demand Side Management
EC	European Commission
EdF	Electricité de France
EPA	Energie Prestatie Advies
EU	European Union
GAP	Global Action Plan for the Earth
GWA / GWL	Gemeente Waterleiding Amsterdam
ICT	Information and Communication Technology
IEM	Internal Energy Market
KIWA	Keuringsinstituut voor Waterleidingartikelen
KWh	Kilo Watt hour
LCA	Life Cycle Analysis
MAP	Milieu Actie Plan
MW	MegaWatt
NEPP	National Environmental Policy Plan
NGO	Non-Governmental Organisation
PNEM	Provinciale Noordbrabantsche Energiemaatschappij
PV	PhotoVoltaïc
R&D	Research & Development
REMU	Regionale Energiemaatschappij Utrecht
SEP	Samenwerkende Energie Producenten
SEV	Stichting Experimenten Volkshuisvesting
SGEP	Samenwerkende Groene Energie Producenten
TSO	Transmission System Operator
VAT	Value Aded Tax
VEWIN	Vereninging Waterleidingbedrijven in Nederland
WMO	Waterleiding Maatschappij Overijssel
WWF	World Wildlife Fund

1 Introduction

1.1 Utility Dynamics, Citizen-consumers and the Environment

Since July 2001, Dutch household consumers have the possibility to switch between electricity suppliers. For the time being this freedom of choice is restricted to the choice between *green* electricity providers only. Although many consumers do not realise it yet, this is an extraordinary development for two reasons. Firstly it means the prime introduction of consumer choice in electricity supply and secondly it indicates a remarkable shift in the policy making towards the introduction of renewable energy resources. Until July 2001 the organisation and volume of green provision and consumption of electricity had been laid down in regulations and policy covenants that were concluded between national regulators and the state-owned electricity sector. From now on, investments in renewable energy production will increasingly depend on consumer demand for green energy. July 2001 is therefore not only a marker for a shift towards more consumer choice in electricity provision, it also signifies a shift in environmental policy making towards electricity provision and consumption.

Green electricity has been marketed since the mid-1990s as a variety of the - until July 2001 - uniform electricity provision. In the mid-1990s a number of Water Companies started to construct a second piped water system, next to normal drinking water systems as to abolish the use of valuable drinking water for minor domestic uses (flushing, washing, gardening). As was the case in electricity supply, it was for environmental reasons that the supply of a uniform service like water supply was diversified.

In a nutshell, such 'green' shifts in the organisation of provision and consumption in both electricity and water supply systems form the setting of this thesis. At least in the Netherlands, environmental considerations and interests are no longer of minor importance in the reorganisation of such provisioning systems, nor in the relations between utility providers and consumers. These kinds of developments made me anxious to know how environmental innovations and transformations in domestic consumption settings are - and could be - achieved and what role provisioning systems (to which householders are connected) are playing or could possibly play.

I will label these provisioning systems of water and electricity *network-bound systems*. A network-bound system can be defined as a conglomerate comprised of a large technical network; social actors related to that; and a collection of rules and resources that structure the operation, all needed to provide specific services. Such network-bound systems include electricity grids and piped gas systems, sewerage and water works, waste disposal and collection systems, public transport and communication networks. Most of these networks provide citizen-consumers the services that enable them to utilise natural resources or the disposal of waste. Therefore the functioning of and the social relations within network-bound systems are crucial for environmental performances in domestic consumption settings.

The study of environmentally relevant innovations and transformations - whether they are technological, institutional, organisational, economical or behavioural - in network-bound systems, requires an approach that recognises environment-induced transformations in the mass of changes that affect these systems and their related consumption practices. We need to distinguish environment-induced transformations from the trends to privatise, liberalise and enlarge these systems, although these dimensions of change are relevant for environmental innovation as well. Former studies on environment-induced institutional transformations in environmental sociology, resulted in the development and refinement of ecological modernisation theory. This theory has shown its value in its application to studies of environmental transformations in a variety of social and geographical contexts (Mol, 1995; Spaargaren, 1997; Frijns, et al., 2000, Mol and Sonnenfeld, 2000). The theory encompasses assumptions on the growing importance or 'emancipation' of 'ecological rationales', parallel to economic and socio-cultural rationales, in the design, evaluation and decision making on production and consumption systems. This growing importance or 'emancipation' of environmental interests and considerations can be identified in technological innovations, in institutional changes or in changing consumption practices. The general idea of the emancipation of 'ecology' is relevant for the study of environment-related social change in network-bound systems. To understand the social processes and dynamics that underlie environmental factors in reorganising network-bound systems and related consumption, we need a context-specific operationalisation of this theoretical starting point. To put it differently: ecological modernisation theory needs to be adapted and specified to the specific context of network-bound provision and consumption.

As this study focuses on environmental innovations in domestic consumption in connection to those in network-bound systems, the social relations between citizen-consumers and providers are of key importance. Hence the study deals with how environmental innovations are being shaped by and are reshaping the social relations between consumers and providers of network-bound services. I touch here upon one of the adaptations and specifications of an ecological modernisation approach to network-bound systems and consumption. While most of ecological modernisation studies, and more in general the environmental debate, has been dominated so far by institutional analyses (see for instance Mol, (1995) for such an ecological modernisation study; Collier (1996) for a study of environmental policy making in the EU and Weaver et al. (2000) for a study of sustainable technology development), my approach introduces the citizen-consumer. The devel opment of large technical systems has often resulted in increasingly invisible and inconspicuous forms of consumption, making consumers rather indifferent to environmental impacts of aggregated consumption. Contemporary developments are such that an analysis of environmental reform in network-bound systems is in my view not complete without analysing the role and meaning of citizen-consumer involvement.

A second - more theoretical - reason for a focus on consumer-provider relations is that it promises to offer a different perspective on contemporary social changes in network-bound systems than one could offer by doing either an institutional analysis or an analysis of individual strategic conduct. In one way or the other environmental innovations shape and are shaped by the way citizen-consumers and providers are mutually related.

Two main research questions can be derived from what has been outlined above.

- Through what kind of social processes, dynamics and actors do environmental innovations take form in network-bound systems?
- More specifically, to what extend do these environment-induced changes shape - and to what extend are they being shaped by - the social relations between citizen-consumers and providers and how do these new consumer-provider relations look like?

I will answer these questions through a theoretical exegesis and an empirical analysis of environmental reform in systems of water and electricity provision in the Netherlands. Theory is needed to develop a perspective for understanding socio-technical and environment-induced changes and relate them to the specific social configurations of network-bound systems. This makes it possible to formulate sensitising hypothesis on the environment-induced dynamics in the transformation of network-bound systems and the related consumption practices. An empirical focus is needed to find evidence for the theoretical derived hypotheses on this matter. An empirical focus on water and electricity systems of provision is rather obvious: as typical network-bound systems, they are without any doubt relevant in environmental terms and they are operating under rapidly changing conditions. Utility markets, for instance, are being liberalised and environmental regulation is being harmonised between member states of the European Union.

1.2 Theoretical Elaboration

The character of the research questions already suggests that social theory plays an important role in this thesis. In studying environment-induced transformations in modern societies ecological modernisation theory has proved itself to be a useful overall framework. For analysing and understanding environment-induced change in relation to network-bound provision and consumption the theoretical framework of ecological modernisation needs further elaboration. I will follow three routes to further specify processes of ecological modernisation in network-bound systems in relation to consumption.

First, consumption practices and especially those related to network-bound systems have to be further analysed in order to understand ecological modernisation dynamics in our object of study. Consumption theories developed in sociological and social-psychological disciplines can be valuable to explore the social or individual drivers for consumption, but fail to connect specific consumption practices, such as washing and heating, to specific systems and modes of provision. Fine and Leopold's (1993) system-of-provision approach and Spaargaren's (1997) model of social practices are better equipped for analysing exactly that relation between consumption and systems of provision. Using these approaches enables me to specify ecological modernisation processes related to consumption practices.

Secondly, studying environmental innovation processes in network-bound systems necessitates a better understanding of processes of continuity and change in large-scale technological systems. Such systems of provision are basically large-scale technical systems that bear some common peculiarities when it comes to socio-technological development and the role that social actors and end-users play in processes of continuity and change. The second pillar in the elaboration of my theoretical framework therefore deals with the social dynamics of technical change and especially the role of citizen-consumers therein.

These two theoretical pillars enhance the understanding of the dynamics of environmental transformation within network-bound provision and consumption. The third and last pillar connects this theoretical understanding to empirical research. In the ecological modernisation of network-bound provision and consumption of water and electricity two themes are most relevant: environmental monitoring and differentiation. Monitoring is an important theme for it refers to transparency of both consumption and provision to providers and consumers. Better insights in not only their own consumption levels, but also in the environmental soundness of provision, helps consumers in reshaping their domestic practices where it comes to the use of electricity and water networks. Differentiation is a relevant theme because it matches with the currently widely observed diversification of green products and services, technologies and resources in network-bound systems. Besides, it refers to the introduction of consumer choice - and thus power - in network-bound systems that have for a long time been known for their uniformity, centralised provision and 'captive' consumption[1].

These three specifications of ecological modernisation theory result in a theoretical framework for analysing and understanding environment-induced change in network-bound provision and consumption. More precisely, these elaborations enable me to formulate a number of 'sensitising hypotheses' on consumer-provider relationships in the environmental reform of network-bound systems. The hypotheses form the starting point for the analysis of empirical cases of environmental monitoring and differentiation in the water and electricity sectors in the Netherlands.

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1 Captive consumers do not have a choice but to consume their utility services from, mostly regionally based, monopolist network providers.

1.3 Finding Empirical Answers

The empirical part of the research consists of a study of the history and dynamics of water and electricity provision in the Netherlands, as well as contemporary cases of environmental innovations related to water and electricity consumption and provision.

A general review of dynamics within water and electricity sectors provides the context in which environmental transformations and innovations emerge. The proposed or already executed privatisation of public networks and the liberalisation of former state dominated markets - whether it concerns electricity, gas, water, rail, telecom or media networks - triggers a wealth of political and academic debates all over the world. There is a widely shared concern over the loss of government and consumer control on essential services as soon as these services are transferred to private hands. Not only the rate of future tariffs and security of supply are a major concern, also the investments in facilities and networks that are considered necessary, not in the least the ones needed to foster environmental reform in these sectors. This general review is based on a study of policy documents, Parliamentary reports, and socio-economic literature. Parts of the research work were done within the context of earlier projects on the diffusion of water saving technologies; on the evaluation of consumer acceptance of dual water systems, and on environment-induced change in utility sectors in the Netherlands, Sweden and Britain (respectively Van Vliet, 1995; Van Vliet, 2000 and Chappells et al., 2000). During these projects utility managers, consumers, policy makers and representatives of consumer and environmental movements were interviewed.

This general review of environmental transformation and continuity in the Dutch water and electricity utilities is essential to understand how currently environmental considerations trigger new relations between providers and consumers, as explained in two empirical themes of environmental monitoring and differentiation. The empirical study of these two themes is narrowed down in two steps. First, an inventory is made of cases of monitoring and differentiation in water and electricity provision in the Netherlands, with a special eye for citizen-consumer involvement in the initiation, acquisition and use of these environmental innovations[2]. To decide whether cases were or were not included, two criteria were used: firstly the innovation had to be at least *intentionally* environmental, and secondly the innovation had the appearance to reconfigure consumer-provider relations. The latter criterion was needed to make sure that selected cases would appropriate the study of changes in consumer-provider relations within network-bound systems.

The aim of making this gross inventory is to cover the wide variety of possible environmental innovations in monitoring and differentiation. The second step is the selection of specific cases. From the inventory a number of monitoring cases is selected that range from simple water metering to advanced interactive feedback systems in energy provision and consumption. The selected cases on differentiation are even more dispersed as 'differentiation' not only refers to differentiation of resources from which water and electric

2 The inventory, presented in Raman et al. (1998), was executed in the frame of an European project on environment-induced change and consumer involvement in utility services (Chappells et al., 2000).

ity are drawn, but also to differentiation of water and electricity providers, of intermediate technologies and of roles that consumers play vis-à-vis providers. The gross inventory and the eventual selection of cases are presented in appendix 1.

In contrast to the 'quick scan' method that characterises the inventory, the selected cases are studied more in-depth, utilising various sources of information. I interviewed initiators and users of innovations, providers of water and electricity, policy makers on national and European levels, and representatives of environmental and consumer organisations (see for a list of interviews Appendix 2). Many interviews were done on-site, at building sites, expositions, and sustainable homes, which rendered valuable insights in the social context in which these, mostly technical, innovations were used. Other sources for the case study research were newsletters, professional journals and web-sites of utilities, technology developers, governments and NGOs.

These in-depth case studies on the two empirical themes of environmental monitoring and differentiation complement the theoretical insights on the ecological modernisation of network-bound provision and consumption of - in this case - water and electricity. As such it enables me to provide more detailed qualifications regarding the sensitising hypotheses and to formulate answers on the research questions mentioned above.

1.4 Structure of the Thesis

The following three chapters subsequently present the three theoretical pillars on which the thesis rests. Chapter 2 lays out a model that focuses on social practices of domestic consumption and how these are shaped by and at the same time shaping network-bound systems. This is followed - in Chapter 3 - by a discussion of approaches towards the role of citizen-consumers in technological change and changing technological systems. It explores how environmental innovation in such systems of provision relates to issues of consumer involvement. As a final theoretical exercise, ecological modernisation theory is presented and adapted to serve as a framework to study contemporary environment-induced change in network-bound systems. Chapter 4 includes the statement of 6 'sensitising hypotheses' on environmental reform of network-bound systems and the subsequent expected changes in consumer-provider relations.

The empirical part of the thesis starts in Chapter 5, with a review of the historical phases through which water and electricity sectors in the Netherlands have gone, with an emphasis on environmental issues and measures taken over time. Rather than presenting a full historical overview of a century of water or electricity provision, the chapter focuses on the changes from dispersed private provision to centralised nationalised provision at the beginning of the 20th century, and from national provision to the contemporary utility market liberalisation towards the late 20th century.

Chapter 6 deals with the issue of monitoring and explores the ways in which monitoring has been used in the past and which roles monitoring has in environmental restructuring of water and electricity systems of provision. The argument is underlined with the pres entation of a number of cases that will be evaluated according to the, in this chapter, developed criteria for consumer-oriented, environmental forms of monitoring.

Chapter 7 explores differentiation on diverse levels of network-bound systems. Starting with a simplified model, linking resources, providers and consumers, I outline the levels of differentiation that are now at hand in network-bound systems. This is illustrated with the second set of cases that have been selected from the inventory of environmental innovations in water and electricity sectors in the Netherlands.

In the concluding chapter 8, the findings of the empirical part are brought together with the theoretical framework and hypotheses derived from it. The conclusions deal with environmental reform in network-bound systems, as indicated in the research questions, as well as the specific findings on water and electricity sectors in the Netherlands. The value of the theoretical framework is assessed for this and future research on ecological modernisation of network-bound systems.

2 Lifestyles, Consumption and the Environment [1]

2.1 Introduction

Over the last decade the discipline of environmental sociology has grown into maturity: it has diversified regarding the contributing world regions, the research themes covered and the theoretical or conceptual models being discussed. The debate on globalisation helped to broaden the originally western or eurocentric outlook that came along with its mainly American and European origins in the seventies. The debate on 'constructivism' versus 'realism' made us aware of some of the complexities surrounding the role of science and technology in the present phase of modernity, referred to by many sociologists as 'reflexive modernity' (cf. Beck, Giddens, and Lash, 1994). The theory of ecological modernisation stimulated theoretical discussion within environmental sociology and contributed to making the field more sensitive to developments in environmental policy-making.

For the future development of environmental sociology, the study of consumption and consumer behaviour constitutes an area of strategic importance. However, environmental sociology has not yet been able to offer promising theoretical perspectives on how to conceive consumer behaviour. The search for determinants of environmentally (un)friendly behaviours - grounded in models from social psychology - came close to a deception. The environmental impacts of what consumers actually do turned out to be very complex. Most studies of consumer environmental behaviour, by focusing on separate products or specific activities, provide little opportunity for consumers to monitor their own behaviour, yet this self-monitoring is essential if consumers are to make their lifestyles more sustainable. So there is a need for new directions to be explored. The emerging field of the sociology of consumption indicates one of the more promising routes in this respect. We would argue that the present day stagnation in the approach to consumer-behaviour could be partly explained by the fact that environmental sociologists have not been able to keep up with the developments that have taken place in the wider disciplines of sociology and anthropology. This is especially true for the study of consumption.

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1 This chapter is a revised version of Spaargaren, G. and B. van Vliet (2000), "Lifestyles, Consumption and the Environment: The Ecological Modernisation of Domestic Consumption" *Environmental Politics* 9:1, pp. 50-76

This chapter aims at contributing to the further development of consumer studies within environmental sociology. In Section 2 we develop a formal theoretical approach to consumer behaviour, borrowing extensively from the sociology of consumption. The study of consumer behaviour should start with the social practices in which actors are involved when pursuing their daily routines. With the help of Anthony Giddens' structuration theory we will give a definition of the formal concept of lifestyle and then go on to discuss the notion of a 'sustainable' lifestyle. The notion of 'system of provision' will serve as key notion when it comes to studying consumption practices from an institutional perspective. In Section 3 the formal model will be refined and extended by applying it to 'domestic consumption'. By taking the household context as a starting point, we outline the general route to (studying) the ecological modernisation of domestic consumption. We conclude in Section 4 with an outline of a future research program in this area, illustrating the kinds of research questions that are generated by our approach.

2.2 Towards a Sociology of Sustainable Consumption

The study of consumption and consumer behaviour has to a large extent been left to economists and (social) psychologists. For a long time, sociologists had regarded consumption and the consumer society as phenomena that mainly deserved criticism. This critical attitude to consumption was shared by many environmental social scientists (Winward, 1994, p. 75). While the legacy of the Frankfurt School can perhaps partially explain this attitude, this factor alone does not suffice to account for the lack of serious research in this area. A more important explanation can be found in the productivist orientation that dominated sociological theories for so many years. Work, factories, labour unions, the division of labour and the role of technology, these were the phenomena that kept sociologists occupied. When consumption was given any treatment at all, it was regarded mainly as a 'derivative' of production.

The bias on production-related social issues is not restricted to academic circles. Also in the field of environmental politics the productivist approach to consumption has dominated. Policy-frameworks for approaching the 'target-group[2]' of citizen-consumers are derived from the frameworks that have been developed with respect to institutional actors in the sphere of production. Consumers are much more heterogeneous and less professionalised when compared with target-groups in the sphere of production. One cannot conclude a covenant with consumers for the simple reason that consumers do not participate in the neo-corporatist consultation circuits that have become prominent in Dutch - and to some extent European - environmental policy making (Liefferink and Mol, 1998; Lauber and Hofer, 1997). Moreover, consumer-groups are not familiar with the highly specialised, differentiated jargon developed by environmental professionals in government and business circles. It is highly unlikely that a consumer-oriented approach can be

2 The concept of 'target group' has been developed within Dutch environmental policy planning to refer to groups which are 'targeted' in a specific way on behalf of policy makers because they have a distinct environmental and social profile. Examples of target groups include farmers/agricultural sector; energy sectors; different sectors of industry; Small- and medium scale enterprises and also consumers.

generated within the existing frameworks of policy. Therefore, a new approach is needed.

A sociological model for guiding consumer-research in environmental sociology and serving as a basis for environmental policy making should allow a precise formulation of concepts of 'environmental behaviour' and 'sustainable lifestyles'. We propose a model rooted in the structuration theory of Anthony Giddens and which can be given a more specific meaning for environmental sociology. The formal concepts of structuration-theory will be connected to some of the substantive themes put forward by the theory of the ecological modernisation of production and consumption. This should prevent some of the problems that come along with using social-psychological models on environmental behaviour as well as economic models on consumer-behaviour. Social-psychological models are strong in stressing the importance of the values and believes human agents adhere to. They are however weak in connecting individual (motives for) action with the 'wider society'. In other words, they lack a proper scheme for analysing the interplay between 'action' and 'structure' or between 'micro' and 'macro' levels. Economic models are used on various analytical levels, but these models do not pay attention to the 'motives' or 'reasons' of citizen-consumers behind a certain pattern of behaviour. Within the economic theory of 'revealed preferences', everything judged an 'irrational' factor is excluded from conceptual schemes. So the task of the sociological model must be to find a solution in which the main pitfalls of both models are prevented.

Within Giddens' structuration theory the analysis of environmental behaviour focuses principally on the behavioural or social practices in which human agents participate. Individual behaviours and its underlying reasons, interests and motives are studied in the context of social practices situated in time and space and shared with others. Beliefs, norms and values regarding (environmentally friendly) action are therefore not assumed to exist in a 'social vacuum' - as they are in the social-psychological model - but in a context. They are analysed as the rules which 'belong to' a specific social practice that is shared with others. The (relative) 'power' of the actor to change the course of action is specific for a certain context too, depending on the resources that are implied in the reproduction of social practices. Within structuration theory, rules and resources together constitute the structures that are involved in the reproduction of social practices.

A formal theory does not indicate the specific sets of social practices that researchers should focus on. The choice is left to the researcher in question. If the focus is on sustainable lifestyles and consumption patterns in a certain country or region at a certain time, one could include those practices that are recognised by the existing policy planning system as having the most relevant environmental impacts. Section 3 will provide a set of practices that is especially relevant for the study of domestic consumption.

Figure 2.1: A Conceptual Model for Studying Consumption Practices

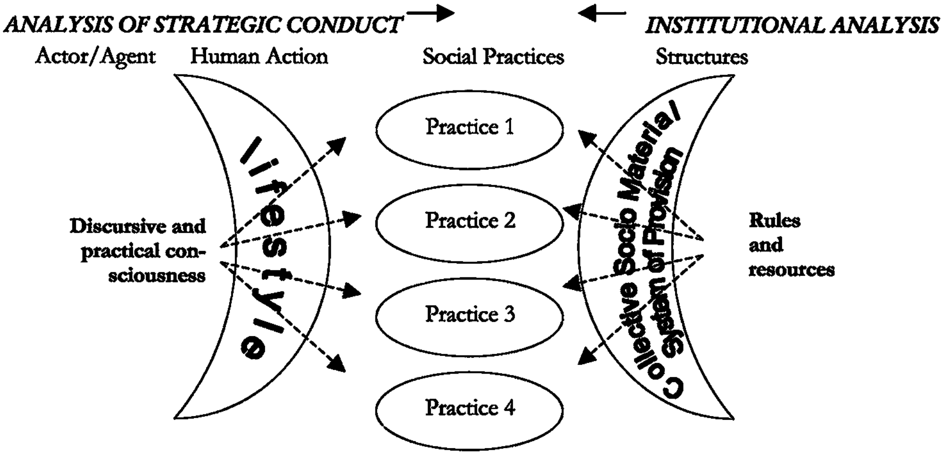

Figure 2.1 presents a basic 'structurationist' scheme in which (consumption) behaviour is linked to structures that are involved in the reproduction of social practices.

Before going into the relationship between action and structure, we should introduce one of the core notions of structuration theory: the concept of the 'duality of structure'. The idea of the duality of structure refers to the dual character of the rules and resources involved in the (re)production and transformation of social systems. Social systems are sets of social practices, situated in time and space. On the one hand actors are 'forced' in their actions to draw on existing rules and resources. In such cases, structures are 'media' in the sense that they enable a human actor to act. On the other hand these structures are in turn confirmed and reinforced by the actors' very actions. In this sense, structures are both media and outcomes of human action.

Structuration theory has deliberately eliminated the concepts of "micro-level" and "macro-level" from the vocabulary it uses to analyse social reality. Throughout the years, too many connotations have become attached to these terms. Micro-processes have become associated with 'subjectivity' and 'freedom of action', whilst macro-processes have been seen as 'objective', as 'structures' that restrain the freedom of action. To avoid the micro-macro terminology, the different lines of approach for research into social practices are referred to as 'institutional analysis' and 'analysis of strategic conduct', respectively. What is at issue here is whether social practices are approached from the 'right' side of our scheme or the 'left' side, as shown in Figure 2.1. In an institutional analysis of social practices the actors' knowledge and skills are 'bracketed out' to focus on the institutions as recurrent reproduced rules and resources. In the analysis of strategic behaviour, the focus of research is on the left-hand side of our scheme. Here, the characteristics of the interaction setting, the contexts of practices, are 'bracketed out'. They are assumed to be a given point of departure for research. The focus turns to actors' use of structures, the knowledge they use to monitor their actions and to the resources they can mobilise to do so.

In the remainder of this section a number of concepts will be discussed that play a role in the analysis of strategic (environmental) conduct of individuals. These concepts are likely to be used in the type of research termed 'micro-studies'. Having introduced these formal concepts, they will be put to use in defining sustainable behaviour in some circumscribed respects. Having elaborated the left-side approach to social practices, we then go on to discuss (environmental relevant) social practices using an institutional perspective. When approaching social practices from the right side of the scheme in Figure 2.1, the focus is on the ways in which social practices are embedded in broader socio-technical environments. We will use some of the terminology as developed in the sociology of consumption and the sociology of technology as these concepts may facilitate the institutional analysis of the 'systems of provision' that underpin consumer-behaviour.

Lifestyles and the Role of Individuals

The actions performed by individual actors diverge, as suggested in Figure 2.1, into a large number of distinct social practices, which is not the same as falling apart or disintegrating altogether. The formal concept of 'lifestyle'[3] refers to the specific form of integration brought about by social actors. In their lifestyles, people realise a - partial - integration of the variety of social practices that span their daily lives. Actors 'bind' their distinct (sets of) social practices into a reasonably 'coherent' unity. As a descriptive concept, 'lifestyle' has become synonymous with the classic concept of 'behaviour pattern' (Mommaas, 1993, p. 160). However, the lifestyle concept does not only refer to the formal process of integration of social practices but also to the 'story' which the actor tells about it. With each lifestyle there is a corresponding life story, in the sense that by creating a specific unity of practices the actor expresses who he or she is or wants to be. The lifestyle serves to express a person's individual identity, a 'narrative of the self'. Both elements are indicated in Giddens' definition of lifestyle: "A lifestyle can be defined as a more or less integrated set of practices which an individual embraces, not only because such practices fulfil utilitarian needs, but because they give material form to a particular narrative of self-identity" (Giddens, 1991, p. 81). Lifestyles refer to the degree of coherence to be found in people's behaviour. The notions of integration and coherence are important because modes of action followed in one context may reasonably differ from those adopted in others. Giddens refers to this phenomenon in terms of different lifestyle segments or lifestyle sectors. "A lifestyle sector concerns a time-space 'slice' of an individual's overall activities, within which a reasonably consistent and ordered set of practices is adopted and enacted" (Giddens, 1991, p. 83). If a person wants to maintain a certain level of credibility, both for herself and for others, then a certain coherence of the lifestyle and a certain level of integration of actions throughout varying practices will become essential.

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3 Mommaas has indicated that the term lifestyle or style of living is as old as sociology itself and was given a central place in the works of Veblen, Weber and Simmel, in particular (Mommaas, 1993: 159-181). Giddens only began to use the lifestyle concept in his later works, as part of his structuration theory on the one hand and as a 'hinge' between the formal theory and his discussion of (late) modern society on the other. We will use the concept of lifestyle as it is used by Giddens in the context of his formal theory.

The Concept of Environmental Utilisation Space

The formal concepts of Giddens' structuration theory need to be connected to the notions of ecological modernisation theory to say something about sustainable lifestyles. Until recently, ecological modernisation theory has focused mainly on institutional analysis. The theory is built on the assumption that during the past decades an environmental induced transformation process has emerged. It has led to new 'rules of the game' for the social organisation of production and consumption.

Ecological modernisation, on the one hand, refers to a sociological theory that has chosen the long-term transformation of Western society as its object of analysis. Conceived as a 'political programme', on the other hand, it refers to the central perspectives and strategies of environmental policies of the Netherlands and other industrialised countries (Spaargaren and Mol, 1992; Weale, 1992; Hajer, 1995). The nucleus of the theory is the view that new, environment-induced sets of rules and resources constitute independent criteria - besides cultural, economic or political criteria - to judge individual and institutional action. In the process of ecological modernisation, the criteria by which an assessment is made of what may count as an ecologically more 'rational' mode of production, gain increasing independence vis-à-vis socio-economic, political or cultural criteria.

An initial analysis of strategic conduct of citizen-consumers - aimed at producing criteria for 'more ecologically rational ways of acting' - can benefit from the lines of thought that have already been developed at the institutional level. For example, the meaning of the concepts 'environmental management' and 'environmental control' in the production sphere may be used in a rather similar way in the sphere of consumption. Environmental management or control by citizen-consumers can be defined as the conscious effort to achieve a reduction in the environmental impacts associated with specific lifestyle characteristics. This effort is based on the acknowledgement of a 'flexible ceiling' covering the total environmental impact of a lifestyle.

The notion of a 'flexible ceiling' or a certain amount of 'environmental utilisation space' requires some further elucidation. The recognition of the fact that there are 'physical limits' to the 'sustenance base' on which the social organisation of production and consumption rests, is combined with the idea of these limits being 'flexible' to a certain extent. The ceiling is set partly by technological and ecological criteria which refer to "the functional components of eco-systems that play a crucial role in the sustainability of social systems" (Opschoor and Van der Ploeg, 1990). Some of these criteria should be treated as 'core' or 'hard' criteria for sustainability in a circumscribed, eco-technical way, referring ultimately to issues of survival of both ecosystems and social systems. Some other criteria are (more) open to political debate, such as 'quality of life' and 'integrity of nature'. Given this definition, the idea of environmental utilisation space can never be fully operationalised by means of one-dimensional technical-scientific concepts and analytical frameworks. This is true for the application of the idea in the sphere of production. It is equally valid, and perhaps even more so, for application in the analysis of more sustainable lifestyles and consumption patterns.

In policy practice, however, the theoretically nuanced concept of environmental utilisation space is often used in a very limited way. The experiments conducted with the idea of an all-encompassing 'environmental ration cards' for citizen-consumers reveal an empiricist reduction of the concept. This is not only unfeasible given our current knowledge, but politically undesirable as well. To our view, the value of the idea of environmental utilisation space lies in its expression of the 'rationale' behind a reduction in the environmental impacts within certain production organisations, consumption patterns or lifestyles. It is a characteristic feature of this rationale that it combines the idea of physical limits with the idea of actively making use of a certain amount of space. Contrary to a concept such as 'limits to growth', the idea of environmental utilisation space evokes the image of available space that can literally and legitimately be 'made use' of[4]. The idea thus refers to the different ways in which environmental resources are being utilised (efficiently or inefficiently, prudently or recklessly) within limits that are set both by (eco)politics and (eco)technology.

The development of more sustainable lifestyles implies that actors (are made to) reconsider all the distinct lifestyle segments or sectors from an environmental management perspective as described above. In doing so they create an 'environmental profile' of the different segments of their lifestyles. The efforts which actors make regarding the greening of their lifestyles may contribute to the level of integration or coherence of their lifestyles. In this process, an optimum distribution or 'rate of exchange' will be pursued by social actors. He or she will look for the optimum exchange rate between the economic, ecological, cultural and social capital - to borrow some concepts introduced by Pierre Bourdieu – that the actor has at his or her disposal at a certain field of action. The assessment of the optimum use of available environmental utilisation space may even result in a process of creative book-keeping and housekeeping. Actors try to achieve the most beneficial distribution between the different segments of their lifestyles. In an analogy to the sphere of production, 'rational action' is therefore no longer determined by economic criteria alone. The rationally calculating citizen will be just as keen on avoiding environmental risks or on making 'environmental profits' as she is on realising economic benefits or enhancing status.

So far for the approach to social practices from the perspective of the left side of our scheme. To complete the discussion of the scheme, we now turn to analysing the ways in which lifestyle-choices are connected with relevant institutions of society.

The system-of-provision perspective of consumer-behaviour

If lifestyle- and consumption issues are discussed within the sociology of consumption, there are at least two distinct ways in which these concepts can be loaded. The two major branches within the discourse on lifestyles and consumption can be referred to as the horizontal 'distinction perspective' on the one hand and the vertical 'system-of-provision-

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4 Another considerable advantage of the term 'environment utilisation space' is the fact that, contrary to the terms used in the limits-to-growth debate, it refers to the interest of the environment as an 'independent' concern, which cannot be reduced to economic categories.

perspective' on the other. From these two perspectives, especially the vertical perspective can serve well in a sociological analysis of consumption behaviour that stresses the importance of the interconnectedness of production and consumption. Systems of provision should however not be analysed from a top-down, productivist orientation but instead also from a consumer-oriented perspective. The 'distinction perspective' will shortly be introduced before elaborating upon the 'system-of-provision-perspective'.

The Distinction Perspective

Perhaps because of the overriding influence of the work of Pierre Bourdieu, some authors almost exclusively relate lifestyle to the stylisation of daily life. People seek to express their sense of style by a specific choice of (cultural) goods. Lifestyle-choices are a matter of (good or bad) taste, and especially the (lack of) understanding that people have of higher culture or art is regarded as decisive for their performance in the field of distinction. This approach to consumer behaviour is focused on aesthetics, fashion, identity, signs and the dream-world of the modern shopping centres. If concrete products are discussed, the central objective is to establish the ways in which they can bring about a specific form of "stylised awareness in matters of consumption" (Lury, 1996). Elaborating upon the work of Bourdieu, Featherstone (1991) claims that "the new conception of lifestyle can best be understood in relation to the habitus of the new 'petite bourgeoisie' as an expanding class which seeks to preserve and legitimise its own particular dispositions and lifestyle. A class fraction most closely involved in symbolic reproduction." (Featherstone, 1991, p. 84). These groups set themselves up as the cultural intermediates that promote a general interest in style by 'estheticising' everyday products and commodities. Additionally they popularise commodities from the 'higher culture' to an increasing extent, thus make them available to larger groups of consumers.

The Bourdieu-inspired streams of thought in the sociology of consumption are important for environmental sociologists because they make us aware of the crucial importance of the social or symbolic dimension of consumption. People do not only buy certain products because these products can be used and 'enjoyed' when being 'consumed'. People 'use' goods and services, according to Douglas and Isherwood (1979), to relate themselves to other people. To understand why things matter to people, we also have to look beyond the matter itself. The first interest of environmental sociologists is usually on the ecological characteristics of certain products and consumption styles. However, they should also recognise the ways in which these ecological characteristics are shaped by the subjective dimensions of the consumption process.

The System-of-Provision Perspective

The approaches emphasising only the symbolic function of products and services however fail to see that changes in consumer culture and consumer behaviour are to an important extent connected with major changes in the organisation of (different sections of) industrial production. The 'horizontal' approach to the dynamics of consumption does not consider the 'history' of the products, their context of origin or their roots in the specific organisation of production-consumption-cycles. Fine and Leopold argue that these contexts of origin should be given a prominent place in what they label as the 'vertical approach' to consumption, (Fine and Leopold, 1993). We prefer the label 'system-of-provision perspective' to refer to the vertical dimension because the term provision (and its corresponding concepts of 'access' and 'use') is more easily connected with a consumer oriented perspective on production-consumption-cycles.

This system of provision approach "expects different commodities or groups of commodities to be distinctly structured by the chain or system of provision that unites a particular pattern of production with a particular pattern of consumption". Empirical research to the changes that took place in product-groups and their corresponding systems of provision, enables us to evade generalist theories which do not recognise the differences between separate clusters of commodities. Existing consumption theories do not pay sufficient attention to differences in the ways commodities are handled in for instance the traffic system, the food system, the energy system, or the housing system. The 'systems-of-provision perspective', makes the "distinct set of imperatives governing different sets of commodities" visible (Fine and Leopold, 1993, p. 4).

Some systems of provision are very stable and predictable, while others are highly dynamic and unstable. This kind of diversity may be approached by introducing some further theoretical concepts, developed by Alan Warde and others in their contribution to the sociology of consumption. Warde has positioned himself in a debate that started in the 1980s among British sociologists putting forward some of the issues of urban sociology in the sociology of consumption. The organisation of 'collective consumption' and its relation with social inequalities was restated with the 'privatised' versus the 'socialised' mode of consumption with a 'consumption cleavage' as a result. Especially the contribution of Peter Saunders triggered much discussion, because he counterposed the two modes of provision in a rather specific way. The privatised mode was identified with freedom of choice, high quality of products and services and enhanced autonomy for the consumer. The socialised mode on the other hand came to represent lack of choice, poor quality and bureaucratic (over)regulation. We are dealing here with a highly politicised discussion with initially little room for nuance. Writing about the market context, Saunders does not spend a single word on the social determinants of consumption behaviour, the market power of producers, or the negative effects of the 'ideology of consumerism'. He simply starts from the premise that "market choices give meaning to individuals' life through consumption" (Warde, 1990, p. 231). When, on the other hand, the subject changes to public services, the stress is on dependency, lack of options, inferior quality and obligation. Saunders considers state-provision as 'rest category' in comparison with the market supply of goods and services. To a large extent, the model is derived from the handling of one kind of product, namely the house. Private ownership of a house is supposed to be one of the indicators for the existence of a consumption gap, the dividing line between the new social classes within the consumption culture. Empirical research was done to show that these new dividing lines would also express themselves in the preference for particular political parties (Dunleavy, 1980; Saunders and Harris, 1990). The superiority of the privatised mode is arguable even in the housing sphere (Kemeny, 1980). One should realise that what is investigated here is indeed an important, yet single con sumption good. Private house ownership cannot function as a model for the way the multiform package of goods and services is handled. When commodities other than houses are at issue, the linking of 'ownership' and 'control' and the relation to 'quality' becomes less unambiguous. Another objection to the Saunders model is that it distinguishes only two major forms of consumption. It neglects consumption in a household context as well as the handling of consumption goods in the 'informal' economy of neighbourhood and family networks. Finally, consumption is more than the purchase of goods only. There are many different ways of supplying products, maintaining products, and disposing of products that are not covered by a bi-polar model like that of Saunders.

Alan Warde can be credited for breaking through the dichotomy of 'privatised' vs. 'socialised' modes of consumption and making room for analytically more fine-tuned analyses of different modes of provision. Analysis of production-consumption cycles within a systems-of-provision approach allows for mixed forms or modes of provision, accompanied by different modes of access as well as different modes of 'use' or 'enjoyment'. In the next section, Alan Warde's concepts to the dynamics of household-consumption will be applied.

2.3 Analysing Domestic Consumption

Now that we have explored a contextual model of consumption with help from the notion of a duality of structure and the systems-of-provision approach, in this section we use these concepts to elaborate our understanding of the dynamics of domestic consumption. The latter is in many ways broader than consumption alone, as it encompasses many more social practices, including household labour and care. The household includes many practices that relate humane agents to the use of natural resources, which makes it extremely relevant to study from the point of view of environmental sociology. We will start with discussing the work of Schwartz Cowan that is in many ways in line with a systems-of-provision approach to consumption. By referring to Per Otnes' analysis of household consumption, we will also show that the notion of duality of structure is extremely valuable when it comes to analysing household practices. Before turning to the ecological modernisation of household consumption in the remainder of this chapter, we end this section with two main issues that seem to be conditional for any change in household practices: those of time-space structures and the standards of comfort, cleanliness and convenience.

Industrialisation of the Household

In her impressive study on the industrialisation of American households, Ruth Schwartz Cowan convincingly illustrated that one cannot treat domestic consumption in isolation from the sphere of industrial production.

> "(T)he industrialisation of the home appears to have been composed of millions of individual decisions freely made by householders: the Jones's down the block decided to (...) buy a washing machine, and the Smiths around the corner fired the maid and bought a vacuum cleaner. But the matter is not as

> simple as that. The Jones's washing machine would not have done them a bit good if the town fathers had not decided to create a municipal water system (...) earlier, and if the local gas and electric company had not got around to running wires and pipes into the neighbourhood". (Cowan, 1983, p. 13-14)

Cowan made clear that any changes in the way we cook, dress and care are directly connected to changes in the food-system, the clothing-system and the health-care-system. And although some of the major 'women's' tasks were indeed lifted out their domestic context and transmitted to industrial sectors of society, Cowan shows that we are not dealing with a one-way process. Where the gas, electricity and water-systems are involved, some of the 'old' chores (drawing the water) were replaced by new ones (cleaning the bathtub). In the case of the transport-system, Cowan showed that women gradually replaced the transport-services that used to be conducted by the butcher's boy, the baker's man, the doctor and the barber. Because she observed similar processes in other sectors as well, Cowan concluded that the industrialisation process eventually implied 'more work for mothers'.

For a number of reasons, the methodology adopted by Cowan can be said to offer a promising perspective also when studying domestic social practices from an environmental point of view. Firstly, she takes a medium to long term perspective. This enables us to think through alternatives to the present socio-technological systems that seem to have a 'fixed' character when viewed only from a short term perspective. Examples are the centralised water and energy networks that were build up during the last century in most European countries. Secondly, Cowan lays great stress on the interconnectedness of so called 'internal' and 'external' processes. She cross-cuts the divisions between the sphere of production and the sphere of consumption. When working with a strict division between these spheres, the meaning of concepts like 'work' or 'industry' tend to be biased because they are thought to be rooted only or primarily in the sphere of production. Thirdly, Cowan theoretically emphasises and empirically illustrates the very intricate connections between so-called 'technical' and 'social' aspects of domestic social practices. Finally, Cowan makes us aware of the fact that in the historical development of socio-technological systems, some roads are indeed taken and some others are not. Technological systems and devices sometimes 'fail', not necessarily because they are technically spoken inferior but because they do not fit the diverging interests of companies, trade unions and households at that crucial moment of its emergence.

To take the analysis one step further, we have to deal with questions about the ways in which consumer-choices on different technological systems are connected to consumers' lifestyle-choices and issues of identity. We should recognise the importance of the relationship between 'inside' factors (such as the internal time-space organisation and 'cultural style' of the household) and 'outside' factors (the external systems of provisions like the electric or power networks).

The Duality of Structure in Reproducing Domestic Consumption Practices

As we have argued more extensively in Section 2, a fruitful way of conceptualising the interplay between agency and structure can be found in the work Anthony Giddens. The Norwegian sociologist Per Otnes applied some of the basic concepts of Giddens' structuration theory to the practice of household-related consumption. The core concept of the 'duality of structure' is given proper expression in Otnes' phrase that domestic consumption can be summarised as a process of 'being served by, and serving, a number of essentially collective socio-material systems' (Otnes, 1988, p. 120). Every time we tap some water or switch on the lights, we are making use of the services that are provided by expert-systems. At the very same moment we contribute to their ongoing reproduction. These expert-systems constitute what Otnes calls 'the collective underpinnings of private life' (Otnes, 1988, p. 120). Without the proper functioning of these expert-systems our daily life would be very difficult to maintain (Otnes, 1988; see also Hughes, 1983). The collective socio-material systems are a special case of systems of provisions. They are special because they imply 'material infrastructures' as an essential element of systems of provision. Once the citizen-consumer has been 'connected' to the water works, the sewage system or the electricity grid, the consumer has become a 'captive' consumer. Captive consumers cannot just shift from one system to another without loosing resources (money, knowledge, skills) that have been invested in the present networks. These so-called 'sunk costs' prevent citizen-consumers from moving freely between different systems of provision, provided that there would be more than one option available.

Although we 'know' in general about our dependency on collective socio-material systems, we use water and energy in a very routine way. We are not consciously aware of the fact that behind the taps and the power-points there are very advanced and extensive expert-systems. We are only made aware of the character of our relationship when confronted with some event that (temporarily) breaks down our routines. This can be an interruption of the guaranteed supply of water and energy or a removal or home-improvement project which we decide upon ourselves. In all these cases the taken-for-granted character is replaced by a serious questioning of the existing modes of organising the social practices that constitute our daily actions. These interruptions of daily routines make us (temporarily) alert and very sensitive to consider alternative modes of organising our consumption practices. When going through periods of de- and re-routinisation, we become aware of the level and the nature of what Giddens calls our 'discursive penetration' of the collective socio-material systems. This awareness can pertain for example to the skills that are needed to appropriately serve the systems, or to the power-relations that are involved in the reproduction of the system. The discursive awareness might also be directed to the environmental impacts that characterise the present make-up of the system.

Studying domestic consumption from a perspective as sketched above has relevance for environmental sociologists for at least one particular reason. Collective socio-material systems that we serve and by which we are being served, represent to a considerable extent the 'sustenance base' of our daily domestic routines. They are 'material' systems not only in the sense of being technical systems, technologies, infrastructures, apparatuses, tubes and gadgets. On a more fundamental level they represent the material- and energy-flows which form the physical substratum to our domestic lives. They are involved in the organisation of our intercourse with the environment.

