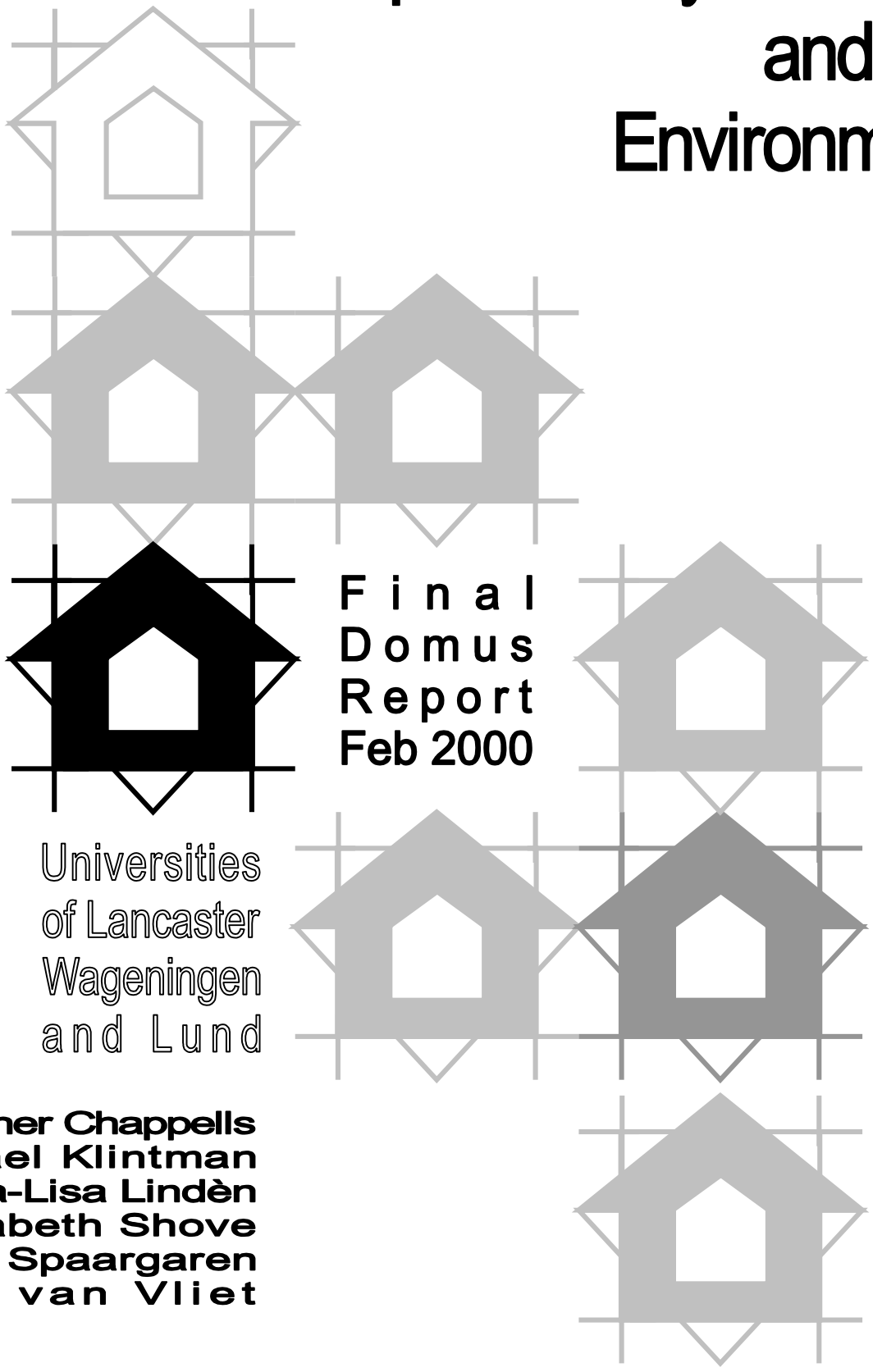
Domestic Consumption Utility Services and the Environment



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1 - INTRODUCTION TO THE DOMUS PROJECT

1.1 Motives for starting the project

The world of water, energy and waste service provision to European domestic consumers has changed dramatically since the early 1980s and is showing few signs of stabilising. The liberalisation of former monopolist utility markets and the privatisation of previously state-owned utility companies has emerged alongside increasingly stringent environmental requirements for the supply, distribution and consumption of water, electricity and waste services. Traditionally, network provision of these services was characterised by natural monopolies and captive consumers. These monopoly utility markets were seen as 'natural' in the sense that they depended on vast public infrastructures which did not allow for competition due to the high investment costs associated with building additional networks. Consumers of utility services were viewed as 'captive' as they have no choice but to use the infrastructures and services provided by the one and only network provider available. Now that natural monopolies have been broken-down, utility companies have been privatised and competition on networks has become possible, the implications for formerly captive domestic consumers deserves closer investigation. This is not only because the rhetoric of privatisation and competition implies that consumer needs and expectations will be bought to the forefront of utility management but also because consumers are being given a more explicit role when it comes to the environmental management of network systems. While the liberalisation of utility markets, the privatisation of public utility companies and the general environmental impacts of these institutional processes have featured heavily in scientific and policy debates, the roles of citizen-consumers in these processes have so far been overlooked and underestimated in these policy and scientific fields.

With these political and scientific shortcomings in mind, it was decided to undertake a research project specifically dealing with consumer perspectives on the provision of utility services. Not only are changing consumer-provider relations in the utility sectors an interesting and neglected area of study, but the services these sectors provide also encompass a large part of the sustenance base of domestic consumption and daily life. In other words, by using water, energy and waste services, citizen-consumers make use of and contribute to changes in natural ecosystems. In combination, these services contribute the greatest overall environmental impact in relation to domestic consumption. To date, social science research on domestic consumption and the environment has failed to give the use of water, energy and waste services proper attention. Researchers have focussed on how to deal with increasing consumption levels rather than on the ways in which it might be possible to influence the roles and responsibilities played out in the intricate relations between consumers and providers. As a starting point for the project we decided to look towards the level of the European Union. It was assumed that overall developments in utility sectors were increasingly being shaped and initiated by EC policy-makers who were defining the frameworks by which national governments legislated new national and regional arrangements for water, energy and waste service provision. The central objective of the research was:

> *to provide policy makers at the EU, national and local level with an inventory and evaluation of the possible and feasible ways in which citizen-consumers are willing and able to become involved in the environment-induced modernisation of public utility infrastructures and organisations in different countries of the European Union. The focus is laid upon public utilities supporting the domestic consumption of electricity, water and waste services in Sweden, the UK and the Netherlands.*

To achieve this objective, three issues needed to be resolved:

1. Firstly, at a conceptual level we needed to pay attention to both the underlying motives and interests of the actors involved and to the socio-political, technical and economic characteristics of the interrelationships between citizen-consumers and providers of network services.
2. Secondly, we needed to explore which factors - both at the domestic level and at the level of (European) policy institutions – can be seen to either facilitate or impede the active involvement of citizen-consumers in utility service provision;
3. Thirdly, the policy conditions and measures - both at the (sub)-national and the European level - which can be designated as having a special relevance for the future organisation of citizenship involvement in the provision of domestic water, energy and waste needed to be identified.

As a starting point, we set up a scheme of interrelations within which our core interrelation between utilities and citizen-consumers was to be studied. The scheme is presented in figure 1 below.

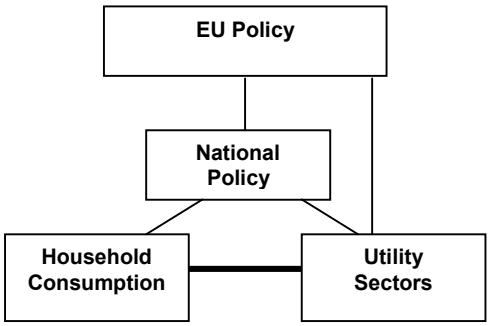

Figure 1: Set of relations under study

As already indicated, we are interested in the changing relations between domestic consumption on the one hand and providers of energy, waste and water services on the other. This relation is shaped by various forms of regulation at the level of EU and national policy. The research programme therefore includes separate studies of national policies in the Netherlands, Sweden and the UK along with an EU policy report. In terms of the core relationship and central objective of the research, we needed to examine citizenship involvement in the context of the ecological modernisation of public utility sectors.

In the following section we first describe how we have operationalised the research with these issues in mind and then introduce the contents of the project report which follows.

1.2 Organisation of the DOMUS research

The research involves three member states of the European Union (United Kingdom, Sweden and the Netherlands) and three sectors of provision (Electricity, Water and Waste Management). The decision to study citizenship-involvement in three different utility sectors was based on the premise that this would enable us to reveal some of the typical network-based features of interactions between consumers and utilities in general. The decision to include different countries of the European Union into the research project was made because of our intention to study the way in which similar 'starting conditions' at the level of the European Union are incorporated into specific national arrangements within public utility sectors. Lastly, the decision to base our study in Sweden, the Netherlands and the United Kingdom, was in order that we might compare the most relevant phenomena in relation to utility relations, without structural factors, such as Gross Domestic Product (GDP) or climate, interfering too much with the central analysis. For instance, GDP's in the three countries are comparable and climatic conditions do not show huge variation. Instead, the selection of countries involved in the study includes a relevant spectrum of different public utility regulation systems: from almost free-market regimes (like the privatised electricity sector in the UK) to regimes of direct state control (like the water sector in the

Netherlands). Furthermore, there were likely to be many different patterns of environment-induced change within the utility sectors in the three countries involved in the research. This would contribute to more encompassing insight into possibilities for environmental change in utility sectors of the European Union.

Aside from the policy studies, the main body of the work on the project consists of detailed empirical research based on case studies of environmental innovation in the water, waste and electricity sectors. These cases are focussed around some key organising themes. In the development of the research we also placed a strong emphasis on the development of a theoretical framework for investigating consumer-provider interrelations, ecological modernisation and theories of domestic consumption and everyday life.

***Operationalising* 'national and EU policy'**

The project includes separate national policy studies that provide the general context for the cases that were to be studied in the later phase. This approach prevented us from overloading case descriptions with discussions of country specific data on policy, utility structures and so on. The three studies each consider the underlying national structures and histories of utility-based provision of water, waste and energy services. The reports focus on issues relating to utility restructuring and regulation, liberalisation and privatisation tendencies, and environmental policy regarding domestic consumption in each sector. The review of relevant EU policies is tackled from two perspectives: first, a policy review is presented of relevant areas of policy-making in the EU, namely regulation regarding water, waste and energy and competition, consumer and environmental policies. In the later phase of the project we also attempt to feedback our empirical results to policy-makers at the EU level to assess whether there are any connections between what we have found 'in the field' and the EU policy making process.

***Operationalising* 'environment-induced change'**

In the central objective of the project we make explicit reference to changes in utility sectors which are in one way or another *environment–induced*. By this we mean that so-called ecological rationales have played a dominant role in the decision-making of agents of utilities, governments or other institutions connected to utility services. This assumption is grounded in the theory of ecological modernisation which served as a starting point to the project. Ecological modernisation theory claims that during the late seventies and early eighties in parts of the western industrialised world sets of criteria have been developed, which allow for a discussion of the ecological rationality of certain technologies, production arrangements and even complete sectors of industry. These ecological criteria have been and still are gradually gaining an 'independent' existence in the sense that they cannot be reduced to economic or political criteria alone. On the level of formal theory, one can conceive of this ecological perspective in terms of a separate sphere that comes to exist alongside the spheres of economy, culture and politics. While ecological modernisation theory is grounded in changes to industrial production (Mol, 1995), it can also be extended in the context of the production and consumption cycle as a whole (Spaargaren, 1997). Therefore, the Domus research attempts to explore and refine the theory of ecological modernisation with a study of environment-induced change in consumer-utility relations. In chapter 2, the theory of ecological modernisation will be elaborated further, while in Chapter 3 we consider how the theory is operationalised in our empirical work.

***Operationalising* 'environment-induced change in consumer-utility relations'**

The main step in the operationalisation of environment-induced change, is our focus on *environmental innovations*. In the context of this research, environmental innovations in utility sectors are considered to be all technical, economic or other arrangements which are 'sold' as being more environmentally-sound in comparison to former arrangements. In addition, we concentrate our study on those innovations that signify a change in the relation between utilities (providers) and citizen-consumers. Given these conditions, the first step taken in the project was to gather and categorise cases of environmental innovations in sectors of water, waste and electricity in all three countries. These ranged from low energy light bulbs to green electricity schemes, water saving toilets to grey water systems and from home composting to differentiated tariffs in waste collection. All these projects have in common the fact that they are at least 'sold' as being environmentally sound and that they reconfigure utility-consumer relations. In a sense, the selected innovations can be conceived of as 'carriers' of the sorts of social changes we are looking for. Categorisation of these cases is not only done by sector, but also by kinds and phases of citizenship involvement in the subsequent processes of innovation. The result of this first inventory is published as separate report (see Raman et al, 1998).

A cross-country and cross-sectoral approach

Taken together, such a set of operationalising principles offer many possibilities for comparative research. There are likely to be differences in both national policy concerning utility sectors and environment and between the sectors themselves, perhaps most interestingly in their timescales of liberalisation and their efforts to deal with consumers and environmental issues. We have deliberately chosen not to study each sector or each case of environmental innovation separately and compare its results afterwards. This would obscure the central objective of the research: to provide a broad inventory of the range of possibilities for citizenship involvement in the ecological modernisation of utility sectors. Therefore a cross-country and cross-sectoral approach was chosen to execute the case study research: structuring elements were neither the 3 sectors, nor the 3 countries, but rather different *dimensions* in the inter-relations between providers and consumers. These dimensions having been selected as the most relevant from the first inventory of cases of environmental innovation and from the accompanying national policy studies. The cases from all sectors and countries are therefore grouped and analysed under five key organising themes which we argue best capture new utility-consumer-environment relations, these are: Monitoring and Power, Product and Tariff Differentiation, Scales and Modes of Provision, Demand Side Management and Networks of Co-provision and Sustainable Homes and Integration. The background to each theme and the process that generated these is described in chapter 3 which outlines our case methodology. Each of these themes is first theoretically explored, which resulted in specific analytical perspectives that could be applied to the cases that were selected out of the first inventory.

1.3 Outline of the report(s)

Before the case study research as described here could begin, we needed to undertake some preparatory work. First, a theoretical framework was drawn up to introduce and relate the approaches taken. This is presented in Chapter 2, which includes a review of theories relating to ecological modernisation, sustainable household consumption, systems of service provision and consumer involvement. It concludes with the design of a framework with which we can operationalise our analysis of citizenship involvement in environmental innovations relating to utility systems and domestic consumption. In particular 'environmental innovations', 'citizenship involvement', and 'systems of provision' are explained and (re)-defined to serve the purposes of present study. Chapter 3 goes on to

describe the outline and methodology of our empirical work concerning environmental innovations and utility-consumer relations. Chapters 4 to 8 deal with the respective themes as mentioned above. The sequence of the themes (from Monitoring and Power to Sustainable Homes and Integration) reflect an increase in complexity in consumer-provider relations as well as some subsequent steps as forecasted in ecological modernisation theory. Detailed descriptions of all individual cases to which we refer can be found in the annex. In the concluding Chapter 9, we attempt to draw together the strands of the research and give an overview of the whole research programme, including that of separate national policy studies, the EU policy report, and the inventory of environmental innovations. Critically, we present our main findings in relation to the research question on citizenship involvement in the ecological modernisation of utility sectors in the European Union.

2 - THEORETICAL FRAMEWORK

ANALYSING ENVIRONMENTAL CHANGE IN THE RELATIONS BETWEEN UTILITY SECTORS AND DOMESTIC CONSUMERS

Bas van Vliet & Gert Spaargaren

2.1 Introduction

This chapter elaborates the theoretical background of the Domus Project, focussing on interrelations between agents of 'utility sectors' on the one hand, and domestic consumers on the other. The aim of the chapter is to converge theoretical issues into a model which both specifies and relates the subjects that have been studied. The basic elements of such a model are conceptions of 'domestic consumption', 'consumer involvement', 'systems and modes of provision' and 'environmental innovations'. These concepts are conceived against the background of changing utility markets. The approach by which we try to relate these issues is that of 'ecological modernisation'.

Our conceptual understanding of *domestic consumption* will be given in section 2. Special reference is made to those aspects of domestic consumption which connect with the use of utility networks. The section ends with notions of *ecological modernisation* of domestic consumption and the relevance of utility services in this respect. Section 3 sheds light upon *systems and modes of provision* which facilitate domestic consumption, of which utility sectors are special forms. Here we pay particular attention to the 'ecologising' of utility sectors themselves. In section 4 we examine the issue of *citizenship involvement* in processes of *environmental innovation* within utility sectors and summarise by presenting a research model which reconnects our theoretical ideas.

2.2 Domestic consumption and utility services

Consumption is often conceptualised as a rather passive process. For a long time, economists, engineers and sociologists represented consumption exclusively as an outcome of production processes. In this view consumers are little more than receivers and users of products, who turn commodities into waste. The consumption process, however, deserves a more comprehensive conceptualisation. Instead of a passive process, we view consumption as an active process of actors seeking distinction from other actors, matching goods with other goods, constructing their identity by selective shopping, and so forth.

Much of the contemporary sociology of consumption is somewhat biased towards the act of *purchasing* commodities and services, as a means of reproducing identity or of social comparison. This bias ignores the fact that much of what is consumed is not acquired, delivered or enjoyed in this form because it is provided by the state, the community, and the household. In addition, many of services provided by utilities do not confer self-identity, mark attachment to social groups or exhibit social distinction. Yet a sizeable proportion of household income is devoted to these items and together they contribute heavily to environmental problems (Warde and Shove, 1997).

What needs to be explored more fully, are the mechanisms which shape everyday practices relating to commodities and services and the extent to which they can be seen to support or impede sustainable consumption. An exploration is also needed of whether commonly known mechanisms behind purchasing behaviour also occur in the specific field of utility products and services. Warde and Shove (1997) attempted to tackle both these issues and found that several mechanisms only applied to items where display was a major consideration. They contended that the roles of acquisition and use are

symbolically different and that many of the practices critical to energy or water consumption are unaffected by mechanisms like ‘social comparison’, ‘identity’, ‘novelty’ or ‘matching’. This implies that we need to extend our understanding of the social mechanisms behind non-sustainable consumption practices both in relation to the use of particular commodities or services and with respect to household consumption in general.

If we accept that consumption is an active, as opposed to a passive process, domestic consumption can be seen as even more active. Indeed, a vital part of domestic consumption is labour, which implies that the term household production would equally be justified here. Household or domestic consumption is not just the sum of individual behavioural patterns, each consciously motivated and evaluated by the actor. Domestic consumption can rather be seen as a whole set of behavioural practices that are mutually related and shared with other households. Examples of these practices are ‘washing’, ‘bathing’, ‘food-preparing’ or ‘gardening’. Social practices are carried out by applying sets of rules, like the know-how to act, the shared norms and values concerning the practice, and resources like technical devices, the power to obtain or develop them, or the money to purchase them. This, however, is not to say that the set of rules and resources are outside the consumers sphere of influence. By applying these rules and resources in their social practices consumers can also be seen to reproduce them.

Of main concern in the context of this discussion are the large technological networks connecting each citizen-consumer to one another. The connection between these networks and patterns of household consumption has been conceptualised by Otnes (1988), who leans on the structuration theory of Anthony Giddens (1984). Otnes' hypothesis is that substantial parts of household consumption consist of serving and being served by a number of essentially collective socio-material systems. These systems are collective in the sense that they are fairly generally accessible and connect all actors with each other so that to some extent a mutual dependency emerges. They are socio-material in the sense that along with the hardware of pipes, cables and terminals, a social network of managers, intermediaries and users is involved. Examples are telephone networks, water and sewerage systems, waste collection systems, and electrical grids. The three sectors under study here - energy, water and waste - are all forms of collective socio-material systems.

As can be said for all sets of rules and resources, these systems enable, but do not determine household practices. Citizen-consumers can be, and indeed are, knowledgeable and capable while dealing with these systems. With every use of the in-house ‘terminals’ the collective socio-material system get reproduced. If no one makes use of the system anymore, it would cease to be maintained. The telegraph system is an example of a collective socio-material system that has not been reproduced and has become virtually obsolete. The process of legitimisation is more difficult to assess; the use of a system does not automatically imply its acceptance by users. An example is consumers’ inability to separate domestic waste into organic and non-organic fractions because of problems of space in small apartments. As we see in our theme chapter on DSM and networks of co-provision, not using a system properly, or refusing to apply it, will tell us much about legitimisation of the system by its consumers.

Moreover, consumers are also actors in areas other than consumption alone. They participate in all kinds of activities that make up our society: at their work place, in societal and voluntary organisations, by voting or other political behaviour (Otnes, 1988). Apart from legitimising collective socio-material systems by using them, consumers also have a role in political and sub-political processes that install, extend or transform these systems. Witness for instance the roles of our sustainable housing providers, in chapter 8, who are closely involved in redefining planning guidelines, or the attempts of participants in green electricity schemes, described in our differentiation chapter, to shape investment in different forms of renewable power. The term ‘consumer’ does not cover all the roles people play

while ‘consuming’ and will be misleading if it is not set in a wider context. Therefore, we propose to speak of ‘citizen-consumers’ instead.

The private ‘terminals’, by means of which citizen-consumers can make use of the networks, complete our picture of highly ramified networks. Examples of terminals in this sense are refrigerators, TV sets, gas stoves, light bulbs, stereos and computers. They are the means by which systems are served by and by which they can serve their end-users. Much attention in environmental and consumption studies, is given to the purchase of commodities and the damage to the environment they are supposed to render if produced or disposed. This now turns out to be rather one-sided. If these commodities were regarded as terminals, then the analysis of their environmental impact would also be related to the socio-collective systems to which they are linked. The role of domestic technologies in helping to re-embed consumers in systems of provision, is a theme we explore more closely in our DSM chapter.

2.2.1 Ecological Modernisation and domestic consumption related to utility services

Having reviewed domestic consumption within its context of serving and being served by collective socio-material systems, we are now able to turn our attention to the kinds of changes we are looking for and the their goals. Overall, we are interested in the potential for a considerable reduction in the environmental impacts of domestic consumption. The theory of Ecological Modernisation, which has been developed since the 1980's by social scientists concerned with environmental issues (Huber 1982, 1985, Mol and Spaargaren, 1992; Mol, 1995; Hajer, 1995; Spaargaren, 1997) provides a useful framework for this sort of research.

Ecological Modernisation is considered as a theory of social change - as opposed to a socio-political programme. As such the theory reflects on a process of institutionalisation of environmental concerns within Western, industrialised societies. The theory 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. Advocates of the theory try to identify social changes in technology and organisation which can result in a decrease in claims on the environmental capacity available, by changing the character of these claims themselves. (Eco)-technological developments are considered of major importance in this respect (Spaargaren, 1997: 169). 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.

The theory not only has institutionalisation processes within the production sphere as its main focus, but also reflects on the role of citizen-consumers in the organisation of production-consumption cycles. Although Ecological Modernisation theory stems from considerations that mainly address industrial production, its core principles could also be applied to processes of consumption. Ecological considerations also emerge in practices of domestic consumption, leading to dematerialization of consumption (from commodities to services), monitoring and monetarisation of resource use and substitution of non-sustainable resources by renewables. These issues are closely explored in our chapters on monitoring, differentiation and renewal, here we seek to provide empirical evidence to support the thesis of an ecological modernisation of consumption, especially as it relates to the serving and being served by collective social-material systems.

As a starting point we also need to take into account current consumption levels and practices and the state-of-the-art of household technology. Ecological Modernisation suggests that we need to look for the ‘optimal’ balance between environmental, economic and social-cultural values instead of claiming that only small is beautiful or an overall reduction of consumption in all its aspects would be necessary. As we show in chapter 6, there are many different modes and scales of consumption or

provision than we might imagine, which require a more sensitive evaluation regarding their environmental and social outcomes.

2.2.2 Water, energy and waste in sustainable household consumption

Water and electricity consumption and waste collection should be viewed within the context of social practices of domestic consumption (washing, bathing, and gardening), rather than as separate and individual behaviours. Within all households, there are several social practices built around the availability of clean water, electricity and a waste disposal system. In thinking about environmentally sound household consumption, these discreet practices and their meaning for the household should be the central focus. This approach paves the way to consider alternative practices which otherwise might not be considered. The interrelation of domestic practices with the entire system providing household resources also needs to be considered. Warde and Shove (1997) argue that these systems have the potential to accelerate consumption levels. Along with Cowan (1983), they argue that household systems usually require consumption in their own right whilst also encouraging the further acquisition and use of associated products. For instance, as we see in our self-provider communities in chapter 8, the decision to provide your own drinking water supply or generate new forms of energy, might also require new plumbing and heating technologies which each come with their pre-scriptions for water or energy use.

It is therefore rather unrealistic to assume that directing policy instruments and measures only towards citizen-consumers could prevent or reduce the environmental impacts of household consumption. For instance, in our DSM chapter we suggest that comfort, cleanliness and convenience standards are more pervasive and embedded in household conventions and infrastructures than we might realise. Therefore, environmental education has a hard job in influencing these alone. It is equally unrealistic, however, to lean on strategies which aim at only a technological restructuring of the collective social-material system behind the back of citizen-consumers. Our exploration of monitoring and differentiation cases reveals instances where innovations are introduced to meet environmental obligations with consumers having no say in their configuration and subsequently little interest in practising more sustainable consumption. More promising are policies and strategies directed to both levels and especially to the interrelation between citizen-consumers and collective social-material systems. As we show in our separate EU policy report, there is still a long way to go in this respect.

The figure below represents the relations between human agents, social practices and structures, in this case referring to domestic consumption practices and the role of collective socio-material systems. In our representation, social practices consist of sets of individual human behaviours that fit in some-one's lifestyle and that partly serve and are being served by collective social-material systems. One could say that individual lifestyles serve as a filter between individual needs and preferences on the one hand and executed practices on the other, while collective social-material systems represent a special bundling of social and material rules and resources.

ACTOR/AGENT - HUMAN ACTION - - SOCIAL PRACTICES (EXAMPLES)- - - - - STRUCTURES

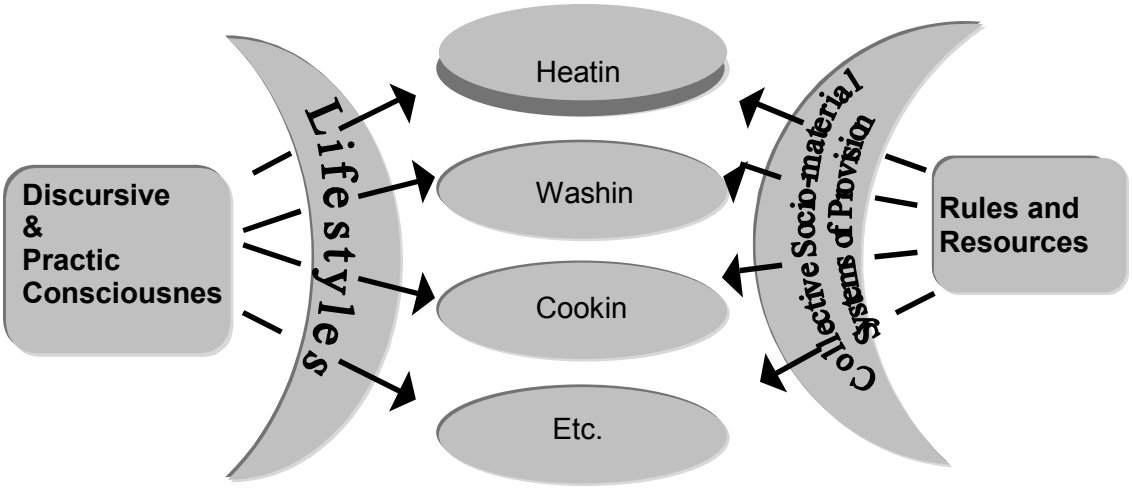

Figure 1: Actor-Structure relationships in case of domestic consumption practices

In dealing with domestic consumption, the Domus research puts social practices at the centre of its analysis. While using collective social material systems, consumers apply and reproduce the rules and resources that come along with it. Rules, such as understanding how to use machines or to run a home, are constructed and reproduced in social interactions. Resources include purchasing power and all kinds of household devices. The social practice of washing laundry, for example, is not just determined by an individual need to clean our clothes. It is also shaped by the availability of material resources (a washing machine, an electricity socket, a water tap, a sewer connection, washing powder); the financial means to purchase these resources; the available time-frame and labour input in relation to other household practices; the labour division within household organisations; social rules about how to dress and represent oneself (clean clothes, changing daily, fresh odours) and conventions of how to wash and dry clothes (not leaving underwear to dry in front of the house).

Elizabeth Shove, among others, puts such cultural aspects of domestic consumption at the centre of analyses (Shove, 1997; Shove and Southerton, 1998). She identifies standards of 'comfort, cleanliness and convenience' as rules to which people adhere and subscribe. In her analysis, domestic consumption practices are seen not only as a mixture of objects and infrastructures but also as routines which make people meet the standards they think of as a 'normal' or 'minimal' requirement. These standards are embedded in technologies and structures of everyday life, to meet them, Shove proposes categorising rules and resources as infrastructures (the plumbing system for instance), objects (commodities) and conventions, uses and practices. Figure 2 represents this perspective.

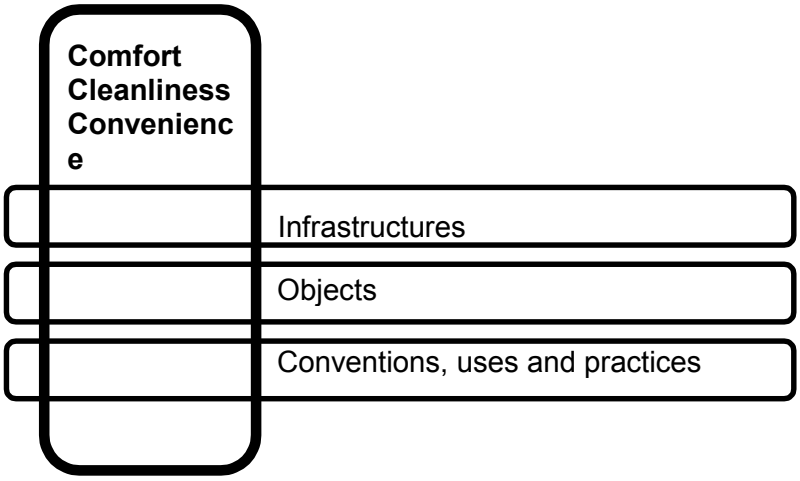

Figure 2: Standards of Comfort, Cleanliness and Convenience by infrastructures, objects and conventions, uses and practices (from Shove, 1997)

Shoves' analysis centred around 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. The anthropology of consumption makes us aware of the variation that exists both across time and across different cultures when it comes to standards of comfort, cleanliness and convenience.

For analytical purposes, we suggest the level of social practices within household consumption is more relevant than either individual behaviour or 'household consumption' in general. Thinking of Ecological Modernisation theory in relation to the practices of domestic consumption needs to take into account both the lifestyle dimension as well as the rules and resources that are structuring and being reproduced by the social practices themselves.

As the aim of the Domus research is to explore the relation between citizen-consumers and collective socio-material systems, we now turn our attention to the right side of the scheme shown in Figure 1. Here we focus on collective socio-material systems of provision, and the different ways in which they influence daily life.

2.2.3 Systems and modes of provision

In the previous section we have argued that utility systems like energy, water and waste services can be conceived as collective socio-material systems. If we emphasise not so much their intrinsic (socio-material) character but rather what these systems actually do - namely providing resources and services to citizen-consumers - energy, water and waste utilities can be conceived of as *systems of provision* as well. Systems of provision can be seen to encompass specific sets of factors which describe not only the way, but also the types of goods and services that are provided by some kind of actor or chain of actors - including producers, distributors, retailers as well as consumers of goods and services. Fine and Leopold (1993), who introduced the term systems of provision are thereby opposed to so-called horizontal approaches of consumption in which all factors that are taken to be of general importance and are presumed to apply across the economy or society as a whole. Instead they argue that that the situation is much more complex: different commodities are structured by the

system of provision that unites a particular pattern of production with a particular pattern of consumption. This vertical approach does not search for all aspects of consumption but looks instead for differences in the way in which production and consumption are united and moderated by the connections between them.

In our research, this connection between production and consumption spheres is our main focus of interest because we intend to analyse the dynamics of the relation between public utilities and citizen-consumers. The systems differ across groups of commodities or services as a consequence of distinct relationships between various material and cultural practices comprising production, distribution, circulation and consumption. An approach which underlines the importance of systems of provision can shed new light upon the differences between the consumption of water, energy and waste services. For instance, it might turn out that an explanation for the differences between social practices around the use of water on the one hand or electricity on the other, is not just found in the physical disparities of the resources, but rather in the specific social and cultural features of their respective systems of provision. Furthermore, it is not only the system of provision, but also the *ways* in which services are provided, accessed and used by consumers which can be important in shaping domestic social practices. These *modes of provision* are discussed below.

Modes of provision

A system of provision may encompass different modes of provision: the system providing water may be run by state companies, private companies or a combination of public and private holders. Also domestic modes of provision are conceivable, such as the use of self-collected rainwater or the use of a private windmill to provide oneself with electricity. The modes of provision are highly dynamic in the utility sectors under study. At the turn of last century, domestic and market modes of provision of water, energy and waste services were changed into public or state provision. Nowadays, the (re)privatisation of these services is discussed again. However, one has to be careful in using the term privatisation randomly for diverging phenomena. Saunders and Harris (1990) gave a typology of privatisation, which is helpful in beginning to unpack the different meanings of privatisation. Their discussion of the subject should be placed against the background of the 1980s in Britain, when societal debate on privatisation of many sectors of industry and public institutions reached its climax. In addition, their typology was mainly derived from the examples of (public) housing and (public) schools. Nevertheless, their basic scheme is still of use in sorting out the different terms commonly used when discussing the utility sectors in Europe – see Table 1.

Table 1: A Typology of Privatisation (Saunders and Harris, 1990:59)

Change in government's role	*New locus of responsibility*	
	PRODUCERS	CONSUMERS
CHANGE OF OWNERSHIP	(1) Denationalisation	(2) Commodification
CHANGE OF CONTROL	(3) Liberalisation	(4) Marketisation

In essence, privatisation means the pulling out of the state, the form of which could take one of four options:

- Denationalisation means that there is a change of ownership from the state to private producers. If state-owned or para-statal companies are sold to private parties, than denationalisation is at stake. Examples are the sale of former national telecommunication companies, national railways or municipal energy companies.

- Commodification goes one step further than denationalisation. It means that state-owned assets are transferred to its end-users. This is the case when rented houses are directly sold to its tenants, instead of a private company that would take over the renting out.

- Liberalisation implicates not so much a change of ownership of state owned assets, but refers to a change of control of markets traditionally dominated by state owned companies. State companies could still be in place after liberalisation, but they have to compete with other parties in the market. This is the case in many (former) utility systems in Europe: In the UK, local authority waste managers now have to compete with private companies due to a Compulsory Competitive Tendering (CCT) process for waste service contracts. The purpose is to lower costs (and consumer prices) by increasing efficiency.

- Marketisation refers to the somewhat imaginary process in which consumers or end-users 'regain' responsibility to provide their own means by returning them tax money intended for public service provision. As an example: the state spending on schooling could be directed not to schools but to parents. Saunders and Harris (1990:62) judge this as changing the status of parents "from that of clients to customers".

The first three processes can be observed in all kinds of markets of service provision and in all member states of the European Union. The scheme is useful to identify exactly what is transferred to whom, instead of using 'liberalisation', 'privatisation', 'third party access' and other qualifications interchangeably in the discussion. The normative connotations of the concepts outlined by Saunders and Harris, however, deserve a critical evaluation. They do not hide their preference for a change towards market modes of provision for all kinds of services, as being the most efficient in all circumstances. On the other hand, they only sketch a generalised caricature of all public modes of provision, as being inefficient and overstaffed, unaccountable, stagnant, uncompetitive and non-innovative.

A concept of modes of provision that identifies only two forms of provision (state or private) is also misleading. There are many forms in between, such as public-private co-operation and outside these two polarities, such as informal and domestic modes of consumption. The role of citizens in consumption processes is not limited to either being a client (state provision) or a customer (market provision). There are many other terms to describe social relationships between producers and consumers: 'supplicants and applicants, partners and punters, spouses and dependants, consumers and robbers' (Warde, 1990:236). These multiple modes of provision are drawn out in our theme reports, where we look at how consumers are co-providers along with a range of other intermediate public and private assemblages.

Furthermore, the private mode of consumption as described by Saunders and Harris does not take into account the long chain of activity between the purchase of raw materials and their final consumption, which takes place within households. Household consumption only partly takes place in the market, and domestic consumers can only partly be conceived of as clients or customers. Questions like who does most of the work and who benefits after purchasing the goods and services seem to be ignored. As well as ignoring other modes of consumption (notably the informal and domestic modes), Saunders and Harris also seem to simplify the provisioning systems. These systems not only differ in terms of the sector of provision, but also on principles of access and manners of delivery. Consumption is a far from unilateral process. Different patterns of consumption

are distinguished by their relationship to the sphere of production. A sociology of service provision, as is proposed by Alan Warde, should be welcomed as an addition to sociology of consumption where so-called 'horizontal' approaches dominate. Concepts of consumption should in some way or the other include the way goods and services are provided to consumers as the latter influences the process of consumption itself.

Service functions - the needs or desires met by means of services - play a central role in a sociological approach, shifting the focus from individual acts of 'consumption alone' towards the provision of embedded services. In essence, consumption is an ambiguous concept "because it artificially severs the work done in delivering a 'consumption function' having the effect of obscuring especially the place of domestic labour in service provision" (Warde, 1990:243). Different ways of obtaining service functions entail different kinds of social relations and have different consequences for social integration. The way services are provided is determined by the resources from which consumers can draw. Resources may be state financial payments, wages, but also state provision, charity or household labour. Availability of these resources varies from one institutional setting to another and this may cause political or social conflicts.

If the research focus is turned towards 'modes of provision' instead of 'consumption', the analysis of the interface between household consumption and encompassing collective socio-material systems can be extended. This gives more insight into how services are provided to consumers, not being limited to the purchase of services or state provision only. The concept includes the possibility of household labour provision or informal provision of services. Also, the production and consumption spheres are more closely connected: Production is not only seen as an origin of resources making the obtaining of services possible. More interestingly, production also comes in as part of the division of labour in service production. The idea of service provision, therefore, is a useful tool to analyse the changes within domestic services resulting from environmental demands and changes in household-related utility sectors. The following can serve as an example: if 'a comfortable living' is conceived as a service, its provision can be obtained by either purchasing electricity or gas from utilities and use it to heat the house. These utilities may be privately owned or state owned. In a service provision approach other means of provision apart from market modes or public modes of provision of 'a comfortable living' are not excluded, such as putting on extra clothes, making a fire, or closing the curtains.

These kinds of trivial looking but obvious means of service provision should be treated seriously in the thinking of sustainable household consumption and the role of different modes of service provision. The hypothesis made here is firstly that utility services are becoming increasingly diversified, not only in feature of the services provided, but also in the modes of service provision. Secondly, we presume that modes of provision relate to the character and level of consumer involvement. Therefore, any operationalisation of consumer involvement should include an understanding of modes of provision. Our case studies reveal even new forms of provision with new roles for both consumers and traditional providers within the systems of provision.

In the Domus project we will first explore utility sectors as systems of provision within changing utility markets. The term 'systems of provision' refers to the sectors providing energy, water and waste services to domestic consumers. It may include actors other than utility companies alone, such as housing corporations, city bureaucracies and other organisations who may provide these services. Public utilities are however the most common providers of these services throughout Europe. Their specific characteristics are discussed below.

Utilities as special systems of provision

Utilities are currently defined as (collective) providers of goods and services mainly through large scale technical infrastructures and physical networks of pipes, cables and the like. They are collective,

socio- material systems of provision with some peculiar features compared to other industries for the following reasons:

- Their products can be marked as essential for many of the basic practices within households. In fact they represent the material and energy flows which form the material sustenance base to our daily lives (Spaargaren, 1997).
- Typically, the products and services offered by utilities cannot be bought in a shop and brought home whenever there is a need for it, but come into the home under a continuous pressure or – in the case of waste services – in a regular schedule.
- A third characteristic is the uniformity of the service offered. Unlike the wide variety and specialisation one can observe nowadays in the world of goods, utility services are characterised by the fact that they are highly uniform, no matter place or time. Electricity come in standardised Voltage, gas in standardised pressure and caloric value, water in average tap water quality and pressure etc.
- The price of the products and services offered by utilities is relatively inelastic: Consumption levels will only slowly reduce while prices rise. Some uses of electricity, water and waste services (heating, drinking, disposing) are in fact so essential that many would not even consider reducing consumption, even if the price were doubled. Because of this price-inelasticity, water or energy saving behaviour is difficult to achieve. However, environmental improvements in the use of these products and services need to be considered as well.
- Because building and maintaining the networks requires heavy investments, there is generally only one network available while and 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 at one place. In most cases, at least until recently, only one provider has existed holding a ‘natural’ monopolist position in the utility market.
- As a consequence of the latter, consumers within such natural monopolist situation are called ‘captive consumers’, as they have no choice between different providers.

This mono-dimensional picture of utility organisation is gradually being challenged. In the last 10 to 20 years, public utility sectors in many member states in Europe have been confronted with calls and measures for privatisation. Government protected monopolies have tended to disappear, first in electricity markets and increasingly in waste and water sectors. The privatisation of networks is reviewed by Guy and Marvin (1996) as 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 importantly, between different classes of consumer. Finally, networks are shaped by local and regional demands and may therefore develop highly unevenly. Such splintering of what was hitherto, at least in aspiration, nationally-homogeneous utility systems has shifted the socio-technical logic governing infrastructure provision. On the one hand, increased levels of social polarisation are surfacing as the quality of service provision becomes much more varied (Graham and Marvin, 1994). On the other hand, commercial and regulatory priorities are encouraging higher levels of network efficiency with potentially 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, a marked unevenness in the quality of utility services offered in different cities, regions and in different sectors of the market is emerging. In this way the logic of nationalisation of utilities that dominated the growth of utility

networks since the beginning of the 20th century is being replaced by a logic of *global-localisation* (Guy and Marvin, 1996).

The splintering of utility networks has had a profound impact on the social, spatial and technical logics driving infrastructure provision. Assessing the social and environmental benefits and dis-benefits of this process is not as straightforward as many commentators on the privatisation of public utilities propound. A closer investigation of the emergence of new styles of utility network management reveal complex patterns of social, economic and environmental change, as explored in our national reports (see Chappells et al, 1998). Since privatisation, utilities have had to take a much closer interest in the economic performance of the cities and regions they serve. New competitive, environmental and regulatory pressures have encouraged utility companies to examine how they can most efficiently and effectively manage their networks in order to increase the profitability of the services they provide. In contrast to the old certainties of the nationalised era - standardised tariffs, homogenous network management, uniform standards of services and cross-subsidies from large to small users to underwrite universal service obligations - privatisation has generated a host of new technical uncertainties and commercial opportunities. The response of utility companies to this new era of infrastructure provision has been highly uneven. Many have attempted to maintain traditional working practices in the face of change while others have begun to innovate successfully. The key shift instigated by the privatisation and liberalisation of utility markets has been the replacement of the ethic of public service - the ideal of cheap, reliable, universal access to utility services for all irrespective of income or location - with the goal of profitability.

As a consequence of privatisation processes, many utility companies tend to diversify the product range they offer. Instead of mass-production and provision of unified products and services, electricity companies differentiate tariffs, offer 'green electricity' and change from providers of electricity to providers of 'energy services'. The chain of collecting domestic waste to landfilling, burning or recycling has become the responsibility of several private and public actors who have been diversifying the services available: domestic waste has been split up in several material streams, connecting several systems of service provision. Water companies diversify on the water quality they offer: potable water, process water, 'household water' and treated wastewater are all on offer depending on the function water is intended to fulfil. Like electricity companies, water companies are becoming more involved in 'water services' like tailor-cut advice on water management and the development of water related technology. These themes of differentiation of service provision are all picked up on in our second theme chapter on differentiation, where we consider what these new green options might mean for consumer involvement in environmental innovation.

Enabling utility companies to compete on former monopolist markets by no means implies that utility markets can do without regulation. Liberalised markets still need safe guards by the state and this is especially true for utility markets. The new Dutch Electricity Act puts in place a national independent authority, which has the task to secure (captive) consumer interests, and to prevent the building of cartels among electricity companies. It is the responsibility of policy makers to ensure that environmental goals, like energy conservation, and market competition do not conflict. In fact, as Slingerland (1997a) suggests, competition could deliberately be used as an (policy) instrument to find the most cost-effective way to stimulate energy conservation. These policy issues have been elaborated in more detail in our national studies of environmental and utility related policies and our EU report.

New strategies of utilities: Demand-Side Management combining environmental goals and efficiency?

Why should utility companies want their consumers to save on consumption of the goods and services provided? On the one hand, it is argued that utility companies are the 'one and only partners' of consumers in energy, water or waste behaviour. There are already steady and enduring relationships

between consumers and utility companies and it would be pointless if these were ignored in energy, water or waste saving campaigns. A second argument emphasises that utility companies are still more or less publicly owned, which explains why the public cause (environment) may sometimes annul the goal of profit making. As a 'para-statal', utility companies may very well be deployed as an executor of government policy aiming at saving energy, water or waste. However, when para-statals become privatised the question still remains of why utility companies should have any interest in reduction of consumption, and if they do what roles could they play in accomplishing such goals?

A simple answer to the first question could be because they are obliged to do so. Privatisation of utility companies does not avert all regulation. There is often a body of regulation on maximum production volumes, for instance by licensing the exploitation of ground water basins. In practice, this causes local water companies to have a severe stake in water saving as we see in our monitoring and DSM themes where there are physical limits on extraction alongside institutional ones. The avoidance of environmentally and economically expensive supply investment could also be a good reason to embrace saving programs.

Another answer is that utility companies are willing to extend and diversify the services they provide, including that of advice and technology development and facility management concerning energy, water saving and waste separation. These efforts diminish the relative importance of solely selling energy and water, compared to a range of more diversified services. As the primary concern of state owned utility companies was a reliable supply of services to anyone, and as lowering costs became the main goal during the 1980s, now, the main goal in a market mode of provision seems to be the 'satisfied customer' (Stoter, 1994). If customers can be persuaded to buy services like information provision or new energy saving technologies, then they are more likely to stick with the same old utility company.

A known strategy of utility companies to combat new environmental requirements while still operating in a market mode of provision is Demand-Side Management (DSM). Demand Side Management 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). It should be stressed that DSM measures are not always designed or implemented for environmental purposes, often they are part of an economic strategy. For an efficient use of infrastructures, utilities try to 'shave' peak demands and DSM is an appropriate tool to do this. Chapter 7 will further elaborate on Demand Side Management, as well as extending the concept with a consumer led perspective.

Having considered the ways in which utility services are organised as dynamic and fragmenting systems of provision, we now turn our attention to the roles of consumers in these networks and specifically their interaction with environmental innovations.

2.3 Consumer involvement and environmental innovations as carriers in provider-consumer relationships

2.3.1 Consumer Involvement in Utility Systems

Consumer involvement has many different meanings but here we refer to the meaning of participation. Consumer involvement and consumer participation can - and will - be used interchangeably. Two questions are relevant:

1. How do consumers take part in service provision?
2. Why should consumers take part in service provision at all?

The first question may be answered as follows. Citizen consumers may take part in something individually or as a group. This is the difference between consumer involvement and public participation, although both terms are often used interchangeably throughout literature. Renn et al (1995, p. 2) refer to 'public participation' as 'forums for exchange that are organised for the purpose of facilitating communication between government, citizens, stake holders and interest groups, and businesses regarding a specific decision or problem'. Examples of these forums are public hearings on specific local policy issues and consumer councils. There are different views on the purpose of public participation, namely either to provide a means by which the collective conscience is revealed, or to provide a means to facilitate conflict and power struggles. Consumer participation may take the form of public participation, such as being member of a forum, but critically, can also refer to less institutionalised settings. One could, for example pose an objection to an official intention by the community council and thereby participate in the process of policy making. While the domestic labour which is needed for the provision of water, or the disposal of domestic waste can be interpreted as involvement in the respect of systems of provision.

Concerning the second question, should consumers participate, there are basically two views. The ethical normative approach prescribes that ideally, consumers should participate as much as possible in the decisions that influence their daily lives. On the other hand, a functional, liberal approach says that consumers should participate simply because it will improve the quality of the decision or preserve society from disturbance. The latter, more pragmatic view is most commonly observed. The concept of Constructive Technology Assessment (CTA) is an example. CTA consists of mechanisms and processes that facilitate societal learning about how to co-produce technology and its impacts (Rip et al, 1995). It is a process in which the future consequences of technology are taken into account during its development. Consumer involvement in design and development is done in order to improve the diffusion and proper use of (household) technology. Consumer preferences and household contexts are systematically taken into account, not solely because consumers should participate (the normative view), but because it will improve technology development and diffusion.

Of the two approaches towards consumer involvement, the functional approach is the one that can be best tested empirically. For instance, one could test whether consumer involvement could help in fostering the process of change. This question however, is too one-sided, for it does not take consumer preferences into account. Strikingly, in many cases initiators of innovations declare that it was the wish of consumers that had motivated them. But in most cases, consumers were never asked[1]. The question whether citizen-consumers really want to be involved in energy, water and waste

[1] An example of how energy companies claim to act on behalf of consumers, while none of them was really asked an opinion is well described by Summerton (1995). The paper describes the case of Swedish energy companies diversifying produced electricity in green, red, blue and white electrons, and claiming that the customer had asked for it.

service provision is a relevant one, especially in the rather invisible systems of provision of energy, water and waste. Instead of answering the question at this stage, we observe that citizen-consumers are already becoming more involved in these systems, due to economic and environment-induced changes in utility sectors. Some of the limits of greater consumer empowerment or participation should however be considered. For instance consumer involvement may take only the form of a new kind of shared responsibility that only releases the executive organisation of full accountability (Gastelaars, 1997).

As most views on consumer involvement have a rather functionalist perspective - consumer involvement conceived as stimulating or impeding system change - we would instead plea for a more actor-oriented approach which emphasises what citizen-consumer interests and needs might be in the context of the ecological modernisation of household-related utility sectors. Our hypothesis is then that citizen-consumers who are committed to environmental lifestyles are likely to become more involved in systems of provision for water, energy and waste.

2.3.2 Environmental Innovations as 'Carriers' of Utility-Consumer Relations

Our approach to studying consumer involvement will focus on investigating specific cases of environmental innovation within systems of provision for water, waste and energy services. We suggest that these innovations can function as 'carriers' of the dynamics in relationships between consumers and providers, and that their close analysis will reveal a great deal about changing utility systems and domestic consumption.

Since DOMUS deals with the ecologising of domestic consumption and systems of provision, the particular innovations that will be studied are (1) intentionally environmental and (2) those that reconfigure consumer-utility relations. The character of innovations may be technical or organisational and is always relative to time, place and social context (3).

Innovations that are intentionally environmental are at least 'sold' to the public as being environmentally sound, which does not exclude other goals accomplished by the innovation like 'more efficient' or 'more appropriate'. At least there should be a potential reduction of environmental impact if the innovation is applied in the proper context.

By the reconfiguration of consumer-utility relations we mean that only those innovations will be selected that involve some kind of deroutinisation of consumer behaviour towards (parts) of the system of provision. Deroutinisation will undoubtedly occur if systems fall out, as in case of black-outs, or at the renovation of the house or the birth of a child. Less dramatic examples are a switch from gas to electric cooking, or the installation of a shower where there was only a bath before. All these moments could be called 'turning points': they implicate the adoption of a different lifestyle and consequently a different pattern of serving of and being served by collective systems. Only at such turning points is the dependence of households on the electricity or water network, likely to be perceived.

All conceptions of innovations are of course relative to time, place and social context. No one would consider a WC innovative whereas a composting toilet can be called an innovation, although ironically enough its principle dates back to times far before the invention of the water closet. The place and social context of the innovation are equally important: Swedish conceptions of what is new differ from Dutch conceptions. Composting toilets are quite normal in Sweden's rural areas, whereas in the Netherlands they are quite new and innovative.

2.3.3 Citizen-Consumer Involvement in Environmental Innovation

As the precise form of consumer involvement in relation to environmental innovation is important in this research, it is necessary to understand the various forms and intensities such involvement might take. To say a little more about the forms that citizen-consumer involvement might take, we look at three possible areas of consumer activity:

1. In-use involvement
2. Sub-political involvement
3. Formal political involvement

In later stages of our research we develop more sophisticated understandings of the intricate ways in which consumers can be involved in the provision of utility services, but as a starting point these categories serve to illustrate that consumer involvement in environmental innovation might take any number of forms.

1) In-use involvement

One type of involvement refers to the way citizen-consumers are individually involved in the development, installation and operation of collective social-material systems in their homes. A diverse range of 'involvements' are relevant here. On the one hand we might see situations in which households are viewed as 'technotopes', meaning that technological devices perform domestic functions in a sustainable way unnoticed by their users. For instance, an energy efficient device fitted into a household infrastructure is commonly referred to as a 'fit and forget' technology, users may be involved in installation but often this is done by housing providers without the consumers knowledge. On the other hand there is the situation in which citizen-consumers use their active involvement in the use of the system as a way of expressing their commitment to a more sustainable lifestyle. For instance, using new eco-labelled washing machines which may consume less water and energy compared to old ones, without any required change of behaviour. While other innovations may require the involvement of consumers to run 'properly', in this case in an environmentally sound manner. An extreme example of the latter is the composting toilet. Involvement 'in-use' may be specified therefore, as 'technical', 'economic' or 'socio-political'. Technical involvement depends on consumer ability to adapt the 'hard-ware', or their responsibilities for maintenance and repair. Economic involvement varies depending on the measure of tariff differentiation for energy, water or waste collection. If it is possible to significantly influence the charges for water, energy and waste service consumption by changing consumption behaviour, involvement in this sense is higher. Socio-political involvement varies according to the way individual citizen-consumers have a direct say in determining what kind of system is installed or in use, or how it is modified. In situations where there is no say at all, involvement is often characterised as low. Highest involvement is assumed to be found in informal or self-provision of services and resources, as in our some of our sustainable home examples in chapter 8.

2) Sub-political involvement

Public participation refers to various means, other than formal political or individual, to influence policy makers and all other institutional actors in society, concerning environment and utility related issues. Although the scale of its impact is quite different, community associations, environmental groups, and consumer councils in utility companies, might all have a say in the planning and operation of utility infrastructures. If utility companies, housing corporations and city councils make any reference to consumer involvement in their planning of new utility infrastructures, most of the times it is this kind of public involvement. Evaluating the innovation at stake, one can check the measure of

institutionalisation of this kind of involvement in all, but especially development and installation, phases of the innovation process. An interesting issue in relation to sub-political involvement is access to information that might enable consumers to fully participate in planning forums and the like. In this respect, EU policy on access to public information is of relevance and is considered in our EU report.

3) Formal political involvement

Political involvement in its formal sense refers to the citizenship right to vote for representatives in Parliament or community council. If only evaluated from the perspective of political involvement, consumer influence on operations and decisions of utilities will be very indirect. If utilities are state-owned, or have the city council as a main shareholder, consumer involvement will be higher than if private companies only have to deal with the government in its role as policy maker. At the local level, city councils may more and more influence the way new residential areas are built. As the systems of provision diversify their infrastructures and products there will be more choice for city councils to decide which infrastructure will be available for future inhabitants.

In terms of the analysis of environmental innovations as a way of unearthing forms of consumer involvement we recognise that two different perspectives are important, namely the 'greening of domestic consumption' and the 'greening of systems of provision'. This analytical approach recognises that environmental innovations may influence modes of production, provision, access or use to different degrees and with different implications for consumers. For instance, green electricity is an environmental innovation that has a different mode of production (renewables), different mode of provision (introduced via a separate tariff system), which in turn has its effects on the mode of access, as not every-one can afford a higher price for electricity use. The mode of use will most likely remain the same, as the electricity delivered is not distinguishable from other electricity. This relation between environmental innovations, modes of production, provision, access and use and the social practices of consumption is schematically presented in Figure 3, which is an extension of the figure presented earlier in section. This framework enables us to keep in mind the complex relationships between both consumers and providers and the collective systems which provide everyday services.

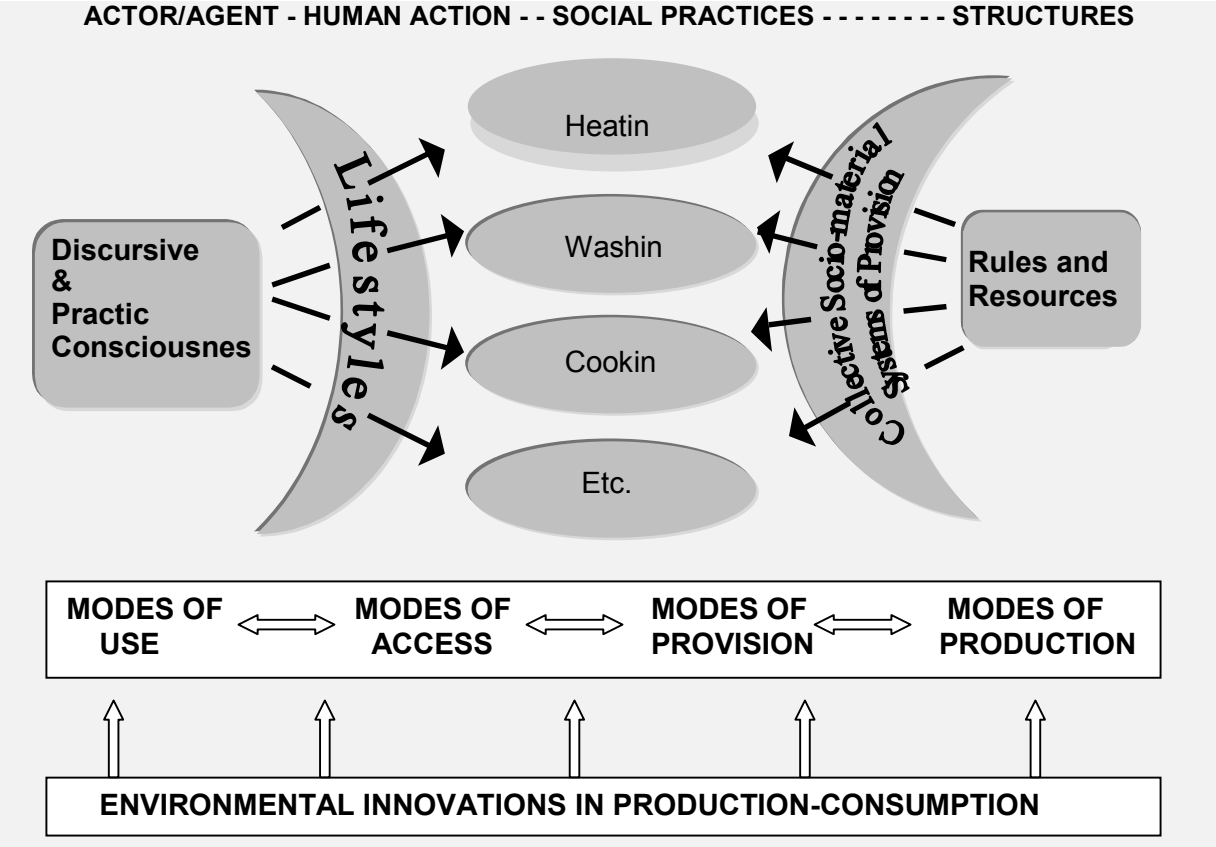

Figure 3: Actor- Structure relationships and environmental innovations

2.4 Summarising the theoretical approach

Consumption of utility services takes place largely within the social context of the household. Domestic consumption has been outlined as a set of reproductive labour practices, rather than as 'passive' consumption. For a large part domestic consumption consists of the serving and the being served by collective social-material systems, among which the water works, electricity grid and waste collection system are some prominent examples. Such an approach to domestic consumption may be seen as contextual, in contrast to approaches that attempt to 'isolate' domestic consumers in their individual homes. It also offers tools to study the various dimensions of utility-consumer interactions, including technological, socio-political and financial aspects.

In relating the idea of the 'household consumer' serving and being served by collective systems, to the theory of ecological modernisation, we have shown that consumer-utility interactions are likely to change. The assumed direction of change is that citizen-consumers will more and more be required to deal with environmental issues in various segments of their lifestyle. In the context of household practices, the ecological sphere will become an autonomous rationale alongside economic or social rationales. This can be analysed by looking at the interactions of consumers with their environmental innovations.

Shifting from domestic consumption level towards the systems of provision, we stated that the provisioning systems of commodities and services partly determine the way they are consumed. Modes of provision vary not only in the role of the state and the locus of responsibility, but also with respect to principles of access and the form of delivery. Consumption is far from unilateral and the

relationship between the spheres of production and consumption strongly distinguishes different patterns of consumption.

Whilst systems of provision has been used as a term to cover actors that provide water, energy and waste services to citizen-consumers (including housing corporations, city bureaucracies, private companies), special reference is made to public utilities. These represent specific systems of service provision and are especially subject to debates on modes of provision, like privatisation and liberalisation. Also, public utilities play an important role in environmental policy. For one, they represent sectors providing the some of the most essential environmental related goods and services: those of energy, water and waste. Secondly, their organisational structure and intermediate position between the state and citizens gives them a unique role in environmental policy. The duality of functions: providing services and goods, and at the same time trying to reduce demand is now a challenge of liberalisation and privatisation. It means that somehow, new incentives must be built-in to keep existing environmental programmes running and to effectuate new efforts by utilities.

3 - METHODOLOGY FOR THEME RESEARCH

Heather Chappells and Sujatha Raman

3.1 Introduction - Methodological Approach and Objectives

This chapter aims to provide an overview of the methodological framework we used to undertake investigations of environmental innovations in the Domus empirical research and to link this approach with the theoretical development of the project. The main objectives are:

- To describe how we designed and carried out our case study research on environmental innovations in the Netherlands, Sweden and the UK;
- To explore how our approach fits with comparative research methodologies developed in the social sciences;
- To explain how these comparative approaches link with the theoretical development of our five research themes and Domus as a whole;
- To uncover some of the tensions apparent in dealing with the complex issues concerning the theory of ecological modernisation, methodological approaches, cross-country research etc.

This chapter is also a good place to reflect upon some of the issues involved in undertaking this sort of collaborative project. With this in mind, the chapter also outlines some of the discussions and arguments involved in setting the project's research agenda. Following these processes of negotiation reveals some of the alternative approaches which could have been used and highlights the value of research which draws together a range of diverse national and theoretical perspectives on the environment, technology and society.

The previous chapters have already outlined the theoretical background to the research and some of the key research questions we set out to answer. Here we are interested in the development of our empirical research programme and specifically how we went about choosing and investigating environmental innovations which would best reveal the new relationships between consumers and providers in utility networks. Already, we have described some of these processes in the empirical research design in our inventory report (see Raman *et al*, 1998) but as this was completed in the early stages of the project it does not fully explain how we came to focus on particular themes. Neither does it follow the logics we developed further into the research programme to link our empirical cases with our evolving theoretical ideas. Nevertheless, the inventory is a good place to begin the methodological discussion.

3.2 The Domus Inventory - First Level Analysis of Environmental Innovations

The aim of the inventory research was to identify the range and type of environmental innovations related to the provision of electricity, water and waste management services in households in each of the three countries. As a starting point, and in line with the theoretical framework, we set up the following defining criteria to guide our search for domestic utility sector schemes that could be included in each country's inventory of "environmental innovations".

a) the innovation was to be intentionally environmental, and

b) the innovation appeared to reconfigure consumer-utility relations.

The first criterion was meant to get us over the hurdle of disputes in the environmental sciences over what counts as "environmentally friendly" change. By starting with the full range of *self-defined* environmental schemes introduced by public utilities and other providers – i.e., those which have been "sold" to the public as strategies whose adoption will benefit the environment – we intended to circumvent as yet unresolved questions on the environment, and to admit a variety of candidates at the outset of the research. It was envisaged that the detailed case research would shed some light on the complexities involved in making judgements about the environmental value of the schemes eventually whittled down from this inventory. 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 is derived from the socio-technical perspective underpinning our research. Domus conceptualizes the ongoing transformation of public utilities in terms of changes in the *modes of provision* of electricity, water and waste 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 heating 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" consumer to an "active" provider of electric or water services, thus increasing her/his level of involvement. On the other hand, a new sewage 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 that are included in the inventory of innovations thus involved varying degrees of reconfiguration in utility-consumer relations.

In compiling the national inventories, each of the researchers identified utility-related environmental schemes by utilising sources such as specialist environmental and utility journals, newspapers, web sites and through consultation with utility experts. Contact was made with a wide range of organisations to find out more about such schemes, including utility companies, charities, research groups, local authorities, housing associations and sustainable housing groups. All in all over 150 types of scheme were included in the inventory, comprising both individual initiatives and multi-location initiatives which featured similar innovations in different places. This was a comprehensive though not exhaustive list of environmental innovations in the three countries. The inventory was organised by electricity, water, waste and cross-sectoral schemes. With various categories to reflect the type of initiator, the main rationale of the initiator (ecological, economic, social), the 'newness' of the project, the other agents involved, the sorts of processes involved (e.g. monitoring, efficiency, renewal), the number of consumers involved, the type of consumer involvement (sub-technical or sub-political), the phase of consumer involvement (in development, acquisition or use) and the nature of consumer involvement (active or passive). This categorisation of cases represented the first level analysis of environmental innovation. Full details of the rationale behind the categories and sub-categories chosen can be found in the inventory report itself (Raman *et al*, 1998).

The inventory was intended as a tool to help frame the main part of the Domus empirical research. Once this information had been compiled it was necessary to think more carefully about the key objectives of Domus in order to select cases for more in-depth investigation. To recap, the main aim of Domus was to explore the extent and pattern of consumer involvement across the phases of development, uptake, use and maintenance of diverse environmental innovations. A key question to

be addressed in this context was the extent to which emergent innovations required the socio-technical transformation of everyday domestic practices related to the consumption of water and electricity, and the production of waste. The general objective of such an empirical programme was to unpack these changing practices and reflect upon the innovations, processes, organisations associated with them. This prompted a selection of cases which would:

- reflect the most significant and novel developments in the utility field;
- explore the full range of consumer involvement in different 'phases' of development and use;
- represent the multiple providers now active in fragmenting utility networks;
- capture variations between the development of innovations in the different countries and sectors;
- expose the full extent to which EU policies are influential in shaping such innovations.

With these pointers in mind, we identified a first list of case types which we felt best met these criteria for discussion in the next stage of the project. These were as follows:

1. "*Smart" Electricity Metering:* New electronic meters which enable the monitoring of energy consumption between consumers and producers, with a range of in-built features such as programming to meet energy use reduction targets or differential time-of-day tariffs.
2. *Green Generation:* New supply schemes in each of the three sectors introduced at a number of different scales, including photo-voltaic (PV) cells or wind turbines to generate electricity, greywater recycling as a form of water (re)generation or home composting in the waste sector.
3. *Green Tariffs:* Pricing systems in the electricity, water and waste sectors which differentiate the tariff and payment structure in order to stimulate investment in renewable energy or to encourage lower levels of water usage or waste production.
4. *Appliance Schemes:* Incentive schemes in which utilities promote the use of water conserving technologies or high efficiency electrical appliances to their customers along with techniques for monitoring usage and providing feedback to consumers.
5. *Water Conservation:* The introduction of water conserving mechanisms (cistern devices, low-flow taps and showerheads etc.) into the 'normal' water networks. The different institutional arrangements for introducing these in each of the three countries was of specific interest.
6. *Recycling Schemes:* The provision of imaginative recycling technologies and initiatives (duobins, less frequent collection, high priced waste sacks etc.). The level to which these counted as innovative varied between the countries. Of interest were the degrees of differentiation of waste and new scheme/bin designs.
7. *Sustainable Building projects:* These 'cross-sectoral' cases in the inventory were seen as a useful way to look at the integration of a number of waste, water and energy innovations at one site.

At this early stage in the project there was considerable uncertainty as to the precise purpose of looking at each of these sorts of schemes and how they linked together, debates over whether they best reflected 'innovation' in each of the countries and confusion as to the aims of the 'comparative' research and the forms it should take. Many of these issues were ironed out in the subsequent stages of the research in which theoretical substance was given to the selection of cases and a subset of more coherent themes developed. This stage of the project also involved revisiting our research objectives in light of the empirical realities and possibilities.