So when people are striving for more sustainable lifestyles and patterns of domestic consumption, the possibilities (not) offered by collective socio-material systems are of strategic importance. When high levels of environmental consciousness meet low levels of 'green innovation' of systems of provision, the result will be a lack of environmental friendly behaviour. On the other hand, domestic agents will only accept more sustainable devices in the field of energy and water under the condition that the devices 'fit' into the overall organisation of their households and lifestyles. There are two main issues concerning household organisation that needs some more elaboration: the time-space structure of domestic routines and the accompanying cultural standards. We will discuss both factors separately.

The Time-Space Structure of Domestic Social Practices

One may wonder why people accept new technologies, or buy certain products or types of equipment. Douglas and Isherwood (1979) suggest as a working hypothesis that they do this to increase their 'personal availability'. This offers a more promising starting point than theories explaining purchasing behaviour from the wish to satisfy needs or the urge to show off, or similar motives. Products are employed to achieve a reorganisation or rationalisation of the household. The products help consumers to set themselves free to carry out other tasks or engage in other activities. To the anthropologist Douglas, the desire to liberate oneself from household tasks is strongly linked to the necessity to be available for activities that increase the status of actors. Status may be obtained from an increase in social capital like visiting friends, organising a big party, and so forth. This specific application of the motive behind the increase of 'personal availability' is less important to our goal than the working hypothesis itself[5].

An important characteristic of household labour is that it consists in large part of periodically recurring activities or jobs that cannot be put off. Douglas and Isherwood illustrate these 'periodicity constraints' of households by means of two types of activities, without further differentiating these two types analytically. On the one hand there are the household routines better known as 'chores': making beds, cooking meals, cleaning the bathroom, shopping. On the other hand there are activities relating to child care and upbringing: breast-feeding, taking the children to school, caring for an elderly parent living in your home, walking the dog. These are activities that have to be performed according to a fixed pattern in time. As partly complementary activities, together they result in a more or less constraining 'pattern of periodicities of household processes'.

Along with the concept of the 'periodicity of household labour', Douglas and Isherwood introduce two further assumptions. First, constraints are held to differ with social class or

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5 In our view, the wish or necessity for a more intensive participation of women in the labour process is an equally important motive. In addition, the increase of 'obligations' or activities in the fields of leisure, recreation and tourism may be mentioned as a determining factor.

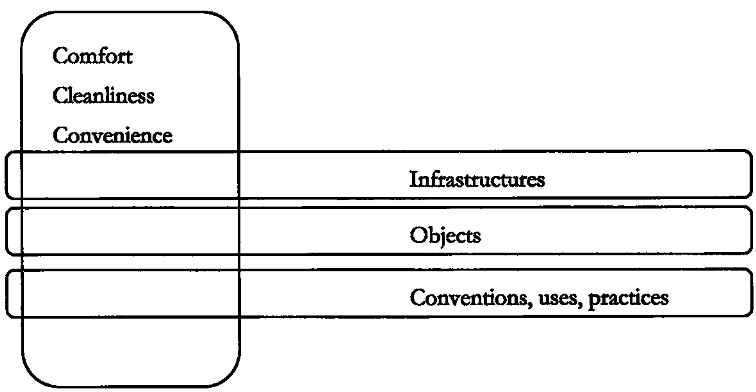
status groups, according to the principle that "the higher the status, the less periodicity constraints; the lower the status, the greater periodicity constraints". Secondly, they are directly linked to the division of roles between men and women. "(T)he most general account of the division of labour between the sexes that fits everywhere would be based on the periodicity of women's work" (Douglas and Isherwood, 1979, p. 120). High-frequency tasks limit the action radius of people - in this case mostly women - in their efforts to arrive at a greater 'personal availability'. As a consequence, women will try to get burdened with as few of these tasks as possible. Douglas and Isherwood are rather positive in their formulation when they observe that "anyone with influence and status would be a fool to get encumbered with a high-frequency responsibility" (p. 120). If possible and affordable, people will try to give these tasks to third parties (baby-sitter, domestic help, window cleaner, etc.) and try to reduce the claim on personal time by 'rationalising' the labour involved, through the application of technology. People make use of commodities and services to free themselves from the most demanding tasks that belong to their specific consumption scale. For this reason, 'scale-facilitating goods' form the key to understanding when we are looking for the relationship between technology and household consumption. The essential point in the analysis of Douglas and Isherwood is that actors, in their efforts to attain a higher personal availability, are trying to free themselves from 'high-frequency-low-esteem' tasks. To put it more generally: it is about the freeing of domestic agents from fixed time-space slots in everyday life. Agents will not accept technologies that make their domestic routines more 'rigid' in terms of pre-given schedules. They will instead actively strive for those technological and organisational devices that give them greater flexibility in performing domestic tasks. One should remember this when studying more sustainable goods and services offered to domestic consumers. For example the idea of 'pooling' of equipment and resources as an environmentally more beneficial alternative to fully privatised goods and services, may contradict the idea of flexible time-space structures.

Standards of Comfort, Cleanliness and Convenience

The perspective derived from the work of Cowan can be regarded as more promising than most of the models used by neo-classical economists because now the focus is no longer on 'isolated choices for isolated products' but instead on 'sets of goods and services' and systems of provision. These sets of goods and services are then connected with specific drives or motives from the side of domestic consumers. In fact this is the kind of approach that Per Otnes has been arguing for (Otnes, 1988). He envisages a social scientific discipline that pays sufficient attention to the spending, the use and the making of products or services rather than their utilisation alone. To give a name to the discipline Otnes proposes 'chreseology of everyday life', which can be interpreted as the doctrine of using, employing and implementing (Otnes, 1988, p. 163-4). Such sociology of domestic consumption relates specific clusters of products and services to specific modes of provision in the context of specific spatial settings of domestic social practices. Examples of these settings are the kitchen, the bathroom, the hobby-room, or the garden. These are the spatial contexts in which actors make use of cooking and gardening tools that can only (be made to) perform properly when connected to collective socio-material systems. The chreseology of consumption should provide detailed descriptions of the daily routines of domestic consumption. This can enhance our knowledge about the various ways in which people relate to technologies, households relate to expert-systems and the 'private' relates to the 'public'.

Writing in the sociology of technology tradition, Otnes does not investigate in any detail the distinct motives and interests of human agents as to answer the question why they are performing these consumption practices. Of course, in their modern, rationalised and stylised kitchen people combine cooking utensils with energy and water to produce a meal. But this obvious fact does not provide us any insights into the taste for food that comes along with their lifestyles and the cooking-culture which these specific domestic agents represent. Elizabeth Shove, among others, put the cultural aspects of domestic consumption at the centre of analyses (Shove, 1997; Shove and Southerton, 1998). She specified them with standards of "Comfort, Cleanliness and Convenience" to which people adhere and subscribe. Domestic consumption practices should be analysed not only as a mixture of objects and infrastructures but also as routines that make people meet the standards they think of as 'normal' or 'minimal required' or 'common'. To meet these standards, Shove proposed to categorise the rules and resources as infrastructures (the plumbing system for instance), objects (commodities) and conventions, uses and practices. Figure 2.2 represents the perspective as proposed by Shove (1997).

Figure 2.2: Standards of Comfort, Cleanliness and Convenience met by Infrastructures, Objects and Conventions, Uses and Practices



Shoves' analysis is different from the one offered by Douglas and Isherwood. She does not treat the 'rationalisation' of domestic consumption primarily as a process of 'doing away' with as many chores as possible. Shove discussed the buying and selling of freezers, refrigerators, bathtubs, kitchens and heating systems in terms of the level of comfort, cleanliness and convenience that these technologies promise to bring to the household, provided that they are properly connected to the systems of provision that support them. On the one hand, these standards are an expression of the specific lifestyles of people. In that sense they are a highly individual, privatised affair. But the number of showers one takes in a week depends not only on the job one occupies or the amount of sporting activities one is engaged in. It is also to a large extent determined by the standards of cleanliness one is accustomed to. These standards are shared with many others and 'learned' in the course of one's life. It is especially the anthropology of consumption that made us aware of the variation that exists both across time and across different cultures when it comes to standards of comfort, cleanliness and convenience[6].

So far, we have discussed household consumption with tools derived from structuration theory and the systems-of-provision approach. Additionally, we have argued that any attempt to innovate or change households - from within or from outside - should acknowledge the way these changes fit in the time-space structure of households and the standards of comfort, cleanliness and convenience to which householders adhere. We turn now to the ecological modernisation of household consumption.

2.4 The Ecological Modernisation of Domestic Consumption

As pointed out in Section 2.2, the essence of ecological modernisation is the 'emancipation' of ecology from culture, politics and economics. Huber (1982) situated ecological modernisation as a third phase of industrial development, beginning in 1980, following earlier stages of the 'breakthrough', to 1848, and 'construction' of industrialisation, from 1848-1980, respectively. Every new cycle and the social transformations that go along with it, is made possible by a new key-technology to arise. Such new technologies have to be picked up by innovative entrepreneurs who bring about a new wave of industrial innovation. Such an evolutionary theory of social change is of course vulnerable to the same kind of criticism that was formulated with regard to all other modernisation theories. However, in its essence, the theory had two main attractive points. First it analyses major changes in the organisation of production and consumption in a direct connection with environmental problems. Second, it puts at the centre of attention the institutions that are most important in bringing about the switch over into more sustainable production and consumption cycles: economy and technology (Spaargaren, 1997, p. 17-18). The ecological modernisation of domestic consumption would stem from the same basic principles: the emancipation of ecology out of the economic and cultural spheres; the reconstruction of domestic practices after a long period of 'industrialisation of the household'; and the introduction of environmental innovations taken up by capable and knowledgeable domestic consumers.

Environmental innovations can only be defined in relative terms, as what is innovative depends on the temporal and spatial context in which they emerge. Innovations might be accomplished in techniques, but also in procedures, financial arrangements, and all other institutions that make the production-consumption-cycle go round. They deserve the adjective environmental if they represent a potential reduction of environmental impact provided that the innovation is applied in the proper context. This however does not ex

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6 Hal Wilhite (1997) for example was able to show how cultural standards concerning 'lighting the home' differ considerably in Japan and Norway or the United States, resulting in different patterns of domestic energy-consumption

clude other goals that may be accomplished by the innovation like 'economically more efficient' or 'bringing more comfort'. It is also important to realise that environmental innovations might come to domestic consumers through all possible modes of provision. Green taxes will mostly be provided through a public mode of provision, while green-labelled food products will mostly be provided through private modes of provision. Some innovations however are typically provided through informal modes of provision like the sharing of cars or washing machines with neighbours or neighbourhood-composting schemes. The ecological modernisation of domestic consumption, in other words, is more than only a derivative of the ecological modernisation in the sphere of production. In fact, many environmental innovations that have been introduced by private companies and public utilities (such as organic food products, green electricity schemes or grey water systems) during the last decade are said to be primarily initiated by the wish of the consumer.

We will conclude our argument by discussing a more detailed version of the model introduced in Section 2.2, followed by an indication of the route to be followed in future research concerning the ecological modernisation of domestic consumption.

Figure 2.3: Outline of a Research Model for Studying the Ecological Modernisation of Domestic Consumption

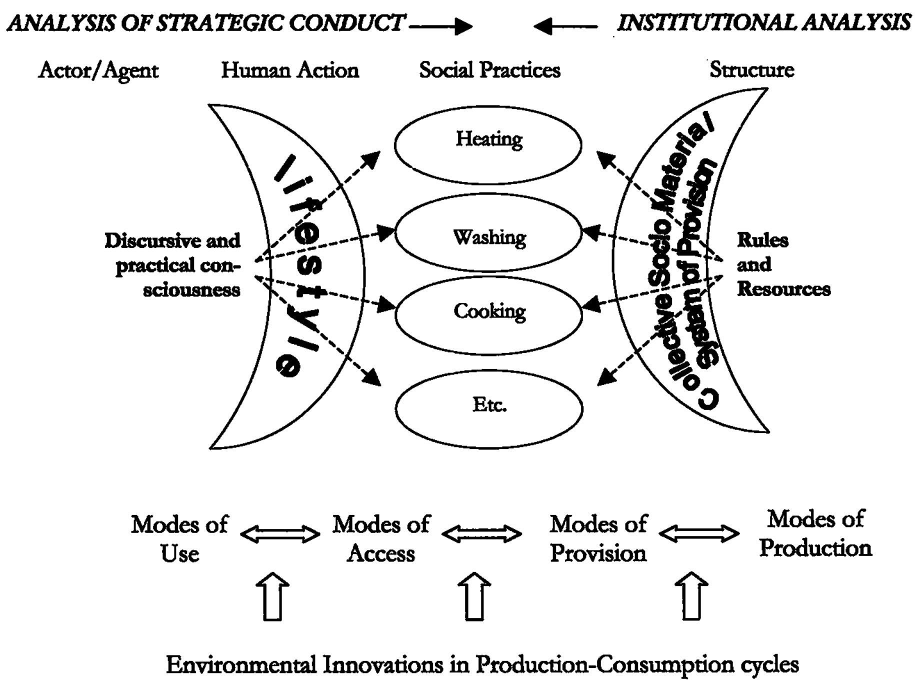

Figure 2.3 presents the model again, with examples in the centre of the figure of the kind of social practices relevant to the study of domestic consumption. The 'formal' model of social practices within the duality of structure is given 'empirical' content by introducing environmental innovations that are developed in the production-consumption-cycles in

modern industrial societies. These environmental innovations in the form of techniques, procedures or social arrangements might be introduced in the cycle of production and consumption by different modes of production and provision and may be accessed and used also in various ways.

On the left side of the model, human actors - aiming at a reduction of the environmental impacts of their lifestyles - are dependent on the environmental innovations made available to them through the systems of provision. On the right side of the model, companies, public utilities and governmental agencies involved in the development of more sustainable goods and services are dependent on human actors. They have to recognise environmental innovations as relevant 'tools' that fit their lifestyles and their internal domestic organisation as well as their specific standards of comfort, cleanliness and convenience.

Over the last fifteen years or so the number of environmental innovations that came available for domestic consumers has increased significantly, at least in a number of European countries (Raman et al., 1998). Not only have the numbers increased, but also the character of the innovations has been changed for the better. Consumers looking for possibilities to 'green' their lifestyles and domestic routines are getting 'served' much better than in the seventies and early eighties. Innovations which can help to lower the direct and indirect energy use[7] of households are no longer accessible primarily to a small group of 'early innovators' who are willing to sacrifice lots of time, space and money to get things done in a more sustainable way. The results of a slow but steady process of the 'greening of industry' are also approaching the front door of domestic consumers of all social classes. The ecological modernisation of production-consumption-cycles will affect, sooner or later, the domestic routines that shape our daily lives.

There is, however, not one best possible way to a more sustainable form of domestic consumption. In fact we witness a myriad of possible pathways, combining different modes of production and provision with different modes of access and use. We now seem to be in the phase of 'exploring the roads that can be taken' and there will be a number of dead-end roads also in the field of sustainable consumption. For environmental sociologists, the 'roads not taken' can be as illustrative and interesting as the roads taken, a methodology used by Cowan before. We have been arguing throughout this chapter that there can be a number of different reasons why things 'won't work'. Green devices can be offered in a way that they do not fit the lifestyles of modern consumers because they effect the standard of comfort in a negative way. Products and services may also be turned down by domestic consumers because the introduction, use and maintenance of the devices do not fit the time-space routines of modern social life. Sometimes (green) products are already a failure at the production line because they are designed and produced from a narrow engineering perspective. Or well designed products which in principle would fit modern lifestyles fail because of their mode of provision, when consumers are not acquainted with

7 The distinction between direct and indirect energy use of households is used in the HOMES-project (Noorman and Schoot Uiterkamp, 1998) to distinguish between on the one hand the energy which is 'directly' used to heat and light the house and the energy which is stored in the products and packages on the other.

the channels used or when they have lost their trust in the providers. These theoretical possible reasons behind the 'innovation-failures' can be explored in empirical research focused on the ecological modernisation of domestic consumption.

Such an empirical study may encompasses environmental innovations, a systems of provision where innovations emerge or household practices that are expected to change after innovation. For example the study of the development and implementation of solar energy devices could include the history of its development, its risks and opportunities vis-à-vis existing energy providing systems and the role of social actors such as manufacturers, energy utilities and local governments in speeding up or slowing down the diffusion of solar energy devices. This should provide insight in how and why household consumers might get involved in solar energy and which modes of provision and production there are to adhere to. Focussing on systems of provision, one might study the chances for ecological restructuring of the energy system and the role of domestic consumers, who through their shared social practices partially define the course of development within these systems of provision. If the ecological restructuring of energy sectors is accompanied with the diffusion of solar energy, the study might emphasise the most appropriate modes of access and use there are for domestic consumers to get involved in solar energy schemes.

In this thesis, the empirical starting point will be the environmental innovations in water and electricity sectors and the role they play in the reshaping of consumer-provider relations in water and electricity provision. As environmental innovations in water and electricity provision and consumption directly or indirectly touch upon the changing of large technical systems, the next chapter will be devoted to theories of technical change and the role of social actors managing and using large technical systems in processes of environmental innovation.

3 Innovation in Network-bound Systems

3.1 Introduction

Environmental innovation in network-bound systems cannot be established in a fortnight. Changes at any nod in the network potentially have implications for the rest of the network as all nods are connected. For this reason, the installation of a local grey-water recycling system in a new housing complex in Arnhem[1] took months of negotiations between the initiators and the water board, the regional Water Company, the municipality, the housing agency, plumbers, constructors and many others. Such an innovation clearly involves technical adaptations to the conventional system of water supply and sewerage, but besides requires the involvement of many social actors who need to make a switch in their conventional mutual relationships. Both water and electricity systems should therefore be conceived of as not only technical, but as social networks as well.

In this chapter, I consider the mechanisms of (environmental) change in network-bound systems, by means of which I cast a new light on the relations between citizen-consumers and providers in these systems. Therefore I especially question the role of citizen-consumers in processes of innovation. Apart from elaborating the theoretical approaches on system change and innovation, I also discuss citizen-consumers' roles in the management of socio-technical systems as to redefine their position commonly described as end-user or 'the demand side'.

I start my search for consumer roles in innovation processes with discussing the main ideas of Schumpeter and Rogers and go on with the body of literature on technological and system change (section 3.2). As I am not only interested in consumer roles in classical innovation processes, but also how consumers relate to systems of provision in daily operation, I explore the theories on the management of network-bound systems (section 3.3). Finally, in section 3.4 the evaluation of approaches provides food to rethink processes of environmental innovation in network-bound systems and the role of citizen-consumers in it. From this I draw the lines for the chapters to follow.

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1 Housing development of 40 houses, completed in 1992 in Rijkerswoerd residential area (see Chappells et al., 2000)

3.2 Innovation, Technological Change and Large Technological Systems

Technological change is one of the core processes of societal change. The major transitions in Western societies that have become known as the Industrial Revolution, The Information Society, Post Fordism, among others (Kumar, 1995), refer in one way or the other to technological change. Not surprisingly though that many sociologists and economists have been trying to explain the backgrounds of processes of technological change. Likewise, many theoretical models have been constructed ranging from theories that assume an autonomous development of technology (technological determinism) to theories in which good entrepreneurship denotes innovation (Schumpeter) and theories which aim to dissolve the dividing line between technological and social change. Here I present a selection of the most relevant theoretical understandings of innovation from the economic and social sciences, which helps evaluating the processes of innovation in network-bound systems that will be presented later on in this chapter.

Economic Approaches to Technical Change and Innovation

Probably the best known work on innovation in economic literature is that of economist and sociologist Schumpeter, who has put the entrepreneur and his/her innovative actions at the core of economic development. According to Schumpeter, the concept of innovation refers to a change in some production function which may include: the introduction of new commodities; technical change in the production of commodities already in use; the opening up of new markets or of new sources of supply; Taylorization of work; improved handling of material; the setting up of new business organizations such as department stores - in short, any 'doing things differently' in the realm of economic life (Schumpeter, 1939, p. 84, 94).

Innovations play a major role - they are in fact 'the prime mover' - in the course of economic development. In his first mayor work, 'Business Cycles' (1939) Schumpeter distinguishes four stages in economic development, starting with an equilibrium in which an innovation is introduced. As a result, there is a first movement away from equilibrium ('prosperity' phase) in which several innovations emerge. After a while, the rate of innovations slackens, prices rise and interest rates begin to decline till an equilibrium has been reached again ('recession' phase). The recession may also be followed by a phase of 'depression', which can be restored to a position of equilibrium via a 'recovery', which closes the business cycle. Further innovations will then start up the whole process again (Swedberg, 1991). Schumpeter further detailed this conception of economic development with four sub-cycles ranging from 40 months to 60 years.

This conception of economic development is much disputed for several reasons: among others for its lack of a theory of diffusion of innovations, the lack of a serious historical analysis and the rigidity of the described business cycles in general. However, what is interesting here is the definition of innovation, its key role in economic development and especially the role of 'entrepreneurs' vis-à-vis consumers in innovation processes.

Innovation conceptualised as 'doing things differently' is an attractive point of departure, as it leads away from rigid connotations it has with 'inventions' or from making reference to technical artefacts only. Secondly Schumpeter was very clear in stating that risk-seeking entrepreneurs initiate innovation processes and not consumers:

> "We will, throughout, act on the assumption that consumers' initiative in changing their tastes (...) is negligible and that all change in consumers' tastes is incident to, and brought about by, producers' action. (...). Railroads have not emerged because any consumers took the initiative in displaying an effective demand for their service in preference to the services of mail coaches. Nor did consumers display any such initiative wish to have electric lamps or rayon stockings, or to travel by motor car or airplane, or to listen to radios or to chew gum. There is obviously no lack of realism in the proposition that the great majority of changes in commodities consumed has been forced by producers on consumers who, more often that not, have resisted the change and have had to be educated up by elaborate psychotechnics of advertising." (Schumpeter, 1939, p. 73)

Although Schumpeter acknowledged the fact that in some cases consumer initiatives in changing taste did matter, like in the temperance movement, he holds "that this class of facts is not important enough to matter and that its neglect will not substantially invalidate our picture" (ibid, p. 74).

The issue of where innovative initiative and action can be located between the domains of demand and supply, consumers and providers is of course a classical one. Schumpeter took the most radical point of view, which can nowadays rather easily be countervailed. For instance, consumer needs do not initiate innovations, but may very well provoke them. Baudet (1986) mentions the pharmaceutical industry, which has been provoked by consumer needs for painkillers, contraceptives, tranquillisers and the like. Besides, institutional consumers such as governments, military apparatus, railway companies or schools have initiated many innovations over time. This also blurs the stringent dichotomy between producers and consumers as Schumpeter holds it to make his point on innovation. With Baudet one can also point to the fact that the role of consumers encompasses much more than changing taste or expressing needs. Especially the countervailing power of consumers is overlooked. Consumers are and have successfully been able to block the diffusion of a whole range of innovations, or to boycott certain companies by not consuming their products. Although consumers can only rarely be regarded as the prime initiators of innovations, they do play a decisive role in the innovation process by sending signals to designers and innovators to develop solutions to consumer problems.

Apart from the question whether consumers or producers initiate innovation processes, the question of what exactly happens in innovation and diffusion processes is also well explored. There are many conflicting definitions for innovation, but there is a remarkable consensus concerning the phases in which the innovation - and diffusion - process can be distinguished (Baudet, 1986):

- Invention or development of a new product or improvement of existing artefact;
- Introduction phase in which small groups of consumers get acquainted with the innovation;

- Acceptation phase, in which a first 10-20% of the potential user-group decides to use the innovation;
- Adoption phase in which the new product is largely accepted and starts to become 'normal';
- Assimilation phase in which the product is considered highly indispensable for consumers and society at large, such as telephones electricity provision or automobiles. This phase can develop as far as that people become addicted or society is adjusted to the artefact or system.

This is of course a highly simplified and a-historic description of phases. It fails to provide an answer to the how and why of adoption and acceptance and does not give much room for the likely opportunity that innovations never reach the last phases of the diffusion process. However, the phases of innovation as described here have become almost common-sense, which has much to do with the widely acknowledged theory on innovation as presented in Everett Rogers' 'Diffusion of Innovations' (1962, 1971, 1983, 1995). Rogers defined innovation as "an idea, practice or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1983, p. 11). Contrary to Schumpeters' ideas, Rogers' conception of innovation refers not only to renewal in production, but also to 'doing things differently' in the modes of provision, application and use. According to Rogers, not solely producers or entrepreneurs but anyone could be innovator. Diffusion, then, is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (ibid, p. 10). Perhaps the most well known classification in marketing and diffusion research is Rogers' adopter categories, the classification of members of a social system on the basis of innovativeness. Would-be consumers of innovations could be categorised as:

- Innovators (the first 2,5%)
- Early adopters (next 13,5%)
- Early majority (next 34%),
- Late majority (next 34%)
- Laggards (last 16%).

Not surprisingly, these categories fit well in the 5 phases of innovation as listed above. The five adopter categories are ideal types, which have to serve as a framework for the synthesis of research findings. Innovators are venturesome risk takers, belonging to the more cosmopolite social networks. Early adopters are a more integrated part of the local social system than are innovators. More often than other categories, early adopters are opinion leaders and role models for many other members of the social system. They decrease uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near-peers by means of interpersonal networks. The early majority adopts new ideas just before the average member of a social system and provides interconnectedness in the system's networks. The late majority is sceptical and cautious towards innovations and does not adopt until most others within the social system have done so. The pressure of peers is necessary to motivate adoption. Finally laggards tend to be suspicious of innovations, and rely on traditional values and experiences from the past. They have limited resources and are therefore extremely cautious in adopting innovations.

One should ignore the negative connotation of the term 'laggard' as it is rather the system than the individual to blame the reality of the laggards' situation (Rogers, 1983, pp. 248-51).

Both the works of Schumpeter and Rogers can be criticised for being too rigid and simplistic especially when it comes to consumer-action in processes of innovation. However both their works have been extremely important as being the first to put innovations at the core of social-economic change and therefore they contributed much to the understanding of economic development. Their conceptions of innovation and diffusion remain influential and useful in fields of business, marketing, and support programmes for new technologies. The conceptions miss however the refinement to facilitate a more in-depth analysis of the social processes that come along with invention, diffusion and adoption of innovations.

Sociological approaches

Apart from an economic viewpoint, innovations have been studied in an already wide tradition of sociology of technology and Science and Technology Studies. Since the 1980s, a school of thought has arisen that considers technological change not as an autonomous process but rather as a product of societal change. Some scholars even remove the distinction between technical and social change and speak of socio-technical change. The following explores the different viewpoints that have been developed in the sociology of technology.

Autonomous versus contextual change

In the days of industrial revolution, technical development was commonly thought of as an autonomous process. Nothing could stop the ever-growing collaboration between science and technology and inventions would regularly pop up autonomously, following the often impalpable pathways of technological or business-cycle logic. Although such views regularly recur in popular media celebrating new technological developments, the idea of an autonomous development of technology has successfully been challenged by many social scientists.

A major contribution from the social sciences was made by Nelson, Winter and Dosi (Nelson and Winter 1977, 1982; Dosi 1982) who developed a contextual approach in which technological change is conceived of as a succession of variation and selection processes within society. Technological defined problems constantly generate technological inventions or adoptions to existing technologies. Variation and selection of new technology do not occur ad randomly, but within certain limits that are determined by the so-called 'technological regime' (Nelson and Winter) or 'paradigm' (Dosi). A technological regime can be conceived of as the dominant cultural matrix of technology developers and encompasses a limited number of scientific principles, insights and heuristics and a limited number of artefacts (Mol, 1991). As such, technological development is pre-structured by the typical heuristics and basic existing technologies that belongs to the technological regime.

However the conditions and limits for technological change are given, this does not tell us much about change itself. The evolutionary models speak of 'technological trajectories' as to define the direction of change within the limits of technological regimes. A trajectory stands for the normal, conventional path and direction of development that is determined by regime conditions. Regime and trajectory are relatively inert as all new problems will be treated with the same heuristics and within the same trajectory of development. Revolutionary technological concepts in the sense of regime changes only rarely occur. A technological regime therefore restricts the development of technology for it reduces the number of variations of technologies possibly to develop. On the other hand, if solutions can be found by following the normal trajectory, technological development speeds up as all conditions in terms of required means and minds have already been set. Such an evolutionary approach still implies a relatively autonomous process of technological change as it is dependent or restricted by relatively autonomous factors rather than human or social factors. Besides, evolutionary terminology like selection and variation still presupposes some sort of an autonomous development path.

The evolutionary approach mainly contrasts with technological determinism in its understanding of the selection process. Selection can take place either between paradigms, between trajectories and within trajectories. The environment within which selection takes place has been identified as a whole of actors, factors and institutions, divided in three dimensions:

- Science and technology, including knowledge and knowledge infrastructure and existing artefacts;
- Economy, including factor costs, consumer demand, modes of production, level of competition etc.;
- Socio-cultural and political basis: power balances, dominant policy styles etc.

Given these sets of factors, it is needless to say that the relation between the selection environment and technology change is complex. Besides it is a mutual relationship in the sense that the selection environment not only steers technological development but is also subject to technological change itself. The assumed independence of the selection environment towards technological trajectories can in fact be challenged on several grounds. The notion of market selection environments assumes a clear separation of interests between supplying firms on the one hand and customers and regulatory agencies on the other. But these are surely not perceived as unalterable structural constraints by technology developers. Advertising influences consumer preferences and regulatory systems may become 'captured systems' of the industries they are supposed to regulate (Van den Belt and Rip, 1987, p. 141-142).

The evolutionary theory of technology development may be useful in analysing technical change concerning single technologies. Van den Belt and Rip (1987) provided a useful extension to the evolutionary approach in their discussion of the dynamics in the synthetic dye chemistry during the mid 19th century. They showed that influence on the selection environment often results in a 'nexus', a social institution that shapes the interaction between trajectory and selection environment. In the case of the synthetic dye industry this was illustrated by the functioning of test departments and the working of the patent system.

The analytical gap between 'technological trajectories' on the one hand and a 'selection environment' on the other remains however unsatisfactory when it comes to analysing the dynamics in larger technological systems. Pinch and Bijker (1987) argue that processes of variation and selection are in fact multi-directional instead of linear. One can only afterwards construct a line in technology development, which implies that variations that do not fit this reconstruction are ignored. Pinch and Bijker rather emphasise technology development as being an outcome of an (unequal) struggle of interest groups, which also defined the problems in the first place. Problems are solved by technology as soon as the most relevant groups conceive them as being disappeared. This social-constructivist point of view puts technology determinism radically aside. Consequently, it pays little attention to the role of existing technological structures in the development of new technologies. The latter seems however one step too far as far as large technical structures are concerned. In cases of large technological networks it would be too hard to neglect the role of already existing infrastructure and technology in processes of change. Technological trajectories seem nowhere as evident as in circumstances of fixed networks, where large scale investments have accumulated over the years and physically impede changes or alternatives to the basic features of the system.

Transition of Large Technical Systems

Network-bound systems can not be treated as single artefacts, but rather as technological systems uniting a whole range of interconnected technological artefacts as well as social actors managing, using and regulating these systems. The level of analysis should then be moved away from single technological artefacts towards whole technological systems as has been done by Hughes (1983, 1987), Callon (1987), Summerton (1994), among others. Hughes language in analysing change in electrical systems is closest to the evolutionary approach, while Callons' study of the introduction of electric cars into the French transport system is strongly based on social constructivist theories (Mol, 1991).

Hughes (1983) studied the evolution of local, regional and national electricity generation systems in the US, France and Germany between 1880 and 1930. Herewith, he has put forward systematic concepts to be generalised to other systems of similar scale and provides a rationale for delineating technological systems from other social systems, small or large (Joerges, 1988). The generalised model of this evolutionary process encompasses three phases. The first phase includes the 'radical invention', culminating in new technological systems, through 'development', involving economic and political embedding to the technological system, to 'innovation', putting the system into efficient use. The next phase is 'transfer', which refers to the mutual adaptation of the new system to environments different from the ones a system has been developed in. The third phase proceeds from 'growth' through 'competition' to 'consolidation'. In this last phase, the dominant system goals are rationalisation and efficiency. The engineer-entrepreneurs gave way to manager entrepreneurs and finally financier entrepreneurs.

Hughes introduced some structural features and tensions of evolving electricity systems: 'reverse salients', 'load factor' and 'momentum'. Reverse salients come up when systems grow. They are technical or organisational anomalies resulting from uneven elaboration or evolution of a system. Literally, a salient is "a line of battle or an expanding weather front. As technological systems expand, reverse salients develop" (Hughes, 1987, p.73). When a reverse salient cannot be corrected within the context of an existing system, the problem becomes a radical one, the solution of which may bring a new and competing system (p. 75). As an example of a reverse salient within electrical systems, Hughes mentions the change of the characteristics of a generator to improve its efficiency. Another component in the system, such as a motor may then need to have its characteristics altered as well to optimally function with the generator. When a reverse salient cannot be corrected within the context of an existing system (involving inventions done by system experts), the problem becomes a radical one (involving new inventors from outside the existing system), the solution of which may bring a new and competing system.

Another common phenomenon in the management of large technical systems is the 'load factor'. It stands for the ratio of average output to the maximum output during a specific period. It is usually presented in a curve, showing the peaks and valleys in daily - or weekly or yearly - output of electricity, gas, or water systems. The load factor not necessarily stimulates growth of large technical systems, but does steer it in specific directions. Diversification of demand is a way to spread peaks over time. Thus an extension over a larger geographical area with different industrial, residential and transportation loads provides increased diversity and the opportunity to manage the load to improve the load factor (Hughes, 1987, p. 72). The load factor is the main starting point for utilities developing so-called demand side management strategies as I will show in section 3.3.

According to Hughes, technological systems do not become autonomous: they acquire 'momentum', also referred to as dynamic inertia (Joerges, 1988). All organisations and people with certain interests in a system add to the system momentum. Manufacturers, utilities and regulating bodies, inventors, managers, owners and investors often have vested interests in the growth and durability of a system. Practitioners, maintaining engineers further the system as it is to avoid de-skilling. The notion of system momentum is close to the notion of technological trajectory from the Nelson-Winter/Dosi model. Hughes emphasises that momentum is not equal to system autonomy as he also provides examples of system momentum being broken due to reverse salients in system development.

Although Hughes emphasises that momentum does not contradict to the doctrine of social construction of technology and does not support technological determinism (1987, p. 67), yet actors' roles in system change are still treated rather one-sidedly. In Hughes system approach, actors merely seem to function as carriers of the system while their social practices are explained only in terms of their function for the system:

> "A crucial function of people in technological systems, besides their obvious role in inventing, designing, and developing systems is to complete the feedback loop between system performance and system goal and in doing so to correct errors in the system performance" (Hughes, 1987, p. 54).

Now that I have briefly explored the theories putting the system in the centre of analysis and making actors as subordinate or 'functional' to it, I now go on with the approaches that promise to put the action in the centre, in other words that emphasise the role of actors in technological or system change. The French sociologist Callon (1980) has in his work elaborated the role of actor worlds and actor networks in technological change. He started from the premises "that development of scientific knowledge and technological systems cannot be understood unless the simultaneous reconstruction of social contexts of which they form part is also studied."

The reconstruction of social contexts is done through a number of steps, starting with describing the actor world: a list of entities and a list of what they do, think, want and experience. Callon uses a broad definition of entities comprising the actor world: they are not limited to human actors alone, but also include the relevant artefacts. So in his evaluation of an ambitious plan to construct an electrical car in France, issued by Electricité de France (EdF) in the early seventies, Callon deliberately included electrons, catalysts, electrolytes and lead accumulators as entities of the actor world that were supposed to change in order to make the plan a success. Callon's main observation of the plan to construct the electric car was that EdF not only prescribed the construction of an artefact, but also the new roles for consumers, research institutes, car manufacturer Renault, a number of Ministries and so on. In the plan, EdF serves as their spokesman and defined the roles, distributed them and delineated a full scenario of things to happen. However, since entities of actor worlds are not easily translated, the destiny of most spokesman is to be brutally contradicted, which in fact happened in the case of the electric car development. Apart from acting as spokesman for all entities concerned, a second form of translation includes a mapping out of a geography of 'obligatory points of passage' within technology development, which could mean for instance the involvement of research institutes to improve performance. A third form of translation is that of displacement of people, information, funding and materials in seminars, projects, or pilot programs. However in the end, translated entities could follow other routes or be brought into other projects and escape the logic of the actor world in which they have been enlisted.

Entities in the actor-world only exist in their context: in juxtaposition with other entities to which they are linked. The power of Callon's model is that it considers relationships between entities that overflow the categories of contract, power or domination known from sociology and economy. In the analysis of the electric car plan, the model served to be highly convincing in explaining the eventual failure of the program, mainly because it put the actors in the centre of analysis. Herewith the model represents the opposite of deterministic models concerning technology development.

A major point of critique to the model refers to its conception of actors and action. By making no distinction between human actors and physical artefacts as entities of an actor network, Callon mystifies the fact that human and non-human entities have different roles to play in technological change. Obviously, artefacts do not and can not have intentions. Artefacts may 'act' within an actor network, but only as a result of and as a subject of human action. Suggesting that technological artefacts have other roles to play than the roles attributed to them by human actors makes the evaluation of technological change rather implausible.

If we accept that technological change is always the result of interactions within a network of social actors, we are now able to focus our attention on specific actors within the networks. The sociology of technology as discussed so far has dealt with how such networks are built, what keeps them together and in what way they determine technological trajectories. These are all investigations from the outside in. In reality network actors - especially consumers - rarely deal with such questions. Therefore I wish to focus on the place of the consumer or end-user in the network and try to view the network from a consumer's point of view. I will discuss two ways of approaching such a challenge.

The first route is to find out where and how consumer choice concerning new technologies is shaped and framed in the process of technology development. This is the enterprise Cowan (1987) has undertaken by introducing the consumption junction: the place and time at which the consumer makes choices between competing technologies.

A second, more pro-active approach is to find and try procedures to successfully involve consumers in the early processes of technology development. This is done in the Constructive Technology Assessment approach and its derived approaches of strategic niche management and finally transition management which encompasses the change of technological systems over the long term.

First I explore the consumption junction as it may be a proper basis for theoretical embedding the more procedural CTA approach.

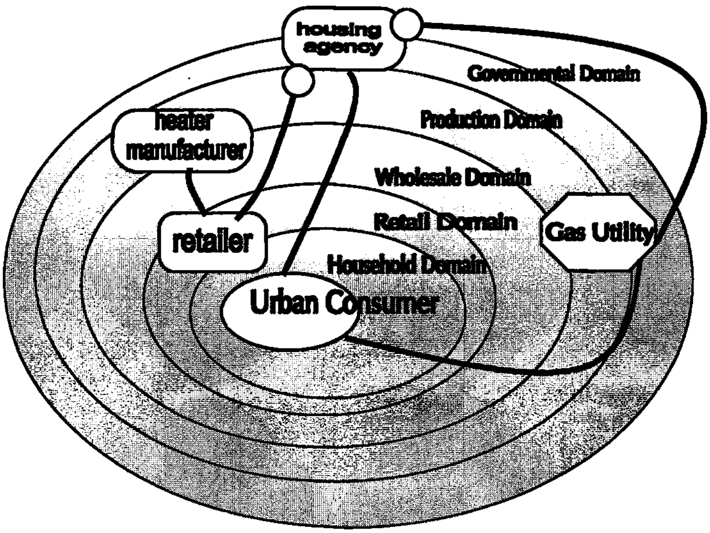
The Consumption-Junction

The term consumption junction is introduced by Cowan to pinpoint the time and space in which innovations are actually brought into use. It is in fact the most crucial point in diffusion processes. A positive decision by the consumer at this point is what technology developers aim for (Cowan, 1987). In respect of the consumption junction consumers should be defined in terms of the artefact or service about which they are making choices. This implies for instance that one should distinguish a person's domestic electricity consumption from the same person's energy use at work. This is well in line with the system of provision approach as presented in the previous chapter, although the focus here is on consumption rather than provision. According to Cowan, it is not the consumer, but his or her consumption choices at a certain place and time that matters.

Starting from the consumer side does not necessarily mean one obtains a consumer bias. The kind of study Cowan proposes is to start the analysis at the consumer side but subsequently consider each step in retail, wholesale, production and governmental domains where consumption decisions are made. It brings into relief the variables that have governed the behaviour of all those relevant social groups who influence consumers' choices. In this way Cowan has studied the whole system of provision of stoves and heaters in the United States from colonial times to present and showed that innovations not necessarily alter the design of artefacts but may rather encompass an alteration in the structure of the industry that manufactured them. But what was better in technical terms was not necessarily better in consumption terms.

To illustrate the kind of analysis Cowan proposes, the figure below shows the connections between different actors in the system of provision and consumption junctions in case of Dutch house tenants and how their heating systems are generally diffused.

Figure 3.1: Example of a Network for Heater Systems. (The small circles indicate the consumption junction (Reworked scheme from Cowan, 1987))



While moving from the consumer domain to the household domain and from there to the retail, wholesale and production domains, one could evaluate the pressures and the interests that may be affecting actors in each domain. In each stage of evaluation, the judgement whether technological change is an improvement will differ. The consumption junction is not necessarily located on the edge between household and retail domains. In the case of heating systems, it may well be located in the governmental domain, as public housing agencies in many cases decide on which heating system will be installed. In case of water or energy utility systems and related household technologies, one may find the consumption junction at governmental or production domains.

This form of analysis does not penetrate deeply into the early processes of innovation. Instead it opens the black box of diffusion. As most artefacts have different forms and meanings at each stage of the process that ends with use, an analysis that ignores the diffusion stage would definitely fall short. Moreover, if a researcher properly deals with the diffusion of artefacts, light might be shed on invention, development and production as well. By including the network in which the consumer is embedded, attention is paid to various social groups who might not have been otherwise considered such as the public housing agencies in the case of diffusion of heating systems (Cowan, 1987, p. 279). Besides, this form of analysis reminds us that different social groups can, because they are embedded in a complex network, produce effects that may be quite different to what they intended.

Constructive Technology Assessment

A second way to deal with changing technological networks from a consumer point of view is to formulate procedures and their preconditions to involve end-consumers in technological change. This is done within the Constructive Technology Assessment

(CTA) approach. Originally CTA holds that societal problems can and should be solved by technology through a 'widening' of processes of technological design. Widening in this context means the active involvement of societal actors in design through 'dialogs', 'scenario workshops' or 'citizen reports'. Societal actors are those who encounter the effects of new technology and who initially do not play a role in its development, such as consumers, employees, companies and NGOs. Not every widening of design processes can be labelled as CTA, for CTA specifically aims at processes of anticipation, reflexivity and societal learning. CTA practices may therefore be viewed as a criticism towards existing practices of technological design. (Schot, 1996, p. 265-266). Schot's argument on the three issues can be summarised as follows:

Anticipating

Anticipating the societal effects of new technologies requires the involvement of societal actors in the design process of technology. Such involvement should not be structured too much: in any case actors should be enabled to define their problems and ideas for solutions themselves instead of only filling questionnaires made up by designers of an almost finished product. The emphasis on anticipation does not imply that all societal effects can be predicted. During technological development, several paths are taken, although certain technological trajectories are recognised. Anticipation should therefore be considered and executed as a continuing process in time and technological change should be as flexible and repairable as possible to be able to adapt to new insights.

Reflexivity

Designers do not only design technology, they generate social effects at the same time. CTA activities try to encourage actors to recognise (hidden) scripts and to understand the co-production of technology and its social effects. This can be done through deliberation, but most of the times such recognition comes up in social controversies. Controversies may be functional for technology development, as long as they do not, as in many cases, separate technical facts from their social reality in which technologies operate.

Societal learning

If technological design can be conceived of as a process of linking design requirements, production structures, market conditions and cultural preferences, then it is evident that actors can learn during all processes. Most commonly however, learning processes are only linearly organised, which means that societal effects are only taken into account after products or processes are optimised and production structures and market conditions are adapted. In this way, the learning process concerning societal effects only concerns an already known technical configuration. In that stage it is hard to change initial designs. Within the CTA approach, there are two levels of societal learning. The first one is to specify and define own designs. The second level is to learn about own assumptions and scripts in order to generate ideas and new questions.

Anticipation, reflexivity and societal learning presuppose each other. For instance, without some kind of reflexivity in actors' choices and practices, societal learning would not be possible. Although the approach is normative in its outlining of procedures for 'good practices' of technology development with the ultimate goal to develop 'better' technology, or better embedded technology (Schot, 1996, p. 287), CTA does not specifically aim at democratisation, environmental sustainability or social equity. However such outcomes could be the (unintended) effects of it.

CTA activities include governmental technology policy declarations which emphasise dialogue and articulation of demand and acceptability of new technology. There is however no special effort at feedback other than publicising results and hoping that technology actors will respond. There are however some more concrete examples of CTA practices[2].