Before moving on to discuss these subsequent developments, it is important to mention the role of the National Policy Reports and their authors in contributing to the selection of themes and the empirical programme which emerged. These reports were completed in August 1998 and set out the institutional and policy histories of the three sectors in question (see Chappells *et al*, 1998; Klintman, 1998; Wolsink *et al*, 1998). The national reports included outlines of some of the innovations to feature most poignantly in the historical development of the national energy, water and waste sectors and which had particularly notable influences on consumer-provider relationships, some of which shaped the selection of research themes. For example, the national reports revealed the importance of metering technologies, tariff developments and renewable generation. In addition, the sorts of utility network dynamics described in these reports helped in the construction of some of the later themes, especially those of Monitoring and Demand-Side Management.

3.3 Consolidating Themes - Pilot Studies, Comparative Research & Theoretical Stance

The next phase in developing the programme of empirical research was to decide on the validity of the suggested innovations as a way of meeting the objectives of Domus. The main question to deal with at this stage was what exactly was to be *compared* in our comparative research. It led to the establishment of five themes for the empirical research and linked these to specific theoretical and research questions.

Comparative Research & Pilot Schemes

A starter paper on comparative research in the social sciences was drawn up by one of the UK research team (see Raman, 1998). It raised a number of questions about the sorts of cases that were to be compared and suggested alternative ways in which this might be achieved by drawing on a range of social research texts and pilot studies undertaken in the UK. The paper was useful to think about the implications of the core theoretical assumptions of the project, which were drawn from ecological modernisation theory, and how these might shape the empirical research. it was decided to focus on specific examples of environmental innovations, which fit into some pre-selected process-oriented themes, exploring processes of utility change and consumer involvement as they emerge. This approach would uncover both environmental and other organising principles and processes connected to utility innovations and enable us to refine our theories of social organisation and change. The decision was supported by evidence from the UK pilot studies in which the logics behind the development of the UK's first windfarm and a sustainable housing scheme were explored. In both these cases, it was unclear whether an "ecological rationale" could be used to explain the whole of development of the innovations. Instead the problem of separating ecological 'logics' of innovation from those reflecting economic, technical and social concerns became apparent. As it turned out the careful selection of research themes meant that we could identify utility innovation in which ecological modernisation influences were identified in all three countries, while in other cases this was less apparent and additions to the original assumptions were necessary.

Developing Themes

Before explaining how we decided on the organising themes for the empirical research it is important to clarify the meanings of "cases", "schemes" and "themes" themselves. Originally the idea had been to identify specific environmental innovations as cases - as set out in the seven cases of innovations outlined in the inventory report. Later it was decided to develop themes into more process-oriented categories as with the inventory categories of "monitoring", "efficiency" and "renewal". This allowed for the fact that the innovations under study are not limited to technological devices only. Some have to

do with increasing the efficiency of consumption of water, energy or waste services. Others have to do with the way consumption is monitored, or with the way services are generated.

After categorisation of environmental innovations from the inventory and following some basic rationales derived from the theory of ecological modernisation, five themes were consolidated as the cases under investigation:

1. Monitoring and Power
2. Product and Tariff Differentiation
3. Scales and Modes of Provision
4. Demand-Side Management (DSM) and Networks of Co-Provision
5. Sustainable Homes and Integration

The first three themes for a large part represent the crucial processes that have been prescribed in the theory of ecological modernisation. To bring ecological considerations into the decision making within the institutions of systems of provision there should be some kind of knowledge about resource use, which is captured in the theme of monitoring and power. A distinction should be made between 'green' and 'grey' options, which in turn should be connected to differentiated tariffs so as to 'economise ecology'. Finally essential parts of the system of provision should be substituted or replaced with sustainable options. The ways in which these options are integrated within existing systems of provision is dealt with in the theme of scales and modes of provision.

The choice of the second set of themes (DSM and Sustainable Homes) was also an outcome of our first empirical work (the inventory of cases) as well as our theoretical findings. A large number of cases dealt with efficiency measures in distribution or consumption of water, electricity and waste services. They include for instance the diffusion and installation of low energy light bulbs, night storage heaters, low flush toilet cisterns, slim waste bins, low volume water taps and so on. A common logic behind such processes of technology diffusion was Demand Side Management, a utility driven approach to optimise the use of their networks of infrastructure. The role of consumers in such approaches deserved however closer elaboration, which is achieved in a separate theme on Demand Side Management and systems of co-provision.

Sustainable homes emerged as a separate theme as many of our selected environmental innovations were combined within building and housing projects that were labelled as being 'sustainable' or 'environmentally sound'. In addition to the other themes in which single cases were analysed, it was decided to add, as another level of analysis, sustainable homes with a focus on levels of integration between technologies and networks, and the consequences for relations between consumers and providers as a main subject.

Each process-oriented theme was reformulated to connect more closely to a number of pressing theoretical questions. Rather than directly compare each country or each sector, the thematic analyses would each centre on particular research issues to build a fuller picture of utility change. These themes would, in combination, shed light on the intricate and diverse nature of consumer involvement and on the ecological, cultural and institutional processes and systems behind these. Some of the issues involved in each theme are described below:

Monitoring and Power

Monitoring and power means first of all making the invisible visible. In former times, the infrastructure of energy, water and waste services was somewhere ‘out there’. Consumers were ‘being served’ by collective social material systems as well as by ‘nature’ without caring too much as to how and why these services where provided. From the 1970s onward, we see several waves of environmental concern becoming translated into a diversity of projects aimed at a better management of energy, water and waste at the domestic level. Projects aimed 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 can be forms of monitoring which serve environmental goals in a socially regressive or socially progressive way and there can be forms of monitoring 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. Lastly, monitoring is especially relevant in the construction of choice, which is central to the next theme.

Product and Tariff differentiation

Product and Tariff differentiation has to do first with the development of choices, the valuation of which can be used as an instrument for social change. The theme focuses on the green alternatives in relation to standard products and services. The central questions here refer to how the green alternative is perceived, what the change implies for price structures and the technical differences compared to the standard device. The debate on product and tariff differentiation so far has been largely a debate between providers and regulators. There are however many possibilities for using differentiation as an instrument for 'constructing green identities' and for a reconstruction of the notion of ‘choice’ in relation to utility services.

Scales and Modes of Provision

This theme is mainly devoted to the question of whether more sustainable innovation is reflected in the scale of the technology and the social relations/ modes of provision which go along with that scale. Is small still beautiful or is sustainable provision in utility sectors related to new relations between centrally provided and de-centrally provided services, between stand-alone devices and grid-connected options? We argue that there is a substantial variation in all sectors and in all countries with respect to what is regarded as an appropriately scaled ‘green’ mode of provision. Our suggestion is that there is no one ‘best’ solution where matters of scale and modes of provision are concerned, but that several alternatives can be identified each of which involves different levels and forms of consumer involvement.

Demand Side Management (DSM) and networks of co-provision

DSM-debates are focused on reducing the need for products or services by better managing their storage and supply. Historically, DSM debates have been initiated from the perspective of institutional actors. In this research, we twist these ideas around and consider DSM from a consumer perspective. What kinds of storage strategies are feasible from a consumer perspective and what kind of socio-technical storage-devices are available to consumers in this respect. How does “consumer-led” DSM relate to “provider-led” DSM? In the classical DSM-discourse the consumer also had his or her place, but the positioning of the consumer was decided by providers and from a provider logic. With liberalisation and privatisation in utility sectors, the need to reflexively organise the relationships between providers and consumers is also recognised and subscribed to by providers themselves. Now that the concept of the captive consumer is beginning breakdown, new strategies to include

consumers or users (as clients) in systems of provision must be developed. To successfully (re)establish provider-consumer relations within utility sectors, concepts and schemes from the past must be redefined and extended beyond strict economic and technical thinking The central theme of co-provision in the context of utility-networks provides a new model for analysing provider-consumer interrelations under conditions of reflexive modernity.

Sustainable homes and integration

Historically, consumer driven debates on utility provision have been of a specific kind too. Here we identify projects which are often assumed to be both socially and technically disconnected from the central networks of utility providers. Local communities managing their own energy, water and waste services are in certain respects literally 'sealed off' from the broader society. Sustainable provision has for a long time been developed from the bottom up, from within and very much against the established power structures. We will describe under this theme the gradual changes that sustainable building/housing projects have undergone during the last twenty years. The keyword here is integration, not just in terms of different technologies applied at the same time within sustainable building projects but also integration in terms of the local initiative becoming more and more encapsulated by central networks, thereby transforming both the character of the local as well as the national system. Furthermore, we witness the gradual broadening of views on sustainable housing and futures by moving beyond the initial focus on just applying new or more sustainable technologies. The newer views have moved into a socio-political debate about what it means to live in homes, blocks, neighbourhoods or local systems which can be said to be sustainable and 'modern' at the same time, thereby experimenting with new forms of local dependencies towards 'external' grids.

Organising the Theme Research

The decision to look at these themes as distinct but interlinked studies meant that each researcher was able to take a more cross-cutting overview and draw together case material from all three countries. This, it was argued, would enable us to better understand the series of critical and discreet processes which were framing environmental renewal and consumer and utility reorganisation across Europe. Within each thematic study it would be possible to identify national differences in the form of schemes, but also to recognise common processes of change and link these to particular social and environmental objectives. As outlined in the introductory chapter, each of these themes reveals different forms of variation - as such each requires a different and specially constructed comparative approach.

Each country was responsible for one or two of the themes (Dutch Team = 1 and 3, Swedish Team = 2, and the UK Team = 4 and 5). Within each of these five themes a number of specific schemes were chosen for further investigation. These schemes might be chosen to allow for cross-sectoral or cross-country comparison alongside a set of other strategic research objectives, for instance to capture variation in modes of provision, to capture degrees of differentiation in consumer choices, to investigate the integration of different social and technical arrangements in new utility systems and so on. These objectives were detailed in thematic research strategies drawn up by the researchers responsible for each theme. These mini-research strategies also outlined the interviews required for each theme, the sorts of questions to be addressed in the interviews and a suggested timetable for the research. The plans were circulated for refinement and comment. A brief outline of the final themes along with some of their comparative and theoretical objectives, research questions and scheme types is set out below:

THEME	COMPARATIVE/ THEORETICAL ISSUES	RESEARCH QUESTIONS	SCHEMES
Monitoring & Power	• Configuration of Power & Knowledge • New Forms of Knowledge – Making the Invisible Visible • Cross-Sectoral Knowledges – Changing Configurations	• What forms of knowledge are generated in monitoring? • What is revealed, what remains hidden and why? • What is the relationship between knowledge and action?	• Electricity Metering • Water Metering • Ecofeedback Schemes
Product & Tariff Differentiation	• Co-construction of Green Identities of Producers and Consumers • Changing forms and degrees of differentiation - sectors/countries • Configuration of Green Identities & Differentiated Practices	• How are green identities co-constructed in liberalised sectors? • What forms of differentiation are emerging in the sectors/countries? • What do green identities mean for differentiated practices?	• Green Electricity Tariffs • Greywater Recycling • Waste Charging
Scales & Modes of Provision	• Fragmenting Scales of Utility Provision • New Consumer and Provider Responsibilities for Systems • Modes of provision - Sectoral Diversity	• What scales of utility systems are emerging in each sector? • What do these scales imply for management responsibilities (P<>C)?	• Renewable Energy • New Water Systems • Composting Schemes
DSM & Co-Provision	• Bringing Consumers back into Networks of (Co-)Provision • Macro and Micro-Flows in Utility Systems • Processes of Storage and Efficiency as Co-Provision	• What are the conventional roles for consumers in utility systems? • How are consumer & provider objectives reflected in organisation of storage, efficiency and flows?	• Efficiency Schemes • Storage Technologies
Sustainable Homes & Integration	• Social and Technical Autonomy & Interdependencies in Utility Provision	• What diverse forms of integration in terms of social and technical components are emerging in green homes?	• Eco-Homes

The five themes are designed to complement each other as is outlined above. By beginning with *monitoring* issues we raise a number of concerns about the flow of information in utility networks and the configuration of knowledge by utilities and users. Such processes of monitoring can constrain or enhance the environmental opportunities in utility systems. *Product and tariff differentiation* is often developed alongside monitoring systems which generate knowledge of the use or production of energy, water or waste and/or relay information between producers and users – this helps to consolidate the green 'choices' on offer and those which are selected. *Scales and modes of provision* deals with the generation of greener forms of energy, water and waste provision, the actual technicalities and institutional and organisational issues involved in the fragmentation of energy supply and the reconfiguration of demand, and the constraints and opportunities available at different levels. *DSM* reflects on the consumers of utility systems as active participants in network management - not just as co-generators - but throughout the supply chain of utility management. The stores and

efficiency devices in place in networks framing what it is the consumer and provider can and cannot do in respect of management regimes. This again defines the scope for environmental interventions in these networks. Finally, the integration of environmental innovations and social systems involves new relationships of technical and social autonomy and changing interdependencies between these. The final theme considers how such relationships and interdependencies are worked out in the *sustainable housing* sector and highlights the scope for different forms of environmental, technical and social integration across the Domus countries.

3.4 Undertaking the Thematic Research – Methods, Interviews & Collaborations

Choice of Methods

The majority of the case research was undertaken in a ten month period between October 1998 and July 1999. In planning the empirical programme a number of key considerations were important. First, how we could capture the degrees of variation in consumer and utility processes given the time and resources available. Second, which methods would be most fruitful in this endeavour. Third, what problems might arise in trying to gain access to utility companies and consumers and how we might overcome these. Fourth, how we might undertake a truly cross-country investigation of utility change and ecological modernisation and learn from each other about the issues at stake in each others' national contexts. Although each of the separate themes comes with its own specific methodology, there are some general issues to note in this chapter with relation to the four issues outlined above.

For each theme a selection of around ten schemes was selected for in-depth investigation. These often involved between two and four schemes from each country, chosen to reflect whatever variables were under investigation e.g., differences in sectors or modes of provision. It was generally agreed that one-to-one interviews with both utility providers and consumers would be the best approach. The researchers agreed that the level of understanding of the subtle layers of consumer involvement that we wanted to capture required an in-depth qualitative approach. As such, interviews would form the core of the empirical programme with a variety of secondary methods to supplement them. For instance, in some cases telephone interviews and secondary survey data was used to back-up findings. In other cases, visits to the site where the innovation was housed were required, particularly in sustainable homes cases where the idea was to see how innovations were integrated in everyday life. For each of the themes the national researcher was required to interview the initiator of their selected schemes in line with the questions set out in the research strategy and where possible interview some of the consumers of the scheme. This approach would connect to our theoretical framework as outlined in the introductory chapter by balancing the involvement of both human agents (drawn from conversations with consumers and providers) and linking these to wider institutional arrangements (drawn from provider interviews and secondary sources).

The third issue was raised by some of the researchers who had practical experience of trying to access information in the utility sectors. In the days of increased competition in the utility world it was recognised that information on consumers and their activities was often commercially sensitive. To overcome some of these problems the researchers utilised contacts within utility companies and also approached a number of other organisations who were able to facilitate access to some of this information, this included utility regulators, local environmental organisations, etc. The objective of capturing a variety of provider organisations also meant that this was a legitimate approach, with conventional utility companies no longer the only spokespeople or actors in the provision of energy, water and waste services.

In relation to the fourth point, it was decided that co-working visits by the researchers to each of the other countries would be a useful way to gain an insight into the processes at work in other national

contexts and to be able to discuss comparative issues with first-hand knowledge. The UK and Dutch researchers each spent a week in each others' countries, jointly interviewing a range of respondents between February and March 1999.

Interviews and Collaborative Visits

Once the interviews had been completed the relevant transcripts and secondary materials were sent to the researcher responsible for writing up the theme, after which a series of draft reports were circulated and revisions made to the interview plan to fill gaps and overcome problems. The findings of the empirical research are summarised in the five theme chapters which follow. There were, however, a number of research problems which emerged during the interview phase of the project which are briefly outlined here.

Firstly, closer investigation of some of the schemes revealed that they did not really fit the theme under study. For instance, the Swedish Team noted difficulties in finding any cases of Demand-Side Management. This led to a revised workplan which focused more on the UK and to a lesser extent Dutch cases. Another general problem was the difficulty of finding consumers who were available to talk about the schemes. While this was not an issue in some themes, such as Sustainable Homes where the consumer was also the initiator, it did prove problematic in other situations. Despite this the interviews with providers revealed a great deal of valuable information about the preassigned roles of consumers and how they often subverted these 'scripts' of the innovation in practice. In other instances utility companies in the UK appeared unwilling to talk about the development of their metering schemes, which were commercially sensitive, but were happy to talk about other innovations such as water recycling or efficiency measures.

3.5 Conclusion

As the theme chapters go on to show, there is a great deal of activity in environmental innovation in the utility sectors in all three Domus countries. The methodology is not developed to assess the extend of environmental innovation in utility sectors, or to compare utility sectors on their environmentally soundness, nor does it provide any vast evidence for environmental impacts these innovations might have. What is interesting is the diverse forms of involvement and underlying logics these innovations imply. The methodological approach we have chosen is specifically developed to unearth these and to shed new light on ecological modernisation processes in the utility sectors.

4 - MONITORING AND POWER

Bas van Vliet

4.1 Introduction

This chapter deals with new developments in the monitoring of flows between consumers and providers in the sectors of energy and water supply and waste management. The emphasis will not be put on in-depth descriptions or lengthy analysis of particular cases themselves, but on the rationales attached to a variety of metering and monitoring projects and on the expectations of providers and consumers associated with these. More precisely, what we discuss here is *knowledge* as a main outcome of any monitoring or metering scheme. What kinds of knowledge are provided through monitoring, to whom would such knowledge be of main relevance, which are the expected and realised links between knowledge and action and which roles do different kinds of knowledge play in the power relations between consumers and providers? The answers may reveal early signs of the newly emerging relations between providers of energy, water and waste services and householders at a time of liberalising utility markets and growing environmental requirements.

After an introduction to the history of monitoring in the provision of utility services in section 2, we shall review the rationales that are expressed in utility, environmental or consumer research into the monitoring of the domestic consumption of water, energy and waste services. This will give us an insight into the underlying logic behind contemporary cases of monitoring in the three sectors involved. We shall illustrate this with our empirical findings around cases of water and energy metering, waste monitoring and cross-sectoral eco-feedback schemes. From section 4 onwards, we attempt to reconstruct these stories, by focussing on the kinds of knowledge provided (4.1), the (presumed) links between knowledge and action (4.2) and the shifting power relations between providers and consumers (4.3). More details about the cases to which we refer can be found in the annex[2].

4.2 A history of monitoring

Ever since utility networks have been constructed and widespread connections to these networks have been established, monitoring the utilisation of networks has become necessary for the following reasons. First, for providers of gas, electricity, water or waste services, the monitoring of consumption has been an important tool for managing supply and network capacity. Monitoring household consumption is also a prerequisite in cases where users are individually charged for their consumption of water, energy or waste services. Secondly, network users have sometimes pleaded for individual monitoring of consumption so they might pay a fair share for their use of the network, or to manage their own consumption levels because of economic or environmental considerations.

Traditionally, meters measuring electricity, gas or water consumption show meter readers aggregate amounts of flows in units of KWhs, Joules, or cubic metres. Historically these have been installed at home entrances or just after the main switch or tap of the incoming network and require manual reading, normally once-a-year. With particular reference to the energy sectors, the monitoring of electricity and gas has been done through individual metering. The meter has become a marker of the physical barrier between the public network and the private sphere, clearly expressed in phrases that

[2] Cases referred to in this chapter and described in further detail in the Annex are: Actie Zuinig Stoken / Zuinig Aan; Automatic Water Meters in East Anglia; Bath Metering Scheme; Comfort Card; EcoTeam Programme; Kronometern; Monitoring Frequency of waste collection; Telemetering Helmond and Water Meters in Amsterdam

are commonly used in the world of utilities. Everything that is done "beyond the meter" refers to household practices and is therefore outside the responsibility of the utility. The monitoring of domestic waste production has only recently been taken on board by the sector. There are only a small number of experimental cases where waste is either weighed or the size of the bin is measured. Also water metering is not as common as in the cases of electricity or gas. Reviewing metering or monitoring reveals some differences between sectors. The fact that whereas energy use has always been metered, the consumption of drinking water was metered in far fewer cases, and waste production only occasionally, is explained by the specific characteristics of the resources. For instance, it is much easier to measure the flow of electrons than to measure the amount of waste put on the street. However, a much more convincing explanation is that energy is often conceived as a privately used commodity in comparison with water and waste services, which are traditionally seen as public goods, essential for citizens' daily lives. Even before the existence of waterworks, city dwellers used publicly provided wells and pumps, and domestic waste collection has largely been performed as a public service. Individual metering of the usage of these public services was for a long time conceived as inappropriate or even improper, and in many cases this is still the case.

Since the 1980s, radical changes in information and communications 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 communication companies are now competing to offer new metering systems that display not only technical flows to consumers and providers, but facilitate broader functions, 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.

Apart from metering, there are various other ways of monitoring the consumption of network-based resources. Instead of individual metering, utilities may estimate consumption levels from block-metering or from metering the supply of resources elsewhere in the network. More refined are different modes of self-monitoring and data logging. In cases where no individual meters are applied, monitoring can be done by regular surveys or by monitoring resources at the supply-side (the amount of water put into the network, the amount of waste processed in a waste incinerator). Apart from technical monitoring devices, there are many other monitoring procedures: from continuously measuring the flow to randomly taken samples, from on-line feed-back information to consumers to offering nothing but a yearly bill which presents the annual consumption load.

There are a number of developments that may serve as an explanation of the growing popularity of individual monitoring. The privatisation of public utility companies and liberalisation of their markets has forced utility companies to adopt more consumer-oriented strategies as, for the first time, they have to compete for their customers. Metering and monitoring are always part of such strategies, as they strengthen the link between consumers and providers and produce knowledge about customers' behaviour. Energy, water and waste conservation strategies that have emerged since the early seventies are also highly dependent on the monitoring of consumption levels. Furthermore, since consumers themselves are now being educated about their contribution to environmental pollution and are being placed in the role of clients of utility services rather than anonymous users, they increasingly feel the need for self-management of resource use within the household. Individual meters or other monitoring devices are increasingly applied. This is facilitated by the development of information technology, which offers possibilities for on-line interactive feedback systems between utilities and households. These developments in metering reflect not only breakthroughs in communication and

information technology, but also a new set of social needs: an increased need for fine-tuning of demand and supply of network services, a need for tariff differentiation made possible through detailed and timed metering, and the need for information on efficiency measures.

4.3 Conventional stories of monitoring domestic consumption

4.3.1 Expectations of measuring, knowledge and changing behaviour

The selection of monitoring cases, was based on the criterion that this was a recent development, a monitoring innovation which served (among other things) environmental goals. It is no surprise then, that our collection of cases of monitoring and metering have in common the assumption that monitoring leads to increased knowledge on the part of consumers about the amounts of energy and water they consume and waste they produce. In many cases the production of knowledge is expected to lead to energy, water and waste conservation behaviour. In many of the cases "resource conservation'' is presented as the main reason for implementing the meters or other monitoring devices.

The Bath Metering Project and the Telemetering Scheme in Helmond, were both experiments designed to reduce energy consumption by offering consumers data on their consumption levels, compared to the figures of previous months and average consumption in the neighbourhood. Self-monitoring schemes such as the Actie Zuinig Stoken has the same goal for gas consumption. Likewise metering programmes have been motivated by the assumption that metering leads to resource conservation. The Amsterdam Municipal Water company's plan for their water metering project in Amsterdam includes a figure of 12% for the expected water saving even before the first meter is installed (GWL interview, 1999). Although such expectations are not based on metering alone, but rather on a combination of metering and education (tips for energy and water saving behaviour), there seems to be an overall confidence in the links between metering, knowledge and changed behaviour in all these projects. It appears that the results of monitoring justify the assumption, at least in the short term. The self-monitoring scheme resulted in a 4.5% to 8.5% saving on gas-use (Loois & Drabbe, 1991: 39), and after the Helmond Telemetering project was finished a reduction in usage was established at 18% for water, 23% for gas and 15% for electricity (Völlink and Meertens, 1999). Similar results were found in the Bath Metering experiment in the UK.

The EcoTeam programme is also rooted in the idea that measuring leads to knowledgeable agents, which in turn is the basis for the behavioural changes that are sought in the programme:

> *When you actually monitor the volume of resources you waste it is something you cannot forget. (…) Similarly, weighing your garbage before taking it out to the trash can provide feedback about whether you are making progress. Practices such as these promote an awareness that keeps people improving their sustainable behaviour - not just for months but for a lifetime (Gershon, 1998, p. 348).*

Although most EcoTeam members until now have been mainly recruited from the already environmentally-aware, well educated segments of society, nevertheless the experiences indicate that members can be very surprised when they are confronted with figures relating to their own water, energy or waste behaviour (GAP interview, 1999). The programme deliberately aims at such 'surprise effects', as these are thought to lead to stronger motivations to reduce the consumption of resources.

4.3.2 Fairness of payment / Pay for what-you-use

Apart from stimulating conservation behaviour, the second common rationale for monitoring and metering is that it enables consumers to be charged individually for their utilisation of services. Like

the sectors of health care and (life) insurance, public utilities such as water and waste services are in a phase of transferring from public services with unlimited access and paid for by general taxes, to diversified services sometimes provided by private parties and paid for through individual, tailor-made contributions. The East Anglian and Amsterdam water metering projects, along with waste monitoring cases, illustrate this trend. Meters are primarily installed to change the structure of payment for the service, along with other incentives. Metering is not only driven by the wishes of the providers. The Amsterdam Municipal Water Company (GWL) refers to the outspoken wishes of their clients as a main reason for investing in a long-term and expensive metering scheme. Until now the drinking water system for Amsterdam has been based on the principle that access to drinking water is a citizen's right (GWL interview, 1999). This idea stems from a century ago, when the municipality decided to invest in waterworks for the entire city as a response to public health concerns. Following this principle, all residents should have free and unlimited access to the pipes of the municipal water utility. Therefore residents of Amsterdam do not pay for the amount of water they use, but fund a public service in the form of taxes. From an administrative point of view there is no individual consumption monitoring, as there is no relation between water use and a payment that is based upon it. The municipal tax for water supply is based upon the size of the home. Over the years, many residents have complained about this system, as they think it is unfair to pay a fixed tax, while their presumed actual water consumption is lower than average. Some residents have requested individual payment systems and have even taken the Water Company to court several times to try and force them to install meters (GWL interview, 1999). In addition, experiments with the measuring of waste (in kilos or volumes) are not conducted simply to monitor the amount of waste, but in order to create a basis for introducing a payment system that is based upon individual usage of the system. As far as the energy sectors are concerned, there are not many cases that are based on a rationale of fairness of payment, generally because energy use has been metered and individually paid for from the very start.

In summary, the recurrent story in cases where metering or monitoring is introduced, revolves around one or both of the following rationales. The first that metering leads to knowledge on the part of the consumer, which in turn is believed to lead to changed (environmental) behaviour. The second, that individual monitoring is necessary for fairer payment systems that replace old payment systems based on taxes, mutual solidarity and public provision with unrestricted access. In what follows we do not attempt to prove the conventional story wrong. In fact some case studies, such as the Bath and Helmond metering projects, show that both rationales could work very well. Instead we attempt to retell the monitoring story which so far does not produce a satisfying answer to our questions concerning the linkages between knowledge, action and power. To do this we go back to the question of what it is that monitoring really does.

4.4 Retelling the story of monitoring

4.4.1 Kinds of knowledge

What monitoring schemes at least have in common is that they all produce knowledge. Swedish Kronometerns produce figures on amounts of money one has to pay for gas or water consumption, Telemetering schemes produce weekly figures for water and energy use, and waste monitoring programmes produce figures for numbers or sizes of bins or kilos of waste put out in a certain period of time. Meanwhile, EcoTeams produce reports full of numbers and tables of individual and aggregated electricity, gas and water consumption, car kilometres, kilos of waste produced and so forth. In addition, these figures are compared with other periods in time, other Ecoteams and average figures for the whole country. What do all these figures tell consumers and what do they tell providers? Which information is revealed and which remains hidden for the actors concerned?

Individual consumption levels expressed in different units

One way to answer the question is to take a closer look at the specific language used in monitoring schemes and the ways in which this is presented, since this might show us which and whose purposes are served. Water meters have a teller that reveals the number of cubic metres of water that have passed the meter since it was installed. This figure of cubic metres of water can also be found on the yearly water bill that calculates how much water has actually been used in the year that has passed. However the number of cubic metres does not tell a consumer very much. Water consumption in households is divided between several different household practices such as washing, cleaning, cooking, or gardening. A water meter does not provide any specific knowledge about these practices separately, such as their dis-aggregated water consumption, timing of use or influences on the household budget. As the Amsterdam Municipal Water Company (GWL) stated if the rationale behind installing water meters was only to provide consumers with knowledge about their water consumption, in order to achieve water-saving behaviour, then there are probably easier and cheaper ways to achieve this by means of mass communication, or installing simple water saving devices (GWL interview, 1999).

A similar story can be told for standard electricity meters and gas meters: they produce kWhs and cubic metres consumed, whereas consumers tend to think in terms of comfort or the money that is involved in energy use. The language used by all these water, electricity, gas or district heating meters is that of the utilities expressing their production and distribution efforts in m3 and kWhs or kJs.

Some of our selected cases are a step forward in this respect. The Kronometern for example displays electricity use measured by Crowns per hour, as well as accumulated costs and whether low or normal tariff prevails at the moment of reading. The language of Crowns per hour is much more oriented towards the needs of household consumers than conventional meters which primarily meet the needs of professional meter-readers and the companies behind them. A Swedish energy company (AO Energi) claims that electricity use can reduce by up to 20% on average once the households have the opportunity to survey and pay for their individual energy use (press note Johansson, AO Energi). Apart from many other advantages for the providers, such as on-line meter-reading enabling utilities to compete for clients outside traditional regions, the Kronometern offers more advanced monitoring possibilities for consumers, with energy conservation as an expected result. Although not initiated by utilities, the Bath metering scheme also offers consumers more information than the usual kWh's only, such as calculated costs, actual and previous consumption levels and even some tailor-made energy saving advice.

Apart from the inappropriate (from a consumer's point of view) language, in which water consumption is expressed, accessibility is also a problem for consumers. The traditional place for water meters in Dutch homes, for example, is under the floor just inside the front door. In most cases it takes some effort just to have a look at the meter, let alone to do this regularly. Even the new water metering project in Amsterdam aims to install meters at the most appropriate place in terms of costs and existing infrastructure, which in many cases will be an inconvenient spot for regular household meter reading (GWL interview, 1999).

The EcoTeam programme is an example of how consumers are educated in using the existing data on energy and water consumption or waste production. EcoTeam members collect all data from meters (and own measurements where there are no meters), compare them with others and discuss ways to reduce consumption. Another programme to motivate consumers into meter-reading and energy saving is Zuinig Stoken, which offers data logging forms and weekly tables to compare own energy consumption with average consumption rates. Telemetering, the Bath Metering Scheme and Actie Zuinig Stoken make utility-related data more accessible for household consumers. Although these two projects had the goal of linking knowledge to action, in practice they only provide knowledge. The

EcoTeam programme is the only monitoring procedure that includes a programme of action that is based on the generated knowledge.

All these monitoring examples have been tested in experiments and evaluated. A common result was that householders were only interested, and actively involved, in monitoring their consumption for a certain period, after which they assumed that their consumption levels would not alter much, or just were not interested any more. For instance the Actie Zuinig Stoken kept householders interested only for a couple of months, and the research team evaluating the Bath metering experiment advises the installation of meters only for a period of three to four months, as further reductions in energy consumption after that date are unlikely. By the end of the project, after 15 months, only 12% of householders were still looking at their displays on a daily or weekly basis. The Ecoteam programme is also finite in its scope, and active monitoring behaviour is certainly less intense afterwards. However a survey among participants two years after the programme finished, showed that most resource reduction behaviour is sustained (Harland and Staats, 1997).

Aggregated consumption levels

Providers are mainly interested, not in individual, but in aggregated levels of consumption, specified per district, income group or other segments of their client base. Especially in situations where former public utility companies have to compete with others, such information may be vital for marketing strategies. Taken together, individual meters are an instrument for producing such information for providers, but not for consumers. Only a few of the new monitoring schemes offer more than individual consumption data to consumers. The telemetering project in Helmond and the Kronometern, gave information about accumulated consumption and costs. The EcoTeam programme is based on comparing individually metered consumption with others or showing individual contributions to the whole. Actie Zuinig Stoken offers the possibility of comparing own consumption levels with the expected consumption level of energy, which is based on outside temperatures and the average consumption of previous years. But generally, knowledge of total, aggregated consumption is only accessible to providers.

Figures on where resources come from and how they are provided

Theoretically, the whole system of provision of energy, water or waste disposal could be monitored at several stages. Apart from monitoring consumption, distribution and production are also in fact monitored, be it only at providers' or institutional level. In the cases of 'green electricity', such information also becomes also relevant for clients. Green electricity emerged as a product some years ago when utilities realised that clients were more and more concerned about how their electricity is generated, and that they were willing to pay an extra charge to be assured of green energy use in their homes. Most green electricity schemes include regular feedback to consumers on the number of kWhs of ''green'' produced electricity compared to the total. There are no such feedback systems in the sectors of water or waste, although there could be a considerable percentage of consumers who would be interested. One of the activities of Ecoteam members, for instance, is to obtain such information from utilities, with variable results, as utilities are not always prepared to share it (GAP interview, 1999).

In cases of electricity co-generated by consumers, for instance with solar panels or windmills, information on the balance between production and own consumption becomes crucial in the dealings with the energy provider. The 'energy balance' homes in Amersfoort, with grid-connected 'solar' roofs, are built to have a zero balance in energy production and consumption. Energy consumption from the grid and production delivered to the grid are therefore separately metered, so as to assess the balance between production and consumption and payments to and from the energy company. The

increase of co-generation options in electricity and water supply (rainwater and grey water use) will also involve an increase in metering and other monitoring procedures.

Related environmental impacts

Another kind of knowledge that could be provided through monitoring is of the environmental impacts of energy use, water use or waste behaviour. There are as yet no meters or monitoring procedures available that display environmentally relevant data (such as ways to generate energy, treat waste or reduce ground water levels). One explanation for this is that utility services have until recently been somewhat uniform in their approach. For this reason utility services have never recognised any labelling or other features to distinguish one product from the other. Commodities like fridges, washing machines, taps and showers, have always come in different sizes, prices and qualities which have made (eco-) labelling relevant. Energy labels on fridges reveal to consumers the hitherto hidden information on (future) energy consumption, thereby enabling consumers to make their own estimates of (short term) benefits and (long term) costs. Differentiation in utility services opened the way for labelling, as green electricity has shown. By participating in the scheme a consumer trusts the energy company to spends his/her money on sustainable electricity generation. This trust is fed by a regular information exchange on numbers of kWhs sustainably produced and distributed. As all electrons coming into the home are exactly the same, the whole green electricity scheme is based on the consumers' trust in the knowledge provided to them. In most cases independent organisations such as WWF are put forward for external control.

Specified figures about household practices

All the monitoring procedures mentioned above produce knowledge about the use of either water, or energy or waste services. Instead of being rooted in one of these three sectors, knowledge production could also start at the level of household practices. The advantage would be that the latter are expressed in a much more consumer-oriented language than a utility-based language. Practices such as cooking, gardening, washing and cleaning are much more connected to what consumers could discursively reproduce about their households than the number of kWhs, or the volume of water and waste flows coming in or out their houses. It would be highly impractical, though, to install meters at every tap or socket in every house. However, an experiment to measure the water or energy use or waste production of some specified practices would provide valuable information for larger groups of consumers to compare the environmental impacts of different practices. Instead of being persuaded to use less water or energy in general, householders would know which practices are most resource-consuming and could act according to this knowledge. An example of such a scheme is *WaterLog* which is being developed with Three Valleys Water in the Northern Home Counties (UK). The scheme involves 12 households in Elsenham in Essex, and the objective is to get more detailed information on how water is used, in order to provide better advice on whether it is worthwhile to get a water meter or not, and for forecasting water use. The Housing Association (Hastoe) is "interested in what people do, not in telling them what to do", and wants to go beyond generalised high, medium, low flow models and get a more accurate picture of flows in homes. There is a meter on every outlet in the house so they know where water is used and where it goes 'even on the hot/cold pipes for the washing machine'. Hastoe and Three Valleys have different agendas for the use of the monitoring information. The problem for the water company, Three Valleys Water, consists in meeting demand in the context of population growth. Therefore they want to know where to emphasise conservation and how to identify which technologies can best tackle conservation. The Hastoe Housing Association is also interested in the perceptions of consumption compared to actual consumption. For this purpose, it is intending to do a survey of what people think they use over a two-week period and check this against the monitoring record for the household.

Consumers' perceptions of resource use may play a major role in how resources are provided. A water manager in the Netherlands explained that it was the wish of consumers to have an outdoor tap with a second quality of water, as they assumed that gardening is one of the most wasteful water-related behaviours. However, compared to total water use, it comprises only a very small amount of water compared to toilet, washing machine or shower uses.

Summarising, the kinds of knowledge which most monitoring schemes produce are based on utility logic rather than consumer logic. Reviewing the kinds of knowledge which the different monitoring schemes of our inventory offer, revealed also the kinds of knowledge that are *not* provided, at least not to consumers. The cases of EcoTeams and forms of smart metering, which do provide some kind of consumer-oriented knowledge, are promising, but are as yet too marginal or experimental to be evaluated as dominant trends in monitoring.

4.4.2 Knowledge and Action

Apart from the fact that knowledge provided through monitoring can be multi-dimensional, geared for different purposes and different actors, there is still something left to (re)tell about the relationship between knowledge and action. Many metering programmes start from the rather uncritical assumption that installing a meter will lead to resource-saving behaviour on the part of the consumer. Beside being dependent on how accessible and useful the provided knowledge is for consumers (see former section), the question remains on what grounds one can assume that consumers act differently as a consequence of monitoring.

First of all, one should put in perspective the link between knowledge and action, as it may not be monitoring which makes people behave differently, but the tariff system that comes with it. In cases where metering is introduced, the method of payment for resources is often changed as well. Instead of paying fixed rates for delivered services, individual monitoring makes individual payments possible, thereby introducing an incentive to save resources. The monitoring of waste streams by weighing waste, measuring volumes or frequency of putting the bins out is only an incentive to reduce waste because it is financially rewarding to do so.

Secondly, we might have a closer look at which actions are monitored and targeted for change and which are not. The sectors of energy supply, water works and waste management are remarkably different in their monitoring schemes, if they are applied at all. Monitoring the consumption of electricity, gas or heating fuels has had the longest tradition, but it was not until the last few decades that this has been aimed at saving resources, by charging consumers individually. The monitoring of water consumption by metering is not as common as meters for energy use, but the aim of installing water meters has been the same: to provide the water company with an opportunity to charge consumers individually. Most of the new devices for energy and water meters ('smart' meters, telemetering) are now partly motivated by their potential to achieve conservation as well, but the traditional goal still remains dominant. Waste disposal by household consumers has never been monitored individually until recently. Like the sewerage system, waste collection apparently was not a service that should be charged for individually. This may lead us also to the conclusion that reduction in usage of waste and sewer systems was not prioritised, at least not as much as in other sectors, where monitoring was explicitly introduced for this purpose. In addition it reveals that flows coming *into* households (electricity, gas, heat, water) are much better monitored than the flows that are going *out* (waste and waste water, not to mention the fumes from boilers and heaters). This can partly be explained by the fact that incoming and outgoing flows are related – water consumption levels are directly related to waste water production, gas consumption to CO_2 or NO_x emissions – and therefore do not need double monitoring. However there are some conflicting areas as well, as the Dutch debate on linking drinking water tariffs to waste water charges illustrates:

'Waterworks in the Netherlands are divided into two separate sectors: drinking water supply and waste water management. The physical dividing line between the two is exactly traceable: between the outlet of water taps and the inlet of wash basins, bath tubs and so forth. Most Dutch householders pay per cubic metre of drinking water they use, but pay a fixed rate per household for sewer services. The idea behind 'Waterspoor' is to introduce stronger economic incentives for water saving behaviour by adding the charge for sewer services to the cubic metre water charges. The result would be higher drinking water prices and hence stronger incentives to save on its use. The waste water 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 collection and treatment. Water saving behaviour would not necessarily lead to reductions in efforts of sewer and waste water treatment systems; on the contrary, there is a minimum of water to be flushed through the sewer system in order to let it function properly[3]*.*

An overview of the consumption of network services which are monitored in households, and the ones which are not, reveals not only a clear division between in-going and outgoing flows, but also where consumers are supposed to take action and where not. The waste and waste water sectors do not have a particular interest in waste-minimisation, especially in times of the growing over-capacity of incineration plants and increasing interest in 'waste for energy' conversion. On the other hand, the water and energy sectors have a stake in the efficiency of resource consumption because of Demand Side Management considerations, or restrictions set by policy.

In any case, the existence of monitoring procedures and metering programmes in network-based systems of provision tells us whether or not consumers are expected to take action, either to pay for it, or to make their consumption patterns more efficient. Uses that are not monitored or metered give us an indication of providers' lack of interest in consumers taking action in reducing the consumption of resources.

4.4.3 Shifting power relationships between providers and consumers

Monitoring and consumer empowerment vis-à-vis providers

In previous sections we have seen that there are different kinds of knowledge that monitoring can produce, as well as different expectations about what this knowledge tells us about how to act or not to act. In all cases where individual monitoring procedures are introduced new power relationships are constructed between providers and consumers. Providers enhance their knowledge about individual and aggregate consumption levels, just as consumers enhance their knowledge about their own consumption levels. Some consumers may feel more empowered when they have more control over the flows coming into or going out of their household. Monitoring devices may fit well into the lifestyles of those consumers who like to measure consumption, do data logging and financial book-keeping and read all labels on products they purchase. For those consumers, any new meter would add to a feeling of 'being in control'.

A closer look at monitoring and power relations, however, shows that the flows of information between both providers and consumers and their mutual visibility may not be equally divided. Increasing and more detailed metering of consumption patterns make consumers' behaviour visible to providers and to providers only. This is close to 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 where every cell can be watched. As all cells have large outside and inside

[3] For the same reason would metering wastewater only make sense when it does not monitor water volumes, but rather the amounts of waste that is carried by it. However until today no cases of wastewater monitoring could be found in the three countries under study.

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 each other. Unlike the old prisons, dark cellars which offered at least some kind of protection to prisoners, now all prisoners' behaviour has become visible to their guards who themselves are invisible to the prisoners. The prisoner has become the object of information and can never be the subject of communication. This is in fact the major function of the Panopticum: due to permanent visibility of prisoners and impossibility of communication between prisoners, 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 works well in the network systems of water, waste and energy 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 nor into that of their neighbours. In these cases, monitoring mainly empowers providers rather than consumers. On-line continuous monitoring enhances this permanent visibility without the consumers' knowing whether or when they are being monitored, and without the monitoring provider being visible. An example of such a situation is an ecological housing project in Dublin, where the temperatures of all rooms in every household in the complex were permanently monitored and made visible on the computer screen of the controller of the energy system. This was needed to organise an optimal energy supply by different means of (sustainable) technology at every time of the day, but also revealed quite a lot about household practices in the house: when the cooking was done, when the dishes were washed, or bathing took place, which rooms were visited at any time of the day, and even when residents went to bed. An eco-Panopticum like this may sound extreme, but is an increasing phenomenon especially in automatic heating and cooling regimes of large buildings like offices and housing complexes.

It is thus too simple to present monitoring as a tool to empower consumers vis-à-vis network providers. To break through the Panopticum metaphor, providers need to be made more visible to the 'captive' consumers, and the segregated consumers more visible to each other. Again the EcoTeam programme is interesting here, as householders are motivated to trace the systems of provision by starting at their homes and then contacting utility companies and other providers for inquiries about resource use, efficiency in material and energy use and the like. Empowerment, in the EcoTeam philosophy, is described as 'the feeling that one's effort can make a difference'. It is influenced by optimism, feelings of control and efficacy and enforced by self-esteem and a feeling of belonging to a team (Geller, 1995 in Staats and Harland, 1995, p. 5). However, EcoTeams may at the same time run the risk of putting undue social pressure on team members to increase their effort beyond what they are willing to do or to disclose information about their household, which they consider personal. This is a high price to pay for increased empowerment in relation to anonymous providers of energy, water and waste services. Global Action Plan, the facilitator of the EcoTeam programme, is now experimenting with individual programmes in which data logging is not fed back through team meetings, but through the Internet, which makes it a kind of advanced self-monitoring scheme. Self-monitoring schemes do not have the drawbacks of social pressure and yet to some extent empower consumers in relation to systems of provision. Own data logging and comparing results with average levels not only increase the visibility of own consumption, but also that of (anonymous) others.

Such empowerment is however only relative: the differences one can make in the systems of provision through extensive monitoring do not go very far beyond the strictly private sphere. One may save on resources, put out the bin less frequently, but monitoring does not provide any tools to change decisions on system levels such as incinerating or land-filling waste, exploiting gas or coal reserves for electricity production, or to use ground or surface water for drinking water provision.

What in fact happens in many cases of monitoring is that consumers are not so much 'empowered' as made co-responsible for the consequences of their own consumption, in particular its economic and societal costs. Individual metering makes it easier for providers to transfer liability for the environmental damage caused by water extraction or coal fired electricity generation to individual consumers, at least in a rhetorical sense. Although consumers are of course responsible for their own consumption, their powers to influence the strategic decisions of providers are not normally increased by getting a meter installed.

Monitoring as mediating technology for the shift from public to market modes of provision

As we have shown, monitoring devices do not just provide knowledge but may be the vehicles for changes that go far beyond metering alone. Apart from offering consumers more insight into their water consumption, the metering project in Amsterdam enables the drinking water supply system in Amsterdam to change its very mode of provision. Water supply will no longer be a public service with an almost unrestricted access for anonymous users, but an individualised supply of cubic metres of drinking water from a known provider to a known consumer. It offers the Amsterdam Municipal Water Company the opportunity to charge consumers individually and even to disconnect defaulters. The hitherto anonymous consumers of the network become known to the Water Company, which changes the relation between consumers and provider dramatically. Illustrative in this respect is that along with the metering project, the Amsterdam Municipal Water company is considering merging with the energy company in the region to get access to its valuable client database, marketing department and client desk, as the company has never had (nor needed) such departments (GWL interview, 1999).

Similar cases of metering and monitoring can be found in other regions and sectors. Privatisation of former utility companies has in many cases led to changes in the modes of provision (from public to market-based) and such changes are only possible if the supply to customers is metered.

Social equity and (in) justice

Lastly, a recurrent and important issue in metered supply of water and energy services is that of social equity. As referred to above, public services unrestrictedly provide resources to all, while privatised metered services will only be supplied if individual consumers comply with the condition of (regular) payment to the provider. The British National Consumer Council for instance strongly resists *any* water metering, especially where lower-income households are concerned (Marvin et al, 1999).

The installation of pre-payment meters have been especially criticised, because they give providers the opportunity to disconnect defaulters quite easily from the supply of resources which are considered essential for daily life. The pre-payment meters of the early years of energy or water provision have now seen a revival. Instead of feeding them with coins as was the case in old (gas) meters, consumers now pay with special credit cards, which they can recharge at supermarkets. Obragas, a Dutch regional energy company which is experimenting with such a system emphasises that its introduction is not meant to exclude defaulters in the future, but rather to provide an extra service to its customers. To underline this, the prepayment system is called 'Comfort Card' and is only provided to volunteering consumers. As a first evaluation revealed, consumers are enthusiastic about the system and feel more in control of their energy use. Recently a Dutch water company introduced a 'Chipflow meter' to 20,000 households in order to – as the company puts it – 'protect non-paying customers against the risk of not getting any water'. This meter also works with special credit cards that can be recharged by the Water Company. If there is no recharging, the meter provides 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). The Water Company in this case does not try to hide the main purpose of installing such meters. The possibility of (self) monitoring, which is heavily

emphasised in the communication that accompanied the introduction of the Comfort Card, is not even mentioned as a possible outcome for consumers.

4.5 Conclusion

There are several rationales which are implicit in the conventional story of monitoring. Retelling the story has taught us that monitoring is not just about providing information to consumers and/or providers, and that providing information to consumers is too easily assumed to be an incentive for desired action. Monitoring is instead a process of quantifying, labelling or evaluating the relations between consumer and providers. Most dramatic changes in the power-relations between consumers and providers can be observed in cases where meters are for the first time introduced, such as in our cases of water metering and waste monitoring. Other cases which may be called 'refining monitoring' seem to be based on the assumption that more (and better) knowledge leads to (desired and specified) action on the part of the consumer. Consumer rationales behind monitoring however are mostly ignored, as most monitoring schemes follow the providers' logic and language of flows and numbers, instead of being translated into consumers' needs like comfort, cleanliness and convenience. Moreover most of the monitoring cases showed the situation of inequality in which visibility is created. Consumers are made visible to providers, whereas consumers only enhance their knowledge about their own consumption levels. The most extreme cases of on-line 24-hour metering represent the Panopticum metaphor in which the behaviour of captive consumers is made visible to providers, reproducing a power balance in which the consumers are the carriers of a situation, and the objects of a system, which empowers providers rather than consumers.

5 - PRODUCT AND TARIFF DIFFERENTIATION (PTD)

Mikael Klintman and Anna-Lisa Lindén

5.1 Introduction – Differentiation and DOMUS

This chapter reflects on the diversity of options for energy, water and waste service provision, in light of privatisation and what the introduction of new green choices might mean for consumers and providers. In pre-modern times it was common to separate water for laundry and for bathing (a water usage shared between household members) from water for drinking. However, it turned out to be very difficult, especially with the dawning of modern urbanism, to separate water qualities without compromising health. Thus one of the most important parts of the modern health project was to achieve a potable water standard which was accessible to all: something that led to a convergence of water provision. Waste management has a comparable history. Pre-modern and rural communities commonly composted organic waste and used it as fertilizer on the land. Much of the waste from food was given to the pigs; metal and glass were frequently reused (Rosén, 1988). Such a separation was institutionalised in the early stages of urbanisation. However, in Sweden for example, this separation more or less ended in the 1920s when artificial materials and synthetic fertilizers started to be used. The synthetic materials were too difficult for farmers to reuse (Johansson, 1997:196). Apart from particular projects, such as newspaper and glass recycling, convergence into one waste "fraction" has been the general pattern for a large part of the 20thcentury.[4]

In this chapter we explore the recent tendency for differentiating electricity sources, water qualities, and waste fractions. It would be untrue to conceive of contemporary processes of differentiation as regressions to pre-modern fragmentation. Instead, the current differentiation of products and tariffs reflects the goal of standardising choices and is rooted in concerns about the consequences for health and environment, as well as the drive for economic profit. Nevertheless the issue of the unintentional risks of water and waste differentiation is still highly relevant.

The theme of product and tariff differentiation (PTD) refers to cases in which a previously single utility supply has become diversified in some way. We examine the supposition that the one-sided model of "offering new choices to consumers" has lost its significance in certain areas of the three utility sectors. Instead we could say that choices are being co-created, with service provision increasingly involving both providers and consumers. Other specifically environmental assumptions are closely related to product and tariff differentiation. One assumption is that new product and tariff choices lead consumers to increased environmental awareness and creative interest. We will investigate the concept of green identities, to assess the extent to which this has been, or is likely to become, the case.

The suggestion that PTD is a powerful part of ecological modernisation is hence based on the following reasoning: as products and tariffs in the utility sectors become differentiated, the public are confronted with new choices of products and services. These new choices might make the public more active. In household routines which were previously taken for granted. There is now a possibility that the public will become reflective and critical clients as well as creating new service options themselves. The question is: what are the opportunities for, or the obstacles to an active involvement in practice. This relates both to *in-use* involvement and new types of *sub-political* interaction between citizen-consumers and providers. In general the issue of PTD as a consumer empowering phenomenon raises the question of whether or not such new types of involvement have the potential to bring about environmentally beneficial changes to utility systems. A careful distinction therefore

[4] See the national DOMUS report for more about sectoral histories.

needs to be made between citizen involvement and the actual environmental outcomes of innovations. It is important to note that evaluations of innovations have many facets, the whole system of evaluation is relevant to the report. For instance we need to recognise that there are lots of apparent choices, that these choices may or may not link to environmental improvement and that choices are not as limitless as we might think, they are also susceptible to convergence and standardisation.

5.1.1 PTD in relation to other Domus Themes

In what ways can the PTD theme be distinguished from the other themes in the DOMUS project? Compared to the monitoring theme, with its focus on knowledge provision and power through metering, the PTD theme instead pays particular attention to the sequences of creating and confronting new product and tariff choices. PTD particularly emphasises how creating and confronting new choices relates to green identities among consumers and providers. A more obvious difference between the monitoring and PTD themes lies in feedback. Certainly, forms of feedback about gradually reduced negative eco-impact are necessary in the PTD theme. Nevertheless, monitoring, in the sense of systematic and precise metering, is not essential in the cases selected for the PTD theme[5]. This is a reason for defining monitoring as a separate theme, which also helps metering to gain more rigorous attention than would be possible if the monitoring theme were mixed in with the others. The differentiation of products and tariffs (supposedly yielding ecologically sound alternatives) is to a certain extent dependent upon processes labelled *systems of scale* in another of our themes. This is exemplified by renewable energy purchased from energy companies as one of several household options.

Product and tariff differentiation is carried out in a plethora of ways in the three sectors. In the electricity sector, our discussion of differentiation is largely based on sources of electricity generation. In the water sector, different tariff systems have been created by providers and consumers on the basis of sources and functions of water. Finally, a variety of waste tariffs and fractions for waste separation have been introduced in all three countries. These are all examples of projects whose results will be analysed in this chapter. At another level, the three sectors have several different characteristics with direct consequences for people's perceptions of them. Characteristics include physical features such as line- or non-line boundedness, and the closeness to our senses. The smell and colour of water and waste plays a role in the extent to which consumers and households initiate green identification processes as they get involved in these alternative practices. This said, it becomes interesting to explore the nature of consumers' identification processes in the electricity sector, which is far less tangible than water and waste, in terms of differentiated forms of generation and organisation. Such differences and similarities between the sectors of electricity, water, and waste – as well as across the UK, the Netherlands, and Sweden – will provide fuel for the conceptual understanding of green identification and practice.

5.1.2 PTD: A Green Identity Perspective

Product and tariff differentiation is closely related to phenomena that have been of interest to various disciplines in the social and behavioural sciences. The 'economic man' outlook emphasises the significance of economic rationality in people's choices as products and tariffs become diversified. Behaviourism and cognitive social psychology focus on incentives and disincentives for greener consumer behaviour in a differentiated market. Within behaviourist environmental research it is standard to use terms like *behaviour change techniques*, and *behavioural intervention.*[6] One element that this type of research may have in common with our position is an interest in the concrete and

[5] Cases referred to in this chapter which can be found in the Annex are: Composting Schemes, esp. community and home composting; Green Electricity Schemes in the Netherlands; Grey water systems; Household water systems; Monitoring frequency of waste collection; Rain water systems; Sustainable Homes Projects.

[6] See De Young (1993). See also Dwyer and Leeming (1993).

manifest cause of environmental deterioration: human behaviour. The fact that human action is directly visible (as opposed to values and beliefs) allows a purely behaviourally oriented researcher to avoid some of the methodological difficulties that, for example, studies of environmental attitudes can raise.

A philosophical objection to behaviourism frequently refers to its claim that the specific, external situation is the absolute determinant of all behaviours. Behaviourism is hence hardly compatible with a scientific interest in human freedom of choice and creativity (Joas, 1996: 2).[7] One branch of behavioural research - the cognitive branch - has moved closer to the research direction that this paper endorses. The cognitive school takes an interest in the inner, creative processes and formations of meaning within an individual. Accordingly, the concept of *behaviour change techniques* has here been replaced by *motivational techniques.*[8] Sayer (1979) sheds further light on the separation of *behaviour* and *action.*

> *"By 'behavior' we mean nothing more than a purely physical movement or change, such as falling asleep, breathing, that is, doing things which lack intrinsic meaning structure. In contrast, doing which we call 'actions' are not wholly reducible to physical behavior even though they may be coupled with it. Actions are constituted by intersubjective meanings: putting a cross on a ballot paper, conducting a seminar, getting married, arguing, doing arithmetic, going on a demonstration are all examples of doings whose nature depends on the existence of certain intersubjective meanings." (Sayer, 1979: 20-21).*

The cognitive perspective's focus on attitudes tends to be especially useful to study when these are combined with other variables. The question is *what* combination is the most efficient one. Wachs (1991:336) has suggested the technique of "market segmentation." Here, people are grouped according to demographic and socioeconomic characteristics in combination with their local circumstances (e.g., local policy, and physical structure). Taken together, these variables are held to explain a significant part of the relationship between attitudes, motives and lifestyle choices.[9]

Getting a picture of the motives for and against such practices is especially important for policy makers. Policy decisions can significantly influence people's motives for and against adopting more ecologically sound practices.

Although the approach presented in this study shares the interest in human behaviour as well as the interest in human creative processes of other approaches, its focus differs in fundamental ways. A crucial difference is that the approaches outlined are generally founded on a top-down perspective. Accordingly, they may generate queries such as: 'how can the leading institutions of society make people change their everyday habits in an environmentally respectful manner?' (Klintman, 1996: 9). In other words, studies in the traditions mentioned above mainly examine which initiatives by policy makers – local authorities or companies – are accepted by consumers and households and how these can determine behaviour. Moreover, such studies have generally been carried out either at the consumer level or the provider level, without looking at the relations between these.

In this chapter, the questions are broader, for instance: how can society improve the conditions for its members actively to participate in working towards environmental improvement?; How can social organisations be modified so that citizens are ready to take their own environmental initiatives, initiatives that sometimes go further than governments appreciate?"[10] This type of question raises the

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7 The very title of Skinner's best-selling book in behaviourism – "*Beyond Freedom and Dignity"* – is sufficient to indicate a behaviourist viewpoint of human practices.

8 See e.g. Geller, Winett & Everett (1982).

9 Based on Dobson and Tischer (1976).; Dobson and Nicolaidis (1974).

10 See Joas (1996) for a comprehensive analysis of the concept of *action* in sociology. Joas holds that the sociological interest in human action has since Comte been an attempt *to "limit the legitimization of the principle of 'laissez-faire' in the vulgarized forms in which classical economics has permeated European thought* (p. 36)."

essential democratic issue of a State and a Government, stimulating the public to require modifications of the State and the Government itself. We aim at illuminating the relations between levels, that is how PTD is co-produced at more than one actor level. It is not merely a matter of top-down versus bottom-up, but rather of how the differentiation process consists of a complex of inter-linked green identities among consumers and providers.

It is interesting to note how PTD in the utility sectors (and possibly in sectors other than electricity, water and waste) can be dealt with differently in other consumption areas. This is due to the fact that differentiation has a longer tradition in most other consumption areas than in the utility sectors. Utility sectors differ from other sectors in their regulatory bases. Yet it would be a serious over-simplification to hold that it is merely the *comprehensiveness* of regulation that separates the two. Instead, extra-utility sectors have traditionally been subject to *different* regulatory frameworks, commonly founded on ideals of free competition, health, safety and – to a certain degree – environmental concerns. These regulations aim both to extend and to limit the choices of consumers. The regulatory processes in the three utility sectors were explored in the national policy reports of the DOMUS project. They will be further examined in this paper, although the examination is restricted to issues that directly concern the green identification of consumers and providers.

The initial questions that this section raises will be elaborated on throughout the paper. They can be summarised as follows:

- How closely is PTD connected to liberalisation in the three sectors?
- Which groups of customers are targeted by the providers for particular green options?
- What are the principal motives for and against introducing and choosing green products/tariffs across the different sectors?
- What does the creation and uptake of green identity mean in relation to what households/providers actually do in practice (i.e. how much of the resource is used)?
- What different kinds of consumer identities and provider images related to PTD can be distinguished, and how are they tied to the three sectors?

5.1.3 The Structure of the Paper

The *second* section of the paper briefly puts the PTD theme in a broader national policy perspective and discusses the concept of 'green identity', which is then elaborated upon in the rest of the paper. Section *three* analyses the role of providers in the co-constructive process of configuring green identities in relation to PTD. The *fourth* section shifts the focus to the role of consumers in the same co-constructive process. In the *fifth* section, we separate four kinds of green consumer identities and three image-related aims of providers. From this we draw conclusions which to various extents are associated with energy, water and waste sectors. The section goes on to introduce specific implementation and policy challenges, and presents some constructive ideas for meeting these challenges.

5.2. The Co-Creation of Green Identities

5.2.1 Policy Background: Conflicting Views of Green Responsibility in the Utility Sectors

A general issue in society, which overlaps with several of our themes, is framed by the following

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Comte aimed at bringing forth a normative and moral dimension of action, hoping to moderate the dominant perspective of 'rational' (as individualist and solely economic) action.

question: should consumers or providers have the main responsibility for ecological sustainability in the three sectors? The strong state ideal holds that legal restrictions and regulations on providers would do the better job. In contrast, the market economy ideal maintains that consumers ought to have free consumption choices and thereby ultimate environmental responsibility. Here we explore both approaches.

Green electricity, for instance, is a market economy way of greening electricity generation. In the Netherlands green electricity may well be presented as a replacement for the MAP agreements (which will end in 2001). The transition to a more liberalised energy market means that whether energy companies will produce sustainably will depend more on the choice of consumers than before. At the same time, there may be less scope for governments to force energy companies to comply to greener regulation or policy initiatives.

Related to public responsibility and freedom, one UK Energy Company representative we interviewed, raised the issue of the levels of independence and free choice at which green consumers are positioned. In this case, the company is a trading organisation. They invest in, and make profit from, renewable generation. The households, while freely choosing what electricity source they want to support, lose money by choosing green electricity.[11]

By asking our interviewees about who should have the main responsibility for the environmental consequences of household consumption, we revealed a hybrid position. Consumers and their representatives maintain that both state and providers ought to have the main responsibility. At the same time, everyone is aware of the fact that a significant percentage of the public still chooses environmentally unsound products, such as electricity generated from non-renewable sources. Would it be fair to say that such product choices are signs of consumers' favouring unrestricted and unsound supply? Or could it be interpreted as the very opposite: consumers giving a hint of what happens in a system of amoral market differentiation? Notwithstanding this, we give examples of the crucial roles of combining provider and consumer responsibility in providing green tariff and product choices. We do this by presenting cases of interaction between policy, providers and consumers.

Is Green PTD Dependent on Liberalisation?

When investigating ecological modernisation and the utilities it becomes relevant to ask how closely PTD is connected to liberalisation and 're-regulation' in the electricity, water and waste sectors. Our case point at the fact that PTD does not in principle presuppose a liberalised market.

In the Netherlands, for instance, **drinking water companies** have a monopoly. Parallel with the liberalisation of other sectors (e.g., telecom and energy), there have been discussions about whether or not to introduce competition and to privatise the drinking water sector. Yet, the majority of water cases from the Netherlands reveals that several kinds of PTD are already taking place. A high level of public perception of problems in the water sector is appearing to trigger creative solutions among consumers and providers within the regulatory framework. It will be illuminating to compare Dutch water differentiation with that of the re-regulated UK to show how competition might still has a role to play in stimulating both consumers and providers to introduce new, and sometimes green, product and tariff choices.

[11] Perhaps it is relevant to see households as placed on two different levels: at one side of the "bottom" level are the households that have to purchase electricity from a monopolised publicly-owned energy provider. That household has no free choice among different providers, but if profit is allowed it goes to the common good, to the public. On the other side of the bottom level, we find the citizen-consumer freely choosing between different providers' electricity. However, this person loses the profit, which goes to the private owner of the Energy Company. On the top of the pyramid is the member of a green electricity cooperative. The person gets the best of two worlds: free choice of energy source and the profit from his or her investment. In this light, one might question the eco-modernist view of reflective consumption in a differentiated market as the ideal state.

Compared to the water sector, liberalisation in the **electricity sector** is more common in the EU countries. All three countries in our study have liberalised at least part of their electricity sector. Re-regulation, in the Swedish energy companies, has meant that the companies have developed their environmental work gradually. According to the southern Swedish Energy Company, one reason for this might be the new competitive situation. Re-regulation has changed the conditions for the energy companies so that the environmental profile has gained importance. For instance, the southern Swedish Energy Company currently works actively with environmental certification in accordance with ISO 14 000. In terms of wind power alone, preparation at the company started in 1986-1987, long before the liberalisation of the electricity sector. The administrative preparations took 3 to 4 years. In 1990, the first two windmills were constructed, these were named 'Annica and Beatrice'. At the time, these windmills were among the largest installation of "smaller" windmill models. Also, it was the first project constructing more than one turbine in the same area.[12] The initiative was taken by the local government (when the company still formed part of the municipality). The local authority's demand was that five windmills be established generating a total of 1.5 MW. The company soon realised that they would not be able to establish and run five windmills within the profit requirements that they had set, so they initiated a wind power cooperative in the area. The utility company was active in this until the cooperative board was established. To date, the southern Swedish Energy Company symbolically owns one of the 900 shares in the cooperative.[13] This is an example of how it is not necessary to connect wind power with liberalisation. Although we might find exceptions in cases where the local supplier does not have any wind power to offer consumers.

Finally, one of the Swedish waste cases illustrates how PTD in the **waste sector** does not necessarily presuppose a liberalised market. It might nevertheless be true that the local authorities are inspired by new options emerging in re-regulated utility sectors. Up until now, reductions of the waste collection fee have become more prevalent in municipalities around the country. It remains to be investigated how common it is for households to ask for this alternative, to examine whether it is approaching "normalisation." It is without doubt a part of the trend towards a more differentiated waste policy, yet this is not followed up by a re-regulated waste collection market, from the viewpoint of the households. Although the municipalities have contractors doing the waste collection, the Swedish as well as Dutch municipalities nevertheless have the final responsibility of getting it done in an organised, sanitary manner (according to the Waste Collection and Disposal Act, 1979: 596; Section 2a, 1990: 235).

In sum, it appears that PTD does not in principle presuppose a liberalised market. However, competition tends to stimulate consumers and providers to introduce new choices onto open utility markets can be seen in some cases and may increase.

5.2.2 Identities and Practices in Choosing Green Products & Tariffs

The Meanings of Green Identity

To discuss identities in relation to consumption choices has become commonplace in cultural studies and sociology. However, because the vast majority of such studies have focused on what are clearly cultural goods – leisure activities, clothing, music preferences – it would be too bold to infer from consumption spheres which are so obviously tied to identity-building, that similar identity processes

[12] Subsequently, they fulfilled the agreement with the local authorities in Lund, by building a third windmill. Moreover, The southern Swedish Energy Company was active in helping a wind power cooperative to build their windmill; this makes a total of four windmills.

[13] In addition to windpower, they say that they also produce other kinds of green electricity, since hydro power from plants constructed before 1996 is defined as green. They have done this all along, probably regardless of the environmental aspects of hydro power. Yet they believe in differentiating the products on the basis of what it actually is rather than defining the production sources with labels such as 'green electricity': it is seen as better that the consumers interpret whether or not the different sources are green. From one of their competitors it is possible to buy clearly distinguished nuclear produced power.

exist for all consumption. For instance, Alan Warde stresses the importance of not underestimating the routine character of certain types of consumption goods and services:

> *"Although some people may attempt to create total life-styles as expressions of personal identity, most, despite the intention of advertising agencies, probably see choices between soaps or soups as not seriously prejudicial to their self-image." (Warde, 1992: 25)*

This being true, we still maintain that the main problem is not that identity is excessively emphasised and assumed to lie behind all consumption, but rather that the concept of identity is often used carelessly. As Campbell (1995) notes, several confusions are involved when identities and consumption meanings are explored. Firstly, the intelligibility of consumption is often wrongly assumed of necessity to imply a consensus about what this consumption means. Secondly, it is a mistake to juxtapose meanings of consumption and *messages* through consumption. Finally, the fact that a subject observes a message does not mean that the other subject, the consumer, has intended to send a message (Campbell, 1995).

As big a mistake as it is to ascribe all consumption to social signs and messages, it is equally fallacious to reject the role of identity altogether, merely based on the intuition that many consumer activities appear to be quite routine-based, as in our case, within the utility sectors. New consumer research accordingly gives to the identity concept new nuances, involving more than status signs and symbolic utility. At present, consumption and ownership are increasingly dealt with in terms of personal development based on more complex identity processes (Madigan & Munro, 1990). This broadened conception of identity turns out to be especially useful when examining green identities in the utility sectors.

Green consumer identities are our main focus here. Nevertheless, the green images of providers are highly relevant. This report highlights how providers try to attract consumers, using a green provider image. It becomes clear that provider images and consumer identities are closely interrelated. Providers' efforts, with their green images, include attempts to influence the green identity processes of consumers. This can be regarded as one whole set of *activities* of identity and practice on the part of providers.