CTA is not a process that is run by technology developers and consumers only. Neither does it take technology as a given with societal impacts as a result. Instead, the process dynamics are central and impacts are viewed as being built up and co-produced during the process of technical change. Societal impacts are not just passive effects of a given technology on its environment, but are actively sought (or avoided) by technology producers, users, and third actors such as governments, unions, pressure groups and the like. These actors are co-producers of impacts (Schot and Rip, 1997, p. 257). Such co-production processes include anticipation, learning and reflexivity. Apart from that, also the properties of technology or artefacts co-evolve with the interactions occurring during development, implementation, adoption and wider use.

As to bring a so far mainly theoretical CTA approach further in to practice, Schot and Rip (1997) identified three possible implementation strategies. The first one is called 'technology forcing', which is commonly used to indicate an effect of government regulation. Technology forcing is the prescription of specifications to be achieved by new or adapted technologies, without specifying the characteristics of the latter. An example is the setting of a policy goal to reduce energy sector's CO_2 emissions with a specific percentage in a certain time period. Not only governments are involved in technology forcing, but also other actors such as insurance companies, banks, user-firms, and NGOs. They do not have the formal authority to make standards mandatory, but in practice they do set the limits and pre-conditions for technological development. Insurance companies may demand compliance with certain safety standards and thereby force a specific technology to be applied, while manufacturers may impose demands on their suppliers. By involving the public through the mass media NGOs can force companies to develop new technologies to reduce emissions.

Although technology forcing enables actors to anticipate and shape their R&D strategies, the approach has some severe drawbacks. Actors may well contest the feasibility of the requirements and use this as an argument not to work in the desired direction. Eventually, this can turn into a self-fulfilling prophecy. Besides, impacts of policy measures are dynamic: they evolve across the course of development and implementation. It is therefore difficult to assess an optimum strategy at forehand.

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2 A widely branched project on Sustainable Technology Development (DTO) provided images of a future sustainable society that were used to publicly discuss the technological development paths that were needed to achieve such goal. Another de facto CTA activity is the closing of material cycles through networks aiming at integral chain management in which waste handling activities need to be connected to design and production activities. Lastly consumer and pressure groups have become interested in building 'nexuses' between technological centres and society and participate in platforms to discuss new products and technologies with firms (Schot and Rip, 1997).

Instead of starting at the regulator that formulate requirements to future technologies, one can also start at the level of technology developers and ask how processes of development and diffusion can be broadened from the start. New alternative technologies such as wind or solar energy generation may need some special support because of their initially uneconomic scales of application or their non-fitting in prevalent technological trajectories. Governmental support and subsidies may be needed, but there is a risk that they result in technologies with limited social robustness or viability in the marketplace. 'Strategic niche management', the second generic strategy for CTA, may partly solve these problems. It can be defined as "the orchestration of the development and introduction of new technologies through setting up a series of experimental settings ('niches') in which actors learn about the design, user needs, cultural and political acceptance and other aspects" (Schot and Rip, 1997, p. 261). Within such time-space niches, the learning processes should take precedence over the goals of the technology actor. Most experiments with new technologies are often not used to learn about possible new linkages between technology, demand requirements and social acceptability. Through strategic niche management anticipation of later phases in the process of introducing a new technology to broader social issues should force technology developers to broaden the design and development process.

A third generic strategy to apply CTA focuses on the interactions between demand and supply of technology and attempts to create 'loci for reflexibility and feedback': workshops, forums and other institutionalised linkages between supply and demand. Several of such meeting points already exist: consensus platforms, client panels and focus groups, test labs and trials. However, most often these are only temporal, offer only limited feedback and do not include an exploration of new linkages between technology, demand requirements and issues of social acceptability. To make them effective for CTA, the existing nexuses should be broadened as to allow for processes of learning, anticipation and reflexivity.

Evaluating, Constructive Technology Assessment is an approach that is much more specific concerning the roles of actors in technology development than in the Large Technical System approaches of Hughes cum suis. Its strength lies in its recognition of the linkages between technology development and societal effects that have been superficially separated in modernist views. It proposes a number of practical procedures to involve users and other actors as well as anticipated societal effects in the design of artefacts and technological systems.

Technological Transition Management

One of the lines along which CTA and especially strategic niche-management strategies have been developed is into that of 'transition management', a reflexive technology policy approach on the changing of large socio-technical systems in the long term, through the facilitation of small initiatives (technological and market niches). The approach opposes those of technological forecasting and scenario studies as these are based on rather simplistic assumptions on technology dynamics. Many of such technology related anticipations are based on a lineair model of technology development, which leads to only a limited choice of either supply-push or market-pull policies. Instead, it is stressed that tech nology policies need to take into account the complexities and social processes involved in technology development (Geels, forthcoming).

The approach stems from a 'multi-dimensional' framework that consists of three levels (Kemp et al., 1998)

- A micro level of technological niches: 'protected' spaces in which actors learn in various ways about new technologies and their use;
- A meso level of socio-technological regimes: rule sets that are build up around a dominant technology and grant it stability;
- A macro level of socio-technical landscapes: a range of contextual factors that influence technological development but that cannot be changed by technology actors.

The meso level of socio-technological regimes is crucial in this respect. It refers to the cognitive, social and technical rule-sets that are embodied in practices, artefacts and organisations. The rules are carried out by a heterogeneous network of social groups: producers, providers, users, financiers, researchers, NGOs and governments. Due to mutual adaptation, the network actors together contribute to coherence and continuity in the socio-technological regime.

The socio-technological landscape provides the broader context for regime and niches. The landscape metaphor refers to the structural character of its influence to technological development: the technological trajectories are guided by the gradients in the landscape. Changes in the landscape only occur gradually and slowly. A transition can now be defined as a gradual process of societal change, in which there is a structural change of characteristics of society (or a significant part of it). Geels (forthcoming) describes a technological transition process as follows:

> "A novelty emerges in a local practice and becomes part of a technological niche when systems builders are able to form a network of actors that share certain expectations about the future success of the novelty, and are willing to fund further development and learning processes. The technological niche is formed against the background of the existing regime and landscape. The further success of niche formation is on the one hand linked to processes within the niche (micro level) and on the other hand to developments at the level of the existing regime (meso-level) and the socio-technical landscape (macro-level). In the niche the technology is improved. Under certain circumstances it may find a place in certain market niches. When the market niches expand, the technology may transform or substitute the existing regime. In a later stage, the new regime may even trigger changes at the landscape level."

Whether a regime shift will occur is dependent of a coincidence and coupling over time of successful processes within the niche, reinforced by changes at the regime level and at the level of socio-technical landscapes. This process is represented in Figure 3.2.

Figure 3.2: A Dynamic Multi-level View of Regime Shifts (Rip and Kemp, 1996)

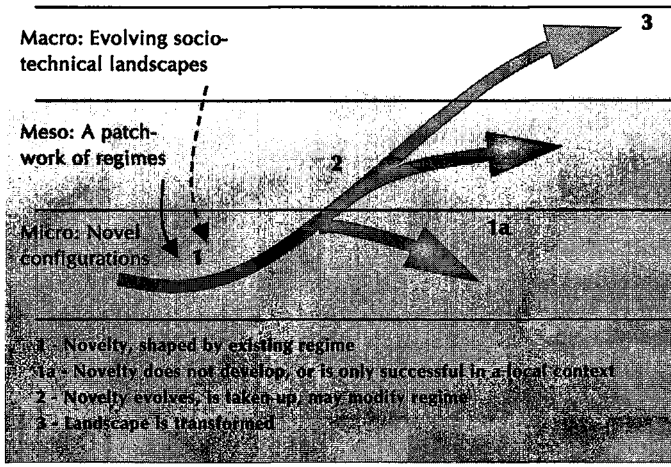


Figure 3.2 illustrates that every technological transition starts at - and is shaped in - technological and market niches at the local level. At the same time it shows that the diffusion of a new configuration is highly complex as it presupposes simultaneous changes in socio-technological regimes and landscapes.

The implication for the management of transitions is that most policy effort needs to be directed towards the facilitation of technological and market niches at the local level. Although the several involved actors do envisage some sort of end goal for the transition process, it is important to realise that form and content of the transition process are not determined in any sense. During the transition process actors adapt to, and learn from new situations arising in the course of development. Hence, transitions refer to possible routes, the direction speed and magnitude of which can be adjusted over time.

The role of eventual users of technology in the transition process is not clearly described although it leaves no doubt they belong to the social networks that steer and/or adapt to socio-technological change. The management of technological transitions is however first and for all directed to technology providers and institutional actors, rather than to citizen-consumers. Though citizen-consumers involvement in transition management would be recognised in case they initiate (or participate in) technological niches such as pilot projects on sustainable housing.

Evaluating Consumer Roles in Theories of Technological Change

All approaches towards technology and system dynamics that have been discussed so far have in common a focus on design and invention of new technology. Reviewing them has provided insights in how and why systems change, and especially offered some valid explanations why systems do not change at all. In all approaches, the role of social actors in technology or system change has been challenged. However, none of the approaches satisfies on this part, as the focus on system dynamics remains dominant. Large Technical System approaches lack a proper analytical tool to explain social interaction that is not primarily aimed at system change but is yet relevant for understanding the daily operation of systems. Although citizen-consumers are no longer treated as end-users only, but rather as system builders, the LTS approaches still keep a system-bias in understanding citizen-consumer behaviour. Social practices are described and analysed only in terms of their relevance for system change. Also the CTA approach is in the end an attempt not to involve social actors in technological development per se, but to create 'better technologies'. However, as we have seen before, the 'betterness' of artefacts eventually depends on the diffusion phase of technology, or more specifically on the consumption-junction. The contribution of the transition management approach is that it recognises the fact that technology development cannot be anticipated linearly from contemporary technology development but rather conceive it as an outcome of a reflexive societal process that cannot be fully anticipated. Yet, transitions can be managed by creating technology and market niches in which different options for transitions can be tested, some of which may evolve into changing socio-technical regimes.

Having discussed social theories on the role of social actors in processes of development, innovation and diffusion of technology within technological systems, the phase that is left thus far is that of operation or management of large technical systems. Rather than suggesting that these phases follow each other in a linear process, I would argue that change or invention, diffusion and adoption of new technologies is a cyclic process. In the next section I turn to the management or operation of technological systems, with a focus on network-bound systems. As a consequence the role of actors is elaborated not only as being potential 'system builders' (as in the CTA approach), but also as daily users and 'system operators'.

3.3 Approaches to Network-bound System Management

Theorising technological change in large technical systems departs from the 'hardware' of large technical systems and goes on to explore factors and actors within and outside of technical systems that in one way or the other determine technical change. The core object of the management approaches to be discussed in this section is not the hardware of large technical systems, but rather its software. Organisation of systems, modes of provision, configuring supply and demand are crucial, although the systems' hardware is taken as a main determining factor for the construction of management models.

As already pointed above, centralised and highly integrated large technical systems most likely have the form of a grid, or a physical widespread network. A network-bound system is a special form of LTS: a socio-technical system that is organised around a specific distribution channel that has been built solely for the purpose of delivering the system's specific commodity to its final destination (or providing its service to end-consumers) (Summerton, 1992, p. 75). Our modern homes are connected to lines of telecommunication, the electricity grid, piped gas system, drinking water, sewerage, cable television system, which are all network-bound large technical systems with a number of specific features that have implications for their management (Chappells et al., 2000, p. 16).

Firstly, their products can be marked as essential for many of the basic practices within both households and industry. In fact they represent the material and energy flows which form the material sustenance base to our daily lives (Spaargaren, 1997). Typically, products and services offered by network-bound systems cannot be bought and brought home whenever there is a need for it, but come into the home in a continuous flow. Unlike the wide variety and specialisation one can observe nowadays in the world of goods, network-bound services are characterised by the fact that they are highly uniform, no matter place or time. Electricity comes in standardised Voltage, gas in standardised pressure and caloric value, water in average tap water quality and pressure.

The price of the products and services offered by network-bound systems is relatively inelastic. Consumption levels will only slowly reduce while prices rise. Some uses of energy and water services (heating, drinking, disposing) are in fact so essential that many would not even consider reducing consumption, even if prices were doubled. Because of this price-inelasticity, water or energy saving behaviour is difficult to achieve. In addition, consumption of network-bound services is largely invisible to consumers. Feedback on consumption is done by periodic billing, but this is often concealing, as tariffs are built on a combination of fixed and variable costs, taxes and levies.

Lastly, because building and maintaining the networks require heavy investments, there is generally only one network available while competition between providers is limited. In public utility sectors it is common to speak of 'natural monopolies'. The 'natural' refers to the fact that it is not efficient to run several water works or electricity grids in one region. In most cases, at least until recently, only one provider holds a 'natural' monopolist position in the utility market. As a consequence, consumers within such natural monopolist situation are called 'captive consumers', they have no choice but to make use of one particular network, operated by one regional provider.

The various management approaches of infrastructures that have been developed by economists and engineers take the unique technical features of network-bound systems as a starting point. Engineers focus on the technical aspects of the relationships between physical infrastructures and dependent functions: how can we design and maintain a water system that provides safe drinking water for all at any time of the day? Economists deal with allocation issues associated with the establishment and openness of infrastructure. While the engineers' and the economists' uses of 'infrastructure' seem disparate, they have in common that they refer to a phenomenon on which other functions (engineering) or activities (economics) depend. Basically infrastructure is important to engineering and to economics because of what is does (Firth et al., 1999, p.24). Hence, most economic and engineering definitions of infrastructures just specify the functions they serve: facilities and related institutions that provide water or gas or electricity, remove waste or facilitate the movement of people and goods. Such management approaches do not primarily discuss system change but rather provide insights in the operation of systems. In most economic and engineering approaches the management of systems seems to be restricted to the big actors, like managers, regulators, NGOs and the like, while citizen-consumers are the subjects of change, qualified as end-users, consumers, or simply 'the demand side'.

An example of an approach that has become popular among both engineers and economists is that of Demand Side Management (DSM). DSM approaches attempt to avoid environmentally and economically expensive supply investment, such as a new reservoir or power station, by managing both the level and timing of demand placed on networks through the implementation of energy and water efficiency. For instance, DSM could include network operators reaching 'beyond the meter' to develop more intimate relationships with some users in order to modify demand on 'stressed' parts of the network. Such initiatives create a new context within which infrastructure providers and users can form a shared interest in the tailoring of supply and demand providing a powerful impetus to energy and water efficiency measures (Guy and Marvin, 1996). DSM measures are not always designed or implemented for environmental purposes, often they are part of an economic strategy. Traditionally DSM has included strategies such as load management programmes, in which utilities attempt to even out peak loads to improve the efficiency of their generation and transmission networks or the promotion of energy efficiency measures to curb demand in certain 'stressed' areas of the network (Gellings, 1996). Connected to new resource ceilings (regulations on supply-building and the 'energy crisis'), DSM has been used to describe initiatives undertaken by - mainly - energy utilities, to manage their resources more economically and environmentally efficiently and develop more 'consumer-focused' relationships (Gellings, 1996; Siohansi, 1996).

It has been suggested that more demand-oriented approaches have provided "an ideal framework for engineers for whom consumers looked like kilowatt meters". The claim is that utilities have been able to develop a more integrated approach which looks at "technical options, customer needs and utility requirements" (Gellings, 1996, p. 285). Moving beyond the meter, utilities can now view consumers as a series of half-hourly or night and day loads who are switched on and off to match certain network capacities, or as a series of hot and cold spots on infrastructure networks (Guy and Marvin, 1996).

Although 'demand-side' implies a more active role for consumers in utility system management - compared to supply-side options - little is known about what these precise roles are. Although some attention has been paid towards the management of micro-infrastructures in the home and how consumers deal with a range of new efficiency devices, this has so far been limited. Consumer roles seem to be still tightly structured, as seen in the profusion of technical fix solutions (water efficient toilet cisterns, energy efficient light bulbs) or provider controllable storage and monitoring devices (heaters and meters). Explanations of how network-bound systems work from a DSM perspective paint a particular picture, one in which there are compartmentalised consumers who operate in a relatively unchallenging utility world of neatly arranged and largely provider controlled activities (Van Vliet and Chappells, 1999).

A more sociological approach towards network-bound infrastructure would rather focus on the social relations that come along in the development and operation of infrastructures as Per Otnes did in defining utility networks as collective socio-material systems (see chapter 2). Such a concept is attractive as it describes network-bound systems from an actor perspective rather than just describing its hardware or its functions. Installing, operating, using and maintaining network-bound systems are all collectively shared social practices, involving competent, knowledgeable actors, ranging from end-users to system managers. Otnes' perspective on network-bound systems opposes the idea that 'captive consumers' have become trapped in a 'technotope' in which their social actions have more and more become determined by large technical systems. These systems have become the 'public underpinnings of private life' as Otnes have called them, but the relations between consumers and providers are reciprocal: household consumption is merely the serving of and being served by collective socio-material systems.

If we take Otnes' concept one step further, and consider the collective socio-material systems from a management point of view, we may conceive citizen-consumers as operators of large technical systems rather than users or consumers alone. An example is that of road traffic regulation. Usually interest groups and power relations 'above' the road transport system - rather than social organisation and integration inside the system - are the focus of research (Juhlin, 1994). Typically for road traffic systems, however is that no single big actor is really responsible for the traffic system. Railways and air traffic have control centres, but there are as yet no equivalents for them in the case of road traffic as the technical integration between the network and the vehicle is very low[3]. "The car driver is king of the road with his vehicle as a perfect tool" (ibid. p. 294). Social interaction in traffic systems is based on formal and informal rules that can sometimes even come in conflict with each other. Norms of courtesy can put traffic rules out of order. Drivers may yield another car where they formally have right of way. These examples point to the fact that the large technological system of road transport is still extremely decentralised. To describe its operational system, a switch must be made away from large organisations towards the activities of individuals. In road systems, it is the sum of individuals with their own preferences, their compliance or non-compliance to formal and informal rules, which makes the system work.

Interestingly, Juhlin also suggests that such a perspective could as well be used for analysing centralised and highly integrated systems such as electricity or telecommunication systems, at least in historical sense, to understand how such systems have become as integrated and centralised as they are. But this is perhaps a too careful approach. Also in so-called highly centralised and integrated large technical systems, the role of users as being system operators is worth to be unveiled. Although not formally appointed to take up such roles, we can say - with Otnes - that citizen-consumers are serving and hence operating such systems as well.

3.4 Evaluation

Until this point I have reviewed a range of economic and sociological theories concerning technical change and operation of large technical or network-bound systems, and have questioned what these theories have to offer for understanding the role of citizen-consumers in changing or operating these systems. The several disciplines all have their own definitions of citizen-consumers and their roles in technical change and operation of network-bound systems. The table below summarises the different insights in consumer roles in changing and operating of network-bound systems:

[3] Juhlin's article (1994) is about centralisation of road traffic management with the help of new Information and Communication Technologies. Indeed, road transportation has since that time increasingly been integrated and centralised with the coming of traffic control centres, electronic toll-roads, and national traffic congestion information systems. Yet, Juhlin's argument of drivers being system operators is still valid.

School of Thought	Main object of study	Citizen-consumers specified as	Role of consumers towards technical systems	Main driver for change or system operation
Business Cycles Schumpeter	Innovation process	Consumers	Negligible	Innovative action of entrepreneurs
Innovation Studies Rogers	Innovation and diffusion	Innovators, early adopters, early majority, late majority, or laggards	Adopting or not adopting innovations	Perceived utility by adopters
Evolutionary Technology Approach Nelson/Winter and Dosi	Technical change	Selection environment	Selection	Variation and selection
Large Technical Systems Hughes, Joerges, Maintz	System change	No special reference. People are system components	To complete the feedback loop between system performance and goals	Reverse Salients / Radical inventions
Social Constructivism Callon	System change	Entities	Social interaction within the actor world	Interacting entities within the actor world
Consumption Junction Cowan	System Change	Consumers of specified artefacts	Buying or not buying artefacts	Decisions at consumption junctions
CTA Schot	Technology assessment	Actors	Co-designing technologies	Involvement of societal actors in technology design
Transition management Geels, Kemp, Schot	Long term Technological Transitions	Actors	Initiators, modifiers, adopters	Novelty development in technological niches
DSM Gellings and Chamberlain	System management	Customers	Matching network capacity	Expected efficiency gains
Chreseology of Consumption Spaargaren, Otnes	Operation of systems	Knowledgeable agents	Serving and being served by collective socio-material systems	Reciprocal action by consumers and providers
System Operation Juhlin	Operation of systems	Users / consumers	Operating systems by using them	Sum of individual preferences, compliance or non-compliance to formal and informal rules

The conclusion of this overview is that theories of change and operation of technical systems - apart from the used terminology - only slightly differ when it comes to specifying the roles of system users or consumers. If we put aside the CTA approach, which deliberately tries to formulate procedures to involve end-consumers in technological change, there are only a few approaches that present consumer action as a serious driver in technological change or system operation: those of Juhlin, Otnes and Cowan. The other ap proaches may - but not necessarily so - include citizen consumers as they speak of 'social actors', 'societal actors', 'actor networks', 'the demand side' or 'selection environment'. Most of these approaches assume however a rather passive role for eventual users of the system.

In sum, the review has shown some valuable ways of assessing citizen-consumer roles in operating or innovating network-bound systems of provision. The goal was not to see 'heroic' citizen-consumers as the agency best capable of undertaking, or to be empowered to undertake, the social and ecological engineering that is otherwise beyond the reach of the system of provision. However, it is still worthwhile to keep track of the changing provider-consumer relations in systems operation and system change as Cowan has shown in her analysis of the consumption junction. The success of any innovation or system change can only be assessed if consumers are eventually able to adopt them and incorporate them into their daily practices.

Environmental Innovation in Network-Bound Systems and the Consumer

This study is aimed at evaluating changing provider - consumer relations in the ecological modernisation of electricity and water systems. Any strategy towards ecological modernisation, as it will be argued in the next chapter, is dependent on processes of environmental innovation. Although diverging in many ways, the approaches discussed here have in common that they link processes of technological innovation with social action and societal effects. Also in case of environmental innovation it is relevant to assess its social embeddedness and societal effects. Hence, discussing the greening of consumption should be linked to a discussion of greening of the systems of provision that are serving - and are being served by - consumption practices, as I argue in the next chapter on ecological modernisation theory. The review of literature on technological and system change and management helps us to assess the possible roles of end-consumers in environmental innovation processes.

As this counts for all systems of provision, the systems of water and electricity provision deserve special attention when it comes to environmental innovation and consumer involvement. Systems of water and electricity provision belong to the intermediate structures that relate citizen-consumers to the natural environment. Drinking water provision links personal health and safety to issues of water pollution and water scarcity. Electricity consumption links what has become a basic need to energy scarcity, risks of energy production and global warming. In other words, normal daily life practices on the one hand and environmental effects on the other are linked in a specific and direct way, namely through large-scale technological networks that are socially and technically connecting consumers to providers and to each other. The lessons learned from general sociological and economic literature on innovations can well be taken on board in evaluating the specific consumer-provider relations in the ecological modernisation of utility sectors.

4 Ecological Modernisation Theory and Network-bound Systems

4.1 Introduction

The study of new consumer-provider relations in the environment-induced changes in water and electricity provision not only requires an assessment of the role of consumers in the operation and development of network-bound systems as has been done in the previous chapter. So far, I have not yet explained what 'environment-induced changes' are, nor have I presented my hypotheses for the study of environment-induced changes in water and electricity systems of provision. For both purposes, the theory of ecological modernisation offers the general guidelines. Hence, this chapter provides the framework to help explain the phenomena in my study of new consumer-provider relations in water and electricity provision. The next section introduces the core elements of ecological modernisation theory and explains how the theory will be used in evaluating consumer-provider relations in environmental innovations. Section 4.3 subsequently lists the hypotheses on the expected changes within provider-consumer relations in water and electricity systems. The chapter concludes with an epilogue on the use of the hypotheses in the empirical chapters thereafter.

4.2 Ecological Modernisation Theory

Ecological modernisation theory has its origin in the 1980s when a number of social scientists started to study environment-induced changes in the industrialised world (see Huber 1982, 1985; Mol and Spaargaren, 1992; Mol, 1995; Hajer, 1995; Spaargaren, 2000). Not surprisingly, with 'modernisation' in its title, it is a school of thought that considers the modernisation process not as an impediment, but rather as a vehicle on the road to sustainability. Hence, ecological modernisation theory opposes the schools of thought that have become known as de-modernisation theory and counter-productivity theory, which dominated the environmental debate in the 1970s and early 1980s.

De-modernisation is the common denominator for Goldsmith's model for an alternative green society in his 'The Blueprint for Survival' (1972); Schumacher's (1973) plea for small-scale technology adapted to its social and natural context and Bookchin's (1980) plea for a cell-tissue society where small cells operate as autonomous political units and decide about their own future. Counter-productivity theorists like Otto Ullrich, Ivan Illich, and Barry Commoner plead for taking into account the real costs of modern production and consumption, including the environmental costs. They argued that industrial development may bring prosperity in the short run, but this inevitably leads to a certain socio-critical point from which the rewards of sustained growth in the material dimension are outweighed by the costs of the socio-environmental dimension. From this point, technologies or sectors of industry are said to be counter-productive (Spaargaren, 1997). These theorists not only criticised modernity for its unequal social relations of production, like Marxists, they also criticised the nature of the production forces and the very character of capitalist growth-led production in general. Environmental degradation, then, is one of the inevitable outcomes of such industrial development beyond the socio-critical point.

Ecological modernisation theory does not criticise production forces or economic growth per se. However it suggests some major shifts that have to be made in the modes of production and consumption. Initially in the 1980s, ecological modernisation theory emphasised the role of technological innovations in environmental reform, especially in the sphere of industrial production. Besides it was critical towards command-and-control ways of governance by the state; had a favourable attitude towards the role of market actors, and had a rather limited notion of human agency and social struggles. Later on in the 1990s, the emphasis shifted from technological innovation to the roles of states and markets as well as the cultural dynamics of ecological modernisation. From the mid-1990s on, the scope of ecological modernisation theory has been broadened including ecological transformation of consumption, and ecological modernisation in non-European countries, including less developed and transitional economies (Mol and Sonnenfeld, 2000).

Ecological modernisation theory has gained a number of connotations over the years. Apart from being used as a social theory, it has been considered as the conceptualisation of a new paradigm in environmental politics and policy. The new paradigm is based on a "fundamental belief in the progress and the problem-solving capacity of modern techniques and skills of social engineering" (Hajer, 1995, p. 33). As such, Hajer considers ecological modernisation as a (dominant) social discourse in contemporary Western societies, rather than an explanatory social theory. Furthermore, several political parties and environmental movements in Europe claim to have adopted the political programme of Ecological Modernisation (see: Van Driel et al., 1993).

Contrary to these connotations, ecological modernisation is here considered as a theory of social change. The theory reflects on a process of institutionalisation of environmental concerns within industrialised societies. It predicts that in restructuring modes of production and consumption, ecological concerns are increasingly becoming an autonomous, independent rationale aside from economic, ideological and socio-political considerations. Furthermore, private economic actors and market mechanisms are supposed to play an increasingly important role in environmental reform, while the role of state agencies changes from bureaucratic, top-down dirigism to 'negotiated rulemaking' and the creation of favourable conditions for such transformation processes. It is also believed that environmental NGOs expand their traditional strategy of keeping the environment on the public and political agendas toward participation in direct negotiations with economic agents and state representatives and the development of concrete proposals for environmental reform (Mol, 1995).

The theory not only considers institutional changes, but also changes in technology and its organisation. It sketches a gradual shift from the use of end-of-pipe technologies (such as filters and waste treatment after emissions being produced) towards process-integrated and prevention technologies. However, the theory does not exclusively put technological change at the forefront. The emergence of environmentally sound and process-integrated technology is merely the result of changes in social practices within production and consumption cycles.

Finally, ecological modernisation theory reflects on the role of citizen-consumers in the organisation of production-consumption cycles (see chapter 2 and Spaargaren, 2000). By applying Giddens' structuration theory and Otnes' derivation from this in the case of household consumption, Spaargaren has extended the reach of the theory to (household) consumption practices. In line with this, citizen-consumers can be considered partly as consumers and partly as system-operators of network-bound systems. They participate in the organisation of production-consumption cycles and therefore could be sensitive to the principles that have guided ecological transformations in other sectors of society as well.

Ecological considerations may - both in production processes as well as in practices of domestic consumption - lead to dematerialization, monitoring and monetarisation of resource use and substitution of non-sustainable resources with renewables. Dematerialization in terms of consumption refers to a shift from the consumption of products or commodities to the consumption of services, which in general renders considerable lower environmental impacts. The monitoring of resource use and waste streams of both production and consumption processes can be considered as a first step in making the so-far invisible externalities to the environment visible to the actors producing them. Such monitoring is in any case required for the monetarisation of resource use: pricing resources and waste streams, which reflect the environmental costs apart from direct costs. A final step in ecological transformation of production and consumption is the replacement of the utilisation of depletable resources, or unsustainable exploitation of natural resources, by renewables.

The relevance of the principles mentioned varies depending on the context in which they are applied. If we consider water and electricity provision and consumption in the light of the principles, the following picture emerges. When we compare energy and water supply with 'normal' commodities and products, dematerialisation seems not as significant as in other sectors. There are hardly any 'dematerialised' alternatives to electricity and water uses in households, composting toilets (which don't use water to flush) and wind-up radios being the exemptions.

However, monitoring and monetarisation are important aspects in all infrastructures of consumption. Monitoring means first of all making the invisible visible. Water and energy systems of provision have been developed in such a way that consumers hardly take notice anymore of their use of these systems; the infrastructure of energy and water services is something 'out there'. Consumers are 'being served' by collective social material systems without caring too much as to how and why these services are provided. From the 1970s onward, several waves of environmental concern are translated into a diversity of projects aimed at a better management of energy and water at the domestic level. Projects aim at monitoring the different qualities of substance flows like water, energy and waste are among the most prominent and frequently observed innovations. The forms however vary substantially. There are forms of monitoring which serve environmental goals in a socially regressive or socially progressive way and there are monitoring set-ups organised remotely from social actors or in the form of active system-management by consumers themselves. Monitoring devices are developed in this context not only to be able to set a 'real' price for environmental goods and as a precondition for self-monitoring of environmental behaviour by feed-back, in many cases they also implicate a redistribution of power between consumers and providers.

Substitution of unsustainable resources with renewables is also a major issue in water and electricity systems of provision. Renewable energy sources replace fossil and nuclear fuelled generation, and renewable water resources replace unsustainable water uses, but in both cases it is unlikely that this will reach completion. Rather, a gradual substitution to some level is more likely. An extended mix of resources from which electricity and tap water are generated would be the result. Such substitution does not mean anything to citizen-consumers if utilities wouldn't make it a part of their marketing strategies. It provides a possibility to differentiate the so far uniform, standardised services. Hence, substitution with renewables and some kind of product and service differentiation are closely related in water and electricity systems of provision. For example, the substitution of fossil fuelled energy with wind or solar energy is being taken up as an opportunity to differentiate electricity tariffs in green and normal electricity.

Environmental Innovations

I utilise ecological modernisation theory - and its inherent steps of monitoring, differentiation and substitution - for the analysis of relations between providers and consumers of electricity and water by focussing on the social implications of 'environmental innovations' in these systems of provision. Reverting to what has been said about this in chapter 2 and 3, innovations are accomplished in techniques, but also in procedures, financial agreements, and all other institutions that make the production-consumption cycle go round. Environmental innovations should primarily reduce the consumption of natural resources and improve environmental quality, and to safeguard both achievements on a long-term basis. It should also result in a better costs-benefits ratio than previous activities (Weidner, 2002). The success of environmental innovations can only be assessed when its diffusion and adoption by final end-users has been successful as well.

Not all environmental innovations are of interest for this study. I will only deal with those environmental innovations in electricity and water sectors that encompass some change in the relations between citizen-consumers and providers. I assume, in other words, that relations between providers and consumers can and will be reconfigured through at least a number of environmental innovations. Besides, although the way in which consumers relate to providers is an essential part of consumer practices in which water and electricity are involved, environmental innovations also have their impact on other segments of social practices. Then they involve some kind of de-routinisation of actors' behavioural patterns. A clear example of such de-routinisation is when systems fall out, as in cases of blackouts in the electricity supply, or contamination of drinking water in the distribution system. Long established habits and routines such as drinking tap water or watching TV have become impossible or dangerous when tap water is contaminated or when electricity is cut down. Less dramatic is the switch that Dutch consumers had to make in the 1960s when the provision of natural gas led to a rapid replacement of many in-house electrical or coal fired appliances. All such occasions implicate the adoption of a different pattern of serving of and being served by collective socio-material or network-bound systems. Environmental innovations could as well implicate the establishment of such new routines, which can be an obstacle for actors representing the socio-material system as well as for citizen-consumers.

Apart from affecting domestic consumption practices directly, environmental innovations affect either the mode of production, provision, access, use or more of these aspects at the same time. For instance, green electricity is an environmental innovation that - compared to conventional electricity supply - encompasses a different mode of production (renewables) and a different mode of provision (separate tariff system), which in turn has its effects on the mode of access (as not every-one can afford to pay a higher price for electricity). The mode of use will remain the same in most cases, as the electricity delivered is not distinguishable from conventional electricity supply.

Summarising: apart from reducing environmental impacts compared to conventional electricity and water provision, the environmental innovations that are selected for this study, cause some change in consumer-provider relations and some deroutinisation in domestic practices.

4.3 Hypotheses on Consumer-provider Relations in Water and Electricity Provision

Ecological modernisation theory has been utilised to study several specific industrial sectors in divers policy contexts[1]. The question is whether the theory is also helpful in the study of environmental reform in systems of water and electricity provision. Which empirical questions could be solved with the help of such theory and what would the study

1 For instance: Chemical Industry (Mol, 1995), Small-scale Industries (Frijns and Van Vliet, 1999) and in industrialised, transitional and developing countries (See Mol and Sonnenfeld (eds.), 2000)

of environmental reform in water and electricity sectors contribute to the theory? I will start with answering the last question.

Development of Ecological Modernisation Theory

The contribution of this study to the development of ecological modernisation theory is in the first place that it tries to widen the scope of appliance and testing of the theory. As a consequence, the theory would gain empirical underpinning from fields that have thus far not been evaluated from this perspective. Systems of water and electricity provision are quite different to industrial sectors that have been evaluated before, as they are structured as grid-bound systems and play a unique, facilitative role in many stages of the production and consumption cycle.

Besides, due to its huge environmental impacts (see table 4.1 and 4.2), and its facilitative role for all other segments of industrial society, the energy sector plays a crucial role in processes of environmental transformation. The sector itself involves major technological developments such as turbine technologies, advanced fossil fuel combustion technologies and solar energy technology. Therefore it serves well as a focus for analysing developments in the direction of ecological modernisation (Midttun and Kamfjord, 1999).

In terms of impact on global environmental change (Green house effect, ozone layer depletion), the drinking water sector is only a small player. It is usually headed under public services, although its main activity is producing and supplying water while drawing on natural resources, which is industrial in character. Whether or not drinking water production causes environmental problems is geographically determined. The depletion of groundwater aquifers causes desiccation of natural reserves or farmland, which in turn may require the intake of more polluted surface water from other areas. Water winning

Table 4.1: Relative Contributions to Air Pollution by Sector: NOx and SO_2

Emissions NOx and SO_2 in 1999

	Traffic	Industry	**Energy sector**	Other
NOx in million kg	270	58,3	**41**	40,3
SO_2 in million kg	23	65,1	**9,6**	2,6

Source, RIVM, 2000 (Milieubalans)

Table 4.2: Relative Contributions to Air Pollution by Sector: $N_2O/CO_2/CH_4$

Top 5 $N_2O/CO_2/CH_4$ emissions in the Netherlands in 1997

	Industry	**Energy Sector**	Traffic	Agriculture	Consumers
Billions of kg CO_2 eq	54.5	**50.2**	36.4	26.8	21.6
Relative contributions	26.6%	**21.7%**	15.7%	11.6%	9.3%

Source: RIVM, 1998

may cause changes of groundwater flows and the disappearance of valuable wells. Surface water infiltration in dunes causes eutrofication and pollution of these areas (RIVM/CBS, 1999). Like the electricity sector the water industry is a facilitator to many other industries and households in particular. The ecological transformation of these sectors will therefore likely to have a spin-off effect to other sectors and actors down the line of the systems of provision they are part of.

Thus, water and electricity sectors' environmental impacts and significance for the economy justify the use of ecological modernisation theory for the evaluation of these sectors. However perhaps a more important feature is that both electricity and water sectors are involved in transition processes that are common in many economic sectors, such as market liberalisation and globalisation. As I illustrate in chapter 5, public modes of energy and water provision are increasingly replaced by public-private or private modes of provision. Public utilities are being privatised, third parties are allowed to supply to the main infrastructures where previously one provider held a monopoly. In addition to this, national infrastructure networks are connected with other national grids, allowing for international trade in water and electricity. Lastly, regional utility companies merge into multinational companies and become actively involved in international trade and investment in water and energy infrastructures and facilities all over the world. The relevance of ecological modernisation theory for evaluating such developments lies in its inherent assumption that environmental interests and considerations play an increasing role in such social transformations. It assumes a growing independence of an ecological rationality from economic and socio-political spheres in the core-institutions and practices of modernity: modern technology, capitalist market, industrialism and the nation-state. Up till now, interpretations of environment-induced transformations are mainly restricted to the level of the nation-state or a number of related industrial societies, such as the EU. However, in an era of globalisation, the nation-state is no longer the only nor most essential level of analysis to study environmental reform. Yet, ecological modernisation theory can be very useful for analysing the synchronisation of globalisation and ecological reform, provided that it is not just scaled up from national to global level, but rather apply its core perspectives to the new, globalised institutions of modernity (Mol, 2000, pp. 136-137). The energy and water utilities that are becoming connected to global networks of energy and water services are therefore a proper case to study synchronisation of globalisation and environmental reform.

A last extension and development of ecological modernisation theory that is aimed in this study is its application to consumer – provider relations. Thus far, the sphere of production and - more recently - the sphere of consumption have been taken up as areas of appliance of the theory. In this study, I wish to elaborate more on 'the fields in between'. How can the theory of ecological modernisation be extended or modified to provide a tool for better understanding of changing citizen-consumer roles towards providers, and the division of responsibilities between consumers and providers where environmental innovations in water and electricity sectors are concerned?

Hypotheses on Water and Electricity Provision and Consumption

Ecological modernisation points out a number of key issues to look at when studying the highly complex dynamics in the sectors involved and the relations they represent. I pose a number of sensitising hypotheses that is inspired on the principles of ecological modernisation theory. The list of hypotheses is built up firstly by applying the general principles of ecological modernisation theory and then by specifying these to the subject of environmental reform in water and electricity sectors and changing consumer-provider relations. The purpose of presenting this set of hypotheses is not to eventually verify or falsify the theory of ecological modernisation in case of electricity and water sectors. They will instead be used as starting points for the different routes to study dynamics in water and electricity sectors and changing consumer-provider relationships.

The first hypothesis concerns the most fundamental change that is described in the theory of ecological modernisation, that of the gradual 'emancipation' of ecological considerations from the social-political and economic spheres of decision making. This suggests that sectors of industry, governments or other units of social organisation increasingly consider their performance in environmental terms in close relation to political and economic terms. Ecological modernisation means that providers of water and electricity services add environmental sustainability to economic goals such as reliability, efficiency, profitability of supply and trustworthiness to the public. Water and electricity sectors therefore restructure their facilities and management systems as to achieve environmental sustainability in the long run. The time frame of such transition should be roughly set to about 25 years, based on earlier transitions in utility infrastructures (for example: electrification of the home, wide spread household connections to sewer and tap water systems). The first hypothesis to be considered is therefore:

i) Providers and consumers within systems of water and electricity provision gradually recognise ecology as an independent rationale next to economic and socio-political rationales in their overall business strategy or daily practices.

Compared to other industries or service sectors, water and electricity sectors were until recently unique in being monopolist, public providers. The introduction of market-based strategies, privatisation of state-owned companies and liberalisation of utility markets has led to competition for clients among providers, and differentiation of the single services and products that were on offer during the period before liberalisation. Ecological modernisation theory does not predict or prescribe the liberalisation of markets, but suggests that where market-based strategies prevail, the same strategies may be used to achieve environmental sustainability. In other words: if a transition to market-based modes of provision leads to competition and differentiation, ecological modernisation theory suggests that competition also includes the competition for the 'green consumer' and the creation of 'green' (niche) markets by differentiating the product range with 'green' alternatives. The second hypothesis is therefore:

ii) Within a context of liberalisation of water and electricity markets, there is (also) competition for the green consumer and differentiation in sustainable products and services

This hypothesis suggests some changes in the roles of consumers in relation to water and electricity providers. Most of such grid-bound systems have been set up as public networks holding a natural monopoly, to which household-consumers have no other choice than connect and use what is made available. The term 'captive consumer' is therefore always used in connection with 'grid-bound systems' and 'natural monopolies'. Natural monopolies will exceed, as competition on the infrastructures is made possible and consumers are enabled to choose between different providers and different services. In addition to this, the perspective of ecological modernisation on domestic consumption suggests that consumers increasingly call for sustainable modes of provision supporting the daily practices of their households. The third hypothesis is:

iii) Former captive consumers of grid-bound services gain authority in choices with respect to the more efficient use of energy and water resources in their domestic practices

As has been argued earlier in this chapter, the monitoring of substances, flows and activities along the systems of provision is one of the requirements for making environmental transformations in production consumption cycles possible. Ecological modernisation of water and electricity systems of provision requires monitoring systems that relate social practices within households to actual resource use. The system of provision between natural resources and actual consumption should be made more transparent to consumers and other actors along the chain of provision and consumption as to enable them to integrate ecological considerations into daily practice. The hypothesis is therefore:

iv) To make systems of water and electricity provision more transparent to consumers and to increase their accountability in terms of environmental performance, there is a growing need for more advanced monitoring systems than the ones currently available.

As another major feature of a process of ecological modernisation of production and consumption, I have mentioned the substitution of unsustainable production, or the utilisation of depletable resources, by sustainable production methods or the utilisation of renewable resources. While this refers to all kinds of industrial production, it is especially applicable for utility sectors. Both renewable energy sources as well as alternative water supplies will lead to generation at a smaller technological scale and on a geographically more dispersed level, i.e. closer to end-consumers. The emergence of such decentralised systems of provision can imply that end-consumers become more involved in the systems of electricity and water provision.

v) Differentiation in resources, providers and technologies in water and electricity provision leads to differentiation in the roles of consumers vis-à-vis providers of water and electricity.

For the final hypothesis, I return to the debate on de-modernisation theories versus ecological modernisation. In both theoretical schools of thought, water and electricity provision play a special role in achieving more environmentally sound societies. In the perspective of de-modernisation, large-scale infrastructures were to be reconstructed or even abolished, to be replaced by local, small-scale facilities, based on renewable resources, appropriate technologies, operated by communities of users. The previous hypotheses on ecological modernisation of water and electricity systems point in some respects in the same direction: the ecological modernisation of water and electricity systems of provision implies the appliance of renewable resources, which in many cases are generated through small-scale technologies such as solar panels. However, small-scale alternatives (both in social and technical terms) will remain closely connected to large-scale infrastructures. Ecological modernisation will further on-grid connections rather than leading to disconnection in social and technical terms as was suggested in Schumacher's 'Small is Beautiful'. Being connected to large-scale systems does not mean that power relations between providers and consumers remain fixed. Through differentiation in small and large generating systems and intermediate technologies captive consumers can become more authoritative towards the way electricity and water are provided to them. Hence, the following and final hypothesis:

vi) Ecological modernisation of network-bound systems leads to the differentiation into small-scale generation and distribution technologies, without disconnecting these technologies from large infrastructures in the way that de-modernisation theorists consider these necessary or desirable.

4.4 Epilogue

The first two hypotheses are of a general nature and will serve the discussion on electricity and water sector dynamics in the Netherlands (chapter 5). The third hypothesis on consumer authority is the red thread for the chapters afterwards: both in discussing monitoring projects (chapter 6) and issues of differentiation (chapter 7), patterns of consumer involvement are the main variable to look for. The innovations are reviewed while focussing on the changes in consumer-provider relations. Hypothesis 4 directly refers to monitoring, while hypotheses 5 and 6 specifically refer to the issues that are raised in chapter 7 on the differentiation of resources, providers and consumer roles. The outcomes of the different studies are presented in chapter 8, in which the hypotheses as stated in this chapter are evaluated.

5 Environmental Reform in Dutch Water and Electricity Provision

5.1 Introduction

The understanding of processes of environmental innovation in Dutch water and electricity sectors can be enhanced if the history of water and electricity provision in the Netherlands is known. This chapter presents an overview of the past and current dynamics in Dutch water and electricity sectors. Such an overview may be done from a variety of perspectives. An economic perspective would use indicators such as economic growth, consumer demand, oil prices, and productivity levels while a more environmental perspective would consider depletion of water and energy resources or national and sectoral CO_2 emission levels. A more institutional approach would be based on national and international policy making on water and energy issues, and the institutional lay-out of the sectors, notably the European Union policies on climate change and water resources, national policies concerning electricity and water provision, environment and nature conservation. Lastly, a more socio-political approach would emphasise the agendas of social movements and elaborate on public protest against nuclear power plants, or the increasing societal appreciation of water management as a guiding principle of spatial planning and housing.

As an attempt to cover parts of all these perspectives in one framework a triad historical framework for utility change is utilised to analyse the dynamics in Dutch water and electricity sectors. Next, this framework (presented in section 5.2) and in particular its last phase of utility development it describes is related to notions of ecological modernisation theory (5.3).

The chapter proceeds to the level of specific changes in regulation and market situation in both electricity and water sectors in the Netherlands. Sections 5.4 and 5.5 discuss water and electricity sector dynamics respectively, presenting historical overviews, governmental policy and responses to environmental issues and liberalisation of subsequent markets. The general conclusion on processes of change in both sectors is given in section 5.7.

5.2 Three Phases of Utility Development

A utility sector is unique and in a sense incomparable to other sectors of industry, because of its network-bound character and the universal services it provides. The initiation and development of utilities is therefore quite different from other known industrial development paths such as the Information Society, Fordism and Post-Fordism (Kumar, 1995). In search for a satisfying alternative, a review of the history of utility organisation in the UK by Graham and Marvin (1995) proves to be very useful. In their review Graham and Marvin present a model that draws upon three historical phases of utility development: one of localisation, one of nationalisation and one of global-localisation. For the purposes of this study the review will be extended with exploring the environmental changes which are typical for each phase of utility development.

Early Systems of Provision - Localisation

The first phase in utility sector development mentioned by Graham and Marvin is that of localisation: the development of several network-bound facilities at local level that supports local economic sectors and households. It results in a 'patchwork' of small local networks, each working on its own 'island' without connections to each other. The configurations of these networks are shaped by local economic, social, political and spatial considerations. Consequently, the networks are divers in terms of tariffs, levels of connection and type and quality of services. Standardisation has not yet been an issue as the development of networks only served local needs instead of national interests. Electricity networks served local industry mainly, while water works were developed to combat most urgent local public health issues once it was discovered that intestinal diseases like cholera were the result of the use of contaminated well water or surface water. This was in fact a first recognition of what now is called urban environmental problems. Making an issue of and finding solutions for urban waste and sanitation at the end of the 19th century has therefore been referred to as the first wave of environmental concern in the industrialised world. While this is particularly true for the development of water works, there were no considerations that could be called 'environmental' behind the development of electricity networks.

The construction of large technical networks can be initiated by private parties but are in most cases eventually used collectively and become public networks due to the fact that the networks become vital to the welfare of whole communities. This is inherently a social process as costs and benefits - economically and socially - are high and there are always net-beneficiaries and net-benefactors. Utility infrastructures are typical public goods. They imply collective investments while it is usually hard or impossible to exclude anyone from the use of them once they are established. This is supported by De Swaan's (1988) analysis of the emergence of sanitation networks in Amsterdam. He concluded that the construction of city-wide waterworks could only start - at least in Amsterdam - after a process of social homogenising within residential areas and social segregation between residential areas. Once this process was completed, wealthier citizens could afford to build collective facilities in their neighbourhood, knowing that their neighbours could also afford to participate and that the poor won't be free riders on it. The invention of the water closet triggered more and more citizens to participate in, and to finance a system of pumps and installations of water treatment. The city became saturated with pipes and eventually only the poorest and most remote neighbourhoods remained deprived of such facilities. By that time it was a relatively small investment for public authorities to provide these areas with common taps, washing places and toilets (De Swaan, 1988). Whether this can be generalised for other cities is doubtful, yet it illustrates the typical social dilemmas that come along with the building of collective networks. It is the phase that predominantly private local networks become public, which indicates the start of the next phase of utility network development.

Public Systems of Provision - Nationalisation

At the time that public interest in utility infrastructures had grown to a certain level, public authorities were likely to become involved in infrastructure building and management. Two main reasons can be identified. Firstly, private parties are not eager to invest in extending the networks as to serve remote areas and uneconomical connections. Secondly, when networks become important to the economic well-being of industries and households, standardisation of technologies, tariffs and connections becomes important. Public authorities form an obvious party to take care of.

The most common form of public involvement is that of state-owned companies being assigned to service connected consumers. In this phase networks become more and more standardised and ubiquitous, and acquire - what Huges (1987) called - a 'momentum'. As an implication system organisations and professionals consolidate the system in organisational and technical terms, thereby hampering innovations that do not fit in the system's technological trajectory. To safeguard standardised technology and procedures and to benefit from economies of scale, infrastructure systems often build up hierarchic organisation structures with command-and-control modes of regulation.

The logic of network management in such public modes of provision is predominantly supply-oriented. Expansion of utility networks is connected with the drive to improve national economic performance and the quality of life. Levels of energy consumption, connection to water and waste networks and levels of telephone ownership become surrogate indicators for levels of national economic performance. Guided by this logic, the specific needs of individual cities and consumers have little impact on the process of network provision and management (Graham and Marvin 1995).

A supply-side approach becomes problematic in times of scarcity of resources, or when depletion of resources causes unacceptable environmental damage. The international energy crisis of the early 1970s exposed the costs of a fuel strategy purely based on supply-side measures, in environmental and economic terms. Energy sectors were urged to take conservation measures and to issue public campaigns to cut down energy demand. Also water pollution and environmental impacts of drinking water production in terms of energy and chemical consumption had became a serious issue during the same period. If we consider the development of utility networks, and especially that of waste management and waterworks as a sign post of the first wave of environmental concern, the first oil crisis (1973) and the publications on the world wide environmental crisis (Meadows, 1972) may be referred to as the second wave of environmental concern. These developments also herald the last step in this phase of public utility development.

Towards the end of the phase of nationalisation the dominance of the supply-side logic in utility provision showed its limitations: instead of extending generation and winning capacity to cope with increasing demand, Demand-Side Management (DSM) strategies were developed. Demand-side management aims to avoid environmentally and economically expensive supply investment, such as a new reservoir or power station, by managing both the level and timing of demand placed on networks through the implementation of energy and water efficiency. For instance, DSM could include network operators reaching 'beyond the meter' to develop more intimate relationships with some users in order to modify demand on 'stressed' parts of the network. Providers and users can form a shared interest in the tailoring of supply and demand providing a powerful impetus to energy and water efficiency measures (Guy and Marvin, 1996).

DSM measures are not specifically designed or implemented for environmental purposes. The logic is rather to increase efficiency in utilising infrastructure capacity. However, as has been outlined above, environment has become a major issue at the end of this phase. Public utilities are assigned to execute national environmental policies concerning energy conservation and water management. Water and waste companies re-brand themselves into 'environmental' companies, thereby emphasising of what has now become their core-business: environmentally sound management of supply and demand of natural resources.

Privatised Systems of Provision - Global-localisation

The phase of global-localisation starts when utility markets become liberalised and state-owned companies are sold to private or public-private providers. The basic rationale for the privatisation of utilities is generally based on a critique of the nationalised sector as being inefficient and overstaffed, unaccountable, stagnant, uncompetitive and failing to innovate. The debate on privatisation started with the central assumption that privatised management would transform the nature of the industries improving levels of service, increasing efficiency and produce more responsive industries (Chappells et al., 1998). However, if privatisation is not accompanied by the entrance of new providers competing on the same consumer market, such expectations prove to be hard to achieve. As a consequence of privatisation of utility companies and liberalisation of utility markets niche markets are being explored for maximum profit and complex layers of competition are emerging whereby old utility firms and new entrants attempt to poach the most profitable customers from the incumbent monopoly.

In this phase of utility development we see a growing cross-investment between previously separate utilities and a diversification beyond the sector, which leads to the emergence of large-scale multi-utility companies. Typical for this phase of utility development is that geographical dynamics are emerging driven by international liberalisation in financial flows and service markets. These globalising forces are pushing private utility companies to both re-embed themselves at the urban and regional level whilst simultaneously attempting to piece together truly trans-national utility systems. The re-embedding into urban and regional levels has everything to do with a re-orientation towards customers who, after all, will be able to chose between providers. The regional markets that utility companies traditionally served are a valuable starting point to enter the new era of competition.

Thus, a nationalisation logic is being replaced by one which mixes combinations of globalisation and localisation. Graham and Marvin (1994, 1995) have equated the privatisation of utility networks with a process of spatial, institutional and social 'splintering' in the delivery, development and management of utility networks. The process of 'splintering networks' has three dimensions. First, networks are not necessarily organisationally unified or integrated - they are characterised by competition between service providers in a mix of competing private companies. Second, utility providers tailor their 'product' according to the local needs of niche, profitable markets - styles of provision vary across the country and between different classes of consumers. Finally, networks are shaped by local and regional demands and may therefore develop highly uneven.

Such splintering of what was hitherto a nationally-homogeneous utility system has shifted the socio-technical logic governing infrastructure provision. Firstly, some authors expect increased levels of social polarisation, as the quality of service provision may become much more varied (Graham and Marvin, 1994, 1995). It can be expected that private businesses will 'cherry-pick' only the most profitable areas and consumers out of the whole, leaving remote customers with only a basic or even no service package at all. Secondly, commercial and regulatory priorities are encouraging higher levels of network efficiency with beneficial environmental results. As this 'splintering' process manifests itself through reduced cross-subsidies, the erosion of standardised tariffs and the selective implementation of innovative technologies, an unevenness in the quality of utility services offered in different cities, regions and in different sectors of the market can be expected. (Chappells et al., 1998).

In terms of environmental management and policy making, the transition to this phase of global-localisation can be characterised as a change from command-and-control environmental regulation of utilities towards marked-based governance models like facilitation and taxation in order to stimulate utilities to improve efficiency or to utilise renewable resources. Typical for this phase is the possible differentiation of utilities' range of services and the 'green marketing' of parts of their activities as to find and create niche markets for green services. The degree of 'greenness' of providers will in such cases no longer be the sole responsibility of a regulator, but rather that of the final consumer who decides whether or not taking environmental considerations on board when it comes to water or electricity consumption.

.3 Liberalisation and Ecological Modernisation

The purpose of elaborating these overall dynamics in water and electricity is to explore the backgrounds of processes of ecological modernisation that may be going on in these sectors. How can the triad historical framework of utility sector development be linked to the theory of ecological modernisation? In other words, how do environmental innovations take form in systems of water and electricity provision in the different phases of utility development? As this study focuses on contemporary environment-induced changes, the emphasis is put on environmental reform at the transition to the last phase of utility development, in which liberalisation of utility markets and privatisation of utility companies are the key developments.

Liberalisation and Privatisation

In essence, liberalisation of utility services encompasses an unbundling and re-allocation of activities and responsibilities between the market and the state. The set of activities and responsibilities encompasses among others generation, transmission and distribution of services; ownership, maintenance and management of network-infrastructure and the setting of tariffs and environmental management schemes. While in the nationalisation phase of utility development these tasks were brought under the responsibility of (single) state-owned companies, liberalisation leads to an unbundling and re-allocation of these activities to several private and public parties.

Slingerland (1999) proposed the following definition for the process of liberalisation of network-bound systems:

> "The process of liberalisation consists of at least two steps: Firstly, an administrative unbundling of business processes which are related to the grid and those who are not and, secondly, the introduction of competition for those business processes which are not directly related to the grid" (Slingerland, 1999, p. 5).

Grid-related functions are transmission and distribution or network maintenance. Functions not directly related to networks are generation and end-user supply. This is the baldest definition of liberalisation one can possibly find in literature. In practice, and sometimes also included in the definition of liberalisation, there are much more processes related to liberalisation: the complete organisational unbundling of generation, transmission, distribution and supply; re-integration of formerly vertically unbundled utilities; mergers between utilities and the privatisation of formerly state-owned companies. Furthermore, liberalisation is commonly associated with deregulation. This is based on the assumption that market mechanisms can replace most of the regulatory tasks that governments held in times of public service provision. Collier (1996) and many others however pointed to the fact that liberalised utility markets require some substantial regulatory systems (as well as the institutions to execute them, like Anti-Thrust Authorities) in order to prevent cartels, the misuse of monopolies and to guarantee reliable supply of services to all customers. Instead of a deregulation, it is therefore much better to speak of a process of reregulation.

Privatisation of state-owned companies is therefore not a prerequisite of liberalisation as the unbundling of business processes does not require them being either state of privately owned. In practice however both processes often go hand in hand: the introduction of competition involves the access of third parties to formerly monopolised markets. Private parties are considered to be more adapted to competition than state-regulated parties, which is one reason for governments to privatise their utilities as soon as competition takes off.

Liberalisation and privatisation of public service industries like water and energy provision is claimed to lead to a number of negative impacts for their environmental performance (see for instance: Reijnders, 1997; Slingerland, 1999 for electricity and Nijhof and Leenders, 1998 and Achttienribbe, 1993, for water).

One argument is that liberalisation would lead to a lowering of end-consumer prices. If one considers consumer price as the major incentive for conservation behaviour - which is arguable in the case of water and electricity consumption - it can be expected that lower consumer prices would rather increase than reduce consumption levels.

Secondly, it is argued that after liberalisation providers will try and find the most cost-effective ways of generating electricity or water winning. Opponents fear that electricity providers will be triggered to utilise cheaper and more polluting resources like coal and oil rather than sustainable resources, like sun and wind. Because Water Companies rely on regional water resources, it is unlikely that a liberalised water market would lead to the exploitation of many new sources or an import of water from other regions, like in the electricity sector. However, for reasons of cost-effectiveness, also Water Companies could opt out the more expensive environmentally sound solutions for water winning and treatment.

Thirdly, it is argued that a fully liberalised market of energy or water provision will limit the possibility of environmental regulation as this may distort market mechanisms. Policy targets concerning for instance the share of sustainable resources in national energy production will therefore be hard to sustain.

Lastly, it has been noted that utility companies will be less willing to provide information on their businesses to their competitors or to the government, which is a main requirement for formulating, implementing and evaluating energy or water policy. This is especially true for policy covenants, which have been successful instruments in among others Dutch environmental policy making before liberalisation took off (Liefferink and Mol, 1998). It has been questioned whether policy covenants between government and utilities on measures towards energy conservation will still be possible after liberalisation of the sector (Correljé et al., 2000).

Apart from these expectations on the negative environmental effects of liberalisation of electricity and water sectors, there are also accounts of more optimistic expectations. Liberalisation of electricity markets may for instance lead to an increased efficiency in generation and supply; an expected transition to cheaper and cleaner gas-fired power stations in the case of electricity provision and an upswing of technological innovation in general. Older and less efficient production units would be taken out of production much sooner than in a system of central planning and monopolies (Vellinga, 1995). Liberalisation would also create better chances for providers to specialise in 'niche markets' like the market for 'green electricity' or the development of products and services concerning energy or water conservation (Slingerland, 1999).

Lastly, instead of joining the debate on expectations towards the environmental consequences of utility market liberalisation, some authors concentrate on the new policy ar rangements that are needed to overcome the possible negative effects of liberalisation (like Reijnders, 1997). One is the sustained governmental stimulation of environmentally sound projects in a broad sense. Another possibility is the temporary or structural subsidising of environmentally sound production by means of project subsidies or low VAT tariffs respectively. Also, a system of tradable units of green production (green certificates) can help to achieve national goals of sustainable energy production in a liberalised market. Levying environmental taxes on non-sustainable production, while exempting green services from it is also a way of steering the market in a sustainable direction. Lastly, also in a liberalised market utility companies and governments could still conclude special voluntary covenants on environmental goals (Reijnders, 1997).

The discourse on expected effects of liberalisation of electricity and water markets on the environment or, to be more precise, on possibilities for environmental regulation is far from converging into a consensus. The arguments pro and contra liberalisation used in the environmental discourse remain rather speculative. Meanwhile, former expectations of liberalisation have been counteracted with empirical evidence in certain countries (mostly Britain) or sectors (energy, water, telecom and national railways) where liberalisation has already taken place. Negative outcomes such as the decreased reliability of services, the raise of tariffs, an increase of electricity imports from less environmentally sound generation units, black outs, and so forth, have been assigned to the liberalisation process. Proponents of liberalisation however claim that these phenomena are the outcome of compromises, incomplete liberalisation or heritages of underinvestment during the nationalisation phase. For instance in times of the January 2001 Californian electricity black-outs, two main opposing explanations were given. On the one hand it was claimed that the crisis was the consequence of liberalising the Californian electricity sector some years earlier. On the other hand, it was claimed that the crisis was due to the fact that the liberalisation process had never been completed: the state had never retreated from the sector as it still sets the consumer tariffs.

Ecological Modernisation in Times of Liberalisation

Ecological modernisation theory is a formal theory and therefore does not provide a blueprint for environmental regulation of global-localised utility sectors, but rather the basic principles that can help building the new policy arrangements needed. It refers to an increasing role for private economic actors and market mechanisms in environmental reform and a changing role for state agencies: from bureaucratic, top-down dirigism to 'negotiated rulemaking' and the creation of favourable conditions for such transformation processes. The theory does not provide explicit guidelines considering the reform of economic sectors or the specific responsibilities that should be allocated to them. Instead it suggests a growing independence of ecological considerations in the design, evaluation and decision making of all actors in the systems of provision, including regulators, providers and citizen-consumers. This may develop within various regulatory frameworks, that is to say, either in liberalised or nationalised contexts.

Considering the hypotheses on ecological modernisation given in the previous chapter, especially the ones on changing market-state relations and authoritative consumers, global-localised modes of provision would support rather than impede a process of ecological modernisation of utility sectors. The liberalisation of electricity and water markets does not necessarily lead to fewer possibilities for environmental governance. However, the changing contexts of utility provision do require new policy arrangements that replace the conventional regulatory framework known from the nationalisation phase of utility development. These new policy arrangements will be drawn much more on horizontal policy making and the inclusion of all actors in the field of water and electricity provision, including utility sectors, citizen-consumers and environmental NGOs. The policy goals need to be extended from economic efficiency to environmental sustainability which implies the monitoring and monetarisation of all non-renewable resource uses throughout the chain, the differentiation into green products and services and the substitution of non-renewables with renewable resources. Decisions to allow competition on certain network-bound systems should be embedded within a new framework that secures continuity of service as well as environmentally sound performance. Like the authorities that are set up to secure level playing fields for all competing parties, also environmental authorities should be installed to secure that these playing fields will become and remain 'green' as well.

Having elaborated the dynamics of network-bound systems in general and the process of liberalisation in more detail, it is time to turn towards analysing the specific dynamics in Dutch water and electricity sectors along the phases of utility development as set out in 5.2. Both water (5.4) and electricity (5.5) sections will start with an overall history while emphasising the period of the 1960s and 1970s in which the first transitions towards global-localised utility provision can be observed. It is also the period in which environmental considerations will increasingly play a decisive role in the course of development.

5.4 Dutch Water Sectors Dynamics

Localisation Phase

It was due to a private initiative of an army pensioner and the Dutch writer Van Lennep that, with British capital and know-how, the first water mains in the Netherlands were constructed in 1854. In the dunes near Haarlem, water was collected by means of a 3,500-metre long drainage canal. It was then transported through a pipe to Amsterdam. Other large cities such as Rotterdam and The Hague followed in 1874 (Ministry of Environment, 1994).

It is commonly thought that the increased knowledge of the correlation between hygiene and contagious diseases has led to the building of water works. Although it was presumed by medics and debated among politicians, scientific proof of a direct relation between contagious diseases such as cholera and poor sanitation was provided only in the 1880s. Medics, convinced of some kind of relation between poor sanitation and epidemic diseases among the poor plead for public funds to build water, waste disposal and sewer networks, much to the annoyance of the wealthier classes, who knew that they would pay for something that would only help poor residents of the city. The invention and diffusion of the water closet however initiated a major breakthrough in the development of water and sewer works in these areas.

Public Systems of Provision: Nationalisation Phase

At the turn of the century, 42% of the Dutch population used water from a piped water system (Van Zon, 1986, p. 63). There were already as many as sixty water supply companies of which 21 were municipally owned. During the decades that followed, the number of Water Companies increased and most of them were taken over by municipalities. The

Table 5.1: Sources for Drinking Water Production

Resource / Production Method	Amount (million m^3)
Ground Water	780
Ground Water from River Banks	80
Surface Water, Direct Usage	50
Surface water via storage basins	155
Syrface water via dune infiltration	175
Total	1240

Source: Ministry of Environment, 1993

municipalities developed programmes to connect every single resident to the water systems that resulted in 99.9% coverage in 1975 (Ministry of Environment, 1994). Several new institutes were founded to back the building and maintaining of water networks. The first was the association of water suppliers (1898) that issued technical standards for new water systems. After WO II this became the most important task of KIWA. The Netherlands Water Works Association (Vewin) was founded in 1952 in order to represent the interests of all 200 Water Companies. This opened the way for the first 1957 Water Supply Act, in which Water Companies were made responsible to deliver tap water to all consumers in their distribution area in a quantity and pressure as public health would require. Also the monitoring of water quality, security of supply, innovation and diffusion of new technologies, planning of future water supply and consumer education were brought under Water Companies' responsibility. All this should be done under cost covering management and with acceptable tariffs (Van Vliet, 1995).

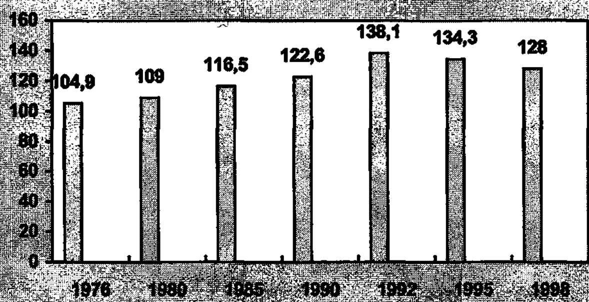
Although the Act has been revised a number of times, most of the main principles are still valid. The water sector has presented its responsibility for delivering safe water to secure public health as a decisive argument in debates on water conservation, dual water systems and privatisation (Achttienribbe, 1993, Van Tuijn, 1998, a.o.). The water sector is now awaiting a new revision of the Act, which has been postponed several times due to an ongoing political debate on privatisation of the water sector.

In the 1960s, it was commonly believed that water consumption per capita would grow up to 390 litres per day (Tellegen et al., 1996, p. 225). In 1970, official government scenarios for per capita water consumption rose up to 200 litres per capita per day in 2000, more than twice as much as in 1970 (Daniëls, 1994, p. 99). These scenario's as well as the increasing frequency of high pollution loads in the river Maas, which especially deteriorated drinking water production for Rotterdam and surroundings, fastened the planning process to build large scale storage basins in 'De Brabantsche Biesbosch'. The national government which had to approve the plans, conditioned that the basins should be dimensioned as large as technically possible to serve other regions as well (Knoppert, 1972). After completion in 1975 the basins would support the production of 500 million m³

Box 1: Growth in Water Consumption

Since the connection of every household to the piped water system, water consumption per capita has risen from 97 litres per day in 1970 to 108 litres in 1980 and 135 litres in 1992 (Fonk and Schep, 1989; NIPO, 1992). After 1992, water consumption per capita has slightly decreased until 128 litres in 1998, which is mainly due to water saving behaviour and technical applications in bathing, textile wash and toilets. (H_2O, 1998). However, population growth has thus far minimised its effect on total water extraction for drinking water supply.

Water consumption per capita in litres per day



Source: NIPO/VEWIN, 1999.

drinking water per year (Verkerk, 1972). The division between ground water and surface water as resources for drinking water production is now as stated in Table 5.1.

Based on the scenarios mentioned above, the national government declared the wish for an up-scaling and strengthening of the structure of the sector. Consequently, in 1975, the Provincial councils were given the task of formulating plans for the reorganisation of the drinking water supply, and the issuing of licences for ground water extraction. The reorganisation has led to a reduction in the number of companies, by means of mergers and vertical integration between supply and distribution. Over the last few years, this reorganisation has come close to completion. In 1975, there were still 111 water supply companies, a number that had dropped to 40 by 1992 and 22 in 2000 (Andersen Consulting & Vewin, 1999). Most Water Companies take care of extraction, purification, transport and distribution, which make them 'vertically integrated'. Most of these are Public Limited Companies, which means that local authorities or provinces own the shares. In Amster dam, the Water Company is a department of the municipal government. By now, there is only one small private Water Company left in the Netherlands (Doorn).

Privatised Systems of Provision: Global-Localisation?

A number of indicators may be used to assess whether or not the water sector is now in a transition towards a phase of global-localisation. One is an increasing orientation on national and international water markets rather than regional home markets only. Water companies may be involved in an upscaling of water markets via merging with other Water Companies. Furthermore, instead of treating consumers as a mass of anonymous water users, they can be seen as different groups of customers with more diverse preferences relating to water consumption. Lastly, in a phase of global-localisation of water provision, environmental issues related to water provision are treated as a market activity rather than a side effect or burden for water provision.

Upscaling and Market-based Orientations

Several Water Companies in the Netherlands have recently merged with electricity utilities or multi-utilities, while other Water Companies have merged with other water supply companies or have started to co-operate with Water Boards, just to prevent a take-over by multi-utilities. The latter companies argue that it is best to keep 'water with water' instead of becoming part of a conglomerate in which water interests are weighed against other business goals of a multi-utility. In 1998 a group of managers of Water Companies and water boards published a manifesto on future water management in which they plead for further vertical integration within the water chain (water quality and quantity management, extraction, drinking water supply and distribution, sewer, and waste water treatment) as opposed to the horizontal integration with other network-bound companies (Nijhof and Leenders, 1998). For the time being, this plea for an organisation of the sector that is based on integrated water management has not yet been translated in new organisational structures as proposed in the manifesto.

Advocates of multi-utilities argue that it is much more efficient to combine network-bound functions. It saves human, material and financial resources to combine management efforts, marketing departments and consumer desks. Moreover, consumers are said to be much better off with a 'one stop shopping' for all their utility services (Prieckaerts, 2000).

Consequently, for the time being there is no consensus among water managers on which

Box 2: Environmental problems related to water production

The production of drinking water, either from groundwater or surface water causes various environmental problems.

Groundwater reserves are in some cases already close to depletion. Of all the yearly deposition (approximately 775 mm), about 200 to 300 mm per annum reaches the groundwater after evaporation. Only a portion of this can be used for drinking water extraction. The use of groundwater becomes problematic due to decreasing availability, increasing necessity for purification after winning (because of pollution by nitrates) and due to desiccation and impoverishment of wetlands and other delicate natural reserves. Governmental policy therefore aims at a reduction of ground water use for drinking water production (now approximately 63%) to the level at which only 50% of all tap water is derived from ground water sources (Tweede Kamer, 1992).

The production of drinking water from surface water encompasses the use of treatment facilities consumeing energy and chemicals and producing sludge; the use of space for water storage basins and – in some cases – pollution of dunes and other natural reserves if surface water is infiltrated for further treatment.

organisational set-up would best serve the interests of Water Companies and their consumers in the future. Moreover, the discussion has been interfered with the debate on privatisation of the water sector and on the management of the water sectors' environmental impacts.

The Ministry of Economic Affairs commissioned in 1997 a study on the possibilities of more market-based modes of operation in the Dutch water sector. The study included drinking water suppliers and wastewater treatment installations. Its conclusions on the current, monopolistic water sector were that costs for tap water production and wastewater treatment were unnecessarily high. It was estimated that marked-based operation of drinking Water Companies would lead to a cost reduction of 6,2 to 15%. Possibilities for market-based operation in the water sector were in the short term to establish an independent network authority which could study and publish comparisons between Water Companies on costs, profits, environment, service and infrastructure (bench-marking). In the middle long run, experiments with tendering of new projects, like the water supply for new built areas should be made possible. Such experiments could lead to dual water systems or the shared use of existing infrastructure. Finally in the long term ownership of infrastructure could be separated from operational tasks, such as tap water production and wastewater treatment. The latter could be tendered to, possibly privatised, Water Companies. The competition between Water Companies would result in a flexible water market with high incentives for economic efficiency (Dijkgraaf et al., 1997).

The study was published at the height of an already lively and still ongoing debate within and outside the water sector on privatisation and liberalisation. Besides, it was published in the midst of a process of renewal of the 1957 Water Supply Act. The Minister of Environment responsible for water supply presented a first outline of the new Water Supply Act to Parliament in February 1998 (Tweede Kamer, 1998, 25869, no 1). The proposals include a number of recommendations that were also mentioned in the report on possibilities of market approaches mentioned above:

- The issuing of 20 years concessions for Water Companies to supply drinking water in a certain area;
- An compulsory benchmarking of drinking Water Companies;
- A study to outsourcing of exploitation water supply;
- Separation of ownership and operation of infrastructure.

One of the first responses of Vewin to the proposals was a denial of the (supposed) inefficient operation in the water sector. Vewin stated that quality, price and security of supply are adequately secured in the current mode of regulation and therefore questioned the need for change (H_2O, 1998, nr. 2, p. 7-8).

However, as an answer to the above-mentioned study and perhaps to prevent an accusation of not being co-operative, Vewin commissioned in 1999 an own bench mark study among 16 Water Companies (Andersen Consulting and Vewin, 1999; Vewin, 2001). Its conclusions revealed that Dutch tap Water Complies with the highest quality standards and that the new forthcoming EU standards would not cause any problem. More than 90% of the clients is satisfied about the services of Water Companies. Environmental impacts of water production and supply vary considerably among the Water Companies, as well as consumer prices. Main determinant for both environmental impacts and consumer prices is whether groundwater or (polluted) surface water is used as a resource for tap water production. Efficiency can be improved in operational costs, which encompasses more than half of total costs of Water Companies (H_2O, 1999, no. 6, pp. 4-5). As

Box 3: 'Waterspoor'

Waterspoor encompasses a new tariff system for water consumption and wastewater disposal by households. Tap water consumption is charged via water meters, while sewer services are charged via a fixed rate. The idea behind 'Waterspoor' is to introduce stronger economic incentives for water saving behaviour by adding the charge for sewer services to the price per cubic meter of tap water consumption. This measure will result in higher tap water prices and hence stronger incentives to save on its use. The wastewater sector opposes this idea with the argument that it is not the water volume, but the waste it is carrying through the sewer system that determines the costs of waste water collection and treatment. After almost 10 years of discussion, the Dutch Parliament accepted in February 2000 that experiments with Waterspoor are allowed between 2001 and 2006 provided that they would be evaluated before 2006 (Tweede Kamer, 2000, nr. 27404)

this bench mark study was Vewin's own initiative, it did not specify which Water Companies had the highest and which the lowest efficiency levels. If such bench mark studies would become compulsory in the near future, they would most probably require more details on individual Water Companies to make comparisons possible for policy makers and consumers.

The political discourse on more market-based approaches and privatisation in the water sector made a major turn after the national elections 1998 and the appointment of a new

Minister of Environment in the new administration. The Ministry is now a strong opponent of a privatised water sector as "commercial interests do not fit in a sector that provides basic needs to captive consumers" (Tweede Kamer, 1999, 25869, no. 4, own translation). At this point the Ministry of Environment has overruled the Ministry of Economic Affairs, that favours a gradual liberalisation and privatisation of the water sector (Tweede Kamer, 2000, 27018, no. 1). Also the earlier mentioned separation of ownership and management of infrastructure is withdrawn from the government's proposals for renewal of the water supply act, which is to be expected in 2002.

When this point of view will be formalised in the new Water Supply Act – which is to be expected – it has also severe consequences for the development of so-called multi-utilities. A number of energy utility companies have recently taken over Water Companies and have developed into so-called 'multi-utilities', combining energy, water, TV-cable and waste services. In doing so, these companies anticipated on a future privatisation of all utility sectors that are combined in their companies. Although privatisation can be expected in waste, telecom and energy sectors, now for water such a pathway has been blocked. This means that when the other sectors will be privatised, the water section of these companies should be separated again as to secure state-ownership (Tweede Kamer, 1999, 25869, nr. 4). Formally, Vewin could not provide one uniform response to this, as it represents both independent Water Companies as well as water sections within multi-utilities. However, Vewin representatives have regularly expressed their preference for state-ownership (see for instance Vewin Director Cals in Van Tuijn, 1998) and independence of Water Companies vis-à-vis other utilities (Achttienribbe, 1993). For instance, in 1992, Vewin pointed in a policy document to the danger of a devaluation of water interests when it would be integrated in a multi-utility company. Besides, with the organisational up-scaling of energy sections within multi-utilities, it was feared that water production - normally of a smaller scale compared to energy production - would be separated from water distribution, which contradicted to Vewin's point of view. Co-operation with energy utilities - in terms of billing, education, construction of infrastructures - was encouraged, but merges into multi-utilities should be avoided. Instead, the water-cycle approach, in which water supply and water management and waste-water treatment would integrate (vertical integration) was considered worth to be studied as a viable long-term strategy (Brandsma, 1992). It is this latter approach that is now actively propagated in a 'manifesto' by the earlier mentioned group of managers of drinking Water Companies, water boards and waste water treatment plants (Nijhof and Leenders, 1998).

Not surprisingly, managers of water sections in multi-utilities responded negatively to the Minister's views. According to the director of Nuon-Water (one of the 4 multi-utilities) up-scaling is necessary if Dutch utilities want to compete in an international market.

> "The Netherlands does not realise that winning, distribution and treatment of water is done within a European market (...) The Minister cannot build walls around our country. (Therefor) it won't be long until foreign companies of a size of multinational Phillips will take the lead" (Leeuwarder Courant, 24-7-99, own translation).

Proponents of liberalisation in the water sector often point to forthcoming EU policy making that eventually wouldn't allow the Dutch government to protect any economic sector, including the water sector, from international competition. Unlike the developments in the electricity sector, however, there are thus far no intentions at EU level to liberalise the water sector as to accomplish an internal market for water (Tweede Kamer, 1998, 25869 no.1, p. 10). EC water directives, including the new Water Framework Directive have had much more to do with quality standards for drinking water and the protection of sources than with the organisational set-up of the water sector in each member state (Van Vliet, 2000a). Not surprisingly, the organisational models for the water sector, especially concerning the relations between market and state actors differ per memberstate. Marked-based organisational set-ups vary among two different models that have become known as the British and the French model (Dijkgraaf et al., 1997). Within the water sector competition between networks (as in telecommunication) is not a viable option. It would be highly inefficient to install and operate more than one drinking water system in one region. Neither is competition on the network (as in railway systems) realistic. Once one Water Company distributes water through a network, it would be highly complicated and inefficient to allow another company to share the system. So competition for the network would be the only viable option if one wishes to introduce competition in water supply. Both the British and French models regulate competition for the network. The British model consists of the privatisation of all parts and tasks of the sector: generation, distribution and supply as well as network management and maintenance. Privatised companies are given a 25 years licence and they keep their (natural) monopoly position. To prevent misuse of this position, they are economically regulated[1] by the government. The French model is a tendering system. Municipalities own and maintain the networks, but operational tasks are tendered[2] out to private parties for a set period of time.

After assessing that there are much more disadvantages than advantages to both models, the Dutch government choose in 1998 to keep up the monopoly position for drinking Water Companies and to issue concessions to Water Companies for an exclusive supply of drinking water in a certain region. Water companies are obliged to supply their captive consumers with enough water of a minimum quality standard. Also ownership and management of infrastructure should remain in hands of the state. A possibility to privatise the exploitation of water infrastructure is left open as the government proposes to commission scientific research to the effectiveness and efficiency of such an arrangement (Tweede Kamer, 1998, 25869, no. 1). However, in 1999, the Minister of Environment

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1 This is done through price-cap regulation: the government sets the maximum tariff for a certain period, based on expected costs to be made. If a Water Company increases its efficiency by lowering its operational costs, it is able to make profits for that period of time (Dijkgraaf et al., 1997, p. 49).

2 The tendering can take two forms: affermage contracts and consessions. In an affermage contract, usually issued for a period of 5 to 20 years, a private company takes care of operational tasks: winning, distribution and supply of water. In a concession contract, usually for periods of 25-50 years, also the management and maintenance of network infrastructure is put out to tender to private parties (Dijkgraaf et al., 1997, p. 57-58). The measure of competition depends on the number of competitors. In practice, competition is limited in the French water sector as only three companies compete for the exploitation of all municipal waterworks.

decided that concessions for exploitation of water infrastructure would only be issued to state-owned companies (Tweede Kamer, 1999, 25869, no. 4).

Water Provision and the Environment

Whether there are any signs of global localisation in the water sector can also be read from the water sectors' strategies towards environmental issues throughout the years.

In 1989, the first National Environmental Policy Plan, (NEPP1) declared the Water Companies as being 'environmental companies', assigning them (among other tasks) with educating the public on water saving behaviour and techniques and an annual reporting on the quality of drinking water and used sources.

The 1992 Action Plan on water conservation (Tweede Kamer, 1992, 22556, no.1) advocates a switch from a policy following demand to a more active and steering water conservation policy. The goals for water conservation in households and small and medium enterprises were set according to what was considered 'achievable' in the application of water saving technologies (Van Vliet, 1995). Compared to the prognoses of drinking water production[3] the goal was to save 120 million m^3 in 2000, 210 million m^3 in 2010 and 315 million m^3 in 2020 in households only (Ministry of Environment, 1993, p. 61). Water companies are the main executors of water conservation policy in terms of public education and the diffusion of water saving technologies. Water conservation has always been a controversial issue within the water sector. The responsibilities Water Companies have on water conservation do not seem to be in line with their 'raison d'être': the supply of tap water against societal acceptable tariffs. Especially after the completion of water storage basins in the 1970s, Water Companies were eager to secure returns on investments and rather tried to maximise their water supply than giving support to water conservation campaigns (Van Vliet, 1995). Before that time, however, Water Companies had to manage demand as their capacity of supply and infrastructure fell short.

In 1967, Vewin launched a national campaign called 'Be Water Wise' (Wees Wijs met Water), with the goal not to spill water during peak times (for instance during dry Summers) (Wijmer, 1992). But not all Water Companies were eager to support the campaign. Water conservation was mainly an issue for those Water Companies that used groundwater for tap water production and which reached capacity limits. Surface Water Companies never had a strong need to lower water demand: selling water was their only profitable activity, and water conservation would harm their results. The slogan 'Be Water Wise' was therefore a compromise invented by Vewin which had to represent the interests of both surface water and ground Water Companies. The slogan can have different meanings: it could mean 'reduce your water consumption', but also: 'be sensible with water' which does not necessarily encourage a thrifty use (Vinke, cited in Van Vliet, 1995, p. 47). The current policy of water saving encompasses the stimulation of diffusion of water saving technologies in households, notably showers, toilet cisterns, washing machines and flow restraints in water taps (box 4) and the introduction of a new, highly disputed billing

3 Prognoses for total water consumption of households were: 845 million m3 in 2000, 933 million m3 in 2010 and 947 million m3 in 2020 (Ministry of Environment, 1993, p. 59)

system called 'Waterspoor' (box 3). Most public education on water saving and water saving devices is still done by Vewin or single Water Companies.

Since the issuing of the 1989 National Environmental Policy Plan, desiccation is considered as one of the prioritised national environmental problems. Although Vewin has always argued that drinking water production has only minor impacts on the problem of desiccation, Water Companies have been appointed as a major target group in achieving the goal of a 25% decrease of desiccated area in 2000, compared to the situation of 1985 (Ministry of Environment 1989). This goal hasn't been reached by far, firstly because the total size of desiccated area appeared to be much bigger at the start of execution of policy measures, and secondly because the problems of desiccation appeared to be much more robust and complicated than expected. The lowering of water levels in both agricultural and urban areas, and the paving of surfaces in new residential areas, industrial parks and roads have much more impact on desiccation and is - because of its diffuse character - much harder to regulate than the easier identifiable ground water extraction by Water Companies.

Epilogue: Global-localisation in Water Supply?

Considering the sequence of localisation, nationalisation and global-localisation, actors within the Dutch water sector can now be divided in those who propagate (some modern varieties of) the nationalisation model, while another segment, roughly the defenders of a privatised multi-utility approach, pleas for strategies that are much more in line with

Box 4: Water Saving Technology in Households

Diffusion of water saving technologies in households was stimulated by a 4 year subsidy programme to the construction and housing sector ('Waterbesparing in de Bouw' (1993-1997)) with the aim to supply 5000 new houses with water saving measures. The subsidies were meant for project developers and housing corporations who applied a minimum set of water saving measures in new houses and for innovators who experimented with more far reaching water saving technologies, such as rain water systems or composting toilets. The aim of the programme was that applying water saving techniques in new houses should be a normal practice for the building industry from 1996 on (SEV/NOVEM, 1994). In many respects this goal has been reached, as dual flow buttons on toilet cisterns have become the standard. Also the appliance of low water using showers and taps have become normal practice in new built areas. The institute for certification of drinking water technologies, KIWA, has issued a low-water use label for tested and approved water saving appliances (Van Vliet, 1995).

'global-localisation' tendencies. With the inclusion of a provision on state-ownership of water supply companies in the forthcoming revised Water Supply Act, the debate on what is essentially a transition to global-localised modes of provision has come to a (temporary) halt. However, considering the current variety of viewpoints among the water supply companies as well as between Ministries of Environment and Economic Affairs on vertical or horizontal integration and privatisation of the water sector, the future of the organisation of the Dutch water sector is far from certain in many respects.

It is against this background that a number of Water Companies as well as some consumer groups started experimenting with alternative water systems in new-built residential areas. Chapter 7 on differentiation and substitution of water provision will deal with some of these environmental innovations and how they are 'embedded' in the societal debate about privatisation and different forms of integration of the water sector. Also the discussion on monitoring in the system of water provision (Chapter 6) can now be 'coloured' with our knowledge on bench-marking in the water sector and on tendencies of global-localisation in some segments of the sector, which leads Water Companies to a prudent revaluation of consumer needs and interests.

.5 Electricity Sector Dynamics

Localisation Phase

Electricity provision started in the early 1880s on a very local level: mainly small power stations in building blocks providing direct current for lighting the homes in the same building block. Public electricity provision started in 1883 in Rotterdam where a first Energy Company was allowed to set up a power station and a wired network. It was a commercial failure: after one year the company had to close down again. A company named after its Russian founder Kothinsky was more successful after obtaining a licence from the municipality of Rotterdam in 1884. With a steam engine and a range of batteries a total capacity of 24 kW was generated and distributed to clients in the Rotterdam harbour (Bläser, 1992, p. 33-34).

Other private companies soon followed the first initiative. However, around 1900 there were still many municipalities without any form of electricity system. City councils were quite reluctant to support electricity systems, as they feared competition for their municipal gas factories. Only under the pressure of an increasing number of requests for concessions, municipalities gradually granted concessions to private companies. At the turn of the century, the number of individual consumers that were supplied grew rapidly while small local networks developed. They were stimulated by municipalities who realised that electricity supply had become an economic factor of importance. In the following decades the number of local and regional networks grew and the dependence on electricity increased.

Also municipalities started to build and operate local power plants. The first to do so were the municipalities that did not own gas supply systems. After some years, the first plans for power plants at the scale of provinces came up. Again, there was much hesitation, this time in provincial councils to build and operate such plants, especially because the economic-political preferences in the early years the 20th century can be characterised as mainly liberal: state involvement in industrial development - apart from facilitating private businesses - was out of the question. Yet, with the splintered development of local networks, the need for co-ordination and up-scaling of production became evident (Bläser, 1992). From the early 1920s until today, the provincial scale of electricity provision and provincial ownership of electricity production plants has been the most common organ isational and technical form of electricity provision. The larger cities like Rotterdam and Amsterdam had their own municipal electricity providers.

Public Systems of Provision: Nationalisation

From the 1920s onwards a next phase in electricity provision was the combination of provincial and national interests and even international collaboration. It is the time of foundation of KEMA, a national testing and certification institute for electrical devices (1924) and the joining of the Dutch association of directors of electricity companies to UNIPEDE (the international union of electricity producers and distributors) in 1926. In 1949 an umbrella organisation of electricity generation companies was founded under the name of SEP (Samenwerkende Elektriciteits Producenten) (Bläser, 1992). It took until 1953 to develop one national grid that connected all networks previously formed. In the 1950s and 1960s, government attention focused on increasing the scale of distribution companies which was considered too small: In 1967, for instance, three quarter of electricity demand was supplied by 17 generation and distribution companies, whereas as much as 95 companies supplied the remaining part (De Goey, 1991). Several Governmental Committees advised to bring about mergers, and even a concept law was prepared, but in the end no policy action was taken. Meanwhile, SEP gained responsibility over the operation of the national network. Nation wide planning of capacity by SEP started in 1971.