The Material Component of Green Identities

The three sectors have material characteristics which are significant in influencing the ways in which green identities are constructed. However, we do not subscribe to material determinism; the material component is only one feature among many. As we shall see, the social and political aspects of green identification appear to have a higher explanatory value. Nonetheless, when comparing the green identification processes in the sectors materialities do have an important role to play.

At this point we make several initial claims, to be elaborated throughout the paper. For the **electricity sector**, a common thread in the three countries is that there is no separate green grid alongside the mains grid provided by energy companies. Thus, the principle of green electricity is in all three countries is one of *investment* in green electricity rather than in a physically and technically separate green grid. To make the conventional grid greener for all users is hereby the aim of green PTD proponents in the electricity sector. This is of course tied to the line-bound nature of electricity; it would be highly inefficient to have more than one main electrical grid system. The *choice* of green electricity is relatively speaking not lifestyle-dependent as a continuous activity. Once a household has chosen to purchase green electricity, the continuous routines do not have to differ from those practised before the green choice was made (however in terms of reduced use, electricity is highly lifestyle-dependent). Green electricity is instead highly policy-dependent, and partly relies on efforts made by providers (who can be consumers themselves, in for instance cooperatives – see the renewal theme). Yet, green electricity triggers complex issues of continuous consumer motivation. In contrast to the water

and waste sectors, green electricity normally requires an extra fee, which continuously needs to be motivated. Certain companies solve this by distributing information every quarter about how the extra money has been invested. This can be interpreted as a way of helping the consumer build and maintain his or her identity as a green electricity consumer.

The differentiation of sources and functions in the **water sector** involves a great deal of lifestyle involvement, as well as dependency on local authorities, water associations, companies, and the like. The most important role of authorities and "providers" in the water sector is to share their knowledge and expertise with consumers. This might include informing them about how to become their own grey water provider. The differentiation of water sources and functions is often technically intricate, and the lay public needs help in initiating and maintaining it. Moreover, water sector innovations are usually much closer to people's physical senses than electricity, and thus raise many cultural tolerance issues. Interesting here is whether acceptance of unpurified water in households with children may create negative reactions among conventional water users in terms of hygienic responsibility. Obviously, green identities need to be constructed that are stronger than the initial senses of water differentiation which compromise hygiene, established through modernity.

Finally, the **separation of waste fractions** deserves a certain adjustment to the lifestyle and the everyday efforts of households. Compared to the water sector, it is possible to initiate one's own composting without much help from authorities and companies, in effect to be one's own service provider. Composting, in addition, is an ancient practice that gives the person direct ecological feedback; successful composting practices result in odourless soil, very useful as a fertiliser for plants. In our cases the importance of social feedback from neighbours and providers nevertheless becomes clear. Moreover, questions about identity and policy are raised in other forms of waste differentiation. What roles do the different incentives offered by the local authority play in household motivation and green identities? How many waste fractions are efficient and acceptable to households?

5.3 Providers and Green Identity

5.3.1 Electricity: How to Make the Invisible Visible

Although it is not possible to distinguish between "green" and "grey" electrons in the same grid, energy companies do have the option of separating the energy sources through organisational and economic differentiation. An explicit aim of an energy company in southern Sweden is to make the conventional grid greener, that is to increase the share of alternative energy offered to consumers. One of the energy companies we interviewed in the UK has a similar view:

> *"The problem of giving people direct green [electricity] is that you are taking this out of the rest of the pool so the rest gets browner. It's important to get more green into the mix." (UK Energy Company A).*

According to this company, it would be unfortunate to polarise green and grey customers in different grids. Mixing the electrons would make it easier to help all people gradually create greener identities.

Still the invisible nature of electricity may lead to socio-material obstacles to consumers being motivated to choose green electricity alternatives. Consumers are concerned with how the extra money for green electricity is invested. The electricity is mixed anyway in the grid, so "who knows where my extra money for electricity alternatives goes?" [14] Thus, the energy providers need to expose

[14] At the British energy company A this is solved by the company sending out a newsletter every 6 months, so that "customers are aware of the consequence of their decision" (to fund green electricity). British green electricity consumers are driven by a number of motives: interest in climate change, green pricing, global equity, energy services (packages of heat, light and power) and concerns over visual impact. It would be interesting to study whether

the green generation of power, to make their green provision and identity visible to consumers. Part of the process of creating visibility involves environmentally trusted organisations controlling the green claims of utilities. The importance of conspicuousness among providers of green electricity is illustrated in the majority of our cases. It is for instance reflected in the ethos of one green tariff scheme in the UK, the company behind which explains how they want to "open up a whole new view of how energy is generated" by improving the amount of green power in the UK in a very visible way "so people can see it working." This visibility critieria is claimed to be the main basis on which the projects are chosen. The informative element in showing consumers how green energy works can be regarded as the manifest function, while a more latent function may be to develop a green identity for the company, one which is hopefully transferred to consumers so that they become more closely connected to the company on an environmental basis – and not based only on getting the cheapest electricity available on the market.[15]

Competition between providers has clearly become more complex and is acknowledged as involving much more than simply satisfying the demands of some rational 'economic man'. One UK Energy Company, for instance, is aspiring to having one of the greenest images of all the electricity utilities in the UK. The company stresses the importance of providing products and services that are influenced by the customer. The major areas in which they are eager to be "the first and best", as their ethos prescribes, are health, safety and the environment. A representative of the company holds that "customers don't want to go with a company that pollutes." Hence the company emphasises the green identity of consumers, perhaps even before such an identity becomes very comprehensive, at least not in action. Nevertheless, such claims may themselves generate a green identity among customers, which they had not developed before they read the slogan from the company. Another tool for green identity construction is that every green customer gets a sticker indicating that the person chooses wind power. Although this appears to be especially important to private companies purchasing electricity (constituting the vast majority of wind power clients), a sticker may affect households as well. One effect is simply to inform others about the existence of green electricity. The other is a message, not only to others but also to the green consumer him or herself, of his or her green identity (cf. stickers for blood donation).

The conspicuous nature of wind power, with its highly visible windmills, makes it efficient in boosting the green identity of energy providers. The Energy Company in southern Sweden believes that wind power has not been a great economic investment directly. Yet the company views the windmills Annica and Beatrice as having given the company an immense amount of (positive) publicity merely by being visible. Moreover, the Swedish company's involvement in a wind power cooperative has strong symbolic value. Cooperatives have idealistic connotations, something that helps the company maintain a trusted green identity. In the light of this, the challenge for the companies, such as one of the UK energy companies we interviewed, who do not currently have any renewable plant of its own becomes apparent. In fact, it recently bought a 5,000 MW coal-fired plant, something that, combined with green slogans, sends environmentally ambiguous messages to households.

An environmentally decisive factor is how much of a provider's green image is coupled with actual market shares. The actual percentage of green electricity provided by energy companies is likely to become an increasingly important basis on which consumers will select their providers. Not all energy

there are clear relative motives – that is, compared to coal, fossil fuels, etc., that perhaps differ between the three countries depending on their energy alternatives.

[15] The British company A was the first to offer customers a green tariff and was also the first to be awarded ISO1401. In contrast to many energy companies – especially in Sweden – this British company has decided to target domestic customers, rather than companies, for green tariffs. They state the reason as that there is "too much competition in large companies." (The other British energy company that we have studied – energy company B – presented a diametrically opposed idea. The vast majority of their customers are instead commercial, something that they justify by their limited size).

companies are happy to reveal their green share. At one UK energy company they have conducted a survey indicating that 30% of the consumers said they would be happy to buy green energy, but at present only 2% are actually willing to pay for this, although as the company point out "2% of 3 million customers is a lot of people."[16] However, there are other processes than the attempts by energy companies to make their green electricity provision as visible as possible in order to maximise the green share of consumers. In the Southern Swedish case, one might ask why the Energy Company does not build further windmills, solar panels, or initiate other green schemes. Currently they "only" sell 1.5 MWh wind-generated electricity (plus the wind power that the company buys from other companies[17]). From our interviews it emerges that the market price of wind power is so low that it does not cover the production costs. In Sweden, at least, wind-produced electricity is thus, on a narrow and short-term basis, economically unsound.[18] Perhaps this is a reason why the Swedish company does not market green electricity more actively. Going back to the issue of mixing all electricity sources in one grid, this mixing might make less visible the fact that green alternatives constitute a rather marginal portion of all electricity generated by the company.

On the other hand, the fact that wind-produced electricity can be unprofitable for the company is also something that can strengthen the company's green identity: "despite the bad economic side of wind-power they produce it!" While green electricity may be unprofitable in the short run, it is reasonable to believe that it will be advantageous to acquire a solid green company identity in the longer perspective.[19]

Faced with certain short-term economic disadvantages, supposedly linked to long-term advantages with the catalyst of a green identity, energy providers need to make acceptable to consumers the economic disincentives. The word 'choices' in the marketing of green electricity becomes crucial. In October 1997, one of the UK Energy Companies we interviewed began to discuss how they could

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16 One must keep in mind the gap between these survey results and green consumer practices. In 1997, the British company A said that they would generate 10% renewable energy by 2010.

17 The energy company in southern Sweden claims that they have sold all their own wind power. Furthermore, they are engaged in other wind power companies, and have bought shares there in order to be able to offer customers wind generated electricity also when all their own produced electricity is sold. The Swedish company in our case has started a daughter company. The reason for this is that they needed a company that can only buy and sell wind generated electricity. Questions emerge as to what extent, and by what means the company tries to turn more households into green electricity clients. The economic statement made by one of the employees that the price for wind generated electricity would need to be raised by 5 öre to go 'round may explain the apparently moderate marketing of green electricity at this point. Green Electricity as a commodity has infinite flexibility in the sense that suppliers can order as much green electricity from other producers as is demanded by the clients. This immense *potential* is however not sufficient in order to augment in a sustainable way the ratio of green electricity compared to electricity using "greyer" sources. Green marketing by energy companies as well as information and greener fiscal policies created by the political authorities are a few of the critical factors.

18 During the first years of operation of the windmills Annica and Beatrice there were no subsidies to be had. When the third one was built there was however an investment aid of 35%. In addition, they got an environmental bonus, that is, wind power plants are subsidized by a sum that corresponds to the energy tax:, which is 15.2% as at today (autumn, 1998). Yet, the investment aid has been reduced, so that if one builds new windmills today, they will be 15% more expensive. Meanwhile the costs for investing per kWh have been reduced. The question is whether windpower can push out some other production source from the system: if not mainly nuclear power, then perhaps fossil fuels, as they hope at the Swedish company. They are not planning to establish new windmills, since the wind conditions are not the of the best in their local area. Nor are they planning to initiate any new cooperatives in the near future. Their policy was to do what they could to share their knowledge and experiences. This lack of initiative on the part of the largest local energy company, once they have established a conspicuously green production, ought perhaps to be analysed in the context of the large number of limited environmental experiments and projects, which are quite rarely expanded to constitute normality.

19 The company's own green identity is maintained on a regular basis, not least through their own maintenance of the windmills. They use Vestas windmills from Denmark. While green electricity may be regarded as somewhat of a fit-and-forget-it system for consumers, the Energy Company has to maintain the windmills at least once a month. The extra service is bought from the provider of the mill. People come from Vestas twice a year to change oil and make adjustments. Aside from that, the Swedish Energy Company incurs modest costs for running the mills – only insurance and administration costs. They have chosen old and safe techniques, rather than new technical innovations.

satisfy people's rising aspirations and thus "give people some of what they want." They came up with the Green Tariff, now referred to as the Green Pricing Scheme because tariff was seen to give the wrong impression, as the company representative explains "it's not fixed (…) we're trying to give the idea of flexibility so you can adapt how much you pay in." It is imperative that the consumers sense that they belong to a special category of clients. This is achieved by making a specific scheme to which green consumers belong rather than merely requiring them to pay a different tariff. The classical sociological phenomenon of strengthening identity through distinction becomes very obvious here. The flexibility that is stressed in the UK case has interesting implications. Flexibility may work by making, for instance, price differences less apparent to consumers. Moreover, flexibility, being the basis for charity of various kinds, has strong connotations of benevolence which might make consumers feel at ease when paying extra, at the same time as their green (moral) identity is reinforced.

The moral, charitable aspect of green electricity is reflected in the way in which one UK Energy Company regularly informs its clients about where their extra money goes. At the moment, for every £1 put into the green tariff, the company also contributes £1 to spend on "independent projects."[20] There was scepticism among the green lobby about what this would be used for. This resulted in the formation of a group of six trustees who talk to individual customers about what they want money spent on, such as windmills and PV panels. The trustees thus ensure the impartial and democratic character of the benevolent efforts of both providers and consumers. This is a way of acknowledging the social and relative nature of constructing a practice as environmentally sound. In addition to keeping the green identities of both providers and consumers alive, this continuous feed-back probably makes the reflexive client draw parallels between this green charity and, for instance, charities in Third World countries, or victims of earthquakes and war. A certain degree of benevolent competition may emerge as to where the extra money is best spent.

5.3.2 Water: How to Make the Visible Acceptable

Differentiation of water sources and functions has features both similar to, and distinct from, differentiated electricity provision. While green electricity is largely provided to reinforce one's green 'muscle power' and to remain a player in an increasingly competitive market, water differentiation has more of a "treasure-like" character. At one UK Water Company, they stress:

> *"The potential to reduce water use is large, up to 30%. If someone can crack it then there's lots of money to be made." (UK Water Company A).*

In a Dutch Case (A), the results have so far revealed an even more comprehensive reduction: 57% in drinking water consumption and in wastewater by 85%. However the pioneering aspect is muted somewhat by the UK water companies further revelation that the big companies are apparently too nervous to get involved. The flexibility of smaller companies makes them more courageous, something that is reflected in the large number of small-scale developments. This relates to dual processes in liberalised utility sectors: the growth of already big companies into even bigger ones, and the emergence of several small, specialised companies.

The Dutch case (A) 40 residences are equipped with extensive systems using rain and grey water.[21] A

[20] In relation to pricing, when they set up the tariff, the British Energy Company A originally put the premium at 10%, but then dropped it to 5%. Most consumers still tend to suggest 10%.

[21] The terrain is mainly unimproved so that rainwater can infiltrate directly into the soil. Rain water that falls on the houses is collected in a reservoir and is pumped back to individual washing machines. The reservoir consists of two compartments. In the first compartment floating particles sink; from the second one water is pumped out. The overflow emerges into a local swampy pool. Grey water (from sink, shower, bath, kitchen and washing machine) is collected and cleaned in a reedbed filter. From a basin, water is pumped periodically into the filter where it is cleaned by bacteria and other microorganisms. From there, the water is pumped to a pond where it is stored and pumped to toilet tanks.

UK Case (B) only 10 households are involved. In pilot plants with household and grey water the providers are generally conscious of the laboratory-like conditions. It is acknowledges that a certain knowledge gap remains as to what might happen in the full-scale real world.

In contrast to the energy sector, one can hardly talk about rivalry in the water sector between providers, in attracting customers by using green arguments and rhetoric. Water differentiation is at an earlier stage, where the main social challenge is to attract households willing to participate in water differentiation experiments. In such projects it may help to offer a certain economic incentive to consumers. A provider in the Netherlands, for instance, offers household water at a lower tariff than normal tap water. This tariff differentiation is currently artificial; it does not reflect all the extra costs that are involved in producing and distributing household water. Consumers are still given a lower tariff to reward them for using household water instead of drinking water. The price difference is 10-15%. In a future perspective this discount is nevertheless realistic since household water, if normalised, will be less expensive to provide than drinking water. Yet another realistic economic possibility for the future is purchasing one's own domestic grey water system as an investment. In one residential area in the UK, the prospective buyers of 4-5 bedroom homes were offered a grey water system for an extra 1,000 GBP. Despite this being a only a small extra investment relative to overall expenditure on the property, nobody was willing to pay for the grey water system. A representative of the Environment Agency in the UK argues that more research is needed to find out about whether people would accept such systems, hence the companies introduction of their 10 home pilot scheme. A problem is that initiatives of this type are limited in terms of available budgets, for larger scale projects other actors need to become involved.

The uncertainties connected with grey and household water schemes involve both providers and consumers. Neither can be sure that the systems will pay off, not even in the long run. Providers have a hard time knowing whether or not consumers will accept the various systems. A main question for providers is what the optimal scale of water systems would be - individual, semi-central, centralised networks. This is explored in our renewal theme. The scale in turn relates to the visibility of the treatment. A goal for certain providers appears to be to hide everything that would remind the consumer about water recycling – a perfect fit-and-forget-it system, removed from the senses. We argue that such concealment might be a way of reducing the dependency on ecological identity. Instead, it may help establish what can be called "green economic identity," the notion of long term gain for one's own wallet, while at the same time "doing something for the environment." The sense of ecological adaptation and identity becomes slightly blurred when the economic aspect comes too much into focus, although whether this is necessarily important is another issue, for instance, the extent to which consumers need to feel, sense and relate to the green identity of their water is debatable.

5.3.3 Waste: To Make the Visible Doable

Differentiation in the waste sector takes place in the fractionating of recyclables, new choices of collection frequency, and different tariffs. Thus it becomes obvious that successful recycling is dependent not only upon willing households, but also on active providers, local authorities and materials companies. Among authorities in the public and private sectors, comprehensive efforts at recycling have become somewhat of an environmental identity symbol. In Sweden, for instance, the official competition for the title "the environmental municipality of the year" takes recycling schemes into account as part of a green identity.[22] In relation to the electricity sector, there is less competition for customers by service providers in the waste sector. Nonetheless, the economic advantages to the providers of successful recycling cannot be over-estimated, and waste companies do often have to bid

[22] For the legal requirements for recycling levels imposed on municipalities and materials companies, see the DOMUS national policy reports from 1998.

for lucrative contracts to deliver services in certain areas.[23]

The waste sector is unique in the way in which it reveals how household action can help to create green identity. In household practices of waste management, providers' recycling schemes have frequently been action-oriented rather than merely appealing to people's green values. Several Dutch municipalities, among them Barendrecht, have introduced highly priced refuse sacks as a means of tariff differentiation. To dispose of domestic waste, citizens are obliged to use these sacks only. By raising the price for sacks and lowering the monthly levy at the same time, the charge for waste collection is related to the amount of waste disposed. Household consumers may save money on waste collection by producing less waste or separating their waste. The option of choosing the bin size and the number of waste bins in residential areas (e.g. in Sweden) can be regarded as creating a similar incentive to reduce waste amounts (or a disincentive to increase the waste) to the waste collection scheme offered by the Dutch areas mentioned above, with their highly priced refuse sacks. Among the waste differentiation cases, this is one of the more top-down ones. Since it is so specifically oriented towards number of sacks and economic incentives, it is hard to see how it would help create a more solid green identity (unless the residents also compare themselves with households which do not do these things). Another differentiated tariff project in the Netherlands points to the risk of economic factors gaining too great a prominence in the providers' attempts at motivating households. The experiment in this project involved the weighing of both organic waste (such as vegetables and fruit) and the remaining fraction. Wheel-bins were equipped with a chip that identified the owner. Weighing of the bins took place as the truck emptied them. Nonetheless, this differs from cases in the monitoring theme since Oostzaan focuses on differentiated tariffs rather than on the feedback effect of metering itself.

One example of a project with slightly more household initiatives is the Anniro project in Southern Sweden. The project was connected to a comprehensive town-and-country programme in Ystad, in turn highly influenced by Local Agenda 21 ideas. After making a request to the local street office, households in the separate houses may have their waste collected every other week instead of every week. This presupposes that the households in question produce low enough amounts of waste, something on which the local street office carries out occasional visual checking.

> *"The pedagogical work is about persuading the customer that longer waste collection intervals are not as frightening as many people suppose. Nothing particular happens to the waste if it lies in the bin one more week. But it is crucial to give households the opportunity to separate their waste in a reasonable way. This is partly our responsibility." (Head of the Waste Section, the Local Street Office, Ystad)*

This whole project started when the municipal Street Office contacted the Chair of the Housing Association. Representatives presented a concrete suggestion and asked the residents if they would be interested. The compost model was already chosen. A rotating composter was given free to each household by the Street Office. In this way the households got a clear and concrete idea of what their practices would involve. All three kinds of differentiation were involved: tariffs, fractions and collection frequency. Although the initiatives in this project show a degree of mutuality between authorities and the housing association, further below we present a case which reflects more bottom-up initiatives.

Is There An Optimal Number of Waste Fractions?

It would be an over-simplification to try to answer this question with a direct figure. Our case studies reveal that there are two crucial aspects of the question which relate to the roles of providers. The first aspect refers to developments in the waste sector as a whole. The other aspect has to do with

[23] Reduced transportation costs, the superior quality of the recyclable fractions sold on the market, and the avoidance of opening further waste sites, are only a few of the advantages of successful recycling and waste management.

providers' understanding of the broader lifestyle picture of households.

Developments in the waste sector as a whole

Developments in the waste sector as a whole, at a political level, constitute the standard, and it would be pointless for residential areas to separate into fractions which are then subsequently mixed up again by the service providers. Nevertheless there is nothing that says that ordinary citizens cannot be part of the political process of deciding the number of fractions. A Dutch example illustrates this, showing how a number of residents of Het Groene Dak negotiated with the municipal waste services about the different waste fractions which they wanted the municipality to collect. Initially the municipalities agreed to separate glass, tins, cork, plastics, aluminium, paper, textiles, and the normal organic and the rest fraction. The residential area also got a 10.000 NGL subsidy to build a shed for the collection of different waste streams and a press to minimise the volume of collected cans. Soon after the start the residents of the project realised that plastics were not treated separately once they reached the municipality, so they stopped separate collection of these. Eventually, apart from the normal organic and rest fractions, only separate paper waste collection works well. Now there are waste collection units for several different waste streams in the neighbourhood and everywhere else in town (in the Metro system, underground containers). Certainly some of these efforts have been overruled by developments in the waste sectors as a whole. Nevertheless, the example makes clear that certain steps in waste management need to be co-created with providers, local authorities or the like in order to be meaningful. This also shows how active consumers can be in pushing forward ecological solutions. Such actions help to develop the green identities of providers, who, by meeting the consumers' requests, stimulate a green practice identity among households, thereby forming a mutual identity construction. In fact, the Metro system in Utrecht is a result of neighbourhood consumer efforts in the whole city. Citizens advised the municipal authority about how their waste should be collected. There was a preference for a system in which a number of waste streams could be brought to a collection point at any time, rather than having complicated collecting schedules.

The providers' understanding of the broader lifestyle picture

This is an area which can be very much improved. In all three countries, we have found a number of cases of providers testing citizens' willingness to separate waste and recyclables in various ways. For instance, smaller wheeled bins and twin bins have been tested across the UK. The conclusion is usually that between two and four fractions collected at the kerb side appear to be the maximum number collectable or separable. However such statements are not a simple catchall solution. The number of fractions that is most efficient is not determined by any generalised laws of consumer behaviour. Projects of this nature should also take into account, and make recommendations about: how to practically separate the waste in households with limited space? where household bins should be (e.g. under the sink or in the garage)? What these evaluations of recycling schemes often fail to realise is that waste separation involves a number of steps and measures in the households. Where can people clean all their bins with recyclables and organic waste? What could they do to reduce the odour? In Het Groene Dak in the Netherlands the residents emphasised the importance of such practical preconditions. One resident states that the distance from kitchen door to collection point is crucial for successful separated waste collection. The difference between 50 and 500 meters makes a huge difference for households' motivation to separate their waste.[24]

[24] However, everything did not turn out perfectly in this consumer-active example. In the residential area, the kitchens did not have special storage places or bins. The Association considered installing "ecological kitchens" but that was too expensive. Instead the Housing association installed the cheapest kitchen available.

5.4 Consumption and Green Identities

5.4.1 Electricity: Free-Floating Greenness

As we have mentioned already, product and tariff differentiation is also about consumers creating, and not just being offered, new choices. Such processes set social reflexivity in motion; citizens do not automatically welcome every new choice with open arms. These processes also lead to questioning how the PTD schemes could better reflect the needs of active and knowledgeable consumers.

Queries often include how green responsibility ought to be divided between authorities, providers and consumers. In the Netherlands, the green electricity product was initially received with scepticism, especially among the environmental and consumer coalitions. There were debates about the link between the commitments that energy companies had made within MAP covenants and green electricity. Were consumers actually being asked to pay the costs of these commitments, which energy companies had to comply with anyway because of regulation? Other consumer views were that green electricity schemes represent just the opposite of the polluter-pays-principle. The green, thoughtful consumer has to pay extra for sustainable energy, while the fossil energy users get off cheaper, despite the environmental costs of their pollution. In this way, green electricity was perceived as the servant of a liberalised market in which the government can no longer determine the share of sustainable energy generation. Whether or not energy companies will use sustainable resources, it is argued, will then be dependent on a small group of environmentally conscious and wealthy consumers. In the context of green identity, such a system is likely to strengthen the green identity of a smaller fraction of consumers, partly because these consumers make an extra effort in terms of absolute green expenses, and partly because they simply distance themselves from the majority of consumers.[25]

Apart from the political irritability that has emerged among consumers, the reflexive (impartial) character of money appears to play a decisive role in the green identity processes of PTD. Georg Simmel (1903/1978) points out the indifferent, objective form of money. The content that it serves can be anything from the noblest pursuits to the most primitive desires. If we dare to label green identity a foundation for the noblest pursuits, PTD helps people become more flexible in their reasoning about what is the noblest. A clear sign of this free-floating green identification is the fact that those organising green electricity at the southern Swedish Energy Company are themselves sceptical about the scheme. In the interviews, these people reveal that they prefer, if anything, to buy shares in a wind power cooperative rather than choose green electricity produced by their own company. Actually, the interviewees do not think that any employee at the company chooses otherwise:

> *"I can look at myself. Ingemar (the other person responsible for green electricity) says that one cannot separate electrons in the grid. At the same time I can understand that an involvement in a certain production type perhaps would lead to more wind power plants being established, if one is very interested in this. But as for my private financial situation, I'm not ready to provide money for possible wind power plants. And I think many people share this point of view." (Person responsible for green electricity, the energy company in southern Sweden)*

Moreover, both persons hold that they would rather invest their green money in a wind power company far away than spend it on green electricity in their own company. This reflects both an environmental and economic rationality. A wind power cooperative would perhaps produce an

[25] Currently, after the Dutch abolition of eco-tax for green electricity, consumer prices vary between 2 and 5 cents per kWh, which makes a total of 50 to 150 guilders per year for the greening of an average electricity consumption of 3000 kWh/year. It is expected that this will result in a further increase in green electricity consumption in the Netherlands

economic surplus which, if they wished, could be reinvested in green projects. As we mentioned above, such a free-floating green identity could even transcend the environmental sphere and lead to debates over whether one's money could not be used for more urgent projects than green electricity generation. However, energy companies have found ways of immobilising the free-floating green identities of certain consumers. At the southern Swedish Energy Company, for instance, there is the option of signing a contract for 3 years. Contractors can purchase wind power electricity at the price of 23 öre/kWh, which is actually 2 öre cheaper than conventional electricity and 6 öre cheaper than wind power without a contract. The three-year wind power contract is a green identity booster, despite the fact that the electricity is actually cheaper than conventional electricity. The green commitment has an identity value.

Furthermore, if one wants to change to this company from another one, one has to buy the hourly electricity meter at a price of approximately 2500 Crowns, that is if one lives outside the "billing area" of the company. The option – created by liberalisation – to purchase electricity from companies in other local areas than one's own, can also function as a way of strengthening identity construction through electricity consumption. The extra consumer effort of searching out the greenest company is closely tied to free-floating green identity.

Finally, we have seen interesting examples of how green identity can turn inward, and how these examples raise questions about the daily routine of one's own household. This is a process which is very much in contrast to the political one, which reflects on which societal levels ought to have the main environmental responsibility. The green identity directed inwards might ask: "How can we in our household change to green electricity and still avoid the extra costs?" Although the answer may require certain lifestyle changes, it appears simple: use less electricity.

In some ways the extra cost for green electricity in schemes in the UK was also justified by relation to the impact on household expenditure as a whole. If the size of the electricity bill has not changed much, despite the extra 10% for green electricity, and other incentives such as direct debit which help generate savings on bills are also initiated by companies that it appears that consumers may be willing to overlook the subsidy for greener fuel. In other cases we have seen more expansive ideas, implying that "the more green electricity we use (in the absolute sense), the better for the environment."

5.4.2 Water: Basic Need versus Cultural and Technical Tolerance

Conflicting Views on the Essentiality of Clean Water

To say that clean water is a basic need is in one sense a truism. Nevertheless, in the Netherlands and the UK the governments acknowledge that all household practices do not require drinking quality water: hence the Dutch and British cases of differentiated water sources and functions. Sweden, on the other hand, has no cases differentiation cases to present in the water sector. Almost all water in Sweden is purified and the use of grey water is very rare, because of the low costs of purifying water and the (in total) sufficient amounts of water in Sweden. However, as far as the motives for saving water mentioned above are concerned, there seem to be several environmental reasons for reusing grey water in Sweden.[26]

In the Netherlands there are two levels of VAT (value added tax): products and services considered basic needs are taxed at 6% ; the rest, so called luxury products and services, have a tax rate of 17.5%. Currently, Dutch households pay the lower VAT level for drinking water. Last year, the Government proposed to differentiate the VAT levy on drinking water: the lower tariff for the first 60 guilders consumed (considered a basic need) and 17.5% for all the water above this level. The defence of the proposal is largely environmentally derived. However, both parliament and the water

[26] See the Swedish national policy report within the DOMUS project. See also Johansson, p. 163.

companies are opposed to the proposal, stating that it is just another way of increasing tax revenues. Besides, the suggested limit is regarded as arbitrary. Is bathing or flushing toilets a basic need, or is only drinking a basic need? Moreover, the opponents to the proposal claim that it is at odds with what the Government gave as the main reason, and that nobody would save on water use if the proposal became reality, because of price inelasticity. We argue that it is an open question as to how elastic water consumption is. While it is obviously true that people do not save water unless they want to, it is not clear how little they are willing to save. Moreover, it is important to bear in mind that such assessments cannot be made accurately by simply asking people. Our cases of waste separation, in particular, indicate how new trial behaviour can trigger new, green identities, something that people do not know about before they have taken part in the trial.[27]

Cultural Tolerance and Green Identity

Conceptions of basic need, and processes of greening one's habits are closely tied to cultural tolerance and identity construction. In the water sector, cultural tolerance is a more prominent issue than in the other sectors. We have not found any single factor which makes consumers accept differentiated qualities of water. The tolerance aspect varies in the different projects, and in most cases it is too early to tell. In general, however, the Dutch and British householders whom we have interviewed support *the idea* of using a lower quality of water for toilet flushing. In the Netherlands especially, this is not surprising. Dutch water companies have since the 1970s communicated the idea that water is something special (clear, healthy, tasty, rare). The idea of flushing this valuable water down the toilet is something that does not comply with this image of water. This can be labelled an ecological motive for saving – tied to a green identity which is about economising over natural resources. In the water sector (in contrast to the electricity sector, which is concerned with the global greenhouse effect), the smaller scale motive of economising is stronger than the concern for a scientifically examined global environment. The tolerance issues are several in the differentiated water sector: health, hygiene, as well as technical and economic uncertainties. We begin by exploring health and hygiene concerns.

In one of the UK grey water cases, where chlorine is used to treat the water before reusing it, the initiator of the schemes noted that when they interviewed people they asked if there were any perceived health problems. In most cases, people thought that there was no linkage with any illness. Nevertheless, certain users did complain about "choking on chlorine fumes" and "stinging eyes", during maintenance of the system. Another significant factor in changing people's positive attitudes towards the system were high faecal E.coli readings in toilet water, which emerged as a particular concern for some of the families with children.[28] One respondent who had already considered buying a grey water system at the beginning of the trial decided not to in light of bacterial readings, as it represented a health risk. It is also important to stress that by using terms such as cultural tolerance, we by no means imply that these health issues would not be real or physically disturbing. Instead, cultural tolerance refers to how much of such matters people in different times and contexts are willing to put up with, and how serious they consider these occurrences. We are also interested in the roles played by thoughts about how friends and acquaintances will perceive such a new exposure of non potable water, with its chemicals and bacteria. One assumption is that if one's own household accepts the use of the differentiated water system, concerned comments and worries among friends and others may function to strengthen the household's green identity, through distinction and a certain

[27] Currently, the proposal is reviewed by the EC and is found not in line with EC directives (H2O journal 32:2, p. 4). The Government is at present working on an alternative plan that would be to make the first 15m3 free of VAT.

[28] As regards people's perceptions of rainwater and cleanliness, people at British Water Company A note that "Water may be clean when it falls, but perceptions change as it crosses the roof and sits around in the storage butt." Nonetheless, the providers at British Water Company A tell us that there is some development of rainwater in UK, for instance a project in Telford with the local council and Water Company A. They have a back-up project which is fitting three rainwater units into houses.

degree of risk-taking. A question mark should here be put over the chemical element, chlorine, which symbolises anything but greenness.

An important aspect of culture and health is how people perceive systems where several households share their grey water. We found initial scepticism about such systems. All the grey water systems managed by the UK companies we interviewed were developed for individual homes adjacent to other houses. The concept of using other household's dirty water was strongly resisted. Nevertheless, some organisations are developing systems for communal schemes, for instance, one of the UK water companies we interviewed had recently become involved in a new development in Lancashire, where a treatment plant was being built for the on-site recycling of communal grey water from the houses on the estate.

Although our British case material indicates a certain hesitation about initiating grey water projects, there is still an emerging issue of "power to insist." With pressure mainly coming from building and water regulators in the UK. Perhaps the regulators' insistence will help in the normalising of water efficiency schemes so that they do not appear too radically green and eccentric. There might thus be limits to the degree of green identity which is productive.

Knowledge and Technical Tolerance

Another part of tolerance is what we label technical tolerance. We here include both knowledge and technical skill, and how much time and effort people are prepared to spend on the water differentiation systems. In the case of the pilot scheme in the UK, everyone was enthusiastic at the beginning of the scheme, and open-minded about whether to keep the system. However, the report produced at the end of the project suggests the situation has dramatically changed. This partly relates to the unreliability of the technology. Instead, the spokesperson claims that there ought to be a fit-and-forget-it system which makes no difference to people's practices. One might ask if the reduced motivation is based on an initial expectation of the current system being a fit-and-forget-it one. Modernity has brought the idea of constant development in terms of domestic facilities and comfort, and if providers do not inform consumers about possible hassles, households might assume that grey water innovations are of the fit-and-forget-it kind. To speculate further around the decreased motivation, the discouragement may be reinforced by a discrepancy between the high-tech image of innovative water differentiation and the very concrete, low-tech problems of the system: lagging pipes, the need for covering colour with blue flush, freezing pipes, and having to climb up ladders to clean out filters.