The energy crisis of 1973 had a tremendous effect on the national primary energy supply. Whereas for a long time oil had been a main energy source for electricity generation, at present the dominant primary energy sources for electricity generation in the Netherlands are gas and coal. In 1996, they accounted for 49 and 42% respectively. Apart from a very small contribution of oil (0.3%), uranium accounted for the remaining electricity generation (Wolsink et al., 1998). Nuclear energy was also envisaged to play a key role, and many new nuclear power plants were planned. However, due to increasing resistance from citizens and the environmental movement these plans were substantially delayed and in 1987, after the Chernobyl accident, finally postponed for an indefinite time. One of the two nuclear power plants was closed in 1997, the last one will close in 2004 (Tweede Kamer, 2000, 26 800 XI, nr. 68).

Governmental influence on the energy sector was reflected in several policy reports starting with the 1974 Energy Report on overall energy policy for the decade to come. During the 1970s and 1980s several Governmental committees gave their advice on the optimal structure of the electricity sector. The most important of these advisory committees was CoCoNut (Commission on the concentration of utility companies) which not only advised on the electricity sector, but also on the gas distribution and water supply sectors as well. This commission advised to go on with further concentration and also to integrate electricity supply with other network-bound provision. Electricity supply companies should have at least a hundred thousand clients and as a result many small municipalities lost their influence on gas and electricity supply. The large power stations and the high voltage grid should be concentrated in one nation wide company and participation of the state was suggested (CoCoNut, 1980). A major reason for choosing this model was the fact that natural gas supply, which is even more important for household energy consumption as well as for the entire Dutch economy, was already concentrated with respect to the functions of production and transport. At the same time distribution and supply functions were still organised on a regional scale.

Although no policy was directly enforced, the indirect pressure brought about a concentration process of electricity distribution companies. By way of mergers the number of electricity distributors was reduced from more than 70 in the early eighties to 35 in 1996 (SEP, 1996).

Privatised Systems of Provision: Global-localisation?

To assess whether there are signs of a transition towards global-localisation in the electricity sector, the same indicators as used in the water sector descriptions can be used. A first indicator is the increasing orientation on national and international electricity markets rather than regional home markets. Besides utility companies may be involved in an upscaling of markets through merging with other (international) companies. Furthermore, consumers may increasingly be treated as different (groups of) customers with diverse preferences relating to energy consumption instead of as an anonymous mass of users. Lastly, in a phase of global-localisation of electricity provision, energy conservation and renewable energy applications become market-based activities rather than side effects or burdens for electricity provision.

When national policy makers are in need for a justification of their efforts to liberalise national utility markets and to privatise public utilities, a reference to EU directives, especially in the field of competition and the internal energy market, is easily made[4]. In 1989, the European Commission formulated the first directive proposals for an EU-wide Internal Energy Market (IEM). As energy sectors are crucial for national economies, member states have been very slow in adopting any directives that are likely to reduce their control over energy sectors. Parallel to a creation of an Internal Energy Market, the Commission also put forward proposals for a Common Energy Policy. The European Commission had to find some unconventional ways to put forward a common energy policy. The Directorate General on competition policy and the European Court of Justice were increasingly employed to seek compliance by member states. The Directorate General on competition successfully advocated that monopolies are only permissible if they are absolutely necessary for the provision of a public good that the market is unable to provide. This implies that the monopolies in gas and electricity must be dismantled. The Commission asked all member states, which had such monopolies, to abolish them or explain why they were deemed necessary.

The Electricity Directive 96/92/EC, adopted in December 1996, concerns the common rules for the internal market in electricity. Member states have had two years to bring into force the laws, regulations and administrative provisions necessary to comply with this directive. The directive sets common rules for electricity generation, transmission and

4 However, many EU directives in this field are initiated or actively supported by the Dutch government.

distribution. Rules for generation concern the procedures to built new generating capacity, these being either authorisation or tendering procedures. Transmission is defined as the transport of electricity on the high-voltage interconnected systems. Distribution is defined as the transport of electricity on the medium-voltage and low-voltage interconnected systems.

Owners of transmission and/or distribution systems should designate a transmission system operator (TSO) to be responsible for operating and ensuring the maintenance. The TSO is responsible for dispatching generating installations and for determining the use of interconnectors with other systems. Member states may impose on distribution companies an obligation to supply customers located in its area. The instrument of a 'public service obligation' may be used to regulate tariffs and require distribution companies to sell electricity to all private customers at equal prices in its area (European Commission, 1997).

Once this EU competition policy was taken seriously, one of the Dutch government's concerns was that the Dutch Energy Companies could be sold to foreign companies. Since the Dutch Energy Companies are much smaller on average than the companies abroad, the government feared that large foreign companies like EdF (France) may buy Dutch Energy Companies. In order to strengthen the position of the generation companies for the anticipated competition on a European scale, governmental plans were to achieve a merge between the four generation companies into one national generation company. This process of merging was supported by governmental subsidies. However due to strong resistance within the electricity sector and some local authorities that through their distribution companies still have some power over generating companies, these plans failed in May 1998. Since then, three of the four energy-generating companies in the Netherlands are sold to foreign investors[5].

The basis for the massive restructuring of the Dutch electricity sector was laid down in the 1989 Electricity Act, most importantly its conditioning for obtaining licences for generation, distribution and supply of electricity. It led to an enforced separation or unbundling of electricity generation and electricity distribution. Other arrangements in the 1989 Electricity Act include arrangements on tariffs, import of electricity and the construction of high-voltage power lines for the national grid (Huygen, 1995). After 1989 there was a remarkable growth of decentralised co-generation capacity. Although formally distribution companies were not allowed to build own power plants larger than 25 MW, they found a way to get involved in non-generation company owned capacity by joint-ventures in co-generation capacity with industrial end-users. In this way, decentralised generation capacity rose from 13% in 1990 to 23% in 1996 (Slingerland, 1997). Another development was the increasing involvement of distribution companies in non-traditional businesses. In this way not only the distribution of electricity and gas, and sometimes water, came in the hands of horizontally integrated companies, but some distributors became involved in waste management, telecommunications, and cable-television activities as well.

5 EZH, UNA and EPON are sold to Preussen Elektra, Reliant and Tractebel respectively (Correljé et al., 2000)

The first legislation with the aim to liberalise the national electricity market was issued in 1996 (Ministry of Economic Affairs, 1995 - Third Energy Policy Document). The document provides for a stepwise liberalisation of the energy market, heavily drawing upon the newest EU Directives. Different categories of electricity consumers (large, medium and finally domestic consumers, respectively in 1999, 2002 and 2007) were assigned to subsequently obtain the right to choose between electricity suppliers. Besides, distribution networks will be opened for the transport of electricity by third parties: companies not being owners of the network.

In early 1998 a revised Electricity Act was accepted by Parliament, which was scheduled to introduce competition in generation from 1999 on. Competition for electricity supply to households will not be introduced before 2004. This implies that households will remain captive consumers for the time being. It is planned to consider privatisation of the electric utilities only after the introduction of competition. In box 5, the state of the art in liberalisation process in the Dutch electricity sector is summarised.

Responses of the Sector towards Liberalisation and Privatisation

In contrast to responses in the water sector, electricity companies have generally been pro-active towards liberalisation and privatisation. As soon as new legislation has enabled trading activities, a huge number of mergers and take-overs has taken place in the distributing sector[6]. Apart from merging electricity distribution activities, the newly formed companies can be considered multi-utilities as they now combine all or a number of the following distribution activities: electricity, gas, water, cable, or waste services. Besides, distribution companies started co-operation with foreign companies to produce or supply electricity to liberalised categories of consumers.

Most visibly, utility companies have intensified their marketing, advertising and sponsoring activities to make them known to the public at large. This can partly be explained by the mergers of the last couple of years that produced several new brand names for which huge campaigns were needed to get the public acquainted (Van Overbeeke, 2000). However, the branding of utility companies is also done to anticipate on the liberalised market for domestic consumers, when the latter may choose between providers. Most of the campaigns are therefore aimed at image building, notably that of a company supplying comfort and convenience to its customers by means of energy, water and waste services. Besides, companies emphasise their commitment to the environment: the advertising costs for different forms of green electricity provision do most probably not reflect the size of the market for green electricity today. Of course, this has everything to do with the accelerated opening of the electricity market for green electricity. Until the complete opening of the consumer market, emphasising environmentally sound activities seems to be one of the few ways for an energy provider to distinct itself from other providers.

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6 Nuon (with a distribution area in eastern and northern provinces) merged with ENW (with a distribution in north-west, including Amsterdam), EWR (west) and Gamog; PNEM (Noord-Brabant), MEGA (Limburg) and Edon (Overijssel) merged in to Essent.

Box 5: State of the art in liberalisation of the Dutch electricity sector

To describe the current state of the art in the process of liberalisation and privatisation in electricity provision, six criteria can be used (Joskow, 1998 in Correljé, et al., 2000):

1. Privatisation: Stimulation of competition by privatising companies in production, transmission, distribution or retail segments.
2. Competition in production: new producers, horizontal disintegration of major companies and deregulation of prices and contracts within the whole production-consumption chain.
3. Free access to the distribution networks: Requires organisational unbundling of vertical integrated producers/distributors and an independent authority to secure equal access.
4. Transparency in tariffs for transmission and distribution
5. Free choice between providers for different categories of consumers
6. Stable and coherent regulatory framework

Ad 1: Privatisation

Three out of four generating companies have already been privatised. The former owners of these companies, mainly municipalities and provinces were eager to sell as soon as it was made possible. The companies had an interest in selling out as they could integrate in international corporations and attract new capital. Furthermore, there is already a great number of private decentralised generating companies. In the distribution sector, the differences in attitudes towards privatisation depends on companies being large or small or being led by social-democrats or liberals. Privatisation is favoured by larger companies and those led by liberal councils. However the national government obliges companies to ensure that at least 51% of the shares are in hands of (local) governments, at least until 2002.

Ad 2: Competition in production

Governmental attempts in 1998 to merge all production companies into one failed. As a result, competition between the remaining and foreign companies is enabled as long as transmission and distribution capacity is sufficient. In 1999, the import balance of electricity was almost 12% of total electricity supplied (Energiened, 1999) and is expected to grow. With the gradual introduction of freedom of choice between suppliers of electricity, the current price co-ordination activities of SEP and Energiened will come to an end. Consumer prices will become a function of the level of competition within the different consumer markets for electricity (Correljé et al, 2000)

Ad 3: Free access to the distribution network

Electricity transport networks are or will be split off from former utility companies. The national transmission network is already split off from the former regulator (SEP) and transferred to TenneT, which is for 51% owned by the government. Since the initial implementation of the new Electricity Act in 1998, DTe operates as an independent authority to monitor equal access and competition on the networks.

Ad 4: Transparent tariffs for transmission and distribution

Currently, there is a so-called 'regulated access' to the grid: there are equal conditions for everyone and they are publicly available. As for 2001, the tariffs should be made transparent to distinguish costs for using the network and costs for supply of electricity.

Ad 5: Free choice between providers for different categories of consumers

To enable a free choice, it is required to adopt the principle of 'retail wheeling', which means that all local distributors should allow any electricity supplier to deliver electricity to consumers via local distribution networks. Electricity prices should therefore be split off from prices for transport and delivery. Large users already have a free choice, the group of mid-scale users will obtain it in 2002, domestic consumers most probably in 2003. As from July 2001, domestic consumers have a free choice between providers of green electricity.

Ad 6. A stable and coherent regulatory framework

A number of specific items in the Electricity Act is still to be formulated. The failure of initial attempts to form one national generating company has resulted in a radical change in the perspectives of electricity sector. As a result strategies of electricity generation and distribution companies now diverge from horizontal or vertical integration, privatisation, merges with national competitors and seeking joint-ventures with foreign companies.

From the first energy crisis on, efficiency improvements on the supply-side of the elec tricity sector became part of governmental policy. By improving the efficiency of power plants as well as stimulating district heating and co-generation, the electricity sector contributed to energy conservation. It took until 1990 when a major covenant between distributors and Government was concluded, until the electricity sector also became co-responsible for energy conservation. According to the covenant, each individual distribution company had to draw up an Environmental Action Plan (MAP). In this plan, measures had to be listed that, dependent on a company's share in total distribution, contribute to the overall goal of 3% CO_2 emission reduction. Measures included the stimulation of co-generation and renewables as well as demand-side management activities. The latter included measures to further energy-efficient lighting and household appliances, loft insulation and more efficient heating as well as information campaigns aiming to influence the behaviour of end-users.

The activities of the Dutch distribution companies were financed by a 2,5% levy (MAP-levy) on energy consumption as agreed upon in the Covenant between energy distribution sector and the government. On a national scale, the activities were co-ordinated by the umbrella organisation of the electricity distributing companies (EnergieNed). Later on, a regulatory levy or 'eco-tax' (REB) is charged on a national level to stimulate end-user demand reduction, although the sector opposed this tax when the government introduced it.

Until 2001 the end-user directed activities in the electricity sector have been carried out by the distribution companies and consisted primarily of the activities mentioned in the environmental action plans which were financed by the MAP-levy. Concerning electricity demand, these activities involved mainly information and advice as well as loans and rebates on energy efficient equipment and appliances, such as light bulbs and freezers.

The introduction of a system of tradable 'green certificates' by the distribution companies

Box 6: Dutch Policy goals on energy conservation and utilisation renewable energy sources up to 2020

Energy conservation:
For the period of 1995-2020: the goal is to have 33% more efficient energy use (1.3% per year) (Ministry of Economic Affairs, 1995), This goal has been up-dated to 1.6-2.0% per year, depending on the chosen scenario for economic growth (Ministry of Economic Affairs, 1999).

Renewables:
The share of renewables in total generation:
- 3% (78 PJ) in 2000,
- 5% in 2010,
- 10% (288 PJ) in 2020

(Ministry of Economic Affairs, 1999).
The biggest share of this energy should be generated from biomass (43%), followed by heat pumps (24%) and wind energy (17%). PhotoVoltaics and thermal solar power each deliver 4%.

in 1998 has had a great impact on green electricity provision in the Netherlands. According to this system, distributors have to distribute 3% of their electricity to end-users from renewable sources. This has to be proved by the number of 'certificates' a distribution company holds. Certificates can be obtained either by generating electricity from renewables itself, or by buying certificates from another renewable electricity generator.

Finally, apart from MAP-related efficiency activities of distributors there is also a market for commercial energy efficiency activities. These can involve advice (quick-scans, energy advice, 'no-cure-no-pay' scans); equipment services (installation, inspection and maintenance, renting); maintenance of energy installations; contract management; energy management, outsourcing and performance contracting. Co-generation activities are also often provided by way of outsourcing.

Energy Conservation after 2000

Parallel to the liberalisation of the electricity sector, the government aimed to modernise its legislation on energy conservation and stimulation of sustainable energy. The White Paper on Energy Conservation in 1998 and the progress report Implementation of Sustainable Energy (1999) both deal with energy conservation and the stimulation of renewable energy in the new era of liberalised energy markets. Earlier policy goals on energy conservation and sustainable energy generation as mentioned in the 1995 Energy Paper have been strengthened due to international agreements on CO_2 emission reductions in the Kyoto protocol of 1997. Besides the economic growth rates that underpinned the earlier energy papers needed adjustments, which resulted in even higher requirements to achieve the goals of CO_2 emission reduction. The current policy goal for the share of sustainable energy generation in total generation is 10% in 2010 (Ministry of Economic Affairs, 1995).

The further liberalisation of the electricity market is guided with the parallel development of a regulating framework and corresponding institutions (DTe) to safeguard public interests in electricity provision (concerning tariffs, security of supply, supply to remote consumers) and to protect remaining captive consumers. The question is whether this development would also help to bridge the - supposed - gap between market-based operation of the electricity sector and policy ambitions in terms of energy conservation and sustainability. One effect of liberalisation in the electricity sector is that its contributions to energy conservation and sustainability policy are not self-evident anymore. EnergieNed, the umbrella organisation of energy distribution companies already declared that energy conservation, after finalising the last MAP programme at the end of 2000, will be an issue for government and clients. Its vice-president declared that "in a liberalised market it doesn't fit to try to persuade clients to reduce their demand from your producers. A collective covenant such as MAP is not possible with companies that compete with each other" (www.wisselstroom.nl, 27-7-2000).

Whether this remark counts for the MAP covenant only or for covenants in general has not been made clear. It is however most likely that future covenants between the electricity sector and the government would encompass the use of renewable resources rather than energy conservation measures. Privatised Energy Companies are more likely to be challenged by investments in renewables than in campaigning energy conservation. Be sides, the interests of Energy Companies will diverge as most of them are already developing their own strategic markets for electricity provision. Evaluation of measures concerning energy conservation and sustainability will therefore have different outcomes for different companies. Lastly in a liberalised market, electricity companies will be less willing to provide information on their businesses to their competitors or the government, which is a requirement for developing policy instruments and to implement and evaluate them. This is especially true for policy covenants (Correljé et al., 2000). To sum up, it is not likely that the policy instruments on energy conservation that have been relatively successful until today will remain successful in a future liberalised electricity market. This does not mean that with the liberalisation of the electricity sector energy conservation policy will come to an end. Energy companies may have a number of rationales for continuation of energy conservation strategies in a liberalised energy market (Keating, 1996 in Correljé et al., 2000):

- Service provision or binding of clients. In a situation where clients may freely choose between providers, it can be economical to help clients making savings on their energy bill as an additional service.
- Avoiding new investments in generation or transmission capacity. This is a well-known rationale behind Demand Side Management and can still be valid, although it depends on how costs for transmission are recovered in consumer tariffs.
- Image building. Energy companies are and probably will be under increasing pressure of governments, environmental and consumer NGOs to commit oneself to a number of societal goals, among which environmental care is an important one.

Whether such rationales will also count for new providers, is not yet clear. On the one hand, newcomers on the market will not have equal experience in energy conservation like the former public utilities have. They will enter the market for business reasons. On the other hand, new entrants are likely to create niche markets as to distinct themselves from conventional providers. Environmental soundness in one way or the other proves to be such a niche market. Of the many newcomers on the market until now, the majority profiles itself as green electricity provider (see for instance: Echte Energie, SGEP, Wisselstroom.nl, among others, listed at www.greenprices.nl).

Epilogue: Global-localised Electricity Provision?

The sequence of localisation, nationalisation and global-localisation proves to be helpful to structure our view on dynamics in the Dutch electricity sector, like it did to structuring those concerning the water sector. The dividing line between a nationalisation phase and phase of global-localisation is once again not very clear-cut. It would be too easy to assume that a liberalised electricity market can be equalled with a global-localised mode of provision, as long as it is not specified what form of liberalisation and what kinds of (additional) regulation modes may be at hand. However, a number of current developments indeed might sum up to a transition from a phase of nationalisation towards a phase of global-localisation in electricity provision: the break-down of state monopolies and the entrance of new small providers; the increasing emphasis on customers and their prefer ences which results in new 'tailor-made' services; and the internationalisation of formerly regional utility activities through strategic mergers and take-overs.

In comparison to the Dutch water sector, there is much more consensus within the sector and the ministries of Economic Affairs and Environment on the general direction the sector needs to take: towards more marked-based operation with regulated third party access, and with a gradual liberalisation of large, medium and small-scale electricity consumers.

Although the old regulatory framework to safeguard environmental issues will no longer be applicable, there will still be ways to cope with environmental issues. Energy conservation measures may not be forced upon Energy Companies by the governmental regulation anymore, but it could be demanded by clients who will have the freedom to move to another provider whenever the Energy Company does not satisfy on this part.

The dynamics in the electricity sector as presented here are the back ground factors for understanding developments in monitoring and differentiation that will be discussed in the following chapters.

5.6 Conclusions

There are considerable differences between utility systems of provision especially in terms of which phase in the transition process they can currently be positioned. For instance: telecommunication has been developed much further into 'global-localised' modes of provision than contemporary water works. But generally speaking, uniform production and mass-marketing have been or are being replaced by more diversified, 'splintered' production and marketing activities. Typical of such a transition is that consumers are, or will be, offered different products, services and tariffs by a range of different small and large providers, instead of relying on one regional state company offering a uniform service. Lastly, the current modes of production and provision call upon individual modes of behaviour, personal values and lifestyles.

On a general level, water and electricity provision in the Netherlands share a history of localisation and nationalisation that have led to regionally based and government controlled utility infrastructures serving captive consumers. The developments in both sectors diverge however considerably where it comes to a possible transition into a next phase of global-localisation. While in the water sector the initial developments towards privatisation and liberalisation have been tempered on political grounds, the forecast for the electricity sector is that of further liberalisation and internationalisation. As a consequence, electricity providers are preparing for a free market for domestic consumers, while new providers are exploring the same consumer market and try to find market niches, among which green electricity is a dominant one.

Representatives and managers in the water sector are much more divided than those of the electricity sector regarding the future directions to follow: vertical or horizontal integration; merging with multi-utilities or keeping water with water; privatisation or maintaining public ownership. Although the water sector will keep its current mode of provi sion and regulation (monopolist, public provision) for the time being, further concentration of Water Companies and a more marked-based operation of water supply can be expected in the near future. A number of front running Water Companies are already adopting more client-oriented strategies and are developing new technologies that serve environmental goals and local needs. Combined with ground water scarcity and the recent development of new treatment technologies, such strategic shifts have among other things brought dual water systems closer to application.

Although the main dynamics in water and electricity sectors such as liberalisation and internationalisation should be attributed to political-economic rather than environmental considerations, during the phases of nationalisation and global-localisation the environment gradually gained importance in both policy making and strategic planning activities within both sectors. During late 1960s and early 1970s electricity and water provision were for the first time related to environmental damage. The emergence of command-and-control environmental regulation matched with the hierarchic organisational structure of both sectors. The unbundling of generation and distribution activities within the electricity sector after 1989 opened the way for joint environmental policy making known as the Environmental Action Plan Covenant between the government and the energy distribution sector between 1990 and 2000.

More than causing damage to the environment, Water Companies claim to suffer from pollution and desiccation of water resources. This double-role was acknowledged in the 1989 National Environmental Policy Plan in which Water Companies were assigned 'environmental companies' and made co-responsible for the protection of ground water sources and the execution of water saving policy. With the consolidation of the public mode of provision, it is likely that the sector will remain responsible for these tasks in environmental policy making.

With the liberalisation of the electricity market a new covenant like the Environmental Action Plan does not seem to be likely anymore. Other actors than electricity providers (notably small and large-scale consumers, supported by fiscal measures) should take the lead in energy conservation measures. However, in achieving the ambitious policy goals concerning the use of renewable energy sources, the sector will remain playing a mayor role, as renewable energy might turn out to be a profitable energy market.

6 Monitoring and New Consumer-Provider Relations[1]

6.1 Introduction

When a group of European academics, gathered in a workshop[2], was asked to read and compare each other's utility bills, most surprising was the seemingly endless diversity in which utilities inform their customers nowadays. The bills turned out to be appropriate markers of contemporary utility change and newly emerging consumer-provider relationships. Apart from the various ways in which humble figures on kilowatt hours and cubic meters were presented, the bills revealed that in some countries new third party service providers had taken over utility operations, in some others that utilities were trying hard to make new product types meaningful to consumers or were adding environmental information and subsequent behavioural advises in the margins of their bills.

The different utility bills are in fact the materialised outcome of various kinds of monitoring in water and electricity provision and consumption. This chapter has the aim to bring some clarity in the different kinds of monitoring and to specify how monitoring should be developed to make a contribution to the ecological modernisation of production and consumption. I will utilise a number of cases of monitoring in Dutch water and energy sectors to illustrate and underpin my argument that monitoring is in fact a process of quantifying, labelling and evaluating the relations between consumers and providers. Furthermore, I will argue that monitoring is to be considered as a two-way road: it is not only a process in which providers supervise consumers; monitoring is also a tool to make systems of provision visible to citizen-consumers.

I will build up my argument as follows. I will start the discussion with the meter representing the 'production-unit' of all modes of monitoring in water and electricity provision. Meters have become the material representation of the cleavage between production and consumption, both in physical and in social terms. I will argue that new forms of monitoring should - and in some cases already do - blur the barrier between the sphere of production and the sphere of consumption and that this requires different meters, metering procedures and consumer-provider relations.

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1 This chapter is partly based on Domus report's chapter 4 on Monitoring and Power (Van Vliet in Chappells et al., 2000)

2 Winter Workshop Infrastructures of Consumption and the Environment, Wageningen, 25-28 November 2000, funded by European Science Foundation (TERM programme)

Next, in section 6.3, I will elaborate on the different meanings of monitoring and present 3 approaches to monitoring that build upon each other: energy revealing approaches; social revealing approaches and a combined approach. In section 6.4, a sample of Dutch monitoring cases in the fields of energy and water consumption illustrates the use of different approaches mentioned above. The analysis of cases in section 6.5 is focussed upon the rationales behind, and the kinds of knowledge provided by the different monitoring schemes in our sample. Finally, in 6.6 the findings of my analyses will be used to conclude on the role and function of monitoring in the ecological modernisation of electricity and water sectors.

6.2 Consumer-Provider Relations around the Meter

Meters as Physical Markers

That the meter has become a physical marker between the public networks and the private home is clearly expressed in the phrases commonly used in utility management literature. Everything that is done beyond the meter refers to household practices and is therefore normally beyond utility's responsibility. Likewise, from a consumer's point of view, the world behind the meters is usually invisible and unknown. The meter-marked divide between individual and public networks has also legally been established for both energy and water networks. House-owners are fully responsible for the maintenance and safety of in-house networks up to the utility meter. From there on and outwards, the networks are subject to utility's liability.

Traditionally, electricity, gas or water meters show aggregate amounts of flows in units of KWhs, Joules, or cubic metres. These meters have been installed at home entrances or just after the main switch or tap of the incoming network. They require manual reading, normally once a year. Individual metering has become normal practice in most energy networks. Water metering is not as common as in the cases of electricity or gas. One explanation for this is that energy has always been considered a privately consumed service while water provision is traditionally seen as a public good. Even before the existence of waterworks, city dwellers used publicly provided wells and pumps. Individual metering of the usage of these public services had for a long time been considered inappropriate or even improper, and in some cases this is still the case. Nowadays, privatised British Water Companies are accused of discriminating against lower income groups to higher classes as they only install water meters in the lower income areas (Marvin, 2000).

Since the 1980s, radical changes in information and communication technologies have revolutionised the potential of utility meters. The new systems have come to be known as 'smart' as a reflection of their enhanced functional and communication capacities, compared with their simpler predecessors (Marvin et al., 1999). Meter manufacturers and ICT companies are now competing to offer new metering systems that display not only physical flows to consumers and providers, but facilitate broader functions as well, such as tariff management, load control, information provision on efficiency measures and so forth. In the electricity sector, a variety of integrated electronic and modular remote metering systems have been developed, whilst in the water sector basic volumetric meters are being supplemented by newer meters with encoded registers and non-moving parts. Smart card and other pre-payment systems are becoming available in both sectors, as well as multi-utility meters, which combine the measurements of gas, electricity and water flows in an integrated unit.

Water and electricity meters are, however, not the only monitoring tools. There are various other methods of monitoring the consumption of network-based resources. Utilities may estimate consumption levels from block-metering or from metering the supply of resources elsewhere in the network. More refined forms are the various modes of self-monitoring and data logging. If there are no individual meters, monitoring could be done by regular surveys or by monitoring resources at the supply-side. There are many other monitoring procedures: from continuously measuring the flow to randomly taking samples, from on-line feed-back information to consumers to offering only a yearly bill presenting the annual consumption load. There is a growth of individualised monitoring systems because, firstly the privatisation of public utility companies and liberalisation of utility markets have increased the interest of utilities in their customers. Size and character of customer databases have become important parameters to assess the value of a utility company. When it comes to the privatisation of a utility company and its networks, their value is much higher when their customers are known and metered. Secondly, energy and water conservation efforts since the 1970s have required the monitoring of consumption levels to evaluate their effectiveness. Data-logging is an inevitable part of individual conservation strategies as it reveals the effectiveness of measures taken. Since consumers have been educated about their contribution to environmental pollution and have been seen as clients of utility services rather than as anonymous users, they may feel the need for better management of resource use within their households.

Consumer-Provider Relations

As noted previously, the flows of information between both providers and consumers and their respective visibility is not always equally divided. In a discussion on current and newly developing metering technologies, Marvin et al. (1999) have presented a range of technology development pathways and their connected consumer-provider relations. The precise technical configuration of the meter is strongly shaped by the often-conflicting objectives of agencies involved in developing and implementing the systems. Each technological development pathway represents a number of metering systems that do not necessarily share the same precise technical component and application, but nevertheless are socially configured in ways which inscribe similar forms of producer/user relationships (Marvin et al., 1999, p. 7). They have put forward four characterisations of consumer-provider relationships related to metering: 1) Limited relationships; 2) distant relationships; 3) authoritative and 4) devolved relationships.

1) Limited Consumer-Provider Relationships

The technical development pathway that Marvin cum suis have called 'monitoring' consists of conventional meters with only simple functions. Consumer-providers relation ships are characterised as 'limited': the meter is an agent recording consumption on behalf of the utility and its relations with users are transacted through reading and billing. With manual and infrequent readings, utilities gain relatively little information on users behind the meter. Likewise, consumers hardly gain knowledge about the system of provision behind the meter.

2) Distant Consumer-Provider Relationships

The modern prepayment meters are categorised in the technological development pathway called gatekeeper. Prepayment cards fulfil a mediating role between providers and consumers, transferring information backwards to the utility and forwards to consumers. In Britain, the installation of pre-payment meters has been strongly criticised by the British National Consumer Council among others, because they enable providers to disconnect defaulters quite easily from the supply of resources which, after all, are considered essential for daily life. The high costs of debt recovery and disconnection are averted as the system is based on self-disconnection by consumers as soon as they stop paying for the service.

Most smart-cards systems have a functionality that far exseeds the limited applications presently being exploited. The cards could be used to store and display much more detailed consumption data, the use of differential tariff rates to modify demand, resource saving tips and a system for debt recovery. In any case consumer-provider relationships are qualified as 'distant' as relations will only be mediated by the card. The smart card replaces all of the billing and most other correspondence between providers and consumers.

3) Authoritative Consumer-Provider Relationships (Producer-led)

The producer-led development path is characterised by innovations at the cutting edge of metering industry, with extended data processing capacities, state-of-the-art communications and increasingly intelligent functions. With these technologies providers can in principle extend their control beyond the meter and into the homes by offering value-added services and extracting new information about users. The technology may be used to help consumers' timing and level of demand and therefore contributes to energy or water conservation. However, it is the provider who decides where such meters will be installed and which functions will be attached to them. In a producer-led pathway the utility seeks to develop a more authoritative relationship with their preferred customers. Taken to the extreme, the producer-led approach resembles Foucault's use of Bentham's Panopticum model of a prison in which both social exclusion and disciplinary parcelling are united. In a Panopticum, prisoners live in cells surrounding a tower from which every cell can be watched. As all cells have large windows, the incoming light reveals every prisoner's silhouette to the supervisors in the tower. However, as all cells are separated by solid walls, prisoners cannot see one another. As opposed to old prisons where dark cellars offered at least some kind of protection to prisoners, here all prisoners' behaviour has become visible to their guards who themselves are invisible to the prisoners. The prisoner has become an object of information and can never be the subject of communication. This is in fact the major function of the Panopticum: due to the prisoners' permanent visibility and their inability to communicate with one another, power is automatically ensured. In fact, its very execution has become superfluous. The Panopticum structure creates and maintains power relations independently of who is actually in power and prisoners themselves have become the carriers of the power situation (Foucault, 1975, in Lambrechts, 1982).

The Panopticum metaphor applies to those systems of water and electricity services where the behaviour of captive consumers is increasingly made visible to providers through advanced (automatic and 24-hour) metering, while consumers themselves do not gain any more insight into providers' strategies or into those of other consumers. In these cases, monitoring mainly empowers providers rather than consumers. On-line continuous monitoring enhances this permanent visibility without informing consumers whether or when they are being monitored and without making the provider visible to consumers.

4) Devolved Consumer-Provider Relationships (Consumer-led)

Applied in a different constellation, the same technologies that underpin the producer-led approach may as well be used in situations where consumers are able to become more authoritative users of information flows. ITC technology can be used for displaying user-defined information on consumption, summarise consumption levels over time and automatically switch on and off washing machines, heaters and the like. The more consumers are able to program the technology, the more consumer-led the approach will be.

Van Den Burg et al. (2001) offered a more extended notion of this consumer-led development path. They broadly define monitoring schemes as consumer-oriented if they involve citizen-consumers (or civil society and consumer organisations) in the process of measurement. In one way or the other consumer-oriented monitoring provides citizen-consumers with the information and knowledge related to the environmental dimensions of social practices. Consumer-oriented monitoring schemes include self-monitoring of consumers as well as monitoring projects in which citizen-consumers disclose the behaviour of producers and thus develop countervailing power. The objectives of both types of monitoring are of course completely different. Whereas self-monitoring is concerned with realising individual savings, counter-surveillance monitoring schemes are directed primarily to realising changes in the systems of provision.

In the exploration of different categories of consumer-provider relationships in monitoring, only little has so far been said about the *kinds* of knowledge that are produced in monitoring schemes and how they might be used in the ecological reform of infrastructures of consumption. After presenting two conflicting approaches on this, the next section will conclude with a combined approach by way of an answer to that question.

.3 Approaches to Monitoring

Although the purposes of monitoring practices range from financial to environmental reasons, the metering and monitoring examples outlined above have in common a focus on increasing the transparency of physical flows of water and electricity to their providers or users. The theory of ecological modernisation draws upon a much broader under standing of monitoring. Transparency is needed not only in figures concerning consumption, but also in modes of provision, access and use. If consumers are supposed to take ecological considerations on board, they need much more of an overview of how the system of provision is organised for instance to trust its claimed environmental soundness. Hence, monitoring should not be restricted to metering only but rather made part of a social system that enhances providers' accountability towards consumers.

Goldblatt (2000) has discussed both approaches towards monitoring in a paper on lay knowledge on energy consumption and communication. He counterbalances a so-called energy revealing/social concealing approach with an energy concealing/social revealing approach[3]. The former approach reveals the figures on consumption but keeps knowledge on the social structuring of the system of provision concealed. Consumers are perfectly capable to monitor their own levels of electricity consumption, but do not get any clue of aggregate consumption levels, environmental impacts of electricity consumption, or organisation of electricity generation, distribution and supply.

The energy concealing/social revealing approach just presumes the invisibility of energy consumption and tries to illuminate its social causes and drivers. Following this approach, energy and water consumption is shaped in complex social systems that often submerge environmental concerns. Invisibility of energy or water consumption is therefore not considered the main problem. Rather it is the social, cultural or socio-technical structures that lay behind electricity provision that need revealing.

The division between the two approaches is part of a general disciplinary divide between the conventional economic-engineering approach to energy analysis and an alternative sociological approach. Not surprisingly, the economic-engineering approach is dominant in most utility-based monitoring projects. It assumes an economic rational actor who takes action based upon information on energy and water consumption. The underlying causes of energy and water demand are ignored or only superficially explored by researchers and policy makers. Instead the alternative approach developed in the fields of sociology, anthropology and Science and Technology Studies questions social needs or purposes for energy and water consumption, which are taken for granted in the economic-engineering approach. It challenges the neutrality of technologies as problem solvers and suggests that they may be part of both problems and solutions (Shove, 1998 in Goldblatt, 2000). Instead of positioning a physical barrier between the world of consumption and the world of provision, this approach would lead to the design of monitoring devices that function as a social switch between consumption and provision. Apart from functioning as a meter, the device would be a mediator between production and consumption, for instance by displaying real-time demand and supply, matching provider characteristics with consumer preferences and enabling choices between services or providers.

In sum, I would argue that 'monitoring' would only be significant for ecological modernisation if its meaning is extended from only 'metering' to the revealing of environmental

3 There is no need to make a distinction between water and energy systems in this respect. Where energy concealing or energy revealing is mentioned in this chapter, one should read 'water concealing' and 'water revealing' as well.

About the Author

Bastiaan Joannes Maria van Vliet (Rosmalen, 1967) finished his Atheneum B education at Mill-Hill College in Goirle in 1986 after which he started his study Environmental Sciences at Wageningen Agricultural University. He did majors in Environmental Communication, Law and Environmental Sociology. The latter encompassed a study of decision making around environmental investments in an oil refinery in the Netherlands Antilles.

After graduation in 1992, he worked as a researcher at the department of Environmental Sciences of Utrecht University. In 1994, he returned to Wageningen University to conduct a study on the diffusion of water saving technologies in Dutch households. Based at the Environmental Sociology Group (now Environmental Policy Group) since 1995, he has conducted research projects on small-scale industries in Nairobi, Kenya; environmental policy in Curaçao; and a European Commission funded collaborative project on utility services and domestic consumption in Sweden, Britain and the Netherlands. Besides these research projects he was involved in an ESF-funded European network of social scientists and co-organised an international workshop on 'Infrastructures of Consumption and the Environment' in November 2000. In 2001 he was appointed staff member at the Environmental Policy Group as well as student advisor for Environmental Sciences at Wageningen University.

De invloed van milieugeïnduceerde veranderingen op de relaties tussen burger-consumenten en aanbieders in netwerkgebonden systemen (de tweede onderzoeksvraag) is geïllustreerd in de hoofdstukken over monitoring en differentiatie. De top-down relatie tussen aanbieder en gebonden afnemer in traditionele monitoring wordt in geval van milieugerichte monitoring omgezet in wederkerige relaties en een tweerichting informatieverkeer ten aanzien van verbruik en milieuprestaties aan beide zijden van de meter. Milieugerichte differentiatie in netwerkgebonden systemen leidt tot de versplintering van consumentenrollen: van de traditionele 'gebonden afnemer' in uiteenlopende en meer betrokken rollen als 'klant', 'co-producent' of 'burger-consument'.

De theorie is vervolgens met behulp van hypothesen over milieugeïnduceerde veranderingen in water en elektriciteitssystemen en de veranderende relaties tussen aanbieders en consumenten getoetst aan de praktijk van milieu-innovaties in Nederland.

Van de 6 hypothesen is de eerste in algemene termen aangetoond, dat wil zeggen: water- en elektriciteitssectoren blijken 'milieu' serieus te nemen, al was het alleen maar als een mogelijkheid om te differentiëren op een van oudsher verzadigde, uniforme markt. Ook de tweede hypothese, over de opkomst van groene services en de competitie om de groene consument, wordt ondersteund door dit onderzoek. De derde hypothese over de toenemende zeggenschap en betrokkenheid van consumenten als gevolg van milieu-innovaties blijkt een generalisatie: deze hangen namelijk sterk af van de wijze waarop milieu-innovaties aan consumenten wordt aangeboden.

De noodzaak van uitgebreidere vormen van monitoring (hypothese iv) is in hoofdstuk 6 aangegeven. Ecologische modernisering vergt een grotere inzichtelijkheid in milieuprestaties van water- en elektriciteitsvoorziening voor en achter de meter. De bestudeerde cases van monitoring laten zien dat veel projecten hier nog niet aan voldoen. Dat de differentiatie van hulpbronnen, aanbieders en technologieën ook leidt tot differentiatie in consumentenrollen ten aanzien van aanbieders van water en elektriciteit (hypothese v) is aannemelijk gemaakt door het case-study onderzoek naar milieu-innovaties in water- en elektriciteitssectoren. Ook is duidelijk geworden dat de (in hypothese vi) genoemde toepassing van kleinschaliger technologieën in de water- en elektriciteitsvoorziening vrijwel uitsluitend netgekoppelde systemen betreft, waarbij niet gestreefd wordt naar zelfvoorziening maar naar de ruimtelijke optimalisering van generatiecapaciteit en naar milieu-efficiency.

Dit proefschrift levert het theoretisch gereedschap voor het onderzoek naar de ecologische modernisering van niet alleen water- en elektriciteitsnetwerken maar van netwerkgebonden systemen in het algemeen. Verder onderzoek kan zich richten op andere netwerkgebonden systemen (met name de voor het milieu relevante transportsystemen en rioleringssystemen), en andere landen (met name binnen de EU). Daarnaast kunnen de inzichten over differentiatie en monitoring ook bruikbaar zijn voor het onderzoek naar de ecologische modernisering van niet aan technologische netwerken gebonden systemen, zoals bijvoorbeeld de voedselvoorziening.

van cases van milieugerichte differentiatie in de water- en elektriciteitsvoorziening een typologie ontwikkeld van burger-consumentenrollen ten aanzien van aanbieders van water en elektriciteit.

Milieugerichte differentiatie kan zich voordoen op verschillende niveaus in de keten van winning van hulpbronnen tot en met de consumptie van water en elektriciteit. Op het niveau van hulpbronnen geldt als differentiatie bijvoorbeeld de inzet van hernieuwbare bronnen zoals zon en wind voor de elektriciteitsproductie of regenwater voor de watervoorziening. Op het niveau van aanbieders betekent milieugerichte differentiatie de opkomst van nieuwe aanbieders zoals groene stroomleveranciers naast de gangbare nutsbedrijven. Differentiatie van intermediaire technologie omvat de installatie van bijvoorbeeld nieuwe monitoringsystemen, dubbele leidingsystemen, of meervoudige tariefsystemen. Naast de rol van 'gebonden afnemer' zorgen combinaties van deze differentiatievormen voor nieuwe type rollen van gebruikers: die van 'klant', 'burger-consument' en 'co-producent'. De 'klant' kan kiezen tussen verschillende (groene) aanbieders en (groene) producten op de water- en elektriciteitsmarkt. De burger-consument toont zich een 'burger' als hij of zij kiest voor het nastreven van maatschappelijke doelen bij de keuze voor en het consumeren van water of elektriciteit, bijvoorbeeld door lid te worden van een windmolenvereniging. De co-producent, ten slotte, is niet langer alleen afnemer maar ook mede-producent van water en elektriciteit, zoals de bewoners van huizen met netgekoppelde zonnepanelen, windmolens of regenwatertoiletten.

Vanuit de rol van 'gebonden afnemer' is door milieugerichte differentiatie in de water- en elektriciteitsvoorziening een variëteit aan consumentenrollen ontstaan. In veel gevallen zullen gebruikers meerdere rollen op zich nemen. De benoeming van 4 ideaal-typen consumentenrollen kan echter gebruikt worden om te analyseren welke gevolgen milieugerichte differentiatie in netwerkgebonden systemen kan hebben voor de relaties tussen aanbieders en consumenten.

Hoofdstuk 8: Conclusies

De twee onderzoeksvragen worden beantwoord door allereerst conclusies te trekken uit het theoretisch onderzoek en vervolgens de in hoofdstuk 4 opgestelde hypothesen te toetsen aan de praktijk van milieu-innovaties in water- en elektriciteitssystemen.

De vraag hoe milieu-innovaties in netwerkgebonden systemen tot stand komen kan beantwoord worden met een verwijzing naar de theorie achter technologische transities: succesvolle technologische 'niches' leiden tot een verandering van technologische regimes en uiteindelijk het technologische 'landschap'. Dit antwoord vertelt echter nog te weinig over de rol van sociale actoren en over milieugerichte verandering. De theorie van ecologische modernisering laat zien dat er verschillende stappen zijn te onderscheiden in milieugeïnduceerde verandering in productie en consumptie. Dit onderzoek heeft laten zien dat de totstandkoming van milieu-innovaties in netwerkgebonden systemen beoordeeld kan worden aan de hand van processen van monitoring en differentiatie.

De elektriciteitssector is hiermee verder in de fase van mondialisering-lokalisering beland dan de watersector. Dit heeft behalve met politieke besluitvorming ook te maken met de fysieke verschillen tussen beide netwerken: water is minder transporteerbaar dan elektriciteit en appelleert meer aan publiek belang (volksgezondheid) dan elektriciteit. Dit heeft dan ook gevolgen voor het karakter van milieu-innovaties en de mate van differentiatie in beide sectoren.

Hoofdstuk 6: Monitoring en Nieuwe Relaties tussen Consumenten en Aanbieders

Monitoring in de water- en elektriciteitsvoorziening omvat doorgaans niet meer dan de bemetering van woningen. Water- en elektriciteitsmeters representeren de strikte scheiding tussen het openbare net en het private systeem, tussen levering en consumptie. De informatie die dit soort meters produceren is vooral bedoeld voor nutsbedrijven om het verbruik aan de consument in rekening te kunnen brengen.

In het proces van ecologische modernisering is monitoring een essentiële stap. Het dient dan echter breder opgevat te worden dan het (letterlijke) bemeteren en gericht te zijn op milieu en de consument. Onder een 'meter' dient ook meer dan alleen een tellermechaniek te worden verstaan: van teletekstpagina's met actuele verbruikscijfers tot etikettering van groene stroom, en van stooktabellen tot EcoTeam bijeenkomsten. Bovendien zou de geleverde informatie inzicht moeten bieden in de milieuprestaties voor én achter de meter. Dit houdt in dat niet alleen de fysieke stofstromen weergegeven worden, maar ook de organisatie van milieugerichte maatregelen voor en achter de meter. Monitoring vervult dan een intermediaire functie van informatie-uitwisseling tussen aanbieders en gebruikers.

Aan de hand van een aantal uiteenlopende case-studies van milieu-innovaties gericht op monitoring van water en elektriciteit wordt getoond dat er op dit moment vele vormen van milieugerichte monitoring bestaan, maar dat slechts enkele projecten voldoen aan de eisen zoals hierboven gesteld. Als de projecten worden geëvalueerd op hun betekenis voor de relatie tussen aanbieders en consumenten, blijkt dat de zeggenschap van consumenten over de toegang tot verbruiks- en productiegerelateerde informatie zeer uiteenloopt. De toenemende differentiatie in producten en services van water- en elektriciteitsbedrijven draagt er echter aan bij dat de informatievoorziening hierover zich uitbreidt. Daarnaast maakt nieuwe informatie en communicatietechnologie veel verfijnder en gebruiksvriendelijker monitoring mogelijk dan tot op heden het geval was.

Hoofdstuk 7: Differentiatie in Elektriciteits- en Watervoorziening en Consumptie

Grootschalige netwerkgebonden systemen kenmerken zich door de levering van uniforme producten door middel van gestandaardiseerde technologie. Differentiatie in producten en technologieën is daarom in principe een systeem-vreemde ontwikkeling. Ook de rol van burger-consumenten ten aanzien van de elektriciteits- en watervoorziening beperkte zich tot voor kort tot die van 'gebonden afnemer'. In dit hoofdstuk wordt aan de hand dat deze technologieën worden ontkoppeld van de grootschalige infrastructuur zoals theoretici van de-modernisering dat noodzakelijk of wenselijk achten.

Hoofdstuk 5: Milieugerichte hervormingen in de Nederlandse water- en elektriciteitssectoren

De context voor de bespreking van milieu-innovaties in water- en elektriciteitsnetwerken bestaat uit een historische analyse van de ontwikkeling van de Nederlandse water- en elektriciteitsnetwerken in relatie tot milieuvraagstukken. Bij de ontwikkeling van nutsvoorzieningen kunnen drie fasen worden onderscheiden: de fase van *lokalisering*, waarin private bedrijven de eerste lokale netwerken aanlegden, die van *nationalisering*, waarin overheden de netwerken overnamen en uitbouwden tot nationale systemen en die (huidige) van *mondialisering-lokalisering* waarin markten voor nutsvoorzieningen worden geliberaliseerd en netwerken en bedrijven worden geprivatiseerd. Enerzijds gaan aanbieders zich hierdoor intensiever op de regionale markt richten en anderzijds richten zij zich op grotere markten.

De overgang naar de laatste fase en daarmee de liberalisering van voormalige nutsvoorzieningen is niet per definitie in strijd met principes van ecologische modernisering. Het biedt een aantal nieuwe mogelijkheden voor meer horizontale besluitvorming in het milieubeleid alsmede ruimte voor milieu-innovaties. De overheid zal echter een grote rol moeten blijven spelen om de water- en elektriciteitsvoorzieningen alsmede de milieuvernieuwing binnen deze sectoren te blijven waarborgen.

De Nederlandse watersector heeft zich ontwikkeld van een grote verzameling kleine lokale netwerken naar enkele grote waterbedrijven op provinciale schaal. Tot op heden is er een dominant overheidsbelang in deze bedrijven. Door middel van 'bench-marking' wordt nu enige marktwerking toegepast. Op milieugebied heeft de watersector altijd meerdere rollen gespeeld: enerzijds zijn zij mede veroorzakers van problemen als verdroging, anderzijds zijn zij de slachtoffers van vervuiling van waterbronnen door derden. De meest in het oog springende milieu-innovaties met betrekking tot huishoudelijk watergebruik zijn de recente projecten waar verschillende meerdere waterkwaliteiten worden toegepast voor verschillende huishoudelijke doeleinden.

Ook de levering van elektriciteit aan huishoudelijke consumenten is tot op heden in handen geweest van voornamelijk provinciale nutsbedrijven. De liberalisering van de markt voor elektriciteit en de privatisering van nutsbedrijven is echter in volle gang. Dit heeft grote gevolgen voor de organisatie van opwekking, distributie en consumptie van elektriciteit en de rollen van overheid, bedrijfsleven en eindgebruikers. Het opstellen van doelstellingen ten aanzien van CO_2 emissies en het aandeel duurzaam opgewekte stroom is onveranderd een overheidsaangelegenheid, maar deze doelstellingen zullen op een geheel nieuwe wijze tot stand moeten komen. Een typische vorm van milieugerichte regulering in een geliberaliseerde elektriciteitsmarkt is het systeem van groencertificaten en de daaraan gekoppelde marketing van groene stroom.

Hoofdstuk 4: Ecologische Moderniseringstheorie en Netwerkgebonden Systemen

Voor de analyse van milieu-innovaties in netwerkgebonden systemen en de relaties tussen consumenten en aanbieders wordt de theorie van ecologische modernisering nader uitgewerkt. In algemene zin houdt ecologische modernisering de verzelfstandiging of emancipatie in van ecologische rationaliteit ten opzichte van sociaal-culturele en economische rationaliteiten in de sociale praktijken rond consumptie, productie en beleid. Hierin kunnen meerdere stappen worden onderscheiden. In de eerste plaats gaat het om het vaststellen (monitoren) van voor het milieu relevante activiteiten, vervolgens de monetarisering van milieubelastende praktijken, de differentiatie van milieuvriendelijke processen, producten of tarieven en tot slot de substitutie van belastende activiteiten door milieuvriendelijker praktijken.

In het geval van netwerkgebonden systemen en zeker waar het gaat om consument-aanbieder relaties zijn hierbij twee stappen het meest relevant: die van monitoring en differentiatie. Monitoring is relevant vanwege het doorgaans onzichtbare karakter van het functioneren van netwerkgebonden systemen en differentiatie vanwege het feit dat deze systemen juist het tegengestelde van differentiatie beogen: uniformiteit in levering op een zo groot mogelijke schaal.

Op basis van deze gedachtegang zijn 6 hypothesen opgesteld die als leidraad dienen voor het empirische onderzoek naar milieugerichte vernieuwing in de water- en elektriciteitsvoorziening.

i) Aanbieders en consumenten binnen de water- en elektriciteitsvoorziening laten in toenemende mate ook ecologische overwegingen meespelen in hun sociale praktijken met betrekking tot water en elektriciteit.

ii) Binnen een context van liberalisering van de markt voor water en elektriciteit, ontstaat er ook competitie om de groene consument en een toenemende differentiatie in duurzame producten en diensten.

iii) Voormalige gebonden afnemers van netwerkgebonden systemen krijgen meer invloed op de keuzes ten aanzien van efficiënt gebruik van energie en water in hun huishoudelijke praktijken

iv) Om water- en elektriciteitssystemen transparanter te maken voor consumenten en hun aansprakelijkheid ten aanzien van milieuprestaties te vergroten is er behoefte aan geavanceerder monitoring systemen dan nu voor handen is.

v) De differentiatie in hulpbronnen, aanbieders en technologie in de water- en elektriciteitsvoorziening zal ook leiden tot differentiatie in consumentenrollen ten opzichte van aanbieders van water en elektriciteit.

vi) Ecologische modernisering van netwerkgebonden systemen leidt tot differentiatie in kleinschalige opwekkings- en distributietechnologieën, zij het zonder zijds aanbieders van netwerkgebonden systemen en anderzijds de aangesloten burger-consumenten.

Hoofdstuk 3: Innovatie in netwerkgebonden systemen

Om de relaties tussen aanbieders en burger-consumenten in innovatieprocessen te begrijpen gaat dit hoofdstuk in op de mechanismen van sociaal-technische verandering in netwerkgebonden systemen.

In de technieksociologie en wetenschapsstudies wordt het debat over innovatie gevoerd rond de vraag hoe technologische verandering zich in de maatschappij voltrekt en in hoeverre dit een autonoom dan wel een sociaal geïnduceerd proces is. Evolutionaire theorieen gaan uit van een maatschappelijk variatie- en selectieproces dat leidt tot de toepassing van nieuwe technologieën binnen de kaders van een door de jaren gegroeid technologisch traject. Revolutionaire innovaties zullen daarom weinig kans van slagen hebben. Sociaal-constructivistische theorieën beschouwen technologieverandering vooral als de uitkomst van een belangenstrijd tussen sociale groepen. Beide invalshoeken zijn ook terug te vinden in de literatuur over de verandering van grootschalige technische systemen.

Voor het betrekken van burger-consumenten bij de ontwikkeling van nieuwe technologie zijn methoden ontwikkeld die een verbreding van het ontwerpproces beogen. Verbreding houdt in het actief betrekken van maatschappelijke actoren door middel van een georganiseerde dialoog tussen ontwerpers en gebruikers. Een recent ontwikkelde benadering voor de verandering van technieksystemen is dat van 'transitie management': technologiebeleid gericht op lange termijn veranderingen door het faciliteren van kleinschalige initiatieven (technologische niches). Transities beginnen met kleine experimenten op lokale schaal, waarbij alle betrokken actoren, inclusief burger-consumenten, leren over de toepassingen van nieuwe technologie. Vervolgens kunnen ook op meso-niveau (regels die zijn vastgelegd ten aanzien van dominante technologie) en op macroniveau (factoren die richting geven aan de technologische trajecten) duurzame veranderingen optreden.

Naast de evaluatie van de rol van burger-consumenten in de *transities* van grote technieksystemen wordt deze ook geëvalueerd in een aantal benaderingen over het *management* van deze systemen. In veel gevallen is sprake van een passieve rol: burger-consumenten vormen hierin de te sturen subjecten of de 'vraagkant' van het systeem. Andere benaderingen voldoen meer aan het idee van 'dualiteit van structuur': hierin worden gebruikers van grootschalige systemen tevens beschouwd als de uiteindelijke 'operators' ervan.

De literatuur over verandering en management van netwerkgebonden systemen is over het algemeen weinig specifiek over de rol van gebruikers of consumenten. De meest bruikbare ideeën voor het vervolg van dit onderzoek worden geleverd door de benaderingen die uitgaan van reciprociteit tussen aanbieders en gebruikers.

gewerkt als meest relevante thema's in het proces van ecologische modernisering van netwerkgebonden systemen.

Voor het empirisch onderzoek heb ik gekozen voor de studie van de water- en elektriciteitsvoorziening in Nederland. Het bevat ten eerste een historische analyse van de ontwikkeling van deze sectoren in relatie tot milieuvraagstukken. Daarnaast is er case-study onderzoek gedaan naar milieu-innovaties met betrekking tot monitoring en differentiatie in de levering en consumptie van water en elektriciteit in Nederland. Daarvoor is eerst een inventarisatie gemaakt van op milieuverbetering gerichte projecten en initiatieven op het gebied van huishoudelijke water- en elektriciteitsconsumptie. Vervolgens is onderzoek gedaan naar een selectie van cases die de huidige variëteit op deze gebieden representeert.

Hoofdstuk 2: Leefstijlen, consumptie en het milieu

Om onderzoek te kunnen doen naar consumptie en burger-consumenten wordt in dit hoofdstuk een benadering ontwikkeld aan de hand van de structuratietheorie van Giddens. Hierin wordt individueel gedrag en haar achterliggende beweegredenen bestudeerd binnen de context van in tijd en plaats gesitueerde en gedeelde gedragspraktijken. Een gedragspraktijk is een verzameling handelingen waarbij sociale regels en hulpbronnen worden toegepast en gereproduceerd, en die 'gekleurd' worden door iemands leefstijl. De benadering gaat uit van 'dualiteit van structuur'. Enerzijds maken actoren gebruik van bestaande sociale regels en hulpbronnen, anderzijds zijn deze sociale regels en hulpbronnen het resultaat van sociaal handelen.

In plaats van 'consumptie' enkel op te vatten als tegenpool van 'productie', heb ik gekozen voor een 'system-of-provision' benadering, dat wil zeggen dat consumptie wordt geanalyseerd op grond van de manieren waarop goederen en diensten worden geproduceerd, gedistribueerd en geleverd aan burger-consumenten. Huishoudelijke gedragspraktijken bestaan voor een aanzienlijk deel uit het bedienen van - en het bediend worden door - een groot aantal netwerkgebonden systemen waar huishoudens aan verbonden zijn. De aanwending van netwerkgebonden systemen in het huishouden dient uiteindelijk om een bepaald niveau van comfort, hygiëne en gemak in het huishouden te kunnen handhaven. Elke poging tot verandering van huishoudelijke praktijken dient daarom rekening te houden met hoe die veranderingen passen in de tijd-ruimtelijke structuur van huishoudelijke gedragspraktijken en de normen ten aanzien van comfort, hygiëne en gemak die burger-consumenten wensen aan te houden.

De ecologische modernisering van huishoudelijke consumptie kan nu onderzocht worden aan de hand van milieu-innovaties die vanuit verschillende 'systems of provision' binnen het bereik van huishoudens komen. Innovaties betreffen niet alleen techniek, maar ook procedures, financiële regelingen en alle andere instituties die de productie-consumptie kringloop draaiende houden. Het zijn *milieu*-innovaties als de toepassing ervan potentiële milieuverbetering oplevert ten opzichte van de technieken of procedures die eraan voorafgingen. In dit proefschrift zullen de milieu-innovaties in de water- en elektriciteitsvoorziening aan de orde komen die een verandering teweeg brengen in de relaties tussen ener

Samenvatting

De Vergroening van het Net. De Ecologische Modernisering van Netwerkgebonden Systemen

Hoofdstuk 1: Inleiding

Recente ontwikkelingen in de Nederlandse elektriciteits- en watermarkt zoals de levering van groene stroom en de aanleg van een dubbel waterleidingnet hebben geleid tot de vraag hoe milieu-innovaties in de woonomgeving tot stand komen en welke rol netwerkgebonden systemen zoals die van water- en elektriciteitsvoorziening daarbij (kunnen) spelen. Een netwerkgebonden systeem is een samenstelling van een uitgebreid technisch netwerk; de daaraan gerelateerde sociale actoren alsmede de regels en hulpbronnen die voor het functioneren van deze systemen nodig zijn. Naast de waterleiding en het elektriciteitsnet vallen daaronder ook bijvoorbeeld het rioleringsstelsel, de aardgasvoorziening of het openbaar vervoersysteem.

Voor het bestuderen van milieu-innovaties in productie en consumptie biedt de theorie van ecologische modernisering een goede invalshoek, maar deze theorie heeft een nadere uitwerking nodig als het gaat om netwerkgebonden systemen. Hierin is consumptie vaak onzichtbaar en zijn burger-consumenten onverschillig geworden ten aanzien van hun gebruik van deze als vanzelfsprekend ervaren voorzieningen. Het onderzoek naar de relatie tussen aanbieders en burger-consumenten biedt dan ook een aanvulling op het doorgaans eenzijdig op productie of consumptie gerichte milieu-onderzoek.

De onderzoeksvragen van dit promotie-onderzoek zijn:

Hoe komen milieu-innovaties in netwerkgebonden systemen tot stand (welke sociale processen liggen eraan ten grondslag en welke actoren zijn erbij betrokken)?

In hoeverre worden milieu-innovaties gevormd door - en in hoeverre hervormen zij - de sociale relaties tussen burger-consumenten en aanbieders en hoe zien deze nieuwe relaties eruit?

De uitwerking van de theorie van ecologische modernisering voor netwerkgebonden systemen bestaat uit drie onderdelen. Ten eerste wordt dieper ingegaan op de relaties tussen huishoudelijke gedragspraktijken en netwerkgebonden systemen. Ten tweede zal worden onderzocht hoe grootschalige technieksystemen kunnen veranderen en welke rol burger-consumenten daarin spelen. Ten derde zullen 'monitoring' en 'differentiatie' worden uit

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Appendix 2: List of Interviews and Informants

De Bongerd, H. Hamstra, Zwolle, 9-3-99

Ecofys / Greenprices, Heddeke Heijnes, Utrecht, 22-03-01

GAP Gelderland, K. Kleinhesselink, Wageningen, 8-3-99

Groene Dak, M. Post, Utrecht, 10-3-99

GWL, Groot and Rolls, Amsterdam, 12-3-99

KIWA, Sombekke, 1-12-97 (tel.)

Nuon-Water, R. Klijn, Velp 23-1-98

Nuon, R. Klijn and P. van der Ploeg, Wageningen, 23-2-98

Obragas, Jacobs and Geerts, Helmond 12-1-99 (tel.)

Polderdrift, Arnhem, 7-10-97

Remu, M. Bakker, Utrecht, 9-3-99

Shell Solar, Van Laarhoven, Helmond, 11-97.

WMO, Van den Berg, Zwolle, 29-1-99

	ker	sel			palities, plumber	stalling water saving devices on toilets	ficiency	
water	Chipflow meter	Several places	1999	utilities	Manu-facturer	Prepaid water provision through rechargeable credit card	Effi-ciency/ monitor-ing	
Energy	Comfort Card	Hel-mond	1998	Obra-gas		Ppre-paid rechargeable credit cards for gas meters. Cards can be recharged in supermarkets	Moni-toring/ eff.	Eco
Cross sect-oral	Eco Teams	Multiple sites	1990 >	GAP	Prov-inces, munici-palities	Guided group meetings in which household envi-ronmental performances are discussed and listed. Feedback from organisation on measure of goal achievement	Moni-toring	Env
Energy	EPA	Multiple sites	2000	Minis-tries of EZ and VROM	Private business energy comp.	Energy Conservation advice at home on request.	Moni-toring	Env
Energy	Solaris	Multiple sites	1998	Green-peace	Min of Econ. Manu-facturer	Public campaign for subscription for solar panels as to stimulate production and lower the con-sumer prices for PV.	renewal	Env
Energy	Sun Power	Multiple sites	1999	Energy compa-nies		Product-service combining the purchase, installa-tion and service of set of PV panels, connected to individual households (net-metering)	renewal	Env
Energy	Zuinig stoken	Multiple sites	1984-now	Energy compa-nies	Munici-palities	Informing and supporting consumers to data log-ging gas and electricity meters. Weekly reference data given in local newspapers	Monitor-ing	Env /eco omi

sectoral	hof				corpo-ration	system, heat pump reuses heat from kitchen and bathroom, telemetering. Rain water collection for toilet flushing and gardening	/ moni-toring	
cross sectoral	Poekel-boek	Den Haag	1996		munici-pality (LA 21)	Consumer participation in several environmental and social projects aiming at a sustainable district and city. It concerns waste, parks, but also energy use and water consumption	monitor-ing	mixed
cross sectoral	Romo-lenpol-der, BEEK 1	Haarlem	1992			passive solar energy, separate waste collection, participation of occupants, 18 houses	efficiency	Env.
cross sectoral	Vathorst	Amers-foort	-->			New housing estate: rain water collection, solar energy, waste charged per kilo	renewal efficiency	Env.
cross sectoral	Wijken voor Mi-lieu	multiple sites	1993-		Advi-sory group	Project of environmentally sound initiatives devel-oped by citizens in collaboration with community agencies, housing associations, schools, and other community organisations.Utrecht, Arnhem, Roer-mond, Oldenzaal, Deventer, Breda	-	social
cross sectoral	Stroom-dal	Schoone beek		Edon, water boards	Munici-pality	District Pathways covered with PV cells (grid con-nected) and overhead pipes for water and waste water. Heat exchange between both.	efficinecy	mixed
cross-sectoral	Banne-Oost	Amster-dam	Spring 1995	water comp. GWL	housing corpo-ration	conservatory, solar heat collector, water tanks for rain water collection and -use in toilets	renewal	Env.
cross-sectoral	Groene Dak	Utrecht	1993	WMN, REMU	ass. of residents housing corp., con-structor	Project of 66 houses, rental and private) with compost-toilets, WSS toilets, rainwater collection in cellar tanks to be used for washing, toilet flush-ing, local waste water treatment by reedbeds in greenhouse 2) Separated waste collection 3) solar heat collection	renewal efficiency	Env.
cross-sectoral	Groot Hoog-waak	Noord-wijk	1996			Solar heat collector combined with (high efficient) after-heating. 2) Rainwater collection, Gustavsberg WSS toilet system	renewal / efficiency	Env.
cross-sectoral	GWL-terrein	Amster-dam	2-1997	ENW, GWL	sub-munici-pality Wester-park, housing ass.	600 houses built on former water comp. site, ur-ban area. 1) (Sun)-heat collector, Total Power in-stallation 2) Low-temperature district heating sys-tem, heat-power systems combined with heat pump, 3) rain water collection for toilet flush tanks, Gustavsberg WSS	Renewal Efficiency	Mixed
cross-sectoral	Leestense Enk	Zutphen	1996		ass. of residents housing corp.	Solar Domestic Hot Water (DHW), Solar heat collectors, 2) Rainwater collection tank (4 houses) for toilet flush and outdoor tap	Renewal	Mixed (social /env)
cross-sectoral	Meer-wijkhof	Benne-broek	1996		Housing corpo-ration	11 houses for elderly people. Heat-power installa-tion with 92% efficiency. Solar heat collectors, heat exchangers at grey water system, rain water collection.	renewal	mixed (social /env)
cross-sectoral	Nieuw-land	Amers-foort	1998	REMU		World's largest PV project in the built environ-ment, applied at 501 houses and producing 1 MW. Three legal arrangements: private houses: owner is also owner of PV cells; rental houses: PV system is also rented, energy is used in-house. In another ar-rangement, the energy comp. is owner of the PV system and inhabitant gets 20% of produced en-ergy, 2) heat pumps in 6 houses, experiment ended after complaints occupants 3) Rain water collec-tion, 24 houses	renewal	Env.
cross-sectoral	Zonne-golven	Boxtel	1999	PNEM	Munici-pality	120 houses. PV cells, conservatories, rain water collection for toilet flushing. Waste separation.	renewal	Env.
cross-sectoral	Zonne-veld	Hazers-woude-Rijnsdijk	1996		Munici-pality, ass. residents	Solar heat collector. Water saving by separate hot water pipe to kitchen, Gustavsberg one-family-booster	efficiency / renewal	Env.
water	Actie Pottekij-	Zwolle / Overijs-	1993	WMO	Schools, munici-	Schoolchildren were sent for a door-to-door cam paign to inform householders on subsidy for in-	Moni toring, ef-	Env.

	park			comp.	board private comp. Housing ass.; munici-pality; province	collected in local pond, treated by reed plants, maintained by community organisation		
Water	Polder-drift	Arnhem	12-1996	Water comp. Nuon-water	Housing corpo-ration , ass. residents	40 houses in district Rijkerswoerd, rain water col-lection (for washing machine) , local gray water treatment (for toilet flush tank). Water saving of 57%, waste water saving of 85%. 2) solar heat col-lectors	renewal	Env
Water	Rainwa-ter col-lection	multiple sites	1995	water comp. (WMO)	housing corp., WAVIN	In-house (roof or cellar) rain water tanks for toilet flushing alone, or for more purposes such as washing machine, shower, outdoor tap. (Zwolle: Oldenerbroek; Amsterdam, Utrecht)	renewal	Env
Water	Schooten , De	Den Helder			housing corpo-ration	Regional surface water for toilet flushing, rain wa-ter collection for washing machine. 46 houses, up-grading of existing residential area.	renewal	Env
Water	Stadsha-gen	Zwolle	1998	Water-comp. WMO	munici-pality, Prov-ince, water board	After a study of possible sources for household water to be distributed in a second piped system for 8500 houses, it was concluded NOT to install such a system. Environmental reasons as desicca-tion were not valid because drinking water here is not produced from ground water. Energy and material for the second network exceeded envi-ronmental and efficiency criteria.	renewal	
Water	Tripstraat	Den Haag	end of 1997	Water comp.	munici-pality housing corp.	128 houses, flush tanks filled with water from clo-seby canal	renewal	Env
Water	WADI	multiple sites		water boards	Munici-palities	Environmentally sound plan for building site, first application of WADIs. A WADI is a drain from which rain water can infiltrate the soil (in stead of being transported via a sewer pipe). No car wash-ing allowed except for appointed places in the dis-trict	renewal	Env
cross sectoral	Ecoge-woon	Geldrop	–>		Builders Asso-ciation (Bou-wver. Beter Wonen)	40 houses for people older than 55. High efficient heaters, water saving measures. 'Ecogewoon' means 'Eco normal', referring to basic philosophy that ecology should be conceived as normal.	efficiency	mix
cross sectoral	Ecolonia	Alphen aan de Rijn	1992	energy and water compa-nies	Novem	passive solar energy, several themes 1) health and safety 12 houses; 2)bio-ecological building, 8 houses; 3) isolation from noise nuisance, 10 houses; 4) long life span, organic architecture, 12 houses; 5) water saving and re-use of construction waste, 10 houses	renewal / efficiency	Env
cross sectoral	Kimen, De	Heeren-veen	1995	energy comp.	Asso-ciation of resi-dents munici-pality.	1) Rainwater collection for toilet flush, 2) Conser-vatories, solar heat collectors, living rooms up-stairs, sleeping rooms downstairs. An ass. of future inhabitants took the initiative. Energy comp. of-fered solar heat collectors for free, a bank offered special mortgage.	renewal, efficiency	Env
cross sectoral	Milieu-woning Flevo-land	Bidding-huizen	1996		St. Mi-lieu-woning Flevo-land	1 house, 60% energy reduction (solar heat collec-tor, isolation measures) and 75% water reduction with Clivus Multrum Composting toilet, grey water and rain water treatment and reuse in garden	renewal / efficiency	Env
cross sectoral	Oude-lands-hoek	Dor-drecht	1998		munici-pality	51 houses, separated sewerage for rain- and waste water. Rain water to ponds in same district (WADI), and used for washing machines, grey water for toilet flushing. 2) Heat pumps and pas-sive solar energy.	renewal / efficiency	Env
cross	Pelgrom-	Zevenaar	1997		housing	Building complex for elderly people. WSS toilet	efficiency	mix

	sing PV cells	sites				fl 6,-/Wp. Conditions: grid connection, minimum of 160 Wp, maximum of fl100.000 or 25% of investment		
Energy	Telemetering	multiple sites		energy companies	housing corporations	Tele-metering energy consumption. consumers are given direct feed-back on energy consumption as opposed to feedback given afterwards (at the bill)	monitoring	mixed
Energy	Vroonermeer	Alkmaar	1998			1250 houses PV cells and total power systems. Part of HAL Vinex building site	renewal	Env.
Energy	Warm Witgoed	-	1997	Energy companies	research inst. (Energiened en Novem)	Hot water fuelled washing machines and dryers Saves 60% of energy. 15 of each installed in households.	renewal / efficiency	Env.
Energy	Waterspin	Den Haag	1997	ENECO	housing corp.	Solar energy and heat pumps (regaining heat form ground water)	renewal	
Energy	Weerselo-straat	Den Haag		ENECO	housing corporation	Low EPC (0.95). Renovation and new buildings. Collective heat pump regains heat from ground water and produces 55 degrees Celsius	renewal	Env.
Energy	Zero-emission city	Heerhugowaard, Alkmaar en Langedijk	-	ENW		Planning of 'zero-emission' city , 2600 houses with 'sun roof' 5 MW PV cells and re-use of residual heat from waste processing plant in Alkmaar (7100 houses)	renewal / efficiency	Env.
Energy	Zetten-West	Valburg	1997	Nuon	housing corp.	Heat recovery unit, air heating, solar heat collector	renewal / efficiency	Env.
Water	Den Haag	Den Haag			Housing corporation	126 newly built houses. Surface water is used for toilet flushing	renewal	Env.
Water	Grey water circuits	multiple sites	1991		associations of inhabitants, housing corporations	Grey water circuit for block of houses. Waste water from washing machine, shower, washing basins and kitchen is transported to a bed of reed plants. There it is treated and drained away to surface water (ditches). Or, alternatively, it is re-used as gardening water of flushing water for toilets. There are restrictions to what can be drained away in washing basins. Eenrum; Haarlem; Axel, Groningen (Drielanden)	efficiency / renewal	Env.
Water	Household water	Multiple sites	1997	water companies	municipalities	Second piped system providing 'household' water to toilet, washing machine and outdoor tap. New built areas. Scale diverges from 400 to 10,000 houses. First system in operation in 1998. Sources of household water dependent of region. In most cases the source will be close to the area. Environmental impacts vary. In some cases, there is a saving of the use of ground water. In other cases, only energy of transporting and treatment will be saved. Few financial benefits for consumers, since price for normal water is low and initial investments are high. Drinking water savings up to 50%.	renewal	mixed
Water	IJburg	Amsterdam	1998 >	GWL	municipality	New housing area to be built in the Y-lake near Amsterdam. Second plumbing system providing household water that is made of nearby lake water, Washing machines, toilets and outdoor tap will be connected to this system. Rain water collection and storage at some houses.	renewal efficiency	mixed
Water	Metering project	Amsterdam	1998	GWL	Munocipality, housing corp.	Project to install individual water meters at every household in Amsterdam. One of the last 2 cities in the Netherlands.	monitoring	mixed
Water	Molenveld	Roermond			Construction comp.)	17 rental houses. Rain water collection tanks (2 m3) are placed in the cellar. The water is pumped to toilet tubs and out-door tap. In initial plans, the washing machine was also connected, but this was postponed for some reason.	renewal	Env.
Water	Morra-	Drachten	1991	water	water	32 rental houses and 36 private houses, rainwater	renewal	Env.

	veen	veen				houses		
Energy	Heerhu-go-waard	Heerhu-go-waard	1991	ENW	Munici-pality, NO-VEM, housing ass., PV-manu-facturer, con-structor	10 houses, grid-connected PV cells producing 24 kWp. Inhabitants only have to give access to tech-nicians for maintenance and monitoring the con-verters.	Renewal	Env.
Energy	Hot-fill washing- and dish-washing machines	multiple sites		energy comp.	Manu-factur-ers, plumb-ers, housing corpo-rations	Modified washing and dishwashing machines with possibility of hot water intake. This makes the (in-efficient) electric heater in the machine unneces-sary.	efficiency	Env.
Energy	Knuttel-dorp	Deventer		Edon		12 rental houses. Heat pump regains heat from ground water. No gas needed, low electricity de-mand. 25% energy saving compared to normal high efficiency heater. It will take longer to get the room heated. Automatic ventilation should replace the ventilation by 'opening windows'	renewal	Env.
Energy	Miner-vaflat	Gronin-gen		EDON en Gasunie		Mini- combined heat power in high rise building 5 kW-gas driven motor	renewal	Env.
Energy	Nieuw-Sloten	Amster-dam	??-3/1997	ENW	R&S, BP So-lar, No-vem (EU-project)	Grid-connected PV cells on the roofs of 66 houses producing 250 kWp	Renewal	Env.
Energy	Noord Gronin-gen	Noord Gronin-gen	1997		Regio-raad Noord Gronin-gen	In eight rural villages, 60 houses in total with solar heat collectors, heat pumps, water saving meas-ures.	renewal / efficiency	Env.
Energy	Odoor-ne-veen	Odoor-ne-veen				Small-scale combined wind (1 kWh) and PV-power generator (480 W), provides a two-person household with electricity. Electricity price is three times higher than normal electricity.	renewal	Env.
Energy	Passive Solar Energy	Multiple sites	1991	energy compa-nies	contruct ors, munici-palities	Refers to the south orientation in building design, conservatories at the south-side of houses and small windows at the north site. Part of sustainable building practices. Apeldoorn; Bilthoven; Bunnik, den Bosch; Delft (Ecodus); Goirle (EU demon-stration project) Haarlemmermeer (Overbos); Zeewolde; Zevenaar	efficiency	Env.
Energy	Plaza Meditterа	Doetin-chem	Fut-ure	NUON, WOG	private comp. (con-structor)	2500 houses, grass-roof, solar heat collectors, low-temp heating system (heat-walls)	efficiency / renewal	Env.
Energy	Punte-gaalstraat 5	Rotter-dam			housing corpo-ration	Electronic energy- and comfort management sys-tem (electronic key). Heating and ventilation turned off while leaving the building. District heating	monitor-ing / effi-ciency	Env.
Energy	Schut-landen	Hooge-veen	1995-1996	energy comp.	munici-pality	Sun-oriented out-parcelling. ventilation with heat recovery, combined solar and gas heater	efficiency	Env.
Energy	Solar heat col-lectors	multiple sites		energy compa-nies	munici-palities	solar heat collectors being subsidised by munici-palities	renewal	Env.
Energy	Stad van de Zon	Heerhugo-waard				1800 houses with PV panels. Use of residual heat from waste processing plant in Alkmaar: Zero emission district. Part of HAL Vinex building site	renewal	Env.
Energy	Subsidi-	multiple		EMH		Energy comp. subsidises installation of PV cells at	renewal	Env.

Category	Name	Place	Date	Provider	Other Agents	Description	Type	Ratio
Energy	Akkers, De	Helmond	1997	Obragas		Tele-metering of energy consumption, 60 houses, results can be watched on Teletext	Monitoring	mixed
Energy	Brandaris	Zaandam	1997	ENW	Housing corp. (Patrimonium A'dam)	Renovation of high rise building, applying solar heat collectors and a combined heat-power installation	Efficiency	mixed
Energy	District heat-power generation	Multiple sites	1990 onwards	energy distributing companies	Municipalities	Combined heat-power systems, providing heat and electricity to all houses in nearby residential area. Replaces piped gas systems. People have to use an electric stove in stead of a conventional gas-stove. Mainly through the increasing popularity of CHP generation, distributing companies became producing companies causing over-capacity of electricity production	renewal	mixed
Energy	District heating	Amsterdam Zuid-Oost	1995	SEP/ENW		District heating, heat from new energy plant (UNA) transported to existing houses. These houses already have gas-fuelled heaters which will stay in place for peaks in heat demand. Heat from UNA should be competitively priced.	efficiency / renewal	mixed
Energy	Drielanden	Harderwijk	1997	GA-MOG		Mini-heat-power generation for block of 10 houses	efficiency / renewal	mixed
Energy	E-teams	multiple sites	1997	utilities: TWM, PNEM WMO	Municipalities	Special teams advising consumers in energy saving measures. People may request for an advice, or may be advised if their energy bill is higher than average.	monitoring / efficiency	mixed
Energy	Eco-solar	Goes				Horseshoe shaped block of houses, solar and gas combined heaters, EPC < 1,0. Water saving measures. Inhabitants may earn 'environmental miles' (in analogy with air miles) if they take additional environmental measures (up to f 6000,-)	efficiency / renewal	mixed
Energy	Energy Saving Building and Living	Multiple sites	1997	REMU	WNF and 5 construction companies	WNF found construction companies willing to build 200 houses with low energy use (EPC of 0.75) in coming years. First 77 houses in Nieuwegein. District heating, PV cells combined with air treatment system that recovers heat, insulation measures	efficiency	Env.
Energy	Fuel cells	Westervoort	1997	NUON	utility comp.	Fuel cell produces electricity to the grid and heat to district heating system	renewal	Env.
Energy	Gas-run washing machines, dryers and fridges	multiple sites		Obragas, other energy companies		Out renting of gas fuelled dryers to customers of ENECO and other utilities. Obragas supplies gas heated dryers with a discount	renewal	Mixed
Energy	Gelderse Blom	Veenendaal	1997	REMU	Housing corporation	Passive solar energy, PV cells, hot-fill washing machines, heat pump, telemetering	renewal / efficiency/ monitoring	Env.
Energy	Goverwelle	Gouda	1990			passive solar energy use (south orientation), solar heat collector, participation by occupants, 20 houses	renewal/ efficiency	Env.
Energy	Groene stroom, eco-stroom, natuur-stroom	multiple sites	1995 onwards	electricity distributing companies	-	Electricity supply with higher tariff (except eco-tax). Extra revenues invested in 'sustainable generation': wind mills, PV and biomass. The latter is debated.	renewal /monitoring	Env.
Energy	Haarlemmermeer	Haarlemmermeer		ENW		100 houses built with 5 PV cells, with possibility to extend the amount of cells by inhabitants themselves	renewal	Env.
Energy	Heeren-	Heeren-	future	NUON		Planning of application of earth heat in 3500	renewal	Env.

consumer to an 'active' provider of electric or water services, thus increasing her/his level of involvement. On the other hand, a new water system developed entirely by the municipality in order to improve water management might require virtually no change in the behaviour of people living in the area. The schemes included in the inventory of innovations thus involved varying *degrees* of reconfiguration in utility-consumer relations.

The environmental schemes were identified by utilising sources such as specialist environmental and utility journals, newspapers, web sites and through consultation with utility experts, housing associations and householders. Over 150 types of scheme in Sweden, the UK and the Netherlands were included in the inventory for the Domus project (Raman et al., 1998; Chappells et al., 2000) comprising both individual initiatives and multi-location initiatives which featured similar innovations in different places. The inventory was organised by electricity, water, waste and cross-sectoral schemes with various categories to reflect the type of initiator, starting date of the project, the other agents involved, the sorts of processes involved (e.g. monitoring, efficiency, differentiation), the main rationale of the initiator (ecological, economic, social), the type of consumer involvement, the phase of consumer involvement (in development, acquisition or use) and the nature of consumer involvement (active or passive).

The table below presents an excerpt of the initial gross tables from the Domus project (Raman et al., 1998). It encompasses the projects that are related to Dutch water and electricity sectors and a selection of descriptive categories. Although presented as a gross inventory, the list is far from exhaustive: most similar cases to the ones already listed are not included. The aim is to get an overview of the variety of cases rather than to have an exhaustive list.

Since finalising the inventory work, new innovations in water and electricity systems have emerged, while other relevant cases came into picture during later research work. The list of cases is therefore extended with a number of cases by using the same criteria as used in the initial inventory. These added cases are listed at the end of the table below. Finally, the cases that are specifically referred to in this thesis are indicated with shading.

Appendix 1: Inventory of Environmental Innovations in Dutch Water and Electricity Sectors

Explanation to the table

To decide whether cases of innovation in water and electricity sectors should or should not be included in this study, two criteria were used: firstly the innovation is to be at least *intentionally* environmental, and secondly the innovation appears to reconfigure consumer-provider relations. The latter criterion was needed to make sure that selected cases would appropriate the study of changes in consumer-provider relations within network-bound systems.

The first criterion was meant to get over disputes in the environmental sciences over what counts as 'environmentally friendly' change. By starting with the full range of environmental schemes introduced by public utilities, housing associations, plumbers, consumers or others it was intended to circumvent as yet unresolved questions on the environment, and to admit a variety of candidates at the outset of the research. Typical schemes being promoted by companies, now operating in privatised and liberalised utility markets, ranged from simple devices (e.g. energy-efficient light bulbs or recycling bins) to more complex systems for the monitoring, measurement or re-use of resources (e.g. systems for recycling used water or meters that provided information to householders on how they use energy).

The second criterion was derived from the socio-technical perspective underpinning the research. The ongoing transformation of public utilities was conceptualised in terms of changes in the modes of provision of electricity and water services to households. Privatisation and liberalisation of utility markets signal a shift from largely state-owned and state-operated network of services to a more fragmented system encompassing multiple modes of provision even in a single country. For example, electricity or water may be provided to households by private companies as well as by individuals themselves through the use of solar panels or self-collected rainwater. A scheme that involves the installation of solar panels connected to the grid or the provision of rainwater collection devices would therefore transform the existing relationship between the householder and the public utility - in each case, the householder is reconfigured from being a 'passive' environmentally relevant systems of provision is certainly not bound to network-bound infrastructures but to other and quite different systems of provision as well.

Differentiation is an important issue in this thesis as it deals with uniform and standardised systems of provision. Differentiation is however not an exclusive theme for such systems. On the contrary, long before utility sectors started to differentiate their services, product and tariff differentiation has been a well-known instrument in the marketing of other products and services and had been used for environmental profiling as well ('green' petrol, EKO-labelled food products, CFK-free dispensers et cetera). Whether differentiation in other than network-bound systems will lead to the same ideal-types of differentiated consumer roles vis-à-vis providers as presented in this thesis, is still an unresolved question. However the typology and categorisation of citizen-consumer roles in the ecological reform of network-bound systems creates an important starting point for the further theoretical and empirical study of environment-induced changes in wider sectors of industry.

making on these matters, serves as an example for further research. The study of other European countries (notably Germany and France) as well as outside the European context is valuable to extend and deepen the understanding of environmental reform in water and electricity systems.

Environmental Reform in Other Network-bound Systems

The theoretical tools presented and used in this thesis can be applied to the study of other network-bound systems as well, notably: the piped gas system, waste and wastewater collection and treatment and public transport systems. Like water and electricity systems, all of these large scale infrastructures enable citizen-consumers to (re)shape their use of environmentally relevant resources. If one would analyse environment-induced change, for instance in public transport systems, and try to grasp the changing relations between providers of transport services and their consumers, the theoretical tools developed in this thesis will be very appropriate to use. Social practices of transportation can be explained by lifestyle variables on the one hand and modes of provision, access and use of transportation systems on the other. The magnitude of technological changes (minor changes within existing trajectories versus technological transitions) and the role of final users (as 'system operators' or merely end-consumers) in such a process can be assessed by using the different perspectives of socio-technical change. The theme of monitoring can be utilised to evaluate whether and how environmental performance of a new transport system is made transparent to consumers, providers and regulators. Finally, the model in which differentiation is split into differentiation of resources, providers, technologies and consumer roles helps evaluating the social consequences of various environmental innovations in (public) transport systems. The environmental discourse around transportation is no longer limited to private car-use versus public transport, but encompasses several modes of transportation in between: collective taxi transport, car rental, call-a-car initiatives, park & rail and so forth. Both monitoring and differentiation are crucial issues in evaluating such phenomena on the changes of consumer-provider relations and environmental reform.

Environmental Reform in Other Systems of Provision

A theoretical challenge is to develop a more common framework to analyse environmentally induced changes and implications for new consumer-provider relations in other than network-bound systems. This thesis provides a number of relevant points of departure to do so as especially the themes of monitoring and differentiation have a much wider reach in the environmental discourse than on network-bound systems only.

The issue of monitoring can be extended to issues of mutual surveillance of consumers' and providers' environmental performance in any system of provision. This can be noticed for instance in the current debates on restructuring the agro-food sector. Here provider and consumer responsibilities in risk-assessment and management are on the brink of a shift from producer-led to consumer-led regulation, which is also labelled as a reversal of production-consumption chains. It shows that consumer involvement in managing consumers, while in other countries it means that citizen-consumers are forced to give up their public right of infinite access to tap water.

This does not mean that the findings of this thesis only count for the peculiar Dutch situation of water and electricity provision. The theory developed in this thesis provides the tools to analyse environmental transformations in network-bound systems, indifferently of national contexts or the kinds of services provided. Ecological modernisation theory encompasses general principles of environmental change that can be applied in the sphere of production, consumption and policymaking in different geographical and socio-economic contexts. Such a general validity also counts for the specification of ecological modernisation theory to network-bound systems. The system-of-provision approach that links consumption to provision; the analysis of change in large technical systems and the emphasis on monitoring and differentiation as indicators for environment-induced change together comprise the set of tools to analyse environmental transformations in other network-bound systems than water and electricity systems, such as sewerage, gas or public transport systems. In the next and last section, I will outline how a research agenda based on the in this thesis developed, analytical tools may look like.

8.6 Implications for Further Research

Whereas research on utility sectors and environment has been dominated by engineering and economic disciplines – focussing on technology and organisation of provision respectively – this thesis has specified and evaluated environment-induced change in former utility sectors from a sociological perspective in which the changing relations between consumers and providers have been emphasised. This can contribute to current research as it demonstrates the so far invisible links in the provision-consumption chain. Insight in these links is essential for predicting or explaining the adoption of innovations or patterns of citizen-consumer involvement in environmental reform. There are at least three directions of research that can be taken from here. One route leads to the study of environmental reform in water and electricity systems in other regions; a second, to the study of environmental reform in other network-bound systems and a third, to environmental reform in other than network-bound systems of provision.

Environmental Reform in Water and Electricity in Other Countries

This thesis deals with electricity and water provision in the Dutch context. From here, it is a small step to study environmental innovation in water and electricity sectors and citizen-consumer involvement in other countries. An international comparison can inform and refine ecological modernisation theory as further developed in this thesis and would be valuable to understanding the national peculiarities and cross-national similarities in network-bound systems. Supranational legislation and regulation of utility sectors is increasingly determining the future of network-bound systems in Europe, at the expense of national policymaking. An earlier European research project (Chappells et al., 2000), in which utility sector dynamics and environmental innovation within the Netherlands, Britain and Sweden have been compared and confronted with common European policy panying modes of provision and organisation of citizen-consumer involvement in water and electricity supply. The current differentiation of resources, providers, technologies and consumer roles, and the monitoring possibilities between providers and consumers, enable a restructuring of energy and water supply into more environmentally and socially sustainable systems of provision. Hence the disconnection of citizen-consumers from large-scale technical systems of water and electricity provision are in this situation neither socially desirable nor efficient in environmental terms.