The need for trial and error is furthermore not what people usually think of when using a new, advanced system. We pointed out that people still have hassles associated with the maintenance of conventional systems. Could the hassles with the grey water system really be much more serious? Our Environment Agency respondent felt that at the moment there was too much maintenance and hassle involved, but also recognises that maybe there would be "a period of adjustment." Once this is fully realised, the technical tolerance level can be raised. In this way green identification among consumers can be established, once people are aware that they are using an innovative, environmentally sound system which might require them to make some extra efforts that conventional consumers do not make.

A still more serious problem than the technology itself has been, according to our interviewees, the lack of support from the manufacturer in this particular case. The respondents felt that people should not have to call the company all the time. The company was slow to respond when things went wrong. We brought up the importance of feedback and knowledge-sharing above, something that is especially important in cases of differentiated water. This is not only important for keeping the system intact, but also to co-create the green identity of providers and consumers: to share experiences and goals.

In conclusion, there is a lot of interest in grey water systems, but few people are willing to put up the

money up front because of the risk of failure. Hence the economic uncertainty adds to the technical one. However, one could argue that we may have been unfair in giving the Dutch water cases little space compared to the UK cases. The latter largely deal with small experiments where heavy chemicals are used. There are several Dutch household water cases (e.g. the Polderdrift case) that seem hopeful, both in terms of cultural tolerance and environmental adaptation (without chemicals being used). The Dutch cases often have reed bed filtering. To be sure, Dutch water cases, further explored in the Systems of Scale theme, reveal certain problems with pumps and ponds. Nevertheless, people keep their spirits up by stressing that their innovative practices are for the sake of the environment.

Finally, a technical problem of flexibility appears to be essential in our water cases. In order to use water from the second rinse from household laundry, "you would have to get inside the machine and fiddle with the controls, which means the warranty is no longer valid." This is why they decided not to reuse washing machine water in one of the British pilot projects. This problem extends the feedback and knowledge aspects, calling for appliance manufacturers to become more involved in the complex changes to the system of differentiating water.

5.4.3 Waste: Individual versus Collective Green Identity

In an earlier section on waste we explored the importance of provider initiatives for successful domestic waste management. In this section we focus on the household's integration of the green waste and tariff differentiation in the individual lifestyle.

The Individual Identity as Part of the Collective Green Identity

The individual versus the collective identity can in this sector be interpreted in parallel with anonymity and feedback in relation to a green social identity. Let us take Anniro in southern Sweden as an initial example. A few households hold that the trial period ended too abruptly. From a situation of being provided with continuous feedback, it subsequently became more difficult to get help from the Street Office (cf. the feedback problems in the water sector above). Some areas of confusion relate to how to adapt the composting routines to the different seasons. Each season presents the households with certain composting problems. During summers the risk of odour is higher, whereas the compost material is likely to freeze during the winter season. However, once the level of information provided by the municipal authority was reduced, neighbours began to help each other out and give advice. This has ultimately led even households with children in the nappy stage to reduce the frequency of garbage collection to every other week. As a comparison, we have not seen social feedback of this nature between lay people in differentiated water schemes. The technical complexity of such schemes appears to make those schemes more expert-dependent than are recycling schemes with individual composting.

The Anniro waste case illustrates the two-sidedness common in schemes with waste differentiation. The limited size of the residential area of Anniro enables the neighbours to get a rough sense of which households are less successful in their composting and waste reduction. Problems, errors and "laziness" are focused on when the waste project is discussed formally (in the Housing Association) or informally in the neighbourhood itself. 'Ungreen' identity is more visible than green identity.

In terms of actual recycling results, the social pressure of a collective green identity is mainly a productive one. In several other cases the same tendency has been observed. Similar results are found in Bath and North East Somerset in the UK (Audit Commission, 1997). The project has developed as a partnership between the local authority and the Avon branch of Friends of the Earth. There it became clear that mini-recycling centres were more successful than larger scale recycling schemes. Large scale solutions frequently make the individual consumer feel anonymous, something which diminishes the collective green identity (see also Klintman, 1996).

As regards motivation and morale, the role of economic recycling incentives is important. How do economic incentives for tariff differentiation combine with green identity construction? We have earlier noted that economic incentives should not be over-emphasised when trying to motivate people into adopting green practices, because there is a high risk that the economic element will over-shadow the ecological benefits. Anniro reveals the positive, yet symbolic, value of economic incentives. Money has its importance, but it does not appear that the saved *amount* of money is crucial:

> *"I don't think that the 500 crowns were very important. It was more that yes, it was good be able to save a little money at the same time. But at the same time, it would be irritating if collection every two weeks was as expensive as once a week. If you have paid a full fee they should come and collect the waste each week. That's probably how most people see it. In that sense money matters, but not in crowns and ören." (Man, 45 years old, living with one adult and two children in Anniro).*

Hence the economic incentive may impact on the recycling morale. Yet, thinking about the time and efforts that people spend on recycling and on learning about composting, this is more an illustration, not of 'economic man', but rather of 'ecological man', of people creating and developing a green identity.

From Ecological Motives to Broadening of Green Identity

As opposed to the water sector, the waste differentiation cases are to a large extent success stories. This gives much cause for hope for the future of green waste differentiation.

In Anniro in southern Sweden, the Head of the local Street Office maintains that the vast majority of households are satisfied with the recycling routines and composting. The chair of Anniro is very pleased with how the composting scheme turned out, both in his own household and in Anniro as a whole. He claims that 75% of households have moved over to a two week interval for waste collection. The chair of the local Street Office tells us that one household has contacted the street office to buy a second composter to use out in their cabin. Yet, there are a few households where the composting does not work very well. The ecological feedback is sometimes more negative here. The one person households have difficulty in getting the composter to work properly. A certain amount of wet waste seems to be needed. Also, the smallest households interviewed in Anniro revealed their feeling of being such a marginal part of waste production that the composting and recycling of their waste would be somewhat superfluous. However, the increasing share of single households in Europe (in Sweden approx. 50%) makes the importance of their recycling obvious. A plausible solution would be to have a few single households sharing a composter.

In Bath in the UK, the comprehensive recycling scheme with direct feedback to residents is considered successful, according to providers (see Audit Commission Report, 1997). The wide range of materials collected from residents is separated at the kerb side into special multi-compartmentalised vehicles. Such kerb side sorting permits direct feedback to residents; materials that are not accepted for recycling are left behind in the box, with a note explaining why they cannot be taken. Today the green box recycling scheme covers about 45,000 households in the Bath and Wansdyke area and employs 23 staff members. Residents in these areas recycle or compost over 25% of their dustbin waste. Accommodating the needs of different residents encouraged a higher participation rate and sorting at the kerb side allows for maximum recovery and minimum rejection of recyclable materials, as well as reducing the need for post-collection sorting.

Finally to present a Dutch example, the results in Oostzaan are very promising. They included a reduction of 60% in remaining waste, and a reduction in green waste of 50% compared to 1992. It was clear that consumers are not used to the idea of paying for their waste collection. The period from October 1993 to April 1994 proved that the application of financial incentives discouraged the

production of waste. Research showed that two-thirds of the inhabitants were content with this system, as on average they had to pay less for the removal of domestic waste. A small part of the remaining waste fraction is taken to other municipalities, but it is supposed that this side-effect will decrease as habituation occurs.

One of the virtues of green identity construction (as opposed to mechanically adopting a new behaviour pattern) is that it can lead to broadened reflections on how to green one's lifestyle. It was this creative process to which we referred at the beginning of this chapter. Changes to one environmentally-related action might lead to other action changes, not only for environmental, but also for practical reasons. In Anniro there are clear practical motives for reducing the amount of packaging of the goods that people purchase. The composting has led the households to plan and adapt their consumption according to the limited space in the rubbish bins. The single household's results are visible:

> *"Now when we have changed to two week collections it means that we buy different things than we used to. We avoid large detergent packages and marmalade jars. Now I buy refills that there is room for in the rubbish bin." (A resident of Anniro, southern Sweden).*

Similarly, in Horsham in the UK the authority is now delivering 140-litre bins free of charge to every household in the district, while households requesting the larger 240-litre bin have to pay an administrative and delivery fee (see Audit Commission Report, 1997). One of the main outcomes of the scheme has been that the small bins and recycling baskets provided householders with the incentive to recycle and compost rather than throw waste into the bin. The practice of composting constitutes here an extension of households' greening practices. With bin technologies and active consumers playing an important part.

5.5 Conclusions and Discussion

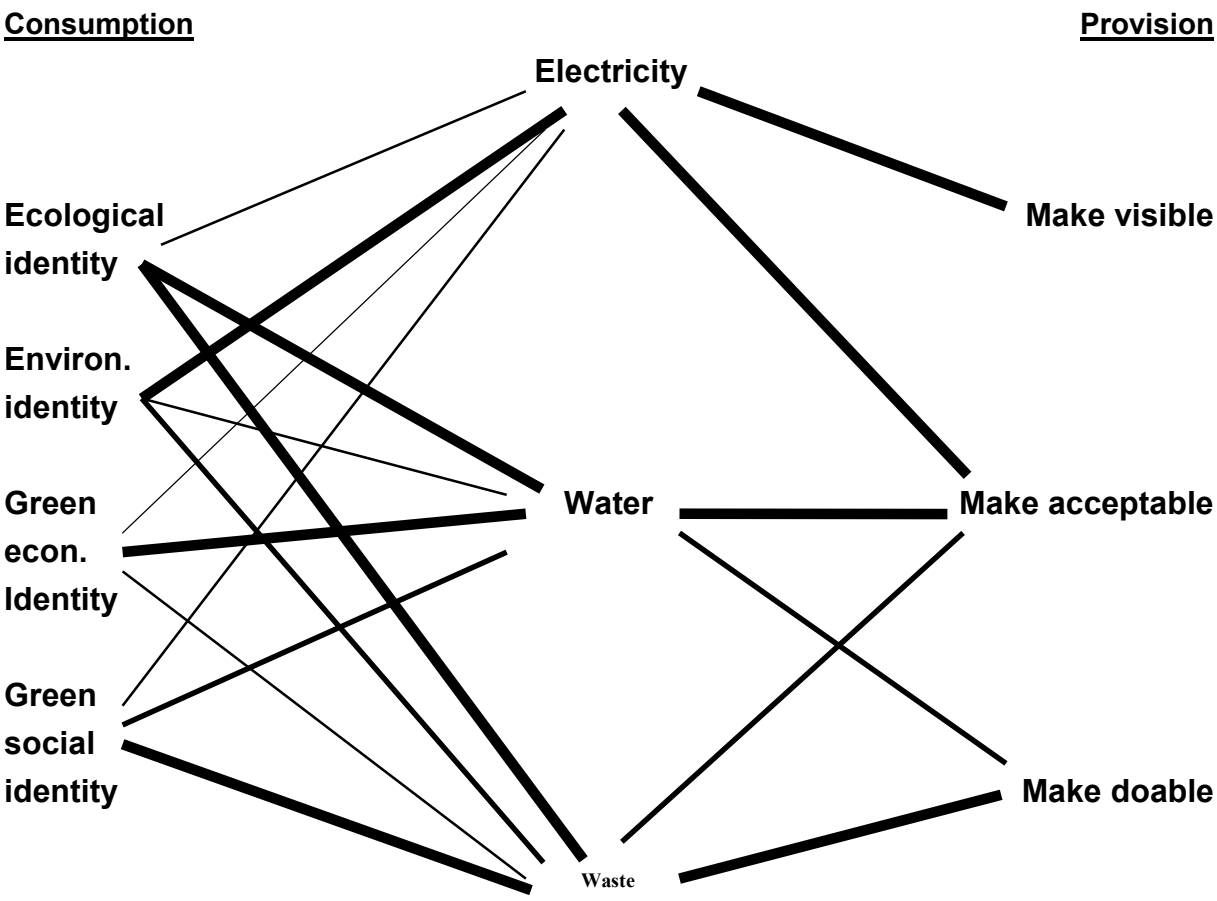


Figure 1: Forms of Green Identity in PTD

To summarise, we attempt to show how different kinds of green identity are connected to sectors and the priorities and objectives of provision. In Figure 1 we distinguish between consumption and provision and not between consumers and providers. The reason for this is that PTD can be provided by consumers themselves, something that we discuss further in Figure 2. The paper argues that green identities among consumers can be divided into (a) ecological, (b) environmental, (c), green economic identity, and (d) green social identity. In Figure 1 we show how consumers in each of the three sectors may hold more than one kind of green identity. The thickness of the lines reflects the strength of each identity. We attempt to show here how the construction of identity through consumption is far more than merely a question of use-value, in the narrow, utilitarian sense, or a question of social prestige. Rather, all the forms of identity presented (except perhaps green economic identity) are closely tied to personal selection of self-image and lifestyle.[29]

Consumption

(a) Ecological identity refers to awareness of local and small scale eco-cycling, as well as of saving resources. It often involves subtle perceptions of the feed-back from ecological processes. Successful composting practices, for instance, are indicated by the quality of the soil. Reduced waste going to landfill sites as a result of PTD is sometimes apparent in local figures for waste reduction. Ecological

[29] For a much more in-depth discussion of consumer identity and image, see Warde (1994a).

identity is also strong in the water sector, as the advantages of water differentiation are easily comprehended as the need for economising over local water resources. The material concreteness of differentiated water also makes ecological identity closely tied to this sector.

(b) Environmental identity, on the other hand, refers to a more intellectual awareness of large scale environmental problems which are debated in media and researched in the advanced sciences. Two of these problems are global warming and ozone layer depletion. Environmental identity turns out to be most intimately connected to green electricity consumption, contributing to a somewhat larger share of investments by greening the, often national, grid. Waste differentiation is also related to environmental identity, as it has been a substantial part of the think-global-act-local campaigns. Reduced waste incineration has also been related to larger issues in the public debate. Local water differentiation in the developed countries, on the other hand, has largely been excluded from the global discussion of environmental problems of water in the developing countries.

(c) Green economic identity is best illustrated by the phrase: "We save money on it, and it is good for the environment, too" (or the same, in reverse order). Green electricity consumption is least connected to such a statement, since it is an economic disadvantage for households to purchase green electricity. On the other hand, this economic disincentive can sometimes function to strengthen environmental identity. In waste differentiation schemes, green economic identity has been reflected in several interviews. However, it appears from the cases that a symbolic economic advantage is more crucial than the actual size of the economic gain. The water sector, ideally, comes close to green economic identity, since using grey water is supposed to enable households to save money, at least in the long run. However, since water differentiation is still in its early stages, this has become reality for far from all consumers in our cases.

(d) Green social identity, finally, emerges in cases where informal and formal, sub-political efforts have an essential role to play in developing and implementing PTD. The waste sector presents several examples of this. Continuous feedback between providers and consumers has been a key to success here. The same is true in cases of water differentiation, although it was only in the waste sector that feed-back proved to have the potential for continuing between neighbours once help from providers started to be less available. The technical intricacy of grey water schemes still makes it quite difficult for lay people to help each other out. Green electricity is something which is still largely based on communication between provider (an energy company) and consumer. It remains to be seen whether or not social networks of neighbours and residents can be developed here.

Provision

Provision also contains green identity-creating components. We have divided them into three components: (a) make visible, (b) make acceptable, and (c) make doable. These need to be described in more detail.

(a) To make visible is close to green electricity provision. Providers in our electricity cases put their main efforts into making their green electricity (by nature invisible) conspicuous. This serves the dual purpose of marketing the product, and establishing the green identity of the company. Interestingly, conspicuous slogans of what today's consumers "really want" may help to construct green environmental identity among consumers, who may not have thought much about environmental issues before. Moreover, making visible the fact that green electricity production is not always economically profitable in the short run also reinforces the idealistic image of the company. The bottom-line is that the main aim of providers of green electricity is to make it visible on the market, thereby 'selling' environmental identity and strengthening the green environmental identity of certain consumers.

(b) To make acceptable was initially assigned to differentiated water schemes. We use this to refer to

the providers' efforts to make the aspects of health, hygiene, aesthetics, and technical feasibility acceptable to consumers in the water sector. In connection with water differentiation, it is relevant to discuss "new" risk emergence and perceptions of risk of kinds that the health-concerned modern society has largely been protected against. Accordingly, providers mentioned fit-and-forget-it solutions as the ultimate ones. Yet, these would have an impact on ecological identity, since this would not be relevant, other than in the initial stage of getting consumers to accept a system. Beyond that stage, a green economic identity would be sufficient. As we have seen, green ecological identity has the advantage of spreading to other household practices than the one where it originated. The thick line in Figure 1, from electricity to *make acceptable,* refers to the economic disincentive inherent in green electricity, which actually made even providers themselves in their role as consumers refuse to accept this. The thinner line to waste reflects the odour and hygiene aspects of waste differentiation: having to keep several bins in the house, having to compost and rinse organic waste. However, these concerns are usually turned in acceptance, if the feedback from providers and neighbours is sufficient. This touches upon the third component of provision, to make doable.

(c) To make doable. This has to do with the physical and practical conditions that providers are largely responsible for, whether it be the consumers themselves or providers. We want to put forward an action-oriented approach. Providers have two main tasks here, which relates especially to waste differentiation, but also to water differentiation. One of the tasks is to develop policy and larger management systems in the sectors so that consumer practices become doable. In the waste sector the number of waste fractions that are recycled by providers is fundamental to what consumers will do. The second task is to improve the physical and practical conditions for waste and water differentiation in the everyday life of consumers. Essential factors here are the distance from households to bins, the extent of physical preparedness in the households, and information about how to decrease practical obstacles at an everyday level.

Table 1: Co-creation of PTD by Consumers and Providers

Consumers	***Providers***
Electricity	
- Selling Green Electricity from consumer co-ops to energy companies	- Providing Technology - Tariff Differentiation (disincentive) - Make Visible
Water	
- Technical engagement and interest in innovations - Co-design of water PTD projects	- Information and feed back - Technical Installations - Tariff differentiation (incentive) - Make acceptable
Waste	
- Suggestions of number of fractions - Physical/practical provision of compost equipment and household bins for recyclables	- Policy conditions - Number of fractions - Improve practical household conditions - Tariff differentiation (Incentive) - Make doable

We have seen examples of how consumers and providers co-construct different forms of green

identities. In figure 2, examples are given of provision of concrete PTD efforts. We show here how consumers take an active part in PTD provision. Nevertheless, the differences between sectors are obvious. As for green electricity, this is the sector where consumers are most distanced from provision, other than in terms of economic provision for green electricity projects. The water and waste sectors have far more consumer activity in providing the conditions for practice together with providers. The waste sector is the one where consumers have the most autonomy of action in improving their lifestyle conditions for PTD practices.

Several matters which have relevance for policy have emerged in this paper. One is the importance of stimulating providers in the utility sectors to establish better collaboration with consumer groups, grass roots organisations and other consumer forums. The research for the PTD theme provided evidence about how often providers base their level of differentiation on over-simplistic assumptions about consumers' preparedness or willingness to act. The number of fractions for recycling is the clearest example. However, in improving the collaboration with consumers it is not sufficient to increase the number of *a priori* surveys of the extent to which consumers are willing to act in accordance with certain levels of PTD. Through studying cases of water and waste the strength of the practical process towards acceptance and doability has become clear. Frequently, it is only after having tried a practice that consumers acquire ecological or environmental identities to the extent that they will take further initiatives, make suggestions to providers, and broaden their green practices. However, this is only one side of the coin. More fundamental appears to be the tendency for utilities to become increasingly larger, whereas PTD might benefit more from the emergence of several small, flexible companies providing specialised green choices. In any case, better green market segment studies are needed. The discovery that even providers were unwilling to purchase green electricity from their own energy company makes it apparent how crucial it is to parallel new product choices with studies of consumers' preparedness to become engaged in new practices. Based on its subsidiarity principle, the European Union can play an important role in emphasising the diversity of conditions at the regional, local, and neighbourhood levels. Regulations at national level which were previously too rigid can thus become more flexible. This is a call for making more subtle assessments of local differences, forms of life, various green identities, and motives, not least through communicating with citizens. At the same time, the EU has a role to play in improving the distribution to consumers of environmental standards and assessments of utility companies. There is still much that can be done in turning these standards into useful criteria for increasingly diversified consumer groups in their new product choices. Standardisation and convergence have simultaneous counter-tendencies not only in PTD. In the next chapter we shall explore both diversification and convergence of systems of scale.

6 - SCALES AND MODES OF PROVISION

Bas van Vliet

6.1 Introduction

This chapter presents an analysis of the different ways in which energy, water and waste systems of provision can be or are being reconstructed in a more sustainable way. As in the former two chapters on monitoring and differentiation, the chapter does not present the findings from the case studies as such, but utilises the cases to support the analysis of what is the main subject of this chapter: diversifying scales within systems of provision. The cases to which the analysis refers are presented in the annex[30]. The analysis of systems and scales in water, energy and waste service provision also introduces the issues that will be dealt with in the following chapters on Demand Side Management and Sustainable Homes.

In section 2, we explore the variety and different dimensions of scales by referring to the typical issues concerning network provision and economies of scales. In section 3, the example of diversity in scales of provision of solar panels will be used to extend our ideas on scales and modes of provision, followed by examples from other sectors. Section 4 deals with national and EU policy on utility provision and what these tell us about the future scales and modes of provision within the three sectors of water, waste and energy. This is followed by conclusions on innovations and scales and modes of provision in section 5.

6.2 Variety of scales

The issue of scales was raised early on in the Domus project, when we began to explore utility-related environmental innovations and found an increasing diversity of scales of technology and organisation. Ever since the consolidation, around the mid-20thcentury, of large-scale public utility networks for energy, water and waste services, there has been little diversification in scales of provision. The provision of water and electricity to nearly every household in Europe has been established through macro networks benefiting from natural monopolies and economies of scale.

Natural monopolies are market situations in which network providers are the only providers in a region, because there is only one network available. They are termed 'natural' as competition between different parallel networks in one region would be economically inefficient for all parties. The term 'economies of scale' refers to the fact that some sorts of provision are only beneficial if there is a minimum number of users or clients, or a minimum size of a network. For instance, the provision of tap water through a piped network would be extremely uneconomical unless a large number of households were attached. As soon as a considerable number of households could be connected and charged for the service, water supply systems became viable.

Initially, water and energy infrastructure were provided by private parties, but the large scale investments that were needed to build the network infrastructures to connect all households, including remote ones, could not be handled by private parties alone. Therefore, state provision of these services became the dominant mode of provision from the beginning of this century onwards. Until the early 1980s, water, electricity and waste service provision could thus be characterised as inherently

[30] Cases referred to in this chapter can be found in the annex under: Amersfoort – Nieuwland Solar Power Projects;Composting Schemes; Green Electricity Schemes in the Netherlands; Grey water systems; Household water system; Rain water systems; SunPower system; Sustainable Homes; Windmill co-operatives

public sector, and on a large-scale (Tellegen et al, 1996).

The inventory of environmental innovations in water, waste and energy showed a wide diversity of scales of innovations within the existing systems of network provision. Although the networks are still large scale, the provision of services has became diversified as have modes of provision. Scales and sizes are however highly relative terms and may refer to different dimensions. Here we distinguish four such dimensions:

- Scales of management (from centralised to decentralised)
- The reach of the system (small versus large numbers of users)
- Scale of impacts on the network (stand-alone versus fully grid connected)
- Level of expertise needed to run the system (lay knowledge versus expert knowledge).

The inventory showed that there are quite a few cases of innovations which involve downscaling, compared to conventional devices or systems, in one or more of these dimensions. Smaller scale, generating technologies such as district heating partly replacing large-scale power plants. The same can be said of rain and grey water systems partly replacing large-scale water works, and community composting partly replacing waste incineration and landfilling.

Such downscaling processes can mainly be attributed to the liberalisation of utility markets and the privatisation of utility networks, which have triggered a process of spatial, institutional and technological 'splintering' in the delivery of utility based products and services and the development and management of utility networks. By ‘splintering’ we not only mean the differentiation of services and products offered by utilities, as discussed in our differentiation chapter, but also the fragmentation of utility services and management practices as they become implemented at a range of different scales.

Apart from the liberalisation of utility markets there are at least two other parallel developments which may well have contributed to the emerging divergence of scales: *demand-side management* as a way to cope with resource and capacity problems, and the increasing utilisation of *renewable resources*.

Demand-side management approaches, which emerged in the late seventies as a solution to resource scarcity or to put ceilings on network capacity, included the downscaling of measurements from system level to solutions applied at the level of end consumers. Instead of expanding resource extraction and infrastructure capacity to meet increasing demand, the new approach was to minimise demand so as to make better use of existing capacities. Technologies that were put in place included night storage heaters to limit peak demand, efficiency devices such as low energy light bulbs, and low flush toilet cisterns, all typically downscaled solutions for large-scale problems. Demand-side management approaches and the role of consumers will be dealt with in more detail in the next chapter.

The second development is the utilisation of renewable resources such as the sun and wind for energy, lake water for drinking water and renewable techniques for waste treatment such as composting. These technologies can be applied and used at a local level, without excluding larger scales of application. This distinguishes renewable resources from conventional ones like fossil and nuclear resources for energy, reservoirs for water supply, or incineration plants and landfilling sites for waste, all of which inherently require large-scale application. The emergence of renewables in the three sectors, and their promising future, will contribute to the diversification of scales of application of energy, water and waste technologies.

Diversification in scales as a consequence of liberalisation, demand-side management and the

utilisation of renewables will change utility-consumer relations considerably. Formerly characterised as the central supply of uniform flows and services for all, utility supply will be fragmented, coming from a range of different small and large providers, among which consumers themselves can play more active roles. With smaller scale technologies, to be applied at the level of households, one may assume that consumers will be more involved in how utility resources are supplied to them. However, diversification of scales of technology does not automatically imply parallel diversification in terms of management or ownership. Indeed, most of the large scale technological innovations, such as biomass power plants, are operated by utility companies while small scale innovations such as low-flow cistern devices and energy efficient light bulbs are most often installed and used by individual consumers. However, our cases also showed some inverse relations between technological scales on the one hand and management and ownership on the other. The wind turbines that are installed and operated by associations of individual consumers are an example of large scale technology and medium scale ownership. The distribution and appliance of low energy light bulbs by housing associations and home-based grey and rain water systems by water companies are conversely examples of technologies that are small-scale in terms of output, while they are owned and managed by large-scale institutions.

To illustrate the possible mixes of different dimensions of scales of provision, we shall first explore the diverse ways in which one particular renewable technology can be made available to domestic consumers. The case of solar power provision is chosen as a good example of how a technology can prove to be highly flexible with regard to the possible combinations of dimensions of scales and the accompanying roles of consumers.

6.3 Scales of innovations and modes of provision, access and use

6.3.1 Diversity in the provision of solar panels

Solar panels may be considered as small-scale technologies, but not in all the modes of provision or dimensions that we presented above. Moreover, although the panels are the same, their modes of provision and access can differ among the cases. Modes of provision include state, market, domestic or informal provision. Solar panels form only a marginal part of total electricity generation as they are still very expensive and have a relatively low output. For instance, the Amersfoort 1 MW project (see Amersfoort-Nieuwland in the annex), which involves covering hundreds of houses with solar panels, is currently Europe's largest solar energy project in the built environment, while one single wind turbine would produce the same amount of energy. However, solar panels are a reliable energy source, producing electricity as soon as they are installed, without many maintenance requirements and without producing noise or other nuisances.

This section does not aim to assess the extent to which solar panels have become diffused among the countries of our study, as it is not based on a survey of such kind. Rather, the examples of solar panel applications will be used to explore the whole range of diversity of scales and modes of provision within which innovative technologies such as solar panels are currently being applied. We shall briefly describe the following schemes of solar power supply to household consumers:

1) Single panels - self-installed

2) Sets of panels – as *SunPower* scheme delivered by energy utilities

3a) Solar roofs - owned by utility

3b) Solar roofs - privately owned

4) Green electricity scheme - using solar power plants

Here, we will only discuss grid-connected applications. Stand-alone solar panel appliances do exist, but these are mainly installed in cases of public lighting in remote areas, buoys at sea or for pumping water for cattle in remote pasture land. What these cases have in common is that they are located far from the main grid. Not surprisingly, in the case of households, we could only find examples of grid-connected appliances, as almost all Western European households are connected to the main grids at some level.

1) Buying single PV panels at the DIY store

The first way of obtaining solar powered electricity is to buy one or more panels with an AC/DC inverter and install them on the roof. By putting the connected plug into the socket of the electricity system, the meter will slow down or turn backwards as soon as solar electricity is produced. This option is still rather theoretical. It is hard to find single solar panels in a do-it-yourself store and if they are available, the price is often prohibitive for many consumers. Energy companies have so far successfully captured the market for (grid-connected) PV panels and are eager to keep it in their own hands, rather than those of home-improvement shops and other retailers. As yet, this is the smallest scale of obtaining solar generated electricity in the home.

2) Have a panel installed by an energy company

According to Shell-Solar, a major solar panel manufacturer in the Netherlands, energy companies are eager to become the 'natural' retailer of solar panels for the consumer market as they are in any other energy related service (interview, Shell-Solar, 1997). The launch in March 1999 of a new product, called '*SunPower'* by a conglomerate of the 4 main Dutch energy companies is therefore no coincidence. The product consists of 3 panels; all its attributes and services can be purchased from the Energy Company by any householder with a roof that is oriented towards the South or South West. In this way, householders can substitute about 10% of their yearly electricity consumption with solar energy. Unlike the former 'single panel option', installation and maintenance will be the responsibility of the Energy Company. Such an arrangement attracts a different and larger group of consumers than the Do-it-Yourself group, as the SunPower system is designed to involve the minimum amount of effort for consumers who are interested in becoming a green utility customer. More than many other environmentally sound technologies, the highly visible solar panels on their roofs may serve as an indicator of their sustainable lifestyles.

3) Living under a solar roof

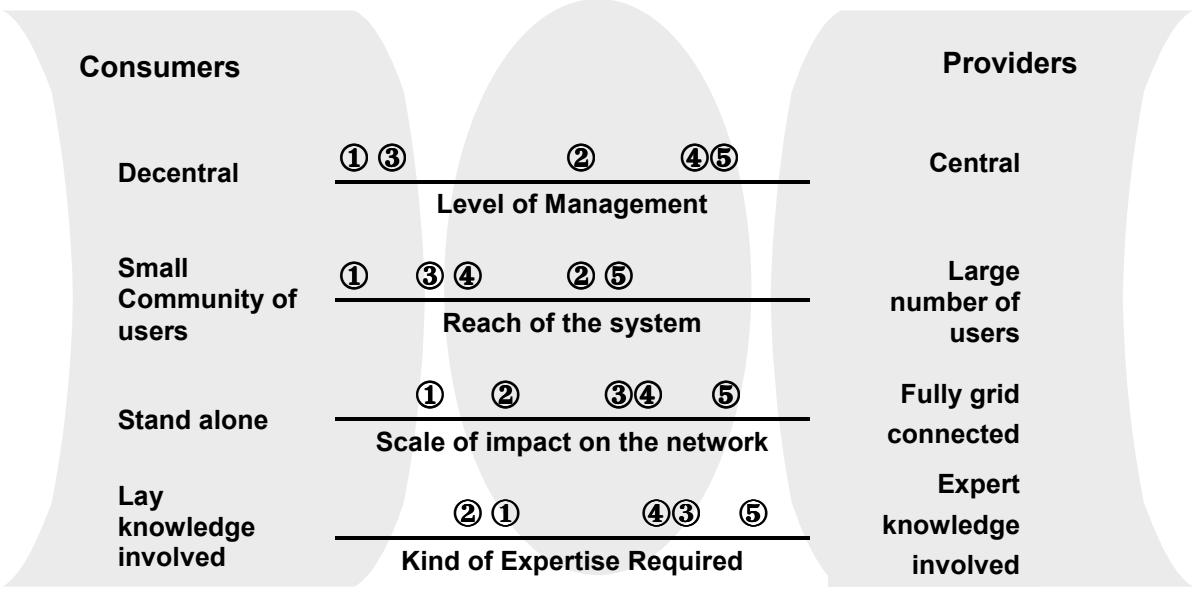
A third way of getting PV electricity is to rent or buy a house with PV panels already installed on its roof as is the practice in Amersfoort in the Netherlands. There are cases of rented as well as owner-occupied houses where the Energy Company owns the roof while the Housing Association or owner-occupier owns the rest of the house. The Energy Company uses the roofs as a solar power generation plant from which electricity is directly transported to the grid. The owner acquires the roof for free, provided that no adaptations to the roof (such as a loft window) are made and that the roof is not overshadowed (thus imposing restrictions on planting trees in the garden). The residents receive remuneration from the Energy Company for the use of their roofs. Twenty percent of the energy generated on their roof is paid for at the normal domestic consumer tariff. At the same new residential site, there are also 150 owner-occupied houses with a privately owned solar roof. The solar power generated is fed to the mains while residents receive the normal domestic user tariff in return. The Energy Company involved in all these schemes stated that they hope, through these experiments in providing solar energy, to gain insight into the technical, social and legal problems related to large scale PV applications as a whole (Remu, 1999).

4) Subscribing to a green electricity scheme

A much more indirect way of obtaining solar energy is to subscribe to a green electricity scheme that includes solar power as a source for green electricity generation. If solar energy generation is part of such a green electricity scheme, it will be in the form of grid-connected, large scale applications: solar power 'plants', such as the series of solar panels that are installed in noise shields alongside highways in the Netherlands. Consumers obtain their solar powered electricity through the normal electricity system, just as in the other applications, but without sight of a solar panel in the neighbourhood. The scheme would be a solution for those who cannot afford solar panels or who do not have a suitable roof on which to install them. The scheme also suits those consumers who prefer to maintain a less conspicuous sustainable lifestyle – the more 'silent' green consumers.

Evaluating solar energy applications

These examples show that solar panels are highly flexible in terms of location and scale of application. Energy Companies and Housing Associations are currently experimenting with different scales and modes of provision of solar power to household consumers. What is being experimented with, apart from the technology itself, is its scale of application, modes of provision, access and use. The four dimensions of scale that were named in section 2 are presented below in figure 1, with the examples of solar energy applications roughly plotted on the bars representing the different dimensions of scale. The left and right sides of the figure represent the classic extremes in energy, water or waste service provision, namely the small scale, stand-alone options on the left side, and the centralised, large scale and high-tech network systems on the right side. The solar energy applications plotted on the bars show us a mixed picture of provision somewhere in between the two extremes.