8.5 Environment-induced Change in Network-bound Systems

The Dutch water and electricity systems have been presented as examples of network-bound systems for the study of environment-induced change and the changing relations between consumers and providers. To what extent can the results of this study be extrapolated to water and electricity systems outside the Netherlands and to other network-bound systems, such as piped gas, sewerage or public transport systems? To answer this, again a distinction should be made between empirical and theoretical findings.

The possibility to extrapolate the empirical findings to water and electricity systems in other countries depends - among other variables - on the phase of their development; in other words how water and electricity systems are organised on a scale of localised, public or privatised modes of organisation. The more similarities with the Dutch situation on this matter, the more reason to expect similar developments in terms of environment-induced change.

Undoubtedly European policymaking on the liberalisation of utility markets and privatisation of monopolist providers shape the conditions under which environmental transformations in network-bound systems take place. The precise requirements concerning the patterns of opening utility markets - as happened in the consumer market for electricity where the first market opening for captive consumers encompassed green electricity only - can make a major contribution to environmental innovations in these sectors. Although there are still many differences in organisation of electricity sectors among the member states of the European Union, the conditions in which they operate are increasingly being harmonised. For instance, with harmonisation of European electricity policy, also the harmonisation of what may be labelled as 'green electricity' is currently being shaped.

For water sectors, such a situation is much further away. There are still huge differences between the national organisational frameworks in which water sectors operate. Water is provided to European consumers by fully privatised or state-owned companies, concession holders or monopolists, multi-utilities (combining the provision of for instance gas, electricity, and water) or integrated Water Companies (combining water services like tap water provision, sewerage, treatment and water management). The unique organisational set-up of the Dutch water sector is a main variable for the kinds of environmental innovations now being issued. Besides, differences in organisational set-up may determine what actually may count as an environmental innovation. In some countries, installing water meters may be seen as a welcomed environmental measure and a service to citizen-between consumers and providers: demonstrating substance or energy flows as well as how water and electricity providers have organised their activities for achieving environmental goals.

v) Differentiation in resources, providers and technologies in water and electricity provision leads to differentiation in the roles of consumers vis-à-vis providers of water and electricity.

Environmental requirements have stimulated water and electricity providers to differentiate in resources and technologies of generation and distribution, and simultaneous market developments have led to the emerging of new providers. The differentiation of resources, providers and intermediate technologies, results in a variety of possible consumer roles towards providers. In chapter 7, a typology and categorisation of citizen-consumer roles towards providers of network-bound systems has been developed as to understand and analyse the consequences of environment-induced changes for the relations between providers and consumers of network-bound systems. From captive consumers, the role belonging to monopolist provision and uniform services, consumer roles have been differentiated into 'customers', 'citizen-consumers' and 'co-providers/participants'. Each of these four ideal-type roles represents a specific mode of provision and pattern of consumer involvement. The differentiation in resources, providers and intermediate technologies renders several new consumer-provider relations, all of which can be categorised between the four ideal types of consumer roles, thus including that of captive consumers. This is well in line with hypothesis v.

Environmental reform in water and electricity sectors implies a greater consumer involvement in the way electricity and water is provided. Consumer involvement is not restricted to either complete self-provision on the one hand or signing up for a green tariff on the other. With the increasing differentiation in electricity and water consumption practices, as shown in the cases of environmental innovation in chapter 6 and 7, the different consumer roles are likely to co-exist.

vi) Ecological modernisation of network-bound systems leads to the differentiation into small-scale generation and distribution technologies, without disconnecting these technologies from large infrastructures in the way that de-modernisation theorists consider these necessary or desirable.

In chapter 4, I discuss the question whether or not small-scale or self-provision is socially and ecologically preferable compared to the provision through large-scale technical systems. From the findings presented in chapters 6 and 7, I conclude that there is an emergence of various combinations of small-scale technologies and large-scale technological networks while there are also several ways in which both can be interwoven. The disadvantages of a large-scale, centralist provision, like the invisibility of electricity and water supply to captive consumers, and the unequal power balance between providers and citizen-consumers have not much to do with the scale of technology. Small-scale technologies not necessarily empower citizen-consumers, nor do large-scale technologies necessarily deprive citizen-consumers form authority. What makes the difference are the accom registering flows of water or electricity by means of a water or electricity meter. The meter has not only become the physical barrier between the external and internal networks, but also the virtual dividing line between the public and the private sphere, between provision and consumption. Monitoring should however encompass more than metering alone. Just the revealing of energy and water flows to citizen-consumers does not seem to contribute much to the understanding of how energy or water are provided, nor does it automatically trigger citizen-consumers to a more environmentally sound use of resources. Instead, it seems necessary to invent forms of monitoring in which chains of provision and the environmental performances at both sides of the meter are made transparent to citizen-consumers in such a way that the latter are able and capable to (co-)decide on the timing and addressing of specific kinds of information concerning the consumption and provision of services.

The review of cases of monitoring shows that indeed the approach, in which physical aspects of energy or water flows are revealed to consumers, while the provisioning systems remain concealed, is still dominating in utility sectors. Most monitoring projects serve other goals than supporting energy or water conservation at the side of the consumer. Examples are the change of a scheme of public financing into individual tariffs or bringing down utilities' administration costs as in the case of pre-payment meters. Monitoring projects that have energy or water conservation as an explicit goal rather uncritically start from the assumption that providing knowledge about levels of consumption automatically persuades consumers to conserve energy or water. It is therefore too early to assess that contemporary monitoring in water and electricity systems enhances the transparency and accountability of netwerk-bound systems in terms of environmental performance.

However, there are at least two main reasons to expect that monitoring within electricity and water sectors can become important elements in future strategies for sustainable consumption and provision. Firstly: the observed differentiation in electricity and water provision in terms of products, services and providers requires more elaborate information about the different services and providers. Such information has to be checked and certified by third parties, such as environmental organisations and anti-trust authorities. For instance the labelling and proper functioning of green electricity schemes eventually requires a revealing of shares of electricity generation by solar, wind, hydropower, biomass or other renewable energy sources. This kind of information has thus far mostly been hidden to the end-users of electricity. Secondly: the observed development in metering technology - from mechanic meters summing up numbers of cubic meters and kiloWatt-hours into 'smart' meters - gives way to much more fine-tuned and interactive paths of monitoring. Although smart technologies can be used in many different ways, including advanced modes of traditional monitoring, they can also support a more consumer-led approach of monitoring in which not only consumption levels are revealed to providers, but providers' strategies are revealed to consumers as well.

I conclude from this theoretical and empirical review of monitoring of water and electricity consumption that this is a process of (re)shaping of consumer-provider relations and that there is a need to develop forms of monitoring which encompass a two-way road of differentiation in both electricity and water provision to household consumers. The most prominent differentiation in electricity provision to household consumers is not that of cheap versus expensive, or flexible versus rigid provision but that of green electricity versus conventional electricity, involving new green providers apart from traditional utilities and exploiting renewable sources apart from fossil or nuclear fuels. The different forms of differentiation in drinking water supply are also generally considered as 'environmentally sound' measures. Dual water systems save the use of heavily treated drinking water for minor household practices. The development and implementation of rainwater tanks has without exception been rationalised on environmental grounds.

In sectors where consumers for a very long time have been considered as 'connections' or 'the demand side', it has been a large switch to deal with different consumer preferences and a segmented consumer-market. Moreover, the invisible character of water and electricity and the low esteem citizen-consumers usually have in utilising these services make it even harder to distinguish one service from the other. Apart from price differentiation, which is possible only to a certain extent, environmental soundness appears to be a key competitive aspect. Concerning their water and energy consumption, consumers are therefore no longer only persuaded to water and energy conservation, but also to making a choice between 'grey' and 'green' provision of water and electricity. The hypothesis on competition for green consumers and differentiation in sustainable products and services is therefore supported by the findings in this study.

iii) Former captive consumers of grid-bound services gain authority in choices with respect to the more efficient use of energy and water resources in their domestic practices.

While it is true that citizen-consumers more and more loose their status of being 'captive consumers' in the sense that they have no choice or say in services or providers of water and electricity, it is a generalisation to say that current developments in large technical systems 'automatically' result in a growing autonomy of citizen-consumers in managing their water and electricity consumption. As I argue in chapter 2 and show in chapter 7, whether citizen-consumers gain authority or not turns out to depend on the modes of provision and access that comes along with an innovation, rather than on the technology itself. The cases of PV panels on the roofs of new-built houses for instance, show that the very same technology can represent very different levels of autonomy of consumers vis-à-vis energy and technology providers.

iv) To make systems of water and electricity provision more transparent to consumers and to increase their accountability in terms of environmental performance, there is a growing need for more advanced monitoring systems than the ones currently available.

As can be concluded from the findings presented in chapter 6, the use and consumption of water and energy resources delivered through large-scale technical networks have always been monitored in some way, either at the input side or at the side of individual users. In the world of utilities, the most common understanding of monitoring is that of ronmental innovation, consumer involvement in the way environmentally relevant resources are provided to them may increase.

The form and degree of consumer involvement in environmental innovation of network-bound systems depends on the specific processes and types of innovation and for that reason, have to be dealt with at the empirical level. The questions of how environment-induced changes have taken shape and how they are represented in the relations between providers and consumers within network-bound systems, have been dealt with by focussing on water and electricity systems of provision in the Netherlands in a period between roughly 1970 until present. In the next section, I use the theoretical elaboration as presented above to discuss the six sensitising hypotheses that structured the empirical research on the matter.

8.4 Environment-induced Change in Water and Electricity Systems: Empirical Findings

The empirical findings on environment-induced change in Dutch water and electricity provision can be categorised under the six 'sensitising' hypotheses as presented in chapter 4.

i) Providers and consumers within systems of water and electricity provision gradually recognise ecology as an independent rationale parallel to economic and socio-political rationales in their overall business strategy or daily practices.

Both the inventory of environmental innovations in water and electricity sectors and the study of dynamics in water and electricity systems showed that ecological considerations increasingly matter in the restructuring of water and electricity sectors. In many cases environmental challenges offer a 'window of opportunity' for a restructuring of the sector: competition between Energy Companies, differentiation of water qualities and testing of new services. Whether these accounts of environmental transformations will eventually lead to a desired sustainable water and electricity provision, or whether policy goals concerning the CO_2 emissions, renewable energy use or water saving will be achieved, cannot be concluded from the selected material. Deliberately, cases of environmental innovation were selected to study the changes in the relations between consumers and providers in times of environment-induced change. This means that the relative contribution of these environmental innovations to the general goals of sustainability could not be assessed in quantitative, technical terms.

ii) Within a context of liberalisation of water and electricity markets, there is (also) competition for the green consumer and differentiation in sustainable products and services.

One of the major changes in contemporary utility sectors is the increase of competition for utility services that were thus far monopolised. This leads to product and tariff differentiation in sectors that were known for their uniformity and high levels of standardisation. In chapter 5 and 7 I show that ecological considerations are at the heart of processes

8.3 Consumer-provider Relations in Network-bound systems: Theoretical Findings

In chapter 2 I argue that the relations between consumers and providers can best be evaluated by using a 'system-of-provision' approach that links consumption patterns to the specific ways goods and services are provided. This approach suggests that consumption practices are partly shaped by the systems of provision that enable these practices. Consequently, the role of consumers in the ecological restructuring of network-bound systems depends on the modes of provision, access and use in which environmental innovations come in reach of consumers, rather than on individual attitudes towards the environment or individual cost-benefit calculations. Such a contextual approach towards domestic consumption should not be restricted to the analysis of supply and distribution chains of flows or commodities. Household consumption practices can not be explained simply by the outlook of systems of provision that support them. In the process of 'serving of and being served by' network-bound systems, it is also important to study the ways in which environmental innovations are incorporated (or not) in individual lifestyles and the concomitant notions of comfort, cleanliness and convenience. For this reason I conclude in chapter 2, that the success or failure of environmental innovations within network-bound systems can only be assessed after thorough study of the technology as well as its' fit or non-fit into various social practices conducted within households.

Throughout this study I show that in the sociology of technology there is only scarce notion for the role of citizen-consumers in the daily operation and change of technical systems. The contextual model of domestic consumption shows that consumers are both serving and being served by these systems. The primary role of citizen-consumers in the operation of large technical systems consists of the everyday routines of use, without which the systems would not function at all. The daily household practices as connected to network-bound systems are therefore as relevant for the study of environmental innovation in these systems as is the study of processes of variation and selection at an institutional level.

I phrase the theoretical answer to the question how environmental innovations in network-bound systems are reflected in the relations between consumers and providers as follows. Firstly , due to the mutual links between provision and consumption practices, environmental innovations that affect the daily operation of network-bound systems affect at the same time the connected consumption practices. Secondly (as indicated in chapters 4, 6 and 7), I argue that if the focus lies on environmental innovations, in terms of monitoring and differentiation, some more specific changes in the relation between consumers and providers can be expected. In terms of environmental monitoring, the top-down relation between provider and consumer that dominated the past is likely to change into more mutual and interactive forms of monitoring in which consumption and production data are revealed to the relevant actors in the system of provision at stake. In addition, differentiation of products, tariffs and services, intermediate technologies and providers inherently mean a break with the past of uniform provision, with only one type of relationship: that of monopolist provision to captive consumer. In both fields of envi and secondly, it is not precise enough in terms of what this means for environment-induced change.

The role of social actors in technological change is described in chapter 3, in a review of theoretical accounts on technological change and the management of large technical systems with a special focus on presumed roles for system users. I conclude that most promising approaches in this respect recognise the role of citizen-consumers as final 'system operators' without whom systems do not function or change. Besides, technological innovation can only be considered a success if the innovation is eventually adopted by and incorporated in the social practices of their final users.

If this were true for technological innovations in general, it still does not provide the complete answer, as there is no specification for processes of environment-induced change. In chapter 4, I argue that ecological modernisation theory is well suited to study such processes of change. The theory describes the growing independence of ecological rationales apart from economical and political rationales in all sectors of society. A process of ecological modernisation includes the monitoring and monetarisation of resource use, dematerialisation (decreasing material use or replacing resources with services), differentiation and substitution of resources with renewables. The argument developed in chapter 4 is that from all these steps, those of monitoring and differentiation can be put forward as the crucial indicators for environment-induced change in network-bound systems for the following two reasons.

Environmental monitoring can increase the visibility of systems of provision to its users, and thereby lower the threshold for environmental renewal. It reveals the extent to which environmentally relevant information on provision and consumption is distributed among providers and consumers and serves as an indicator for an emerging discourse on environment-induced change.

Environmental differentiation is a second core issue because it inherently marks a transition from uniform provision in network-bound systems towards dispersed, pluralist modes of provision. Such a transition is a prerequisite for the development of those environmental innovations that do not fit in the technological trajectories that characterise the phase of uniform provision.

To complete the theoretical exploration of changes in network-bound systems, chapter 4 concludes that monitoring and differentiation are essential steps and thus important indicators for the emergence of a process of environment-induced change. For the empirical study of environment-induced change in network-bound systems it therefore proves necessary to trace and evaluate efforts of monitoring and differentiation, as done in chapters 6 and 7. Before presenting the results of this work, I describe first to what extent environment-induced changes in network-bound systems are reflected in the relations between citizen-consumers and providers.

The dominant message that can be derived from the study of literature on technological change (as presented in chapter 3) learn that it is hard to change large-scale technical systems. Socially and technically, large-scale systems acquire 'momentum': once established, technical networks are maintained as they are because system providers, regulators and users have built up interests in growth and durability of existing networks. An already laid-out network is often more competitive than any alternative system, large or small scale, since investments have already been made, institutions have been set up, and trajectories of innovation have already been set out. Large technical systems do change in the course of time, be it mostly along well-established development paths or 'trajectories'. Radical changes are only likely to occur after the emergence of 'radical' problems that can only be solved by new inventors from outside the existing system.

Solving the environmental problems related to the operation and use of network-bound systems often require radical changes in these systems. The term 'radical' does not mean that change should be achieved in a fortnight but rather, that well-established socio-technical systems should be redirected or replaced by others. In chapter 3 it is argued that such technological transitions require the change of socio-technological trajectories - well-established pathways of technological development - as well as landscapes, the gradients that guide and condition the direction of these trajectories. The first step in achieving such major socio-technological transitions needs to focus on the micro-level of technological 'niches': protected spaces in which actors learn in various ways about new technologies and their uses.

Apart from these general features of socio-technological change in network-bound systems, the socio-economic and regulatory context for environment-induced change in these systems needs to be taken into account. As extensively outlined in chapter 5, the liberalisation of utility markets and the privatisation of network providers leads to a fragmentation of networks at the local level, while at the same time providers increasingly deal with business opportunities and enter strategic alliances on a global level. Such a development represents a transition from a nationalised, uniform, monopolised era of provision to a fragmented, privatised and liberalised era of network-bound provision. Environment-induced change cannot be considered separately from this development and the implications of these changes for environment-induced technological transitions has to be taken into account. Especially the technological regimes - the sets of rules that are embodied in practices, artefacts and organisations - that come along with the new 'global-localised' modes of provision, differ considerably from monopolised and national modes of provision, that characterised the earlier phase of utility provision.

So to give a theoretical answer to the first question, this research shows that socio-technical changes take form in network-bound systems through gradual changes in technological regimes and landscapes, triggered by major changes in the ordering and regulation of network-bound systems and the creation of niches of technological innovation. There are two problems with such an answer: first it does not reveal what the role of social actors - especially the final users of such systems - would be in technological change,

8 Conclusions

8.1 Introduction

This study aimed to investigate the new relations being shaped between consumers and providers within network-bound systems in an era of liberalisation and ecological modernisation. Two general research questions formed the starting point. First, how do environmental innovations take form in network-bound systems? And second, to what extend do these environment-induced changes shape - and to what extend are they being shaped by - the social relations between citizen-consumers and providers and how do these new provider-consumer relations look?

These questions have been approached with the help of a theoretical framework that takes into account the specific character of environment-induced change in network-bound systems on the one hand and the role of citizen-consumers' on the other. As a next step this framework has been put into use in the evaluation of cases of environmental innovation in the Dutch water and electricity sectors. This conclusion subsequently provides the answers to the two main research questions. A distinction is made between the development of theoretical notions (section 8.2 and 8.3) and empirical findings (section 8.4), the latter being built around the discussion of the set of 'sensitising hypotheses' that I presented in chapter 4. Apart from the findings of the study of water and electricity sectors, the relevance of this study for network-bound systems in general is assessed in section 8.5. The last section (8.5) presents the possibilities for further empirical and theoretical research.

8.2 Environment-induced Change in Network-bound Systems: Theoretical Findings

In several aspects, network-bound systems differ from other systems of provision. Firstly, these network-bound systems can be characterised as large-scale technological systems and secondly most network-bound systems provide, what have become essential services (i.e. energy, water, or communication) and therefore require special regulatory regimes to secure its supply. When trying to assess environment-induced change in network-bound systems, these characteristics have to be taken into account.

Firstly, the most prominent differentiation in electricity provision to household consumers is not that of cheap versus expensive, or flexible versus rigid provision but that of 'green' electricity versus 'conventional' electricity, involving new green providers next to traditional utilities and renewable sources next to fossil or nuclear fuels. The differentiation in the drinking water supply sector is also based on ecological considerations: without exception household water is sold to the public as being 'environmentally sound' water as it saves the use of heavily treated clean drinking water for minor household practices. Also the use of rainwater tanks has - without an exception - been motivated on environmental grounds, regardless whether energy use is weighed against avoided water consumption.

Secondly, in both sectors one can observe a trend towards the use of tailor-made, process integrated technologies rather than large-scale, end-of pipe solutions known from the past. The concept of distributed generation and micro-power enables electricity sectors to issue green solutions adapted to local circumstances. But the picture is more diverse than that. Green electricity may be generated in large-scale wind parks or biomass power stations as well as in small PV panels on the roof of a single house. Different scales of technology and modes of provision co-exist and will most probably remain so. As long as there is a central main grid that connects all generation units on the one hand and householders on the other, in essence this system allows for flexible and tailor-made solutions.

Although the drinking water supply system is less dispersed in terms of scales and modes of provision, a range of scales and technologies has been applied to the existing technological network. Household water systems mark a breakthrough in the so far uniform supply of tap water to all households, and are adapted to local circumstances such as the availability and quality of surface water in the area of application.

Thirdly, the role of citizen-consumers in both electricity and water provision is changing from passive captive consumers to a range of other roles. There are many possibilities for citizen-consumers to 'green-up' their electricity consumption practices, from obtaining green electricity from general electricity providers to becoming a member of a windmill association. The roles for electricity consumers therefore diverge from being only captive consumer to being customer, citizen-consumer or co-provider as well, each encompassing other modes of involvement in the ecological modernisation of electricity provision. The variation in consumer roles in the electricity system is wider than those found in the system of water provision. Rainwater users can be considered co-providers of water, although for the necessary back-up they still rely on the conventional water system. The introduction of household water did not change much to the relations between consumers and providers because users of such systems are still captive consumers. Contrary to the electricity system however, where all forms of electricity generation produce the same product, the possibilities of water use are dependent of the way it is generated or treated. Rain water systems produce water which is excellent for washing, but not for cooking. Further differentiation in water generation technologies, which is currently being experimented, will therefore have much more impacts on household practices and consumer roles towards providers than electricity differentiation would.

among many consumers and much more involvement among a few co-providers and self-generators. This is, however, subject to the level of transparency in the 'greenness' of electricity, the arrangements concerning grid access for new providers, and the willingness of consumers to consider electricity consumption as a tool to 'green up' their lifestyles.

7.5 Conclusion

The aim of this chapter is to compare water and electricity sectors in terms of differentiation and ecological modernisation processes that are going on in both systems of provision. Before any conclusions can be drawn, it should be noted that much of the observed differences can be assigned to the physical and technical features of both systems. For instance: transportability of water is much lower than electricity which explains why water networks are locally or regionally based and electricity networks are connected to national and trans-national grids. Also, as water cannot easily be mixed with water from other sources or providers, it is not possible to have multiple providers serving one single regional network.

However, the differences that can be found in differentiation paths cannot be assigned to technical or physical conditions only. We have seen that water and electricity sectors have different technological regimes, involving separate regulatory systems and social networks (see chapter 5). The differentiation paths of electricity and water sectors have at least as much to do with these social and institutional variables as with the physical/technical features.

Differentiation in water and electricity provision has been considered as one of the features of a process of ecological modernisation in network bound systems of provision. However, without specifying the aspects of network bound systems that can possibly differentiate, such hypothesis could not easily be tested. This chapter has explored the forms of differentiation that are and can possibly take place in the network-bound systems of provision. Differentiation of sources, providers and intermediate technologies and the various combinations that can be made in between, result in a differentiation in possible consumer roles towards providers as well. After having explored the various forms of differentiation in Dutch water and electricity sectors, it is now possible to be more precise on the matter of ecological modernisation.

An undoubtedly important drive for differentiation in so far uniform network bound systems has been the liberalisation of utility markets and privatisation of utility companies. It has enabled the emergence of multiple providers, utilising multiple resources and serving an increasingly differentiated consumer market. However, the patterns and outcomes of contemporary differentiation in water and electricity sectors cannot be explained without making reference to the theory of ecological modernisation. Notably its notions on green differentiation, the preference for integrated technological solutions rather than end-of-pipe measures, and the involvement of stakeholders other than governments in designing and executing environmental policy. This can be underlined with the following arguments:

1998, Greenpeace opened an information and reference desk that listed consumers' subscriptions for solar panels. After a year, there where enrolments for 15,000 panels which convinced Energy Companies and the Ministry of Economic Affairs to come up with a subsidy program that lowered the consumer price of a panel below 450 Euro (www.greenpeace.nl).

A number of Energy Companies have issued the Sunpower system: a complete set of 4 to 6 PhotoVoltaic panels that can directly be installed on the roof. The expected electricity production amounts about 10% to 15% of average electricity consumption of one household. The set is installed on the roof and connected to the domestic electricity system using a normal socket, making the electricity meter run backwards if more electricity is produced at a given time by the solar array than is being used in the house. Any kiloWatthours of electricity produced are thereby credited against consumption ('Net-metering'). The initiative of Sunpower shows that Energy Companies are actively trying to broaden their business: apart from being electricity distributor, they wish to develop into 'energy service providers'. The Sunpower system proves to be an effective instrument to keep the so-far small niche market for PV panels in hands of utilities.

Evaluation of Green Electricity Schemes

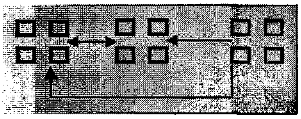
Although the selection of green electricity schemes is not exhaustive, it provides a comprehensive picture of the current variety of green electricity resources and modes of provision. In addition, it gives us a clearer idea of the diverse relations being worked out between green electricity providers and consumers. We have seen that many, if not all Energy Companies have issued green electricity schemes of some sort. At best these have coloured electricity production green, at worst they have re-allocated the green portion to a small group of consumers while painting the rest a little more brown. Electricity market liberalisation has also opened a window of opportunity to experiment with the entrance of several independent green electricity providers and traders.

Processes of diversification of scales are likely to continue in the electricity sector, as electricity is a flexible, easily transportable form of energy provision. With co-generators like PV panels on consumers' roofs, the electricity grid is partly transferred into a storage system of redundant electricity that is produced at the household. Instead of a one-way road, the main grid has been opened up in both directions.

I conclude that green electricity schemes reflect changing relations between consumers and providers but not in easily definable ways. The changes require a closer reading of the forms of differentiation – seen through the different technical, institutional, organisational and social arrangements along national, local and household grids. Depending on the precise configuration of these arrangements, consumers' roles may range from consumers, customers, citizen-consumers or participants in electricity service provision. This exposes the contradiction that consumers might become more authoritative in certain areas, while others remain captive consumers as green electricity schemes range from possibilities for self provision on the one hand, to compelled consumption of largely generated green electricity on the other. In general green electricity schemes imply more involvement

Consumer-Providers

The wind-farmer described at the start of this chapter is a typical co-provider of green electricity. Few households will have the space to install a wind turbine on their premises, let alone they will all be able to find their way in the labyrinth of municipal licences and regulations. However, there are techniques available that are relatively easy applicable on household level such as PhotoVoltaic panels and Micro Heat-Power systems. These techniques enable citizen-consumers to generate their own electricity, without being disconnected from the main electricity grid. On the contrary: a grid connection remains essential as back-up and as a storage base for excessive production of electricity.



Although the use of PV in the built environment is still quite rare, PV technologies are gradually diffusing into housing and building sectors. After a period in which solar panels were simply attached to existing homes, currently architects who specialise in sustainable building increasingly apply PhotoVoltaics in their designs. Municipalities, developers and Energy Companies have been collaborating in building projects to apply PhotoVoltaïcs in residential areas with varying success (Van Mierlo, 1997).

A succesfull example is the 1 MW project in Amersfoort, where more than 12,000 m^2 of solar panels are installed on 500 new houses and a number of utility buildings. These panels are capable of generating 1 MWh annually, which is equivalent to the average electricity consumption of more than 300 households. The project is not only designed to experiment with PhotoVoltaic technology, but with that of various kinds of ownership and client-provider relations in energy provision as well. To allow investigation of the effects of the various forms of ownership and management, half of the installations are owned by the local Energy Company, while others are owned by residents. Agreements have been made with the developers concerned, which include accessibility of the installations and liability for any damage. A right of superficies (building right) has been established in respect of the plots. It has also been stipulated that the solar panels should remain unshaded. The residents are remunerated by the Energy Company for the use of their roofs. Twenty percent of the energy generated on their roof will be paid for at the normal domestic consumer tariff. The other half of the solar-power installations has become residents' property. The solar power generated is fed to the mains and in return residents receive the normal domestic user tariff. Evaluating its ownership of the roofs, the Energy Company stated that this will not have a follow-up elsewhere. There was too much expertise needed on roof construction, which is obviously not the core business of an Energy Company (interview REMU, 1999).

Projects like that of 1 MW help increasing the demand for and experience with PhotoVoltaic panels, which is considered to be essential for the growth of solar energy utilisation in the Netherlands. For a wider diffusion, the price of solar panels needs to decrease, which can only be achieved if demand and production increase. Greenpeace Netherlands' campaign 'Solaris' (1998) was aimed to achieve a breakthrough in this apparently vicious circle of highly priced PV panels due to low demand and vice versa. In April have stopped advertising and have put new green electricity customers on a waiting list. Other companies just raised the price for green electricity (de Volkskrant 30-11-99).

However, with the opening of the green electricity market for household consumers in July 2001 - which means that consumers can choose their own green electricity provider - old and new providers raised their advertising efforts. For the first time consumers in one region are asked to consider a switch to another electricity provider in another region, just because the one is supposed to be 'greener' than the other. Herewith, the differentiation model switches from source differentiation to provider-differentiation. Besides, if services do not satisfy, one is free to switch to another provider, which means the end of the role of being captive consumer and the start of being green electricity 'customer'[3].

Green Electricity by Independent Providers

With the liberalisation of the electricity sector, the distribution networks have been opened to other providers than traditional Energy Companies. Some of these new providers are hardly more than 'energy retailers': they buy electricity from the cheapest or the greenest producer and sell it to their customers by using the distribution networks that are already in place. New providers range from commercial, internet-based companies to idealistic associations for wind or solar energy provision.

In the Netherlands there are about 20 windmill co-operatives representing some 6000 household consumers who are share-holders of one or more windmills installed by the co-operative itself (www.ecn.nl). Electricity is transported to the electricity grid and sold to the energy distributor in the area. Profits derived from the exploitation of a windmill are re-invested in installation of new turbines, as most members of windmill co-operatives state that they do not see this as a financial but rather as an environmental activity. Since 2000, windmill associations have merged into SGEP (Co-operating Green Electricity Producers) The merger was enabled by new legislation on direct delivery of green electricity to consumers (www.sgep.nl). After an initial payment, members will be co-owners of the assets of the association, mainly wind turbines. In addition, a small proportion of electricity directly consumed by these members will be covered by the generated green electricity and will be delivered at the same price as normal electricity. Members still pay their local Energy Company's bill, but the Energy Company must settle this with SGEP. SGEP opposes the green electricity schemes of Energy Companies, as they include power generation from biomass and waste incineration and are therefore not green enough.

The consumer role that fits these kinds of green electricity provision and consumption is that of a citizen-consumer: consumers participate in environmentally sound systems of provision just to make electricity provision in the Netherlands a bit greener than it would be if they did not participate.

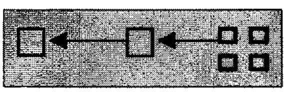
3 This is however subject to possible additional conditions providers might put on breaking contracts and whether they are legally allowed to do so.

Dutch Logo of Eco-Power

The emergence of green electricity is a useful phenomenon to understand the new relations between consumers and providers, in the sense that it is one of the main ways in which (old and new) energy providers are competing today. Green electricity schemes essentially take advantage of the extended opportunities in electricity markets in order to differentiate the consumer market. In addition, the development of such schemes reflects how environmental issues are becoming institutionalised in the new market situation. Nowadays, there is a range of green electricity schemes available in the Netherlands (as well as in a number of other European countries) and this is likely to extend.

I have borrowed the definition of 'green electricity' from the German Grüner Strom Label: "power that is generated environmentally friendly from renewable energy sources or in co-generation". The 'greenness' or environmental soundness of different forms of green electricity is the subject of many debates. However, the lens through which I wish to explore green electricity schemes focuses on variation in the relationships emerging between electricity providers and domestic consumers. This adds insights from a consumer perspective to what has so far been a provider-dominated debate on green electricity developments.

Utility-based Green Electricity Schemes



Green electricity schemes provided by conventional electricity suppliers can be divided into two types: 'green source' and 'green fund'. (www.greenprices.com). The former are more popular and refer to schemes where the supplier buys a unit of electricity from a renewable source for every unit purchased by the consumer. In contrast, green fund schemes do not involve the purchase of green energy as such. Instead consumers pay a premium above the normal unit price of electricity, which is treated as a charitable contribution and is invested in small-scale renewable energy schemes. In the Netherlands the 'green fund'- types of green electricity schemes have now all been replaced by green source types (interview Greenprices, 2001)

In the Netherlands green electricity was first introduced in 1995. From 1999 on, all electricity-distributing companies offer Green Electricity under various banners. Sources for green electricity generation are wind power, biomass and waste incineration, solar power and some hydropower sources. Independent organisations such as WWF supervise green electricity schemes and monitor the claim that no more green electricity is sold than generated. Since the abolishment of regulating energy tax for green electricity, consumer prices vary between an added price of 2 and 5 cent per kWh. A successful mass-media campaign by WWF in 1999 has sped up the number of green electricity consumers from 100,000 (September 1999) to 140,000 (January 2000) (www.greenprices.nl). Because of a rise of the regulating energy tax for normal electricity on 1 January 2000, which made green electricity in some cases even cheaper than normal electricity, Energy Companies provision towards consumers who become co-providers of water. This is closest to the scheme in figure 7.7.

Evaluating Dual Water Systems

With this diversification of water qualities offered to household consumers, single uniform piped water systems are increasingly accompanied by other small and larger scale water systems. As yet, there are no signs that dual water systems will become the new standard in Dutch water supply (Van den Burg et al., 1999). Various forms of rain water systems and household water systems are now being tested and evaluated. It is not even clear whether any dual water system will survive the current debate on environmental and economic soundness of these systems. However, reviewing the technological trajectory along which technology has been developed during the past decades, it can be expected that if dual water systems will survive the current debates on environmental and economic soundness, it will most probably take the shape of central household water systems provided by Water Companies, rather than small scale rain water systems applied at the household level.

Although household water systems are new in technical terms, the way the household water system was introduced and communicated to residents in Wageningen did not differ much from standard procedures. The decision to build a double network was made by the Water Company and the municipality, and there was no consumer involvement in the lay out or the supposed uses of household water. Also the other household water projects in the Netherlands (IJburg, Leidsche Rijn and Meerhoven, see Chappells et al., 2000) have been planned and developed without any early involvement of householders. So, differentiation in water provision has so far nothing to do with consumer choice. The implementation of household water systems therefore fits well into the first scenario of differentiated utility provision as sketched in figure 7.2. Consumers remain captive, providers decide on resource differentiation and only involve end-users after having installed the system.

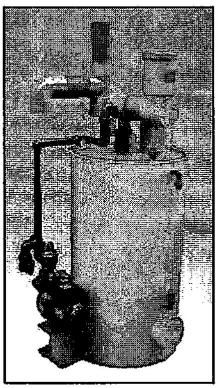
7.4 Differentiation in Electricity Provision and Consumption

History of Standardisation and Differentiation in Electricity Supply

Until recently the provision of electricity, investment planning and guaranteeing of supply was the responsibility of state-owned companies serving captive consumers within natural monopolist markets. With the gradual liberalisation of European energy markets, this form of electricity provision has undergone a substantial transformation. In a few years time most European households will no longer be captive consumers of their regional energy suppliers, but will be able to choose between a range of different providers. As a result, Energy Companies will increasingly try to persuade customers into supply contracts by means of product differentiation or reduced energy prices. Other providers are also entering the energy market, thereby widening the range of modes of provision (i.e. through supermarkets, consumer associations and trade unions) and products and services.

volved in the business of water service provision, thereby including services 'behind the meter' such as water-saving or water-substituting technologies (Stoter, 1994). Another Dutch water manager (interview WMO, 1999) explained that selling and maintaining rain water systems does fit into the business strategy of his Water Company, as the company specialises in water technology and water services in a broad sense. Furthermore, apart from the use of rainwater for some household practices, consumers will always need a drinking water supply as a back up. Stimulating the diffusion of rain water systems is not necessarily an impediment to normal business, especially when the Water Company wishes to shift its core business from drinking water supply to some kind of general water service provision.

The rain water systems that have been installed in the Netherlands have a good record: rainwater appears to be very suitable for washing clothes because of its low Calcium content. Therefor, less detergent is needed. Householders who use these systems state that they very much like the idea of using rain water for washing and flushing. In the sustainable building site 'De Bongerd' in Zwolle, a householder stated that "at every downpour, there is the satisfying prospect of yet another rainwater laundry" (Holtsprake, 1998).



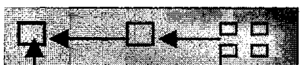
A Rain Water System

In another sustainable housing project (Het Groene Dak, Utrecht) a rain water collection system is installed in the basement and supplies rainwater to a number of toilets and washing machines. The system has worked satisfactory since its installation in 1991. However in the evaluation, one of the initiators of the project stated that the electricity consumption, that is involved in pumping rainwater from the basement to toilets and washing machines makes it not worthwhile building rain water systems in new homes. Apart from perceived environmental benefits, the installation of a rainwater collection system in 'Het Groene Dak' was born out of the wish to become less dependent on large technical systems, like the water supply system. Now, after 10 years it is felt that a single and centralised system of water supply would still be the best option in terms of environmental impact and economic costs. The ideal was to become less dependent of the central water supply system but the balancing of electricity consumption and water saving after some years of usage has resulted in a change of focus towards grid-connected solar energy (Post, 2000).

Obviously, rain water systems have never been installed to save money. With current prices for tap water and rain water systems, the investment will only be cost-effective after 30 to 60 years of usage, depending on subsidies for installation (Chappells et al., 2000). Yet, as in the case of 'Het Groene Dak', rain water systems can fulfil the need to stop the spilling of tap water for flushing and washing, or to become partly self-providing and partly independent of large technical systems. If households install rainwater systems, roughly half of their water consumption could be covered by rainwater and Water Companies could consequently loose half of their water supply to household consumers. This form of differentiation in water provision transfers part of the responsibilities of water ness of their laundry that was washed with household water, nor in their householdwater-flushed toilets (Utrechts Nieuwsblad, 29-1-2000)

A social monitoring study in Wageningen consisted of a survey among future users of household water and a survey among the same sample of respondents after half a year of usage (Van Vliet, 2000b). The outcome here was that users had learnt more about their own water consumption and environmental problems related to water consumption in general. Besides, a great majority was just happy with having the system installed. However, some more possibilities to participate in the decision making on the project and on the specifications of the system would have been appreciated. Also the information that residents received before moving to their new homes was beneath expectations. A considerable number of residents only found out about the system after moving into their new homes. In practice, users of the system realised that while for many practices household water quality would suffice (such as floor and window cleaning, car wash), they missed the possibility to heat the water.

Co-provision by Captive Consumers: Rain water systems



Rainwater butts have been used for ages, and now seem to make their comeback in residential areas. They are hardly ever missed on the lists of devices that show the environmental soundness of new homes. Butts are mostly used for gardening and watering plants. Meanwhile new and more complex rain water systems have been applied in a number of (sustainable) homes. Rain water that runs off the roof is collected in a storage tank and then distributed to toilet butts and sometimes washing machines. Most of the systems are automatically topped up with tap water as soon as the rain water level reaches a minimum level. These rain water systems can be divided in systems that make use of gravity and systems that use electric pumps. Gravity systems have a tank on the attic, which puts restrictions to the size (and weight) of the tank (up to 550 litres). Systems that use pumps, mostly have a tank in the basement of a house or in the garden and can contain much more rainwater (up 17.000 litres for collectively used systems). The disadvantage of a gravity system is that its location puts limits to its size and capacity as bigger tanks would require a heavier construction of the house. Small tanks need more frequent topping ups of tap water, which is less water saving. The costs of such systems are therefore relatively high. Systems that need electric pumps obviously have as a disadvantage the use of electricity[2]. This makes rainwater systems costly and less environmentally sound.

Since the 1990s, the leading technological paradigm in the system of water provision has gradually been challenged by the initiatives of some innovative Water Companies. By asking the rhetorical question, "Does a Water Company just deliver drinking water, or more?" one Water Company director implied that Water Companies should be more in

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2 According to measurements done in 'Het Groene Dak': up to 0,8 kWh per m3 of rainwater. Energy-use of producing and supplying drinking water is estimated at 0,5 kWh/m3 (WoonEnergie, 1995)

provided by the Water Company instead of co-provided by householders themselves, as we will see in the section below.

Responses to Household Water Systems

By 1999 there were 6 new residential sites where a household water system is installed and which obtained the status of experiment from the Ministry of Environment. This means that the projects are closely monitored for their environmental, social and health aspects as to give an input to future policy decisions on water supply. Although highly different in terms of size and resource base, the systems have in common that they all provide a minor water quality through a second piped system that is connected to toilets, washing machines and - in most cases - the outdoor tap.

Since the pursuing of the first household water projects in the Netherlands, there has been lively debate regarding the net environmental benefits and the costs of household water systems. One Water Company that intended to build a system in a new residential area even withdrew the project after an intensive LCA research (interview WMO, 1999). Preliminary outcome of the debate is that each appliance of household water systems should be evaluated, as the positive or negative impacts on environment as well as the economic costs highly depend on its location and the source for the drinking water that is distributed (Van den Burg et al., 1999).

Although most household water projects have partly been motivated by referring to the "wish of our customers" (see Vaessen, 1998, among others), studies to public acceptance of household water systems have only been executed after household water systems have been put in operation. A study commissioned by GWA (Gemeentewaterleidingen Amsterdam) (Van Duikeren, 1997) offers some insight in public acceptance of a dual water-system at forehand. A group of 400 respondents living in new-built areas of Amsterdam was asked whether they would accept a second quality of water for toilet flushing and laundry. Another water quality for the toilet was commonly accepted. For the washing machine, it was only acceptable if washing results would not be affected. Half of the respondents was prepared to pay the same price for household water as for drinking water and 20% was even willing to pay more for it. Acceptance of a dual water system increases if the price for the second water quality is lower than tap water. 70% of the respondents could mention other possible uses of household water: gardening, car washing, cleaning (windows, waste bins, floors, the dishes), and even cooking (Van Duikeren, 1997, pp. 17-18)[1].

After some years of experimenting with household water, social monitoring on consumer acceptance of household water revealed that there are hardly any problems of adaptation encountered. In Leidsche Rijn (Utrecht), consumers experienced no difference in cleanli

[1] It should be noted that these results are derived from a group of respondents that is not actually going to live in IJburg. Their answers may well be influenced by the fact that the questionnaire was rather hypothetical for them.

in the area as long as possible. Household water projects are an outcome of this change of thinking. Although the official policy still holds to its principle of one water quality for all purposes (Ministry of Environment, 1993), a number of Water Companies has started experiments with dual water systems, utilising rain water or surface water from the direct neighbourhood of the residential sites. This second water system is meant for toilet flushing, laundry and gardening.

The emergence of household water projects can also be explained by structural changes in the drinking water sector itself. Independent Water Companies in the Netherlands are becoming rare as many companies have merged into multi-utility companies. All Water Companies hold a 'natural monopoly' in the region they serve, especially in the domestic consumption market. However there is an increasing pressure on Water Companies to reduce production costs as well as to reduce water winning from ground water resources. The study on possibilities for liberalisation in the water sector (Dijkgraaf et al., 1997), commissioned by the Ministry of Economic Affairs gave the internal debate an extra impulse. Most Water Companies immediately rejected the idea of liberalisation and received a broad support from Parliament and the responsible Minister. However many Water Companies do feel the need to renew their policies towards a more client-oriented, market-based approach (see Stoter, 1994; interview WMO, 1999 and interview Nuon, 1999). Instead of issuing water bills, providers are increasingly inclined to listen to the wishes of consumers and municipalities (interview WMO, 1999). Municipalities that are planning the major new residential areas take up the new approaches of water management and ask Water Companies to co-operate in new projects such as Leidsche Rijn and IJburg (interview GWL, 1999). This kind of collaborative planning has resulted in a number of different household water systems. The systems range from small (200 houses in Wageningen) to large (18,000 in IJburg) and from utilising water from local ditches and canals (Wageningen) to that of half-treated surface water tapped from a major transport pipe (Leidsche Rijn).

Being forced to work in a more commercial way, some Water Companies see household water projects as a form of product differentiation on a traditionally saturated market (interview Nuon-water, 1998). In this case the household water projects not only postpone new procedures and investments to obtain concessions for additional water winning in the region, but also serve as an experiment developing new businesses. The expectance is that household water not only substitutes part of drinking water demand, but will eventually exceed it as well.

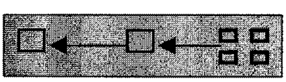
A last rationale for increased interest in household water projects is that Water Companies are eager to remain involved in water related services. Experiments with individual rain water supply can be a threat to Water Companies, as half of domestic water consumption can be covered by rainwater supply; a loss of half of Water Company's supply. Household water can be seen as an answer. Like rainwater, household water is an environmentally sound alternative for drinking water use as it is used in practices where drinking water is not really needed. The difference is that the second water quality is still would introduce the risk of inappropriate links between the two systems with pollution of drinking water as a result.