① Single panel ; ② SunPower system; ③ Solar Roof (Private); ④ Solar Roof (Utility Owned); ⑤ Green Electricity Scheme; Conventional Electricity Provision

Figure 1: Scale dimensions in solar energy applications compared to conventional electricity provision

The scheme shows us the co-existence of different dimensions of scales in the case of solar panels whereas conventional electricity provision (fossil fuelled or nuclear power plants) only fits into the large-scale dimensions. Not only does solar energy imply some kind of downscaling of electricity provision in all dimensions, but it also means a *de-coupling* of different dimensions of scales of provision. By de-coupling we mean that either small-scale systems (in the technical or geographical sense) do not necessarily require local actors to manage them or that they only cause minor changes in the conventional system of provision.

The figure shows the possible diversity in scales in cases of solar energy provision but could also be used for water technologies (rain water, grey water, household water and conventional water systems) or waste collection and treatment facilities (home composting, community and central composting schemes, waste separation on different levels).

Apart from enabling us to assess the different technical scales, which the above scheme attempts to do, the solar panel example also provides an insight into the diversity of possible modes of provision, access and use of environmental innovations in utility networks. The modes of production are left out of the equation, as these relate to the manufacturing of solar panels, which occurs in a whole production chain from raw material (silicium) refinement to assembling panels and inverters into a solar panel system. Our emphasis here is on the trajectory from solar energy provision to its use by householders.

Modes of Provision of solar energy

Modes of provision are generally referred to as market mode, public mode, or informal/household modes of provision (Warde, 1990). All these modes of provision can be recognised in our example of solar energy provision, although the market mode of provision seems to be dominant. Informal or domestic modes of provision of PV generated electricity (the single panel option) are rarely seen and increasingly overshadowed by the initiatives of energy companies. The recent SunPower system launched by a conglomerate of Dutch energy companies fills the hitherto unfulfilled *market niche* of

consumers who wish to make use of 'home-made' solar electricity. However, the boundaries between modes of provision prove not to be so rigid in practice. The utility-owned solar roofs, for example, are the result of a collaboration between a public-private energy company, a privatised housing association, private housing developers and manufacturers and the municipal authority of Amersfoort, while the whole project is co-financed with national and European Community funding. The SunPower system is the outcome of a pilot project launched by Greenpeace Netherlands, which, as part of its goal to achieve economies of scale has introduced solar panels in the Netherlands. This became the SunPower product only after a subsidy was granted by the Ministry of Economy, which brought the price within the reach of average household consumers.

In sum, modes of provision in practice can hardly be described as either market, public or informal, but in the main as a mix of two or more of these modes. In particular, systems such as those for photovoltaic electricity generation are not yet economically rewarding compared to conventional systems and need public funding and facilitating to reach the stage of large-scale implementation.

Modes of Access to solar electricity

The modes of access theoretically include the buying, renting, leasing, self-constructing or just gaining access to a service. As we have shown, the modes of access to solar energy differ greatly in all applications. Consumers may get access to PV generated power either by subscribing to a green electricity scheme that (partly) relies on solar power; by renting or buying a house with solar panels; by purchasing a *Sunpower* system; or by buying and installing their own solar panels. What is being tested in current solar energy projects – apart from the technology itself – is, in particular, which of the modes of access is most appropriate to make solar energy within the reach of domestic consumers. In their short experience of PV applications in the built environment, energy companies have already come to the conclusion that it would be better to provide PV generated electricity to the households on whose roofs it is generated rather than directly transporting it to the main grid. This would add to the visibility of the application and hence to the involvement of the consumer in the (co-)generation of solar power. Even in cases where consumers do not use the electricity that is generated on their roofs, the energy company in Amersfoort has put much effort into making people feel 'proud' of 'their' solar panels (interview, Remu, 1999).

Modes of using solar energy

Unlike the variation in the modes of access, the *modes of using* solar generated power do not seem to vary much, since, in technical terms, the product (electricity) comes to the customer in the usual way and through the same 'terminals' (fridges, TV sets, lights etc.). Likewise, there is no indication that householders have adapted the timing of energy consuming practices to the hours of sunshine. In most cases, this would make no difference in any case, since most solar panels are connected to the central grid, which serves as a storage system. In many cases solar panels come with separate metering. Instead of incoming flows only, now the balance between delivery from the grid and delivery from the panels can be made visible. Whether this monitoring leads to changes in behavioural practices or influences households in other ways remains to be seen. However, there is no indication that spectacular behavioural change should be expected. For instance, a survey by Sylvester (1998) among 50 tenants of the solar houses in Amersfoort revealed that – compared to a control group – there was no significant change in environmentally relevant behaviour after two years of living with solar energy. The extent to which householders felt comfortable with these new scales of provision or of how convenient they found living with them is also unclear.

6.3.2 Diversity of scales and modes of provision in water, energy and waste sectors

It is not only in solar energy that scales have become increasingly diverse. The inverse relationships between the different dimensions of scales can be seen in other examples as well, for example in the

cases of dual water systems, wind energy and composting schemes.

Water sector

All dual water systems provide consumers with a second quality of water apart from normal drinking water supply. The smallest scale of such a system is that of an outdoor rainwater butt, or, a somewhat more sophisticated version, a rain water tank placed in the attic or basement of a single home, collecting rain water from its roof and supplying this to toilet cisterns and/or washing machines. Some grey water systems (like Water Dynamics in the UK) are available in a similar size. Individual consumers may purchase these systems themselves, but in most cases such systems are installed by housing associations, project developers or water companies in newly built and usually metered houses. Regular maintenance and cleaning is undertaken by householders themselves who have the benefit of lower water bills in return. On a much larger scale, household water systems supply a second water quality as well. These systems cover between 400 and 30,000 houses and are built and maintained by water supply companies.

This divergence in scale dimensions brings us to the issue of costs and benefits of these innovations. Individual appliances are relatively expensive, as they require separate storage, plumbing and pumping for each household. Payback times are very long while water prices remain at the current low levels. Most of the small and large dual water systems are therefore not purchased by individuals, but installed by property owners, housing associations or developers. These actors however do not gain the benefits of a lower water bill and need to seek additional financing. This is either obtained from the state or from other funding sources, or the cost is borne by consumers who pay higher fixed costs for installation in their home (through higher rents or higher take-over costs). High investment costs for infrastructure, combined with low priced flows, are typical for the water sector. Therefore small-scale alternatives like rainwater or grey water systems may have many additional advantages, overruling the dominant argument of economies of scale.

Energy sector

Modern wind turbines normally produce more electricity than one household can consume, hence it comes as no surprise that wind turbines are mostly operated by utilities, municipalities or associations of consumers. As in the case of solar panels, consumer involvement in the operation and use of wind energy differs widely among our cases. The Dutch windmill co-operatives, along with the wind farm at Delabole in the UK were initiated by citizen-consumers who were concerned about the environment. Although the schemes are set up as an investment scheme, environmental rather than economic reasons were cited as one of the main reasons to participate. The Lundavind co-operative, which was initiated by the utility company, also attracted customers who had mainly economic motivations to participate, not least because they expect a rise in electricity prices in the near future.

The way in which participants can identify with the wind turbines that generate their electricity varies with the scale of management and operation. Most of the windmill co-operatives in the Netherlands are not site specific, as they have members in the whole region. The turbines are situated in optimal wind locations and not necessarily where members actually live. None of the members can point to a windmill in the direct neighbourhood to show his or her concern or involvement in environmental issues. In the Lundavind and Delabole cases, the wind turbines cannot be missed. Apart from generating electricity, they also quite bluntly externalise the image of sustainable communities living there.

Waste sector

In contrast to previous examples, the different scales of composting schemes (from home composting to community composting and national composting schemes) are neatly matched with the scales of

management of service provision. Home composting is done by individual garden owners, community composting schemes are managed by communities or housing associations, and national organic waste collection and composting schemes, as in the Netherlands, are operated by a network of municipalities, waste companies and a small number of composting plants throughout the country. As technological scales and scales of management increase, the role of consumers is reduced, from full waste processing (as in home composting), to (separate) waste collection only.

In sum, we may conclude that divergence of scale dimensions does not occur exclusively in the case of solar energy. The mix of scales has in each case specific consequences for the modes of provision, use of the resources involved and the level of consumer involvement. It is, for instance, too simple to suggest that small-scale innovations would always induce more consumer involvement because they are 'closer' to households than large-scale ones. Furthermore, solar heat collectors and solar panels, household water and rain water appliances, and all composting schemes remain dependent on conventional large scale infrastructures, although their use is sometimes less intensive and different in some respects.

The last section deals with the question of what future systems of provision may look like in terms of scales, and from the perspective of national and EU policy.

6.4 The Future and Politics of Provision

The current landscape of diverging scales of technological devices and modes of provision of water, waste and energy services may be a temporary one. In the case of solar panels in Amersfoort, the energy company is clearly experimenting with modes and scales of provision so as to develop standards for a new method of energy provision. One of their findings is that future applications of PV panels will be likely to include a connection to households underneath the solar roof rather than not involving consumers at all.

But what about the character and scales of the other innovations we have studied? Will all diversity in the end converge into 'optimal' scales (in terms of economy, environment, involvement) of utility provision? Is there any sign of optimum packages for modes of provision, access and use of environmental innovations in former utility sectors? If any answers can be given at this stage in the development of new scales of utility organisation these can only be given in relation to each sector as the resource characteristics and specific organisational features of each sector are likely to be significant in establishing optimal scales and modes of provision.

Electricity

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 being a one-way road, the mains grid has been opened up in both directions. In the electricity sector the emerging concept is that of distributed generation, described as the strategic use of small generation units at or near load centres, geographically dispersed but interconnected to a utility's distribution system (Invernizzi, 1998, p.134)[31].

> *Just as the market for large mainframes – the bulk of the computer market in the 1960s and 1970s – was invaded by personal computers in the 1980s, so the large central power stations, which have formed the basis for the utilities' business through this century, will be supplemented in the next (decades) by a multitude of smaller generating*

[31] Load centres: where electricity consumption takes place

units located closer to users. (Invernizzi, 1998, p. 134)

The latest EU renewable policy facilitates the access of small generators to the national grids, so as to allow for the development of a system of small and large generators connected to one main network. Although the picture of future systems of electricity provision is being revealed as a network of small, diverse and dispatched generating technologies, connected together by the main grid, it is still unclear precisely how such a system will be organised in each country. Apart from general provisions such as the compulsory installation of a Transmission System Operator responsible for the national grid, and regulation of Third Party Access, the European Commission does not interfere with the organisational set-up of member states' energy sectors, as long as they do not impede the Internal Energy Market.

Water

Water utilities are slowly adopting similar kinds of strategies to those seen in the electricity sectors. By asking the rhetorical question, ''Does a water company just deliver drinking water, or more?'' a Dutch Water Company manager implies that water companies should be more involved 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 (WMO, 1999) explained that selling and maintaining rain water systems fits well into the business of his water company, as the company specialises in water technology and water services in a broad sense. Furthermore, apart from the use of rain water 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.

Compared to electricity, water is a less uniform and less transportable resource. European standardisation of drinking water quality will be realised by setting minimum quality standards or maximum standards for pollutants so as to safeguard consumers' health. Different water sources (ground water aquifers, lake water, river water), and different treatment and distribution technologies make unfeasible, and indeed not desirable, to standardise water technology all over the European Union.

With the diversification of water qualities offered to household consumers, as a result of the emergence of grey water systems, household water or rain water systems, single uniform piped water systems are increasingly accompanied by other small and larger scale water systems. As yet, there are no signs of any one standardised (dual) water system that will dominate in the near future. Competitive technologies (such as 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. Moreover, as experimenting with dual water systems continues, the lack of national and EU legislation on (dual) water standards becomes increasingly apparent. For example, it is still unclear what the minimum quality of household water or grey water should be in terms of health risks. For the time being, water companies apply bathing water standards to household water, but this may not be the most suitable set of standards for the (household) practices for which it is used.

Domestic Waste

General domestic waste management systems persist alongside the introduction of small or larger scale composting or recycling schemes, but the collection and treatment of intermingled domestic waste in bulk has been split-up with different systems responsible for different waste streams. The diversity in waste management and treatment systems has probably never been as great as it is today. Not only has the number of waste streams that are separately collected and treated increased, but also the technologies of storage, collection and treatment, as well as their scales, differ within

similar waste streams, as we have indicated in our cases of composting schemes. Viewing the current developments in waste sectors, it is hard to visualise a future of more standardised modes of domestic waste processing within and among member states of the European Union. For instance, even the highly standardised method of organic waste collection and composting in the Netherlands, which has been in operation since 1994, is now under pressure from the municipalities who plead for less rigid and more flexible schemes that allow for alterations according to specific local conditions. However, the increasing popularity of waste for energy conversion may be a competitive factor for separate waste collection as well. The closing of landfills and the building of an increasing number of incineration plants, especially in Southern European countries, may influence attempts to implement similar composting schemes such as those in the Netherlands. Such developments could well be more decisive for the way domestic consumers handle their waste in the future, than other localised attempts to influence consumer waste behaviour.

6.5 Conclusion: Upscaling and downscaling provision and grid dependency

This chapter has dealt with a number of innovations in the waste, water and energy sectors and investigated the interface of different dimensions of scales. The aim of the chapter was not to provide empirical input as the basis for making generalised statements on the upscaling or downscaling of service provision for all the sectors and countries concerned. However, we can conclude that where environmental innovation meant a downscaling of service provision in a technical sense, this did not imply a disconnection either in technical or social terms from the main energy grid, water network or waste system. Small-scale and potentially stand-alone systems providing water, energy or waste services to individual households do exist, but they are always connected to, or backed up by, the main network infrastructure.

A second general conclusion is that consumer involvement in the systems providing water, waste and energy services will *not necessarily* increase simply with the introduction of small scale innovations like PV cells, rain water systems or composting bins. It is the combination of different scale dimensions (including management, network connectedness and expertise) and modes of provision, access and use, that will facilitate consumer involvement. In other words, the technical or geographical scale of environmental innovations is not the main determinant of the level of consumer involvement. A participant in a large scale green electricity scheme might be much more involved in the greening of systems of electricity provision than a consumer in a house whose roof is owned by an electricity company that uses it as a small-scale power plant.

Thirdly most of the innovations result in the opening-up of uniform, one-way, large-scale infrastructures, into two-way infrastructures with additional functions. Some of these new functions include the storage or back-up of resources generated by small-scale technologies, and the related possibility of taking resources in or ‘buying-back’ rather than merely distributing them.

Lastly, the current, highly diverse landscape of scales and modes of provision of water, waste and electricity does not seem to point to any predictable future of new and standardised systems or modes of provision. Most likely, the process of diversification will go on and actors other than traditional utilities will enter the field. In the following chapters on Demand Side Management and Sustainable Homes, upscaling and downscaling of technologies and management responsibilities will be further explored from the perspective of consumer involvement in the provision of utility services.

7- DEMAND-SIDE MANAGEMENT & NETWORKS OF CO-PROVISION

Heather Chappells and Elizabeth Shove

7.1 Introduction - DSM and DOMUS

> *"DSM approaches attempt to avoid environmentally and economically expensive supply investment by managing both the level and timing of demand placed on networks through the implementation of energy and water efficiency measures" (Siohansi and Davis, 1989)*[32]

In the last decade, demand-side management (DSM) has emerged as an alternative approach to infrastructure provision which has challenged traditional supply-side approaches, as such it has been the focus of much attention from regulators, utilities and academics (see Siohansi, 1996; Guy and Marvin, 1996). In this paper - which presents the findings of research on our fourth theme of the Domus Project - we think about the adequacy of DSM as a conceptual and strategic tool with which to perceive and manage energy, water and waste services. Tracking the history and implementation of DSM we ask whether this re-orientation of utility management really gets to grips with the relationships and processes at play in networks of provision. In contrast to the previous themes, we focus here on technologies of storage and efficiency throughout utility supply chains. Many of these innovations have critical roles to play in environmental programmes, by helping to control and reduce the flow of water, energy and waste and consequently the distribution and consumption of these resources. They also provide a focus for investigating interactions of demand/supply and provision/consumption across utility networks, being strategically positioned at a range of macro and micro-levels.

We begin with a review of the conventional interpretations and applications of DSM by utility managers in different countries and highlight some of the inherent assumptions and missing dimensions of these approaches. We then present a generic map of the key *dimensions* of networks of provision and use this as a guide to analyse some of the hidden relationships between consumers, producers, resources and technologies which are embodied within such networks, but are currently overlooked in conventional approaches to systems management. The sorts of *conceptual* issues which slide into view once we have this new network map include: resource ceilings, expectations and thresholds of service, and 'moments' of system reconfiguration. Case material from interviews with energy, water and waste managers practising DSM in the UK, the Netherlands and Sweden provides the empirical basis to explore these new concepts and enables us to re-tell some stories about the organisation of networks. Here we focus on the stories of *hard pressed* utility managers and selected *self-providers*[33]. This approach allows us to consider the dominant DSM strategies and relationships of mainstream utility managers, alongside those of self-supply and 'self-imposed' management. Our analysis then considers the implications of these new network relationships for consumers and considers their roles as network co-providers involved in the management of environmental innovations, in the configuration of resource ceilings and in the negotiation of service standards.

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[32] For the purposes of Domus we also need to add to this definition of DSM 'and measures for the re-shaping of waste patterns'.

[33] By 'hard pressed', we mean those managers who are known to be actively pursuing DSM strategies as a response to either institutional or physical resource ceilings which are seen to be more 'intense' in relation to other service providers. The reorganisation of utility services in the UK also means that consumers can increasingly take charge of the provision of their own energy, water and waste systems so can be seen as 'self-providers'.

7.2 Conventional DSM - Managing Peaks and Loads

Demand orientated approaches to the management of infrastructures and resources began to emerge in the 1970s partly as a consequence of the energy crisis, partly in recognition of the escalating capital cost of increasing capacity. The concept of "demand side management", first developed in the energy sector in the United States, represented a way of thinking about the sizing of infrastructure which took account of providers' ability to manage and manipulate demand as well as supply. Such strategies typically involved paying more attention to consumption and consumer behaviour (Gellings, 1996), in order to improve the efficiency of generation and transmission networks by evening out peak load, and by curbing demand in 'stressed' areas of the network so as to delay further investment (Siohansi, 1996). As such DSM represented a shift from supply-side approaches, which relied on investment in macro-level capacity building as a means of meeting uncurtailed demand, towards resource capacity building through the restriction of demand. The introduction of DSM strategies has involved the introduction of a range of different devices throughout utility networks including the subsidised installation of light bulbs, insulation, water saving taps and other equipment. In effect such measures defer the timing and level of demand and can also be seen as a form of 'non-consumption', which makes commercial sense if the savings on new investment in power stations and distribution networks are taken into account - in other words DSM encourages the production of so-called "nega-watts" (Lovins, 1996).

In Europe, demand-side logics have also emerged most strongly in the energy sector. With measures implemented by utilities to reduce energy consumption, level off load curves, reduce strain on the environment and offer improved customer service (Aitken, 1996). Although slower to catch on than in the United States, DSM is now practised in many member states of the European Union. During the early 1990s, the European Commission's Energy Directorate commissioned a series of studies as part of the SAVE programme, many of which confirmed that DSM was an attractive, cost-effective and readily available resource, but that a range of policy and legislative changes would be needed to provide utility incentives to capture these opportunities (Boyle, 1996). Further initiatives, such as an International Energy Agency Programme, have also encouraged collaboration and research into the opportunities for promoting DSM and have identified a range of possible mechanisms for enhancing such provision, including: funding (utility loans), support (energy centres, ESCO development) control (integrated resource planning) and market (energy branding) (see IEA, 1999).

In the UK, several utilities have initiated electricity DSM programmes on stressed parts of their networks during the 1990s (see Guy and Marvin, 1996; Formby and Redford, 1994). The government funded Energy Savings Trust (EST) has also taken a hand in promoting initiatives, often in partnership with local authorities. For example, the Village Energy Reduction Assessment (VERA) which involved an intensive energy efficiency installation programme in a Norfolk village (EST, 1997). Despite these targeted pockets of activity McEvoy et al (1999) suggest that relatively little progress has been made towards DSM-related energy efficiency improvements in UK homes with as many as 70% of UK households still to invest in such measures. In addition, a number of regulatory and institutional impediments to DSM, such as weak building standards, lack of action to remove VAT on insulation and conservation materials, fuel-switching incentives which remove the political urgency for efficiency, and insufficient funding for organisations like the EST have been identified (McEvoy, 1999). In the Netherlands energy sector, demand management has been motivated more by environmental concerns and has taken an innovative path towards the introduction of levies for DSM measures (Boyle, 1996). As part of a covenant with the electricity sector, energy companies have subsidised the purchase of energy efficiency devices, insulation measures, high efficiency heaters and solar collectors (Slingerland, 1997). In contrast to the UK, McEvoy (1999) notes how the Netherlands has managed to use the cheapness of current energy prices as a positive opportunity for introducing environmental levies. In Sweden, utility DSM has had a lower profile altogether, where building

regulations already make high efficiency levels mandatory, although local level activity through municipality energy efficiency programmes are common demand reduction initiatives (Klintman, 1998).

In other utility sectors demand-side approaches have also been emerging since the 1980s. In the UK water sector the environmental regulator has set up a specialist centre to research, promote and encourage collaboration in water DSM and the government have supported a Water Summit and developed a 10-point water plan which advocates DSM as an alternative to major supply works (DETR, 1998). The economic regulator OFWAT has also supported DSM initiatives requiring that these are fully investigated before any supply side measures can be approved (OFWAT, 1997). Furthermore, several of the most water-stressed utilities have initiated DSM schemes on their networks, including Yorkshire Water's attempts to promote efficiency in remote villages where mains supply is intermittent and political pressure has been most intense (Yorkshire Water, 1997). In the Netherlands, water DSM measures have been initiated more by environmental regulation. Policies to prevent desiccation of natural reserves forced water companies to close water winning sites and to look for alternatives. Efficiency measures (dual flush on toilets, water saving showers) have in some cases successfully postponed investments in new water extraction and treatment plants and the scope for DSM activities is increasing (Wolsink et al, 1998). In Sweden, water regulations have again encouraged the development of in-built efficiency since the 1970s, while municipalities have encouraged local initiatives to curb water use (Klintman, 1998).

In the waste sector, DSM has not emerged as a strong rhetoric, possibly due to the characteristics of waste itself and its management. By demand management in the waste context, we mean curbing production in the home by generating less packaging or other waste elements or diverting it to new, more efficient disposal sites, such as the compost heap[34]. As with energy and water load management, waste can also be seen as a product for which different devices, such as recycling or compost bins, can be bought in at the level of the household to try and defer its production in time and space. One of the complicating elements in talking about DSM in relation to waste is the fact that it is not sold or provided in the same way as energy or water services. In the UK, the cost for waste collection services is still embedded in Council Tax fees so incentives connected to household financial arrangements are weak. The rise of differentiated charging in the Netherlands and Sweden is closer to the traditional model of DSM connected to rebates and economic incentives.

As the above accounts suggest, much research in DSM has looked at the way in which utilities seek to manage their territories by combining DSM devices and financial incentives to control the level and timing of demand in particular network locations. These investigations have tended to be dominated by utility evaluations with a technical, engineering and economic focus, with only more recent interest from environmental regulators and policy groups. There are a number of elements of network management which fail to get explored in such interpretations and which we now go on to explore.

7.3 Missing Dimensions - Resources, Providers, Consumers and Technologies

Firstly, conventional approaches to DSM have tended to underplay the importance of the specific character of the environmental strains or resource problems which are framing the strategies they choose to employ in each sector. In many cases a static and commodified resource situation of peaks

[34] Another element of waste demand management might be source reduction and environmental consumerism, which focuses on influencing purchase decisions of the product components that may become our waste (see Ebreo et al, 1999). Here we are concerned more with management of waste through the household and decisions regarding its storage or efficient management for disposal or reprocessing.

and loads is envisaged, rather than dynamic energy, water and waste ebbs and flows[35]. The peculiarities of these sectors and the particular flows of electrons, water molecules and waste components along grids and between households, providers and resource pools are often hidden behind a language of cubic metres and kilowatt hours around only certain network points. This makes it difficult to envisage how resource ceilings (e.g. limits of resource use) come to be configured and how these are mediated and adapted through a variety of sub levels throughout the supply-chain. As we go on to show looking at specific resources and how they move through utility supply chains reveals a great deal about the diverse relationships of domestic networks of provision. By taking a comparative view of utility sectors we can also gain valuable insights into the emergence of DSM logics in relation to particular energy, water and waste infrastructures (Guy and Marvin, 1996).

Although the emergence of DSM initiatives is wrapped up with the creation of new contexts of consumption (Guy and Marvin, 1996), surprisingly little is said in conventional DSM scenarios about the multiple roles of consumers as participants in strategies. Lovins (1996) explains how the current focus on engineering or economic models of human behaviour used to devise DSM programmes are not only incomplete but misleading and calls for more socio-cultural studies of households and their energy consumption practices. Some attempts in this direction have been made, Lutzenheiser (1992) explains how engineers often presume that consumers desire technologies which are transparent, automatic and reduce the need for consumer control and are often surprised to find that consumers over-ride systems and use them in ways that were never intended. To get to the core of a household's energy-related activities, the complexities of the everyday meanings ascribed to demand related technologies need to be bought to the fore. Another issue, and one which we only touch upon briefly in this report, is the variation in responses to demand side initiatives among different social groups, who each have different levels of access to utility networks, and consequently different scope for demand manipulation (see Drakeford, 1997; Marvin et al, 1997).

Conventional approaches to DSM also fail to pay enough attention to the technologies implicated in DSM and to their social as well as technical meanings. Storage and efficiency devices are not only used to contain or reduce flows of water, waste of electricity, they can also be seen as mediatory devices which reflect changing utility-consumer relationships. Currently such technologies of control and access, from lightbulbs and self-closing taps to massive storage reservoirs, are often seen as utility-tools for the re-engineering of resources, not as socially configured or 'scripted' devices which reflect changing management objectives (de Laat, 1996; Jelsma, 1997). As we have suggested if we look more closely at these devices at a number of sub-levels within utility networks we can begin to get a clearer picture of the complex social, technical and physical processes at play in constructing networks of provision. Mediating technologies play a powerful role in controlling and reaffirming access to grids and sub-grids for providers and consumers and in shaping the social, physical and financial flows and pulses which characterise them.

Linked to the creation of new consumption contexts for DSM has been a dramatic re-configuration of production interests (Guy and Marvin, 1996). Utilities are no longer the only legitimate managers of demand side initiatives. Groups such as housing associations and local authorities have significant roles to play in negotiating and delivering new energy, water and waste services for their tenants as they become providers of not just affordable housing but also service packages and quality of life (McEvoy, 1999). In addition, the tendency to view the dimensions of DSM from the provider-side fails to consider the roles of consumers, as 'self-providers' of energy, water or waste networks and services. Lovins (1996) describes how signs of decentralising networks are now appearing across utility networks and how power plants and local storage devices with surprising capabilities will shift to

[35] In a paper connected to the Domus project (see Chappells et al, 1999) we discuss how seeing water as a dynamic resource that flows rather than a mono-dimensional and static resource can lead to new perspectives on water and its management. Similar stories can also be told for energy and waste resources.

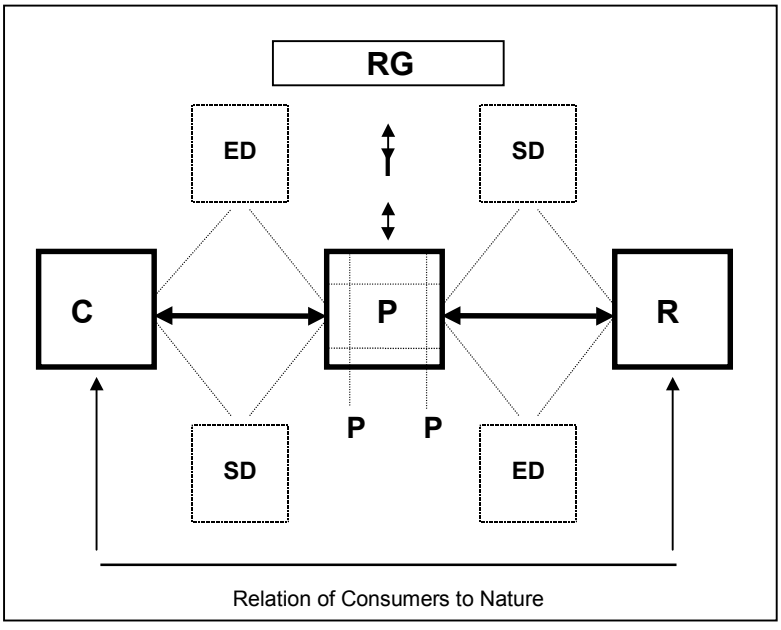
our roofs, basements, backyards and driveways, quicker than we think. These developments will challenge what we think of as a 'utility' as conventional grid connections are lost. As we go on to show, in our examples of self-provided storage and efficiency devices, there is already evidence of this shift to devolved networks across the UK, the Netherlands and Sweden. However, these are not evolving in any easily trackable linear way and rather than disconnection per se we see the negotiation of on-off grid relationships between conventional utilities and new providers, as witnessed in our previous chapter on scales of provision.

In summary, there has been a tendency to promote DSM as a linear system of delivery from utility provider to end-consumer, with resources represented as rather static and mono-dimensional elements in this distribution process. Furthermore, despite claims that DSM represents a more consumer-focused strategy, it seems that consumers have only tentatively been drawn into the utility provision picture. Our intention is to challenge this approach and show how network management can be better understood by looking at dynamic resource ceilings, mediating technologies, active consumers and fragmenting providers. By re-telling some DSM stories we hope to shed light on the what can only be described as a puzzling phase of utility management, where new institutional and environmental pressures suggest an uncertain future for networks of provision. This research is all the more important given that utilities themselves are now positioning themselves to move beyond traditional DSM and are struggling to redefine their roles as resource managers and to put the policies, regulations and measures in place which will facilitate this shift (Gellings, 1996; Nadel and Gellers, 1996).

7.4 Mapping Network Dimensions

Our first step in unravelling what we consider to be the important dimensions of networks of provision was to draw a generic map:

Figure 1: Generic map of networks of provision



Dimensions of Networks of Provision

C = Consumers & Collective Consumer Organisations

P = Providers including utility companies (splintering) and new providers (fragmenting p's)

R = Resources, including reservoir, landfill, power station capacities

ED = Efficiency Devices to reduce flow or timing of demand (hippos, flow valves, waste bags)

SD = Storage devices to contain & manage demand (reservoirs, cisterns, bins)

RG = Regulators and National and European Governments

I = Intermediaries such as new service companies acting on behalf of P's or RG's.

- In the figure we are interested in the relationship between three significant elements of networks, i.e. C<>P<>R.

- The figure helps to conceptualise the social, technical and spatial 'positioning' of the consumer (C) in a network of demand connected relations which are crucial in understanding the options for DSM to be practised.
- To the left of the figure, we can see how consumers (C) are often in complex relations with their providers (P), with the use of mediatory elements such as efficiency (ED) or storage (SD) devices to manipulate and manage demand around the household.
- To the right of the diagram, the provider (P) is also involved in mediating the flow of resources (R) using storage and efficiency innovations on distribution networks. These can help to ease or delay the impact of demand on physical resource ceilings and simultaneously redefine the level of the resource ceiling.
- At the base of the diagram the C<>R arrow, represents the way in which the consumer relates directly to nature, and their influence on the physical resource ceiling.
- The increasing number of providers (P's) captures how providers are being fragmented, with the internal divisions of providers also indicated by the splintering in the (P) box. This fragmentation of provision with new entrants and internal splintering will change the relations between resources and consumers in many new ways and will challenge the meanings and practices of DSM and network management.
- The influence of regulators and the government (RG) in shaping the evolution of and responsibilities for DSM and other strategies also needs to be considered.
- Some of the influential intermediary agencies (I) which are responsible for implementing demand related activities on behalf of utilities or governments are also shown. These include energy services companies (ESCOs) and others.

If we study this map of networks a number of new conceptual issues emerge. In the next section we explore some of these before we go on to consider how far they are reflected in the actual DSM strategies of managers in the three Domus countries.

7.5 ***Concepts of Network Provision*** - Ceilings, Expectations, Thresholds & Moments

By looking at the utility provision map in a new light and rethinking the issues involved in demand-side management and other management initiatives, a number of concepts come into view. These concepts are not only interesting to reflect upon theoretically, but also help us to make sense of our empirical findings and to better understand the core C<>P<>R relationships at work across networks of provision.

i. The first concept relates to ***resource ceilings*** of demand. Here we are not only interested in physical resource ceilings but also institutional ceilings. The capacity of a local landfill site, the regional water storage situation, the relative distance to local power stations and the weather are all influential in setting resource limits and ceilings for demand managers and in influencing the operational activities which ensue. Institutional ceilings of demand are also relevant: the environmental agendas of organisations, the amount of a resource that households are able to afford, the restrictions on access to the electricity trading pool, or the regulatory limits set on the building of new infrastructure. Likewise we suggest that ceilings are not just set at a macro level, but are re-set throughout the entire supply chain. By identifying storage and efficiency technologies as mediatory devices right across networks we are able to reveal the ways in which macro and micro resource ceilings become configured. Regulators and utilities may be

responsible for consolidating macro resource ceilings and in doing so begin to shape the ways in which DSM becomes operationalised, but the shaping of sub-level ceilings involves consumers and a range of other intermediaries whose contribution to DSM programming is often overlooked. By tracking resource ceilings as they are mediated through different stages of storage: from reservoir to pumping station to toilet cistern; we can reveal the multiple levels at which resource relationships of provision networks are negotiated.