In sum, since the phase of nationalisation, the leading technological paradigms of the water supply system have been the issuing of a single water quality standard, provided by a single water supplier through a centralised and collective supply and distribution system. A study on the innovation and diffusion patterns of a range of water saving technologies (Van Vliet, 1995) showed that, although this technological paradigm was challenged by a number of initiatives in the margin (there were several experiments with rainwater systems and composting toilets), it still was the main set of principles for actors in the field to frame their vision on the future of water provision in the Netherlands. Examples of smooth-diffusion technologies were water saving showers or toilet cisterns and dual flush toilets. Confronted with more revolutionary innovations, like rainwater provision, composting toilets and dual water systems, representatives of the water supply sector and the Ministry of Environment were highly pessimistic on the chances for successful diffusion.

Environmental Innovation and Differentiation in Water Supply

Notwithstanding this attitude of main actors in the water sector towards dual water systems, since 1995 there have been several new experiments with rain water systems, so-called household water systems and waste water recycling schemes. The majority of these techniques have been applied in typical 'niche-market' environments. The main input has come from national policy concerning sustainable housing that has been developed since 1995. It encompassed subsidy programmes for specific themes of sustainability in housing and building, among which water saving was a prominent one. The National Foundation for Experiments in the Housing Sector (SEV) has put forward and effectively subsidised a great number of 'example projects' categorised in themes like building materials, energy saving and water saving. Especially the small-scale dual water systems, like rain-water and grey water recycling schemes, could therefore be developed and applied. The emergence of household water systems, applied at the scale of residential areas, can be explained by other factors. I will first deal with household water systems and than go on with small-scale dual water systems.

Resource Differentiation and Captive Consumers: Household Water Systems



New building sites in the 1990s look quite different than residential areas that were built before that time, especially in its design and use of water. As far as possible, the natural groundwater levels are kept intact, as well as existing waterways and ditches. In designing sewage capacity, the transport of large amounts of relatively clean rainwater was seriously questioned. Furthermore, urban planners and residents increasingly value the aesthetics of water in the living neighbourhood. Redundant water that is not led away from the area as usual should be dealt with anyhow. National anti-desiccation policy made designers think of decreasing the paving of parking plots and sidewalks in order to let more water infiltrate into the soil (Tjallingi, 1992). Modern water management now aims at storing water

7.3 Differentiation in Water Provision and Consumption

History of Standardisation and Differentiation in Dutch Water Supply

The first water system in Amsterdam was designed to distribute water from the river Vecht to the city, but this water was soon too polluted to consume. At the end of the 19th century Amsterdam already had a dual water system: one distributing Vecht-water and one for water that was filtrated in the dunes. Vecht-water was supposed to be used for cleaning practices, dune water for direct consumption (drinking, washing). However, residents were soon reluctant to use Vecht-water and utilised dune water for all practices (Wijmer, 1992; Van Zon, 1986).

This differentiation avant-la-lettre of water qualities has not been followed up until very recently. Since the early 1970s, when water saving became an issue in the Netherlands, dual water systems have been proposed as a way to save extensively treated drinking water. Next to the drinking water supply, the provision of some sort of supply of a minor quality of water for uses like flushing, cleaning and gardening has been proposed. However, every time the idea popped up in newspapers or political debates, Water Companies and national policy makers in this field quickly rejected the idea for various reasons (Installatie, 1985; Ministry of Environment, 1993; Van Vliet, 1995). First, many Water Companies just stated that water saving was not an issue at all. The Netherlands is located downstream of some major rivers that can supply as much water as needed. If surface water were used as a resource, water saving practices would only increase the costs per unit of drinking water produced. Other Water Companies, utilising ground water, are traditionally more convinced of the need to reduce consumer demand as to avoid new investments in winning sites and technologies. However, a second water system, supplying 'use' water or flush water, had until recently been conceived of as non-economic and above all threatening safety and health. The latter argument was most strongly put forward by national policymakers and VEWIN, the association of Water Companies in the Netherlands. In a public information booklet on the water sector (Ministry of Environment, 1994), the Ministry puts it as follows:

> "Every now and then it is proposed to use other kinds of water (of minor quality) in households, for instance to flush the toilet. The double pipes and double connections needed for this alternative make it however very expensive. Besides, the chance of misconnection between pipes will increase, implying an extra risk for public health. In general, individual use of grey water and rainwater is a vulnerable and costly process. The cost-effectiveness of such homebound systems is so low, that it is better to spend the money on other, more urgent environmental problems." (Ministry of Environment, 1994, p. 29, own translation)

Until today, one of the leading principles of national policy of water supply for households is that only one quality of water should be supplied for human consumption in all households (Ministry of Environment, 1993). This principle should protect citizens for consuming unsafe or unhealthy water simply by not providing it. A dual water system monopolist markets involves an increasing consumer choice between providers and services.

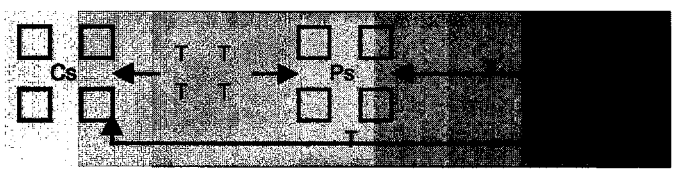
Citizen-Consumers

As new providers enter the utility markets and new services are developed to create niche markets, a range of new relationships between providers and consumers emerges. Some providers appeal to their customers not only as being merely consumers, but also as conscious citizens who take individual action to serve social or environmental goals. Examples of services that appeal to the role of citizen-consumers are fair-trade labelling, green electricity schemes and eco-labelling of food, timber, clothes and so on.

Participants or Co-providers

In addition to situations in which water or electricity flows from providers to consumers, new technological and institutional opportunities enable consumers to generate electricity or water on their own. This is in some cases initiated by citizen-consumers, for instance those who wish to be disconnected or stay independent from large technical systems. In other cases providers take the initiative to decentralise their generation facilities for various reasons, which requires some sort of consumer involvement as well. Figure 7.6 illustrates the co-provision option, in which consumers directly explore resources next to their grid- connected provision of water and electricity.

Figure 7.7: Utility System of Provision - Co-provision



A range of examples of such co-provision can be mentioned here: consumers with solar panels on their homes provide at least a part of all electricity that is consumed, as do owners of rain water systems for water. Co-provision may also take the shape of collective provision: as a member of a local windmill association, consumers participate in the provision of green electricity to the grid.

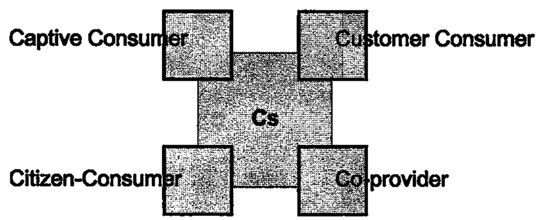
These ideal-types of consumer roles following typical forms of differentiation in utility systems of provision, will be used to evaluate cases of innovation and differentiation in water and electricity systems, presented in the following sections. However, I emphasise that these roles are ideal-types. In reality only mixes of these roles will be found. Moreover, in a differentiated utility system of provision, all consumer roles described here are likely to co-exist in space and time.

The aim of the following is not only to find evidence that differentiation in water and electricity sectors is indeed encompassing resources, providers, and intermediate technologies, but also that environmental innovation in utility systems can fit into diverging consumer roles towards providers.

probably belongs to the most inconspicuous forms of consumption (Shove, 1997). Conspicuous forms of consumption are the mechanisms that make individual lifestyles identifiable to others. In this way the fragmentation of utility markets and possibility for greater differentiation of goods and services offered within this market, provides the enhanced opportunity for a once inconspicuous form of consumption to become increasingly conspicuous through the symbolic potential associated with differentiated systems of provision (Southerton, 2000).

The process of lifestyle differentiation as an outcome of differentiating utility systems of provision is still very premature. However, it is possible to identify a number of old and new 'consumer roles' towards utility providers. The 4 typical consumer roles sketched in figure 7.6 below set the conditions for the range of possible consumer roles towards providers. The first type of consumer role - captive consumer - offers the least possibilities for lifestyle differentiation, whereas the last one - co-provider - offers citizen-consumers a range of modes of access and intermediate technologies to underpin lifestyle choices.

Figure 7.6: Differentiated Consumer Roles



Captive Consumers

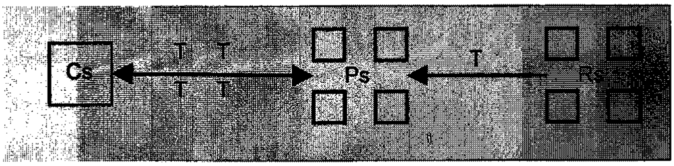
This role is normally associated with monopolist modes of provision. The traditional relationship between utility providers and clients is that of a single regional provider serving captive consumers, leaving no choice for the latter to choose between providers, products or services. As water and electricity provision are rather invisible and above all uniform, conspicuous consumption and social distinction by means of electricity and water consumption are not likely to occur. The role of captive consumer can however still prevail in a differentiated market, irrespective its celebration of free consumer choice. For instance, the switch between providers can be made rather difficult by putting up high transaction costs, obliging the use of a provider-specific meter or creating entanglement instead of transparency in information on tariffs and conditions.

Customers

In a process of liberalisation, providers rename and reconfigure public service/client relations into business/customer relations. This is a slightly more emancipated role towards providers. Contrary to the case of captive consumers, the needs and preferences of customers do matter to providers. They issue new products and services to strengthen customer relations and have a stake in keeping customers satisfied as liberalisation of former electricity and water. Most of the uniform technologies like local distribution networks, sanitary systems, meters, taps and sockets have been developed during the nationalisation phase of utility development. In the transition to the next phase of global-localisation and as a next step in the process of ecological modernisation, such technologies may be replaced by new environmentally sound technologies: for instance local CHP generators, rainwater toilets, 'smart' meters and solar panels.

Figure 7.4 represents the scenario of increasing consumer choice between providers and how electricity or water is distributed, stored or metered. Intermediate technologies in this arrangement may be self-monitoring technologies, technologies enabling tariff differentiation, or in-house storage devices for energy or water. As many of these technologies, such as smart meters, grid-connected solar panels or rainwater systems enable or even require some sort of interaction between consumers and providers, the spheres of consumption and provision become mixed up.

Figure 7.4: Utility System of Provision - Differentiated Intermediate Technologies

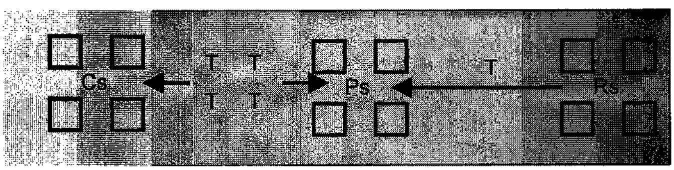


IV Differentiation of consumer roles

The picture (Figure 7.4) of differentiated resources, providers and intermediate technologies as an outcome of market liberalisation and ecological modernisation approaches completion. Yet, it fails to inform on one essential aspect: that of consumer roles towards providers.

First, the figure should be revised into the following figure 7.5, which gives room for a differentiation in consumer roles.

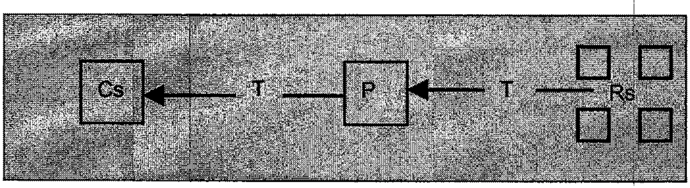
Figure 7.5: Utility System of Provision - Differentiated Consumer Roles



The different consumer roles deserve some further explication. Giddens' account of lifestyles, as presented in chapter 2, holds that in times of globalisation and a widening access to various cultural styles of consumption individuals are increasingly required to choose their own styles of consumption. Until recently, this has not been applicable to the consumption of utility services. Although infrastructures can provide the means for some conspicuous forms of consumption - for example the use of power-showers, oversized fridges or elaborate forms of garden lighting - the consumption of electricity or water ment techniques like infiltration of surface water in river banks and membrane filtration have opened the way to win, otherwise unusable, water resources.

The first ideal-type arrangement (I) still represents rather traditional relations between resources, providers and consumers. Captive consumers are supplied by monopolist providers that utilise a more differentiated base of resources (Figure 7.2)

Fig 7.2: Utility System of Provision - Differentiated Resources



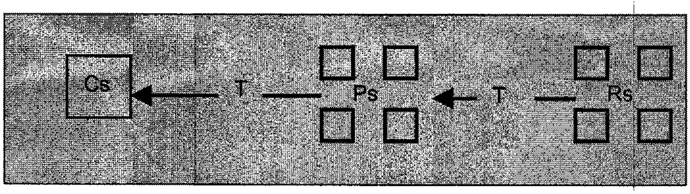
This scheme is a model for instance for a situation in which utilities start to explore renewable resources for parts of their electricity generation or water winning capacity. The utility market in this situation has not yet been opened to consumers who remain 'captive'.

II Differentiation of Providers

Apart from resources, also providers differentiate as soon as monopolies are abolished. New providers enter the energy or water markets, and try to create new and in many cases 'green' niche markets. The new providers may be organised quite differently from traditional utilities. Some are only trading organisations that form an intermediary between energy providers and household-consumers. Also consumer associations, environmental NGOs, windmill-co-operatives and single consumers may act as providers of utility services.

Figure 7.3 shows the differentiation of providers. Various providers make use of the same distribution network to which consumers are connected.

Fig 7.3: Utility System of Provision - Differentiated Providers

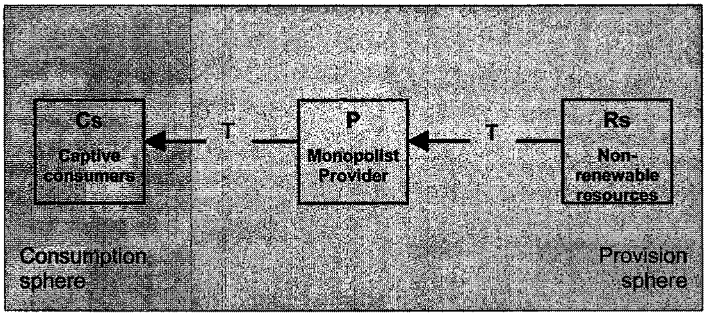


We have seen a transition to such a system of provision in a number of European electricity sectors. The Netherlands opened its green electricity market for household consumers in July 2001.

III Differentiation of mediating technologies

Differentiation can also refer to technologies for distribution of electricity and water from providers to consumers; monitoring of consumption and provision and user access to

Figure 7.1: Basic Scheme of Utility System of Provision



The horizontal spine shows the relations between consumers (C), providers (P) and resources (R). Providers are the intermediaries between consumers and natural resources, a relationship which took shape in the early stages of urbanisation when direct access for consumers to resources (water extraction sites, woodlands) were increasingly replaced with mediated access sites (reservoirs, power stations or landfills). Collective socio-material systems emerged to mediate the provision of these resources to consumers: these include the electricity grid and water works.

Located within these utility systems are a series of mediating technologies (T's), including distribution, storage, efficiency and monitoring devices. Different combinations of these devices assist providers or consumers in managing resource flows in time and space.

The role of consumers in this type of provision is rather passive: their influence on which and how energy and water are provided is almost nil. There is no choice between technologies, providers or resources. The physically determined cleavage between the spheres of consumption and provision is that of the utility meter. Both economic and environmental considerations can lead to the following stages of differentiation in the system of provision as sketched above.

I Further differentiation of resource use

First of all, there is a differentiation of resources from which electricity or water is generated. Of course, both electricity generation and water winning have never been dependent on single resources. Since the first energy crisis in the 1970s, a further differentiation has taken place in the energy sector as to become less dependent on crude oil from the Middle East. Since then, the Dutch energy sector has intensified the utilisation of North-sea oil, gas, CHP, and renewable resources (solar, wind, biomass and hydropower) (Ministry of Economic Affairs, 1995). However, a gradual substitution with renewable resources requires a further differentiation and would include the input of biomass, solar and wind resources.

There have always been various sources for the winning of water, e.g. ground water, surface water, well-water. Ground water winning is increasingly restricted due to desiccation of natural reserves. Since the last decade, Water Companies have therefore sought other sources and treatment methods to fulfil the growing need for drinking water. New treat

To say that distributing generation is also emerging in the water sector would be an exaggeration. However, debates on (ground)water scarcity and desiccation have triggered a number of experiments in local generation and distribution of 'household water' as well as the installation of rainwater tanks and wastewater recycling technologies in some experimental sustainable housing projects. At least the paradigm of 'one water quality for all household practices' is currently being challenged and the scale of water provision, as well as water qualities being used in the home, is differentiating.

Differentiation in water and electricity systems is something new as technological regimes have always been centred on uniformity and standardisation. The latter not only concerns generation and distribution technology but also the services provided to consumers. Roles of citizen-consumers in provision of water and energy are likely to change as well. Differentiation for the first time introduces consumer choice in electricity and water provision. Moreover, apart from captive consumers and users of utility systems, they may become co-providers and indeed operators of home-based systems.

This chapter is aimed to clarify the notion of differentiation in water and electricity sectors and connect it to the theory of ecological modernisation. I argue that as ecological modernisation of energy and water sectors involves the gradual substitution of the utilisation of non-renewable resources with renewables (hypothesis 2, chapter 4), as a first step some kind of differentiation is needed of hitherto uniform and standardised providers, technologies and services. Moreover, I argue that the current differentiation in electricity and water sectors is environment-induced or rationalised.

As differentiation encompasses much more than products or tariffs only, section 7.2 explores and categorises the possible levels and sources of differentiation in utility systems. This system-based approach is connected to consumer-based approach and the section ends up with the linkage of four typical forms of differentiation with four typical roles of consumers towards providers.

In section 7.4, I discuss the levels of differentiation that are involved in some recent innovations in the Dutch water sector and their repercussions for hitherto uniform consumer-provider relations. The same is done in section 7.5 for innovations of the electricity sector, collected under the heading of green electricity schemes. The conclusions on differentiation and ecological modernisation in water and electricity sectors are presented in section 7.6.

7.2 Levels and Sources of Differentiation in Utility Systems

Differentiation in utility systems refers not only to products or tariffs, but also to many other links in the system of provision. I first discuss the kinds and sources of differentiation starting from a basic scheme of operation of utility systems. Next, I go on to assess the possible new consumer roles in water and electricity provision and consumption as a consequence of processes of differentiation.

A system of utility provision can be simplified as a large technological system linking natural resources, providers and consumers.

7 Differentiation in Water and Electricity Provision and Consumption

7.1 Introduction

Picture from Nuon Commercial

"Start your own Energy Company" is the pay-off of a recent TV-commercial from one of the main Energy Companies in the Netherlands. We see a farmer with his own windmill on his premises acting as an authoritarian home-based Energy Company manager. In front of their windmill the family assures us they also do it for the environment. The ironic tone reveals that the commercial is not really meant to encourage customers to install their own windmill, rather that the Energy Company is not what it has been before. The company not only distributes electricity, but provides energy services as well and might even act as a humble customer of self-generators like the wind farmer in the commercial.

The story line fits well in what has been called the Micro-Power revolution that is believed to be at bay in the United States (Dunn, 2000). Over the years, Combined-Heat-Power technology that is well known in industry has been developed into increasingly smaller scales and can now be applied at household level. There has been a gradual increase of PhotoVoltaics applied at the level of individual homes too. Energy Companies slowly seem to abandon the technological paradigm of centralised large-scale generation and distribution of power and put in place a paradigm of 'distributing generation' (Invernizzi, 1998). It means that distributing companies put small generation capacity at several nodes in their network and act as co-ordinator of consumer demand and supply rather than as distributor of electricity only.

A last eye-catching differentiation in electricity supply is the development of various kinds of 'green electricity schemes' encompassing differentiated tariffs for 'green' and 'normal' generated electricity by Energy Companies. This is a remarkable development as it shows that ecological rationales may initiate the differentiation of formerly uniform modes of provision.

However, there are reasons to expect that monitoring within electricity and water sectors is developing into the desired direction. Firstly: the observed differentiation in electricity and water provision in terms of products, services and providers requires more elaborate information about the different services and providers. Such information is to be checked and certified by third parties, such as environmental organisations and anti-trust authorities. For instance the labelling and proper functioning of green electricity schemes eventually requires transparency in the shares of electricity generation by solar, wind, hydropower, biomass or other renewable energy sources. Such transparency can only be offered if other organisations than providers themselves are involved. Secondly: the observed development in metering technology - from mechanic meters summing up numbers of cubic meters and kilowatt-hours into 'smart' meters - opens the way to much more fine-tuned and interactive paths of monitoring. Although smart technologies can be used in many different ways, including advanced modes of traditional energy / water revealing, they can also support a more consumer-led approach of monitoring in which not only consumption levels are made transparent to providers, but providers' strategies are made transparent to consumers as well.

of information on provision and consumption, matching consumer needs with a variety of utility services.

6.6 Monitoring and the Ecological Modernisation of Network-bound Systems

The use and consumption of water and energy resources delivered through large-scale technical networks have always been monitored in some way, either at the input side or at the side of individual users. In the world of utilities, the most common understanding of monitoring is that of registering flows of water or electricity by means of a water or electricity meter. The information revealed from these meters serves providers rather than consumers. The meter has not only become the physical barrier between internal networks (at household-level) and external networks (at system-level), but also the virtual dividing line between the private and the public sphere, between consumption and provision. Applying ecological modernisation theory to water and electricity consumption and provision leads to a reconsidering of *what* is being revealed to *whom.*

The information provided through monitoring should include information concerning environmental performance at both sides of the meter. Levels of water and electricity consumption should be expressed not only (or necessarily) in kilowatts or cubic meters but also in terms of environmental impacts, like the relative contribution to CO_2 emissions or the contribution to a previously set individual goal. Furthermore, environmental data on the *kinds* of services and flows should be revealed: composition of the mix of resources, and - if possible and relevant - their origin, modes of exploitation, treatment and distribution.

The answer to the question *to whom* such information should be addressed has implicitly been answered as well. Citizen-consumers will generally not feel empowered towards providers once they get a meter installed. Consumer involvement in the ecological modernisation of electricity and water services requires them to monitor providers and modes of provision as well.

The review of cases of monitoring in Dutch water and electricity sectors show that indeed the approach in which physical aspects of energy / water flows are made transparent to consumers while the provisioning systems remain concealed is still dominating in utility sectors. Most monitoring projects serve other goals than supporting energy or water conservation at the side of the consumer. Examples are the change of a scheme of public financing into individual tariffs or bringing down utilities' administration costs, as in the case of pre-payment meters. Monitoring projects that have energy or water conservation as an explicit goal rather uncritically start from the assumption that providing knowledge about levels of consumption would automatically persuade consumers to conserve energy or water. It is therefore too early to assess that contemporary monitoring in water and electricity systems makes these systems transparent and accountable to citizen-consumers in terms of environmental performance.

Table 6.1: Rationales of monitoring water and electricity consumption and character of consumer-provider relations

	Energy/water revealing?	Social revealing?	Consumer-provider relation
Watermetering Amsterdam	Limited to aggregate figures of water consumption (if noticed at all)	No	Limited
Zuinig Stoken	Data logging activities reveal data on consumption over time	No	Limited
Telemetering	Weekly updates and comparisons with previous figures and with personal goals	Partly, average figures of total consumption in the neighbourhood, general information on water and energy efficiency	Both Authoritative and Devolved
Smart Cards	Reveal levels of consumption since last recharge	No	Distant
Actie Pottekijker	No	Limited to the ways how to get a water saving cistern installed	Authoritative
EPA	Yes, as a first step in taking energy efficiency measures	Partly, as the ways to obtain measures and subsidies are disclosed to consumers.	Devolved
EcoTeams	Depending on own data logging	Depending on own initiatives, but part of the programme is to reveal how water and electricity is provided	Devolved

The cases show that although monitoring consumption and provision of electricity and water is increasingly gaining importance, 'energy revealing' is still the dominant approach. Nevertheless, apart from 'energy revealing' other rationales are gradually being developed. Not all the monitoring projects aim at data logging anymore. Some projects aim to extend consumer's knowledge on how water and electricity is provided to them while others refine technologies to obtain more information on consumption patterns and levels.

The way consumers are involved and the degree to which they control monitoring data and monitoring objects vary among the cases, as can be seen in the last column. Consumer-oriented monitoring implies that consumer-provider relationships are devolved or distant at least. Only in these categories of relationships, citizen-consumers are able to access and control information on water and electricity consumption and provision. There are hardly any cases of monitoring that fulfil both the requirements of a consumer-orientation and a combined energy and social revealing approach. The EcoTeam programme comes close although this is not a programme that would become very popular among wider circles than the environmentally conscious it has served until now. Smart card systems have the potential to fulfil both requirements as their possible applications range widely from data logging and supporting prepayment schemes to displaying all sorts total of 8350 households (one of 6 million) have been involved in 1187 EcoTeams (Vakblad Afval, 10, p. 6). However, as opposed to effects of most other behavioural change interventions, effects achieved with the EcoTeam Programme seem to be lasting and for some themes even improving after participation has ended. This is the conclusion of a survey among ex-participants two years after being involved in the EcoTeam. Harland and Staats (1997) recommend lowering the threshold for participation in the programme, which is mainly related to its team aspect. A more individual program would attract a larger number of people. Such a program should make it possible but not necessary for participants to meet each other. However, group pressure seems to be one of the keys behind the success of the program, next to the monitoring of consumption. Moreover, GAP is rather reluctant to change the programme on this point (interview GAP Gelderland, 1999).

In terms of monitoring, this programme requires most consumer effort in meter reading and data logging. Besides monitoring individual consumption levels, the EcoTeam programme is the only scheme that stimulates participants to gain environmental information higher up in the system of provision: what kinds of electricity is supplied to them, where does drinking water comes from, to where is my waste transported to after disposal, and so forth.

6.5 Analysing Rationales in Contemporary Monitoring Practices

Table 6.1 summarises the result of applying the energy/water revealing – social revealing dichotomy as well as the categories of consumer-provider relations to the sample of monitoring cases discussed in this section.

Workbook. As a guide, the Workbook contains loads of tips and ideas to reduce consumption or to make environmentally sound choices. Besides, all Ecoteam members keep a diary of their savings. The monthly meetings start with recording all individual data and comparing them with previous recordings. In this way the team members gain insight into their own behaviour and track their individual progress as well as the progress they made as a group. All quantitative data from EcoTeams are collected and analysed in a central database at the GAP office and sent back as a feedback to the teams in a so-called team-report. The idea is that householders actually get convinced they can make a difference, which is referred to as a process of empowerment. To monitor their consumption, EcoTeam members make use of existing meters for gas, water and electricity to monitor consumption, but use less obvious monitoring methods as well, such as weighing garbage bags before putting it on the street for collection. The EcoTeam meetings subsequently concentrate on six themes: garbage, gas, electricity, water, transport and consumption (mainly shopping behaviour). The subsequent themes are prepared by one of the members. Preparation may consist of contacting the utilities and other providers to obtain environment related data and suggestions. The members are encouraged to gather all data about meters, how energy is provided in the region, how water is produced and how waste is collected and treated. The co-operation that members experience from providers in general is however quite disappointing. Utilities are not very much co-operative in providing figures on energy or water demand in the region. EcoTeams distrust rather than trust utilities as a partner in achieving the environmental goals (interview GAP Gelderland, 1999).

To get people involved in EcoTeams, regional GAP organisations present the programme at festivals, seminars or organise information evenings in municipalities. GAP volunteers also recruit householders through door-to-door visits. The reasons why people participate in an EcoTeam include: their worries about the environment; financial reasons (saving energy, water or waste is saving money) or social reasons (EcoTeams offer a good occasion to get to know the neighbours or to reaffirm or share your sustainable lifestyle with others). People participating in EcoTeams mainly belong to the 'early adapters', the already environmental conscious and the highly educated. Only in cities where this group is already involved, other target groups are approached like the young families and employees at offices and factories. The lower income groups and students are groups that have not (yet) been involved or actively approached (interview GAP Gelderland, 1999).

This picture of EcoTeam members fits well in the demographic and socio-graphic characteristics of a survey sample of EcoTeam members in the Netherlands (Harland and Staats, 1995). One third of the sample (N=205) has had college or university education and 64% had an higher than average income. The household size was small: the biggest share of the sample (35%) consists of two-person households and 64% was smaller than 4 persons (Harland and Staats, 1995, p. 8).

The aim of GAP is to get 15% of the Dutch households involved in the EcoTeam programme, which would represent the critical mass that - according to GAP - is needed for environmental change. This seems already much too ambitious. By September 1998, a paigns like these are municipalities offering subsidies on solar heaters right at the time that most house-owners in one area consider the replacement of their heaters which are all of the same age.

Energy Performance Assessment

The Energy Performance Assessment (Energie Prestatie Advies) is an example of a new consumer service in the system of energy provision. It is the first national co-ordinated energy advice service, adding up to a huge number existing energy services on a local scale.

An Energy Performance Assessment (EPA) can be obtained on request and provides insights in the energetic quality and energy performance of a home (www.epadesk.nl). The goal is to stimulate householders to make energy conservation measures: improved constructions, insulation measures, and installing energy efficient installations. An advice starts with the assessment of physical conditions of the home and actual energy consumption. Depending on budget and consumer wishes, the most appropriate measures will be assessed. Besides, the adviser browses all subsidy programmes to see whether measures can apply for a governmental or Energy Company subsidy.

EPA started as an initiative of the Ministries of Environment and Economic Affairs, but has now taken over by private businesses. The advisers are linked to and trained by installation companies and Energy Companies.

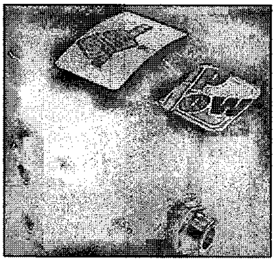
Different than in other cases, monitoring is not done continuously through metering or data logging, but encompasses a service that is requested only once. Not the flows of electricity and water form the object of monitoring, but the physical conditions in which water and energy are used.

EcoTeams

The EcoTeam Programme is yet another way of monitoring consumption patterns in relation to the environment and takes consumer commitment again one step further.

The EcoTeam Programme is an initiative of an international environmental organisation called 'Global Action Plan for the Earth' (GAP) and aims to improve ecologically relevant behaviour within households. At its founding in 1990, GAP set environmental goals for the year 2000 and converted these to individual households. The goals are ambitious: a 65% reduction of waste disposal, a 30% reduction of electricity, gas and water consumption and a 40% reduction of fuel consumption for transport. GAP's main assumption is that many people want to help create a better environment, but they often do not know where to start. Furthermore, it is assumed that people hold the opinion that their individual effort will be negligible. These are the people GAP wants to get involved (Harland and Staats, 1997, p. 1-2).

EcoTeams are small groups of 6-10 householders who can be neighbours, club members, friends, or colleagues. They meet once a month to exchange ideas and discuss achievements of the individual households and the group as a whole by following the EcoTeam special credit card that can be recharged at the Water Company. If there is no recharging, the system supplies a last 500 litres, after which water supply is stopped. Customers pay an extra charge for the meters, to settle the debts they have incurred in previous years (PZ, 1999). According to its manufacturer, 'the ChipFlow meter is a customer friendly instrument designed to solve the problem with defaulters'. In addition, the ChipFlow meter 'helps to improve cash flow in the water industry' (www.chipflow.com/main.htm).



The Water Company in this case does not try to hide the main purpose of installing such meters: namely the self-disconnection of non-payers. The possibility of (self) monitoring, which is heavily emphasised at the introduction of the Comfort Card, is not even mentioned as a possible outcome for consumers.

Seen as a monitoring device, smart-cards oblige consumers to monitor their energy or water consumption. From a provider's point of view, it saves administration costs and especially the need to 'switch-off' defaulters from using the network: the 'switch-off button' is now in the hands of the consumer. The positive evaluation of Dutch volunteering consumers is in sharp contrast to a rather common indignation about prepayment meters in the UK. British Energy and Water Companies are accused of installing prepayment meters to save administration costs as well as and the hassle and humiliation of switching-off non-payers from essential services. Consumers have no choice but to recharge their smart-cards if they wish to have energy and water again (Marvin, 2000).

Actie Pottekijker[4]

'Actie Pottekijker' was a campaign to persuade householders in the province of Overijssel to have a water saving toilet cistern installed. The campaign was carried out by a conglomerate of Water Companies, the provincial government, environmental NGOs, the Ministry of Environment, plumbers and 15,000 school children. The latter were sent to make door-to-door calls and ask whether householders did have a water saving or dual flushing toilet system. If not, householders were offered a reduction on the costs of installing a water saving device by one of the plumbers who participated in the project.

In terms of water saving, the campaign was a huge success: 62,000 households had a water saving device installed, which summed up to a billion of litres water saved every year (H_2O, 1993)

This monitoring scheme is peculiar in many ways. To have one's water consumption monitored is likely to be less embarrassing than being questioned about one's toilet layout and use. The monitoring task was left to schoolchildren. Less extraordinary is the fact that the campaign aims at a mass substitution of one household device to make huge savings in terms of overall water or energy consumption in one area. Examples of cam

4 Translation: 'Snooper Campaign', or literally: 'Pot Watcher Campaign'. In Dutch, the expression particularly is well chosen, as 'pot' is a popular word for 'toilet' as well.

knowledge of what would appear on their energy bills (Obragas, 1999). The Telemetering experiment lasted only three months, much to the disappointment of the householders. However it appeared to have been an expensive and technically vulnerable system for the utility company, which decided not to repeat it in the short term.

The Telemetering project is an advanced and more convenient form of self-monitoring than the Zuinig Stoken campaign described above. Moreover, the commitment asked from consumers to set individual goals proved to be much more stimulating to save energy and water. Although this was only a short-term experiment, more monitoring projects like this are likely to be done: privatised utility companies might need such extra services to compete with other utilities. Besides, it can be expected that the improvements in information technology will make such projects less complicated and less expensive in the near future.

Smart Cards

Pre-payment devices help - of force - consumers to monitor their consumption because energy and water flows are interrupted if no action is taken. Pre-payment meters for gas or electricity were already used in the early 20th century. New devices based on information technology have come up after decades of absence. With the liberalisation of the electricity market, supermarkets have announced to sell electricity to consumers, which will be in the form of a rechargeable 'smart' cards like the Comfort Card and the Chipflow card described below.

EnergieNed, the former umbrella organisation of the Dutch energy distribution companies has started an experiment in which 100-200 households will get a gas meter with a pre-payment system installed. The consumer can (only) buy gas with a smart-card that can be recharged in the local supermarket. This system makes meter-reading by the Energy Company obsolete. To make sure that people do not unexpectedly run out of gas, a spare amount of a hundred cubic meters is available. One of the participating energy utilities is Obragas that issued so-called Energy Comfort cards to 100 households (to a representative sample for the Dutch population). Since the start in October 1998, these households did not need to pay monthly prepayments or energy bills anymore. Instead they could directly monitor the financial consequences of energy consumption. Some householders even checked the pay-meter before and after having a shower to check for how much money they had used gas to heat the water. It was expected that households would be able to save up to 10-15% on their energy bill. A survey among participants after half a year of usage however showed average savings of 5%. A majority of participants to the project (67%) would opt for the Comfort Card after the experiment would come to its end in December 1999. It must be stressed that consumers participated on a voluntary basis. According to its provider, prepayment will also in the future remain a voluntary option. (Obragas, 1998).

The Chipflow meter has recently been introduced by a Dutch Water Company to 20,000 households in order to - as the Company puts it rather euphemistically - "protect non-paying customers against the risk of not getting any water". This meter also works with a efficient homes. Apart from conventional water, electricity, and gas-meters there is a separate unit that collects data from these three meters. These data are sent via a two-way TV-cable to the computer network of Obragas, the utility company in this area. Obragas attaches client related information to the data and sends it back to the customer. The customer receives a weekly personal update of water, gas and electricity consumption figures via Teletext.

Before the project began its organisers advertised the following: firstly there would be no more meter-reading visits and secondly, the system would provide direct feed-back on consumption, which would 'almost automatically influence behaviour' according to Obragas' press release in 1997.

The 29 households were given weekly feedback on gas, electricity and water consumption over three winter months (1997-1998). The information was presented to consumers on TeleText pages presenting actual consumption figures compared to aspired levels of consumption. Levels of achievements were visualised with a smiling, a neutral, or sad-looking face. Furthermore, cumulative gas, electricity, and water consumption figures were presented as well as an estimation of annual costs given the current accumulated level of consumption.

A social monitoring research effort (Völlink and Meertens, 1999) was conducted before and during the project. It included pre-metering (T1) of gas, water and electricity consumption at the experimental and a control group, mid-term metering (T2) after which conservation tips were given to half of the experimental group and metering (T3) just after the experiment ended. Before the experiment started, respondents were asked to fill in questionnaires on their energy and water consumption behaviour, and to set a personal reduction goal of 5, 10 or 15%. Earlier research had proved that the combination of giving feedback with personal goal setting is much more effective than giving feedback alone. The advice after T2 on energy or water saving contained simple one-liners like "having a bath = 120 litres, taking a 5 minutes shower = 57 litres" and only appeared if there was an under performance compared to the goals set.

The chosen personal reduction goal was 8,4% on average. Comparing the experimental group's T3 consumption of gas, electricity and water with its consumption in T1, reductions of 18% for water, 23% for gas and 15% for electricity were achieved.

There are no significant performance differences between respondents who had set low goals (5%) and those who had set higher goals (10 and 15%) for gas and electricity conservation. For water conservation, the householders who had set lower goals did much better than those who had set higher goals. However, the latter had a much lower water consumption level at T1. The effect of the advice that was given after T2 could not be significantly assessed. The householders of the experimental group very much appreciated the feedback. They were mainly interested in the comparison between current and aspired levels rather than in real consumption levels (Völlink and Meertens, 1999). According to Obragas, many households made a competitive effort to energy saving and sometimes they even tried to compete with their neighbours. Customers appreciated the advanced saving behaviour. I will return to these rationales in the evaluation of all cases in the next section.

Actie Zuinig Stoken (Thrifty Heating Campaign)

Electricity and gas provision has commonly been metered since their establishment at the start of the 20th century. The purpose of metering is to monitor consumption and charge consumers according to meter readings. However, after the energy crises of the 1970s and 1980s, meters obtained an additional function: to inform and support consumers in their energy saving practices. An example of such use of meters is the annual energy conservation campaign organised by Energy Companies called 'Actie Zuinig Stoken'.

Since the early eighties, Energy Companies in the Netherlands have been persuading their consumers to monitor their domestic energy consumption by means of a weekly feedback scheme. At the start of the heating season (around the first of October), participating households obtain a table to register their gas and electricity meters weekly. Every week until the end of the season (end of March), consumers can compare their own figures with the figures published for that week in the local newspaper, Teletekst or - more recently - the Internet. The figures are provided by the utility companies and are based on outdoor temperatures, during that week (for gas) and average household consumption of electricity in the previous year. The scheme was issued for the first time in Den Haag in 1984 and became known in the whole country after 1986. The highest countrywide participation rate was 31% of Dutch households reached in the 1987-1988 season, but they decreased afterwards to 23% in 1989 and 14% in 1989-1990.

The scheme combines the instrument of self-monitoring with advice for simple energy saving practices or devices. Participants saved more energy than non-participants during the same period (7-11% versus 2,5%). A bottleneck is that it is a temporary instrument, as householders tend to participate only for 2 to 3 subsequent seasons and then quit (Loois and Drabbe, 1991).

The scheme is an easy way to guide consumers to their meters and draw their attention to their consumption as well as their savings. Combined with advice on energy saving practices, it is an instrument for a considerable group of consumers that wishes to make the effort. It is however not much more than that: energy conservation requires not only willing consumers, but also the willingness of housing corporations to invest in home insulation or condensed boilers, the availability of energy efficient devices, financial of fiscal support from governments and utilities, and so forth. The scheme hardly pays attention to these issues as it prescribes the action solely from the consumer side.

Telemetering

Modern versions of data-logging schemes are called 'Telemetering', or 'smart metering'. During the last 5 to 10 years, there have been a few experiments with 'smart metering', including a Telemetering project in Helmond.

Telemetering is a feedback system on energy and water use based on the use of home televisions. It has been tried in Helmond with 29 households living in new-built, energy-

After the introduction of individual water meters it is expected that consumers will save 12% of their water consumption, a figure that is based on a literature study of other metering projects (GWL, 1998). Actual figures of Amsterdam water consumption per capita per day are however rather unreliable. They are based on known figures of water production divided by only an estimated number of Amsterdam residents. GWL works with the figure of 156 litres per capita per day, which is high compared to the Dutch average of 128 litres per capita per day. In any case, if the metering project were meant for water saving only there would be many other and more economical ways to obtain the same result. However, the social and political pressure on the Water Company to install meters has become too hard to sustain (interview GWL, 1999).

Most consumers responded positively to the project and many of them think their water bills will eventually be reduced as a result. However, after its introduction that large families in small houses may get a much higher water bill, while small families in big houses will be better off. The City Council has already anticipated this effect and has promised to compensate the low-income groups that will suffer most from the introduction of water meters.

In a survey commissioned by the Water Company, residents were asked whether they would actually use the water meters to monitor their own water consumption. 24% of the respondents (N=546) would not do so, one third said maybe and 40% said definitely yes. 23% of the respondents expect their water bills to increase after installation of a water meter. 31% think it will remain the same and another 31% expect them to decrease (NIPO survey in GWL, 1998).

The Amsterdam metering project is more than a huge technical operation; it also means a radical change in the relation between GWL and its customers. Thus far GWL has no customers besides the municipality to which the Company is accountable. This means that GWL lacks all facilities to interact with water consumers, such as a client desk, a marketing division, a customer administration unit, and so forth. The metering will make water users known to GWL and GWL to its users. This will require a costly organisational set-up fitted to serve individual customers. This was one of the considerations behind a possible merger with the regional Energy Company. One of the acknowledged benefits of such a merge would be the access to a database of customers in the region as well as the access to an organisational infrastructure to deal with these customers (GWL, 1998 and interview GWL, 1999).

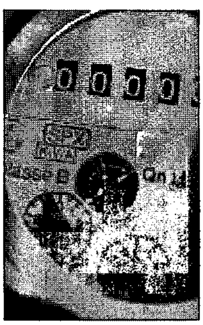
The role of water consumers towards the water provider will also change considerably. Instead of being anonymous users of a public service, householders will become water customers. Although consumers will not have a choice between products or providers, they will be charged for their individual water consumption.

The Amsterdam water-metering project can be seen as an example of many other cases with comparable rationales to legitimise metering: meters help consumers to be charged only for what they consume, which besides may separately facilitate to water or electricity information or social structures of provision as well as to matching patterns of consumption with those of provision. Such monitors reveal to consumers and providers the environmental performance at both sides of the meter and citizen-consumers are capable deciding on the timing and addressing of specific kinds of information concerning the consumption and provision of services. The devices and procedures to fulfil this function may range from data logging schemes and 'smart' meters to labelling and certification systems.

6.4 Monitoring Water and Electricity Consumption - a Selection of Cases

To illustrate and strengthen the argument, I present seven contemporary cases of innovation in water and electricity consumption and provision in which monitoring plays a dominant role. Apart from this common denominator, the cases differ greatly in terms of the rationale behind and character of monitoring procedures. The order of cases follows the line from metering substance flows to monitoring environmental practices in consumption and provision. At the same time we see the role of the meter as a cleavage between provision and consumption is reduced.

Amsterdam water metering project



The drinking water system in Amsterdam is based on the principle that access to drinking water is a citizen's right (interview GWL, 1999). This idea originated some 100 years ago, when the municipality decided for the sake of public health to invest in a waterworks for the whole city and established that all residents should have a free and unlimited access to it. Therefore residents of Amsterdam do not pay for the amount of water they use and instead pay a municipal lump sum for the public water supply. In administrative terms there is no individual consumption as there is no relation between water use and a payment that is based upon it. The municipal tax for water is based upon the size of the homes, with rooms, bathtubs, kitchens and garages all considered separately when assessing the tariff. Over the years, many residents have complained about this system, since they think it is unfair to pay a fixed tax when their actual water consumption might be lower than average.

The Amsterdam City Council decided in February 1998 to gradually introduce individual water meters for all 427.000 household connections to the Municipal Water Company (GWL). This decision was motivated by the principle of pay-what-you-use as well as by environmental considerations (GWL, 1998). The current piped water system is not fit to individual household connections as 85% of Amsterdam homes are located in apartment buildings where water pipes are crossing vertically through the individual homes. The water-metering project will take some 30 years as GWL is dependent of house-owners and housing associations redesigning houses and refitting the water pipes to enable the installation of individual water meters.

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