In tracking resource ceilings we also show how the dominant linear model of relations between the resource and the consumer can be redrawn. Conventional ways of representing C<>R relations indicate the pooling of natural resources at a grandiose scale, their consequent containment and commodification as resources and a gradual filtering down through pipes and wires to a consumer who sits at the end of wires removed from the problematic and uncertain antics of nature. Throughout this smooth, linear transition from nature to consumer the intricacies of network flows are lost from sight along with providers who are busy behind-the-scenes putting into place 'buffers' which absorb, store, plug and pool not only resource flows but also configure relationships between consumers and the natural resources on which they depend. Looking again at storage and efficiency devices we can show how the mediation of C<>R flows is not so clear-cut. Flows can also go into reverse, become unexpectedly impeded and influence consumers' lives more directly than we are led to believe. At these points the roles of consumers and others in network management and their relations to nature and resources are accentuated, for instance in dealing with leaks, power cuts or other disruptions. The extent of these activities is also influenced by the 'remoteness' of resource ceilings from households. For example, the ability for the household to directly relate to nature may be very strong in situations where a local pond is used for all water supply and their are no intermediary ceilings set by providers, whereas in other cases resources will be so far removed (physically) that household ceilings and relations to nature are always strongly mediated. The extent to which ceilings get lost in translation and the associated communication of the resource problem may influence the types of demand related activities which emerge.

ii. The second conceptual relationship to explore relates to the ***expectations and thresholds*** of DSM provision and how these connect to particular DSM technologies which can either reinforce or challenge the reliability of flows between C<>P<>R. If we look at service expectations in a traditional way, the supply-fix logic based around vast reservoirs, landfill sites and large power stations meant that consumers were provided with a guaranteed and secure supply with little pressure to modify their use of resources. With the introduction of DSM new levels of compromise were required as consumers were asked to accept interuptible supply matched to particular financial incentives and technologies. As DSM has developed in the 1990s, the introduction of devices for water, energy and waste efficiency implies a 'stretching' of responsibility along the supply chain and into household's plumbing systems or lighting infrastructures. All of these developments imply the mediation of particular levels of service expectation. The extent to which consumers or providers are willing to adapt infrastructures in pursuit of demand modification rests on processes of threshold-setting, not just in financial terms but also in a personal sense. The payback times for a new technology, the changes to standards of comfort or cleanliness implied with the demand management measure, and the back-up systems which maintain flows in times of system breakdown are all critical in assessing the scope for network change and demand reduction.

In exploring expectations and thresholds of provision networks our aim is also to investigate how reliability and security of supply are negotiated by different types of providers. For instance are self-providers more willing to compromise reliability to meet other environmental, social or private service expectations and are their thresholds of provision different from those of other

mainstream providers. The mediation of expectations around storage and efficiency devices and the setting of new thresholds (financial or otherwise) can reveal the degree to which different consumer and provider groups are willing to accept particular levels of accuracy, reliability and security of provision. The extent to which these new expectations and thresholds might reflect different scales of provision, embedded consumer habits, geographical contexts, or new business ethics can all be assessed. For instance, we can look at the changing expectations in light of institutional changes such as privatisation and whether the shift from supply-side approaches and guaranteed mass production towards DSM appear to compromise the levels of service customers can expect or redefine them in new ways. Alternatively we can explore whether the implementation of efficiency devices at the scale of say three houses, a village or blanketed across regions, makes any difference to consumer expectations and satisfaction.

iii. The third concept we need to explore relates to the significant **moments** of DSM. Here we are not concerned with merely one configuration of time (e.g. 'utility-set' time of peak or non-peak loads or night and day), but about a range of macro and micro moments across the DSM map. On one level are the macro dynamics of process of change, the big moments of infrastructure investment which can redefine the whole logic of utility management. For instance the energy or water crises which spurred on the adoption and development of the DSM paradigm or the new institutional pressures which have encouraged the development of more competitive market based approaches to utility service provision. On the other hand we also need to think about the significant micro moments of everyday lives and specifically how heat, water and waste production or use are modified in the home. Again we can look at the storage and efficiency devices or DSM and their associated control panels and timers, to consider these micro levels of time management, to go beyond the utility load management rhetoric and timetable.

By extending our conceptual understanding of the time zones and significant moments of DSM and utility networks, we can consider how consumers can become involved in manipulating demand and to what end. The relative freedom different actors have to boost heat or to save water for later and how this connects with daily routines and standards of comfort and convenience are of particular interest in this context. This will enable us to look at the flexibility of supply and demand and ultimately how far consumers can directly reconnect to resource control or not. The temporal aspects of network management that DSM brings into view can then be reconnected to our findings about expectations and thresholds, with fine lines being mediated between shut-off regimes and non-consumption, consumer acceptance of personal thresholds of discomfort and inconvenience and the financial thresholds and resource savings that make particular levels of service interuption or non-provision worthwhile.

7.6 Selecting Domus DSM Cases & Research Objectives

The conceptual issues which emerge when we try to view network management in a different light can be investigated by looking at a some examples of strategies and technologies being deployed by utility providers. Our empirical research is based on a number of pilot interviews with DSM actors in the UK, the Netherlands and Sweden[36]. In each country, the researchers identified those utility managers they

[36] For the DSM Theme research we decided to conduct only selected pilot interviews with utility managers. This enabled us to gain an understanding of the relationships of provision across the three countries, within the confines of the Domus project resources. A future research agenda in this area would take a more comprehensive look across the utility sectors and involve interviews with providers at many different scales of provision. For more detail on organisations interviewed see annex B.

considered to fit the model of the hard pressed and innovative DSM organisations, along with some self-providers who were managing their own energy, water or waste provision. In addition we drew on a range of other secondary material, including published reports of DSM projects across the three countries and information gained during the compilation of the Domus inventory (see Raman *et al*, 1998).

In the UK, we chose to interview Scottish Hydro-Electric plc, who had linked Generation, Transmission and Supply operations enabling us to connect physical resource issues to the activity at the household level[37]. They also fit our hard pressed model in the sense that their geographical territory is large with many remote points on networks where DSM activities are more concentrated. For water we spoke to Southern Water who are located in one of the drier areas of the UK and have a well documented programme of water saving schemes (Demand Management Bulletin, 1998). For waste the interview was with Sutton Borough Council who are an Outer London Borough at the forefront of recycling initiatives in the UK and presumed to be facing considerable pressure on landfill space due to their location in the South East of England, where suitable land for waste disposal is at a premium and population is most concentrated. In addition to these core interviews we also drew on the findings of other interviews undertaken as part of Domus research, but not specifically targeted towards our DSM theme. These included interviews with: Northern Electric, Eastern Electricity and Anglian Water.

In the Netherlands interviews were conducted with two water companies: GWL, the municipal water company for Amsterdam who face pressure in supplying purified drinking water to a large urban population; and the Overijssel Water Company in Zwolle who are seen to be innovatory in respect of DSM initiatives. In Sweden no convincing hard pressed cases were found for water and in electricity, however, researchers spoke to Alingsas Energy who are intensively involved in DSM as a way of reducing reliance on district heating in some areas.

We also reviewed some material from interviews with other providers of utility services who can also be seen to be 'hard pressed' in some way, including *self-providers* and other mediators of utility provision such as housing associations. This was necessary in order to unpack to some extent the influence of scale and type of provider on the setting of resource ceilings and the deployment and use of different storage and efficiency devices. In addition the emergence of new types of utility providers gives us some idea of the changing responsibilities for demand-side management and reveals the connections between pressures of privatisation or environmental concern and the strategies of network management. In the UK, relevant interviews include those with self providers of energy, water or waste at Allerton Park in Leeds and at the Hockerton Housing Development in Nottinghamshire. In addition in the UK we spoke to Housing Associations who are introducing DSM measures in households with the mission of providing affordable resources for tenants, most notably an interview with the Hastoe Housing Association, located in the water stressed South East of England. In the Netherlands these included interviews with the initiators of the de Bongerd Housing Project in Zwolle, and the Groene Dak Development in Utrecht. While in Sweden, evidence from the Myrstaken and Solbyn housing developments is used.

During the interviews we asked a number of research questions, relating to the following key issues:

- How do managers set resource ceilings and what are the physical and institutional issues which have a bearing on this?
- What sorts of demand-side management strategies and technologies (e.g. introduction of storage and efficiency devices) they have chosen in recent years?

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[37] The Scottish Electricity Companies differ from their counterparts in England and Wales, where supply activities may now be separated from the generation of electricity.

- What are the ceilings associated with these devices and where are they positioned through supply chains (e.g. macro through micro levels)?
- How are decisions made regarding the implementation of these particular strategies and configurations of devices and what are the logics behind manager's choices?
- To what extent are consumers involved in the appropriation and use of these strategies and devices?

The objectives of these research interviews were:

i. To identify the type and nature of resource ceilings that different scales of providers have to manage and to understand the physical and institutional pressures behind the setting of these ceilings;

ii. To explore the types of technologies chosen to manage demand and relate these to changing intensities of ceiling setting, consumer expectations and thresholds, and the rescheduling of demand activity;

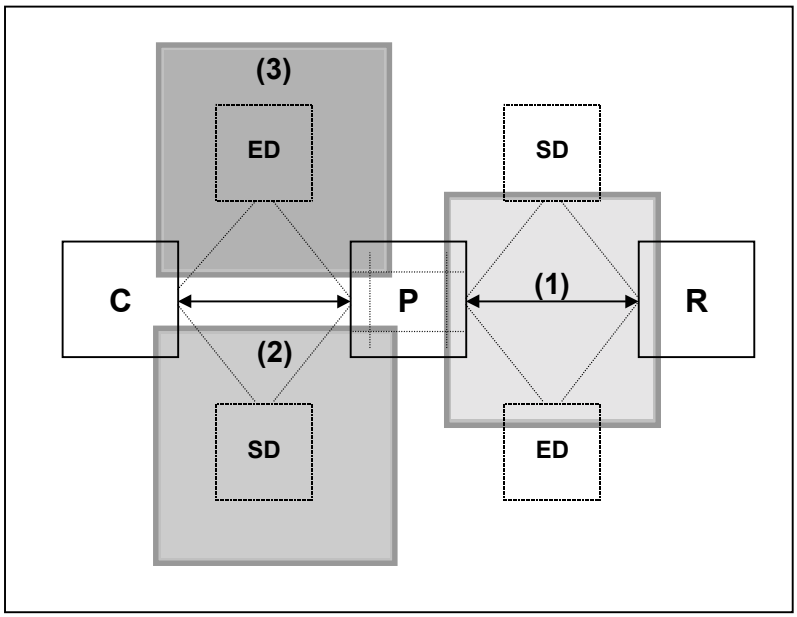
iii. To consider in the light of these findings how the consumer can be reconnected to the generic map of provision networks and the implications of this in relation to ceiling setting, network relationships and management responsibilities.

iv. To re-connect these findings to the stabilisation of demand for resources and environmental imperatives and to suggest areas of the utility networks map where policy makers, regulators and managers could focus their attention in the future to influence the efficient provision of energy, water and waste.

7.7 Retelling some stories of DSM - Strategies & Technologies

In this section, we analyse selected activities of utilities or self-providers around some of the devices and strategies they appropriate and deploy, and in doing so open up some areas of our networks map to greater scrutiny. The first step in this analysis was to plot some examples on our map (see Figure 2), before exposing these 'grey areas' by retelling some stories of demand management, as told to us by network managers themselves.

Figure 2 - Extracts from the hidden map of DSM



Examples of demand strategies & devices

(1) Macro Ceiling Setting - Physical & Institutional P<>R Pressures of DSM

(2) Storage Devices (SD) - Containing 'R' between C<>P

(3) Efficiency Devices [E] - Manipulating C<>P<>R flows

(1) Macro Ceiling Setting - Physical and Institutional P<>R Pressures of DSM

We began by asking providers about the resource ceilings for DSM, as a way of understanding the physical resource problems which frame the entire demand management programme that emerges. By talking to them about what is happening in local reservoirs, landfill sites or power infrastructures we were able to consider how these problems are being represented by utilities before we considered how they were mediated through storage and efficiency schemes at a range of sub-levels.

The first point which emerged from many of these interviews was that the managers in question were not necessarily as hard pressed as we had assumed, at least not in relation to the physical resource problem in their management areas. At Sutton Borough Council we heard how there was no physical problem of landfill stress as planning permission had just been granted for a new landfill site in the Borough. Macro ceiling setting in Sutton was instead shaped by high 'self-imposed' targets for environmental performance set by the Liberal Democrat Council. In the GWL interview in Amsterdam, the respondents explained that "there are no real ceilings you can extract what you want", referring to the ease with which they could extract surface water from the River Rhine relative to those water companies who rely more on ground water resources. Their limits instead related to the capacity of their purification plants and the reliance on public and policy institutions:

> *"We are now using 95% of our capacity which is the maximum. We cannot infiltrate more water into the dunes, so we need another purification plant. This is planned already, but we need the permission of the City Council as well as the money. Expanding capacity will only be accepted by the public and policy makers if we install water meters".*

At the Overijssel water company in Zwolle, a ceiling was set on groundwater abstraction by regulators, so despite there being plenty of water in the province which could be tapped this was strictly controlled. In the UK water industry, one utility manager explained how he was quietly cynical about DSM and felt that water companies were being pushed towards regulators favoured options, with utilities losing control. In light of this the company was considering joining forces with other UK companies to try and regain control of options and push for more long-term supply options, rather than what they saw as "knee-jerk" DSM solutions. Summing up the companies resource situation, the manger explained:

> *"We've done our demand-supply balances for the next twenty-five years taking into account predicted changes in water yields and changing demand, and we will be able to meet this demand by using the best cost-efficient measure, the minimum cost solution"*

In the Electricity Industry, at Scottish Hydro Electric we heard how the main resource pressures were the expense of new power stations, the significant problem of installing diesel generators or submarine cables to remote island communities, and the pressure from regulators for energy efficiency standards of performance. While at Alingsas Energy in Sweden, the pressure to install efficiency devices came from the need to curb the consumption of district heating users, who consume far more electricity than other Swedish Households. In all of these cases, the companies involved were restricted not by the physical impossibility of finding new supply capacity, but by political, economic and institutional pressure. Furthermore all of these managers mention the 'back-up' option of supply investment, but to legitimise such investment this they are required to 'show willing' or 'pay lipservice to' demand side options.

Other providers tend to look more at the consumer side to define demand problems. For instance in the case of Hastoe Housing Association, although there is environmental water stress in the area and difficulties of abstraction, the main reason for setting a ceiling on how much water is available to use relates to 'stressed households'. The housing association's tenants are seen to be water restricted in an economic sense and measures are implemented to ease this pressure. In self-provision communities the resource ceiling is also (self-) imposed in a way that fits the household's water ethics

rather than the absolute availability of water. For instance, all the households at Hockerton and Allerton Park in the UK could re-attach to mains water or ship in tankers to refill their reedbeds, but the decision to limit water use is shaped by household beliefs and values, the idea that it is possible to produce water from "within their own valleys" and not rely on outside help. In practice, maintaining this self-imposed water ceiling may prove difficult, but in theory many of these self-providers fought to reject the commonly asserted utility rhetoric that decentral systems are not really advocated.

(2) Storage Devices - Containing 'R' between C<>P

The second 'grey area' of our utility provision map we want to explore is the way in which resource ceilings are reconfigured throughout supply chains. If we concentrate our analysis around some of the sub-level storage devices of DSM we can see how resource ceilings and problems are 'pooled' and 'sapped' in a complex series of negotiations between providers and consumers. Where this absorption of resources takes place and who by is of interest in this context and can be explored around sets of storage technologies. For instance, sets of recycling bins on the doorstep to transfer stations and landfills for waste or storage heating technologies and local sub-stations for electricity, along with radiators, batteries, hot water tanks and sinks. The configuration of these devices (their capacities, shelf-life and distribution) reveals the thresholds of investment decisions by providers by setting parameters such as: the amount of time consumers will go without the flow of electrons, water or the removal of waste; the volumes of resources or containment capacity needed at particular network points to adequately flush away water or conceal rubbish. The sizing of storage devices and time schedules inscribed in them are critical in influencing the organisation of everyday life.

At Sutton Borough Council in the UK, the waste resource problem for domestic consumers gets absorbed relatively quickly as we move from the household to the provider, the choice of storage technologies being central in this process. If we look at recycling programmes more closely, the collection of newspapers is negotiated with tenants who are responsible for maintaining their adopted waste deposit site (often located in private gardens or residents car parks). A set number of recycling bin storage devices are provided by the council (a couple of wheelie bins for private households or larger communal bins for apartment blocks or small estates). Consumers of the bins can deposit their newspapers and glass at their own convenience while ensuring that this does not take place late at night when other residents may be trying to sleep. There is also a financial incentive as resident groups are paid (by the tonne) for the amount of newspaper and glass they deposit. The council is faced with a problem however, in that the market for (and hence the demand and income to be made from) old newspaper is notoriously uncertain. They could ask households to adapt their deposits to match the changing demand for newspapers, but this would involve constant renegotiation of personal thresholds of convenience and payback. As it is, the council absorbs market uncertainties itself, and adopts a philosophy of "maximise collection of recyclables and find a way to deal with it". This logic brings into play a series of sub-stores (transfer stations and materials recovery facilities) around which waste resource problem is absorbed by the council on the households behalf. The sight of the blue bins at the kerbside is a constant and consistent feature of the waste network of provision regardless of the negotiations and new ceiling setting going on behind-the-scenes.

In the UK electricity industry the introduction of storage heater technologies reveals the transitory nature of resource ceilings. Introduced as early as the 1950s in the form of huge boxes of sand, these technologies have evolved to ease resource pressures, by storing heat and absorbing some of the uncertainty of supply. This has enabled providers to cope with a range of different demand problems such as power cuts or massive increases in demand, especially at peak times. At the same time the pressure on consumers bills has been eased as night-time absorption by the heaters involves cheaper rate electricity from 1am onwards. This rescheduling of demand solution to the under and over capacity resource problems faced by utilities at their power stations has however redefined network

ceilings. As managers' at Northern Electric and Scottish Hydro Electric explained, Economy 7 became a victim of its own success as another significant peak emerged in the early hours of the morning as the nightstores kicked-in. This unexpected response to utility tinkering with the timing of consumer demand on networks, has forced utilities to rethink their demand rescheduling strategies.

Encouraged to talk about the consumer aspects of night storage heating and of other programmable heating scenarios, the Scottish Hydro-Electric manager also explained the trade-off involved in aligning consumer demand to fit the ceilings imposed of supply. Representing the 'supply' part of the company his primary concern was to respond to customers' expectations, and to deliver what they took to be a "fair amount of heat in the day". At the same time, 'generation' managers in other parts of the company attempt to build in as much flexibility as possible to accommodate fluctuations in generation and capacity. These twin objectives can be achieved by means of more sophisticated storage technologies along the utility supply chain and "more controllable" heat for households. How these arrangements work in practice is revealing in terms of the form of C<>P relationships. For instance, in one of the Scottish Hydro schemes a heating system was installed with a three-zone timer (see Scottish Hydro, 1998). The timer is pre-programmed by the utility to ensure that energy is delivered at times which meet the generator's requirements. Consumers can, however, change the settings and boost or lower the temperature of a particular zone. What surprised the company was the extent to which customers were "happily readjusting the system and using more than just the pre-programmed options". One elderly tenant explained how she had re-set the temperature and time zones (on the advice of a engineer) since she found that the house got too warm. Such a situation highlights how micro-adjustments can increase the uncertainty of demand and shows how technologies, as well as commercial imperatives, mediate the struggle between the fundamentally different priorities of households and utilities.

In our visits to self-provider households water storage devices (rainwater tanks or reedbeds) were often more obtrusive than in conventional households, so that the resource capacity available was instantly visible. At Groene Dak and Zwolle in the Netherlands, although storage for water was hidden in basement containers, households had visible indicators, a rope pulley, weight and pencil marks on the wall in the first case and an electronic measure and display in the second, to tell them about the status of their on-site rainwater storage capacities and enable them to monitor the household resource ceiling and carefully time their use throughout the day, week or seasons. At Hockerton in the UK at the macro level, the storage of water in the reedbed was closely monitored to ensure careful use and extraction for sub-level stores in each of the five households. This influenced other storage-related investment decisions such as whether to buy a bath or shower and how large the toilet cistern should be. If poor investment decisions, reckless usage or the vagaries of the weather meant that the resource ceiling was reached the costly option of wheeling water in from outside was the only alternative left. To counteract such scenarios the households spent a lot of time and effort in thinking through the best long-term investments, with each device fitted carefully monitored and evaluated in cost and efficiency terms. Personal thresholds were also taken into account, for some families the inclusion of a bath was essential but they were prepared to compromise on the frequency with which it was used or the level of water it contained. The proximity to macro water resources in self-provider schemes, in contrast with the relatively free-flowing on-tap supply in mains fed households, is without doubt a constant reminder of the resource capacity available and the need to take particular care when levels are low. While water companies in the UK were considering building new supply capacity if water levels fell in their regions or populations increased, the self-providers were largely restricted to the limited containment capacities available on their sites. They felt they were already doing all they could to extract the only other resource available - the generation of negalitres.

(3) Efficiency Devices - Restricting 'R' Flows between C<>P

Another set of technologies are commonly bought into play as part of DSM strategies - efficiency devices. These often very simple looking gadgets - cistern devices, light bulbs, flow valves, showerheads or taps - play perhaps surprising number of roles in the adaptation of resources, expectations, thresholds and moments of provision. For a start, these devices help to challenge the taken-for-granted nature of resource flows, by altering the pace, velocity or wattage of energy, water and waste, although these changes are often barely perceptible. They also present something of a contrast to conventional supply-side utility provision where it is assumed that flows are strongly robust in the sense that supply is guaranteed, safe and uninterrupted to such an extent that consumers might even forget they are there. Although efficiency devices rarely make a dramatic dent our daily lives, we can still make a cup of tea in the morning with a water saving tap and read our books at nightime with an energy efficient light bulb, their introduction does influence the fine-tuning of our everyday activities. In addition these changes are taking place in areas of provision networks where stability has until now been the apparent 'norm'. With the introduction of more and more efficiency devices there is a real possibility that our expectations of security and reliability or standards of comfort may be configured differently to reflect new provider and consumer relationships.

While many utility companies interviewed were attempting to keep networks as tightly controlled as possible they were also beginning to recognise the new challenges they faced in doing so, especially where demand side strategies were implemented rather than those of supply reinforcement. The Scottish Hydro Electric representative explained that from the company's point of view, while building a power station is seen as robust, demand-side measures, such as the distribution of energy efficient lightbulbs to households, are less so, because customers might not use them, or might not use them at the 'moment' which the utility expects or wants:

> *"The problem is that whilst its an obvious connection to make, that if everyone reduces electricity use by CFLs it defers the need for a new power station, there are things that you can't account for that make it so uncertain. One customer had an energy efficient bulb almost for a year still in its box, because the other one hadn't worn out yet" (Scottish Hydro Representative)*

Such scenarios highlight the importance of the scheduling of provider and consumer activities for successful efficiency schemes. What we see in many cases is the mis-match of utility-time - the schedule to which they think the household will operate in - with households' own time-schedules. Such examples, raise a number of important issues for utility managers in devising schemes and introduce consumer-times into a DSM debate that has so far talked mainly in provider-moments. In this case, as in a number of others, the inability to predict consumer activity meant that utility company was uncomfortable with the shift away from more robust and guaranteed networks of supply and was unconvinced of the value of DSM schemes which involve consumers (however tentatively) in the co-management of network provision.

A linked issue is that of the financial thresholds of utilities and their expectations in terms of payback from consumers. In Sweden the investment in energy efficiency by household consumers of Alingsas Energy locked them into a six year repayment deal, but the company was unsure what would happen if consumers decided to move away from the area. While in the UK, the Scottish Hydro Manger argued that there was a missing link between the enthusiasm of regulators and the government for efficiency schemes and the commercial incentive for the utility. In this case customers are allowed to change suppliers with only 28 days notice, allowing them to take advantage of energy efficiency retrofit schemes and then take their custom elsewhere. Unless this rules was changed the company was reluctant to invest more widely in energy efficiency, and required longer term customer contracts. For utilities these institutional arrangements severely compromise their ability to strengthen their control over C<>P<>R flows and cause them to reflect on how worthwhile DSM schemes are in

particular communities.

The intensities of efficiency investment programmes across different parts of utility territories, are also strongly influenced by the level of payback to the companies. The Alingas managers were careful to select only those customers for efficiency investment that they considered to be unlikely to move homes. In the UK a levy to fund energy efficiency is paid by everyone, but the redistribution of this money is concentrated in specific 'problem' areas. For instance, in Scotland, the island population represent only 7.5% of Scottish Hydro's utility's customers, but over 25% of the standards of efficiency budget is spent here. This policy of 'insulate and isolate' certain areas of the network may create different expectations of service in particular regions and influences the threshold-setting activities of consumers and providers. In some of these communities intensive programmes of efficiency measure installation were being undertaken, with close collaboration between a local utility worker and the residents. Convincing such residents to part-invest in efficiency measures which will secure their future supply and reduce reliance on untrustworthy diesel generation and submarine cable supply is seen as more worthy of utility time and effort as the paybacks are greater in relation to supply capacity investment deferred. In this way the utility tries to involve certain consumers in the co-provision network while in other areas where flows are more robust there is less need to do so.

The introduction of devices to reduce water flows through toilet cisterns is another particularly revealing example of how network management responsibilities are being renegotiated between consumers and providers. Described by managers as a 'quick-fix', hippos and their counterparts (soggy doggy's and save-a-flush) devices were being introduced by most of the UK water companies we interviewed. These devices are sent out to consumers along with instructions on how to fit them into their cisterns. The successful use of the hippo as a water efficiency measure relies on the maintenance of flushing routines. It is no good if households feel compelled to flush the toilet twice after every use, as is often the case, because they feel the volume of water provided post-hippo installation is too low. The routines of flushing and the scale of the flow reduction achieved by the cistern device need to be carefully matched if any water saving is to be achieved. One of the companies we interviewed claimed that their cistern device was more efficient despite allowing a larger volume of water each flush than others, because households were less likely to flush twice. Such fine-tuning of social and technical flushing regimes is just one example of the importance of sizing and scaling demand-side strategies.

Another cross-country issue also emerges when we look at the efficiency of toilet cisterns more closely. The UK utility logic in introducing hippos is that it provides a 'fit and forget' technology for consumers and enables providers to be shown to be actively promoting water efficiency right across their regions, or as one water manager more cynically noted, to 'pay lipservice' to regulators recommendations. In the Netherlands and Sweden, such devices tend to be regarded as an end-of-pipe solution which represents a less thoughtful approach to water management. In both these countries attention is focused instead on making the cistern itself more efficient by designing it with a smaller capacity in the first place, requiring a different sort of investment by households and providers. Such an approach is backed up by stronger regulatory signals, than in the UK were large capacity toilet cisterns are still the norm.

The logic of providing consumers with low maintenance efficiency technologies is also reinforced in Housing Association projects in the UK, where one manager argued that:

> *"You need to think about environmental impact, if it's an active response you want, you're relying on other people to do something so you're not in control, if you want results you should start with passive technologies".*

In this case, the company was keen on the use of mousser taps to reduce water flow and the installation of low flush toilets, rather than technologies such as the introduction of water butts to

collect water for garden watering. The differences between private household initiated schemes and schemes for housing association tenants was also highlighted, with the former seen as being more committed to managing and maintaining active systems. In many of our self-provider cases this is borne out, with households expecting to have intensive self-servicing regimes. For instance, at the Hockerton Housing project cistern devices were dismissed as an inefficient add-on, with frustration that the introduction of low-flush toilets was not being supported more by water companies, regulators and the government, who instead favoured what they saw as 'novelty devices'.

7.8 Consumer Involvement - Networks of Co-Provision

In this section we focus more closely on what our stories of resource ceilings, storage and efficiency devices tell us about the involvement of consumers in networks of provision and their changing relationships with resources and providers. There are three key points to make:

- That consumers are mini-infrastructure managers and network co-providers in their own right and can act as generators, ceiling-setters, maintainers and users;
- That providers are able to set parameters of consumer involvement by the careful scripting of storage and efficiency devices (with demand schedules and macro/micro ceilings) ;
- That the relationships between consumers and the resources on which they depend are influenced by the proximity to and level of particular resource ceilings, and that these ceilings are being radically redefined by a range of new intermediaries and providers within networks.

To expand on the first point, consumers have many more roles to play in utility networks than represented in conventional DSM - in other words we have described what could be seen as networks of *co-provision*. Consumers are demand-side managers in their own right, not only as self-providers of new macro-stores at a local level, as in some extreme cases but also as the 'sensitive fingertips' of other mini-infrastructures around the home. Drawing consumers into networks of provision not only as indiscriminate end-users but as system generators, installation engineers, capacity-setters and maintainers inevitably challenges what has come to be taken for granted - that consumers have no real interest in the finer details of demand management. It may be true to say that the language of peaks and loads fails to interest many households, but the retuning of heating or water systems to provide comfort or cleanliness are part and parcel of the everyday experience. By viewing household involvement in utility infrastructures in this way, it becomes clear that that consumers' habits and practices define the challenges and problems which utility providers confront in keeping networks as robust, reliable and controlled as possible and in reducing demand.

On the other hand we have also shown how utility providers are in a position to define the scripts which shape just how much household consumers can do. As we have seen, new technologies of storage and efficiency have the double promise of permitting greater consumer responsibility and flexibility, whilst also offering suppliers more opportunities to manage and manipulate demand. As such utility providers still have a considerable influence over the forms of consumer involvement that are possible. The size, shape and capacity of bins, tanks and energy storage bricks, and the controllers associated with them, influence not only the levels of resource ceilings which consumers can relate to but also the degree to which everyday life can be rescheduled. Careful reading of the design implications of these devices and the range of consumer interpretations which might emerge in the intricate processes of everyday life can reveal the potentials for energy and water manipulation.

Infrastructures are not static and they have many dimensions, the management of which involves the setting and resetting of many different ceilings, which shape the form and power of particular flows. As

organisational fragmentation and decentralisation is at work across infrastructures, there are many potentially significant but as yet unknown implications for the control and management of the flow, stocks and stores of energy, water and waste - which may now be in the hands of many different actors. The setting of resource ceilings and the negotiation of responsibility for maintaining levels of demand to match these limits on network capacity was shown to be a process of negotiation along supply chains. At a macro-level we saw utility companies locked in a process of ceiling-setting with regulators, while elsewhere in supply chains providers and consumers became involved in micro ceiling-setting activities - for instance in agreeing the size of bins and timing of collection for recycling. Other intermediaries and providers, such as energy or water service companies or housing associations also have the potential to reset resource ceilings.

The involvement of consumers in some micro ceiling-setting processes does not necessarily imply that households are becoming more connected to resource problems at a more macro level. As we have seen where utility companies are the intermediaries of demand management there are various attempts to 'buffer' consumers from the from the uncertainties of the physical and financial flows which characterise energy, water and waste. The absorption of demand fluctuations by utilities around sub-stores in the supply chain and the attempts to routinise household behaviour in relation to heating regimes or recycling practices shows how management strategies are tied up in the conventional logics of protecting consumers from resource problems and of keeping networks as robust and reliable as possible. So while demand management may involve changing household routines, many consumers may still remain disconnected from the changing intensities of resource problems in their local areas, due to the careful sub-scripting of utility storage arrangements. In contrast in self-provision communities we found the proximity of reservoirs and other storage facilities to be a constant reminder of the macro-resource problem at stake. Particularly in schemes where water management was decentralised and where the fail-safe of utility buffers were removed, providers faced their resource ceilings every day and were often compelled to adapt their personal thresholds and practices to ensure that networks were maintained. Many self-providers were also more willing to accept that their flows of resources may be less robust than those of mains systems, but were more willing to accept this, to a certain extent.

In our investigations of the three Domus countries it appears that frameworks of provision still tend to be skewed around the interests and capacities of mainstream providers who are keen to maintain a close grip on the flow of resources. Consumers are not often explicitly enlisted in the role of resource managers, and in situations where they are required to act specific end-of-pipe consumption responses are expected. Utilities are surprised to recognise deviation from these long scripted patterns and practices and are increasingly having to confront these as they cross the threshold and take more interest in household affairs. For instance, as Mrs Jones re-sets her heating, and 'disrupts' the pre-programmed timetable of the company. How conventional utilities will react to the possibility of more and more active consumers and new providers around the edges of, and within, mainstream infrastructures will be interesting to observe. At present the deferral of responsibilities to consumers is kept within relatively tightly regulated parameters - seen in the profusion of fit and forget and control technologies. One other potential utility response to the increased 'interference' of consumers and others in network management is a shift back towards more proven and robust supply technologies. There are numerous examples of plans in the pipeline for new reservoirs, landfill sites and power stations if efficiency and storage devices fail to deliver a robust enough system of provision.

To summarise, the balance between provider and consumer interests influences the setting of ceilings and how much water and energy can flow along supply chains at particular moments. In focusing on the changing responsibilities of utility network management around some storage and efficiency devices we have revealed the extent to which consumers and providers are co-owners and co-managers of a complex and highly interdependent series of systems and technologies which together

make up electricity, water and waste infrastructures. In conventional DSM approaches to management many of these connections and inter-dependencies are lost from view.

7.9 Networks of co-provision - Policy Implications

Our final question in regard to this theme is to ask what our reconceptualisation of network relations implies for the policy-makers, regulators and managers who are responsible for controlling demand for resources. To try and answer this question we consider some of the mechanisms and measures which are being suggested by these organisations as a way of facilitating more demand responsive modes of network management, and reflect upon their relevance in managing the sorts of networks we have described in this paper where active consumers, flowing resources, fragmenting providers and mediating technologies are bought into play. Rather than attempting to consider all the DSM relevant policy mechanisms which have been discussed as ways to facilitate the more efficient production and consumption of energy, water and waste resources in recent years, we will concentrate here on just some of the approaches currently being advocated by European and national policy makers and discuss how they fail to capture many of the network dimensions we have revealed.

Consumers value as mini-infrastructure managers is only partly recognised in current demand management strategies. One set of mechanisms which has been suggested as a way of representing customer service needs alongside those of producers has been Integrated Resource Planning (IRP). This approach looks to find the least cost options for utility management, which also includes social and environmental dimensions. The problem is that such approaches often fail to capture the complexities of everyday decision-making, which are shaped not just by a few predictable end-use decisions but also by the cultural significance which is attached to particular water, energy or waste services and long standing routines and habits. The first policy consideration then is to find ways to ensure that network managers properly recognise influence consumers have as co-providers in networks of provision and the cultural significance of these. Such an approach would allow for creativity and differentiation in devising new services tuned into consumers everyday lives and which may promote more successful resource-saving strategies. Currently consumer oriented policies mainly emphasise the *protection* of consumers from providers, but do not offer many tools to help consumers in taking up their roles as competent co-providers of water and energy provision or waste services. In practice many consumers and other co-providers encounter difficulties and delays in applying innovations, which can be traced back to regulation that is only framed for - now outdated - public utility provision.

A starting point for understanding how consumers are implicated in the management and control of flows in utility networks might be to look at the critical processes such as the scheduling or sizing of network flows and capacities from a consumer perspective. Demand management is not just about getting the balance between customer use and utility load profiles evened out, it is also about matching the time-scales of providers and consumers. Project schedules need to recognise that consumers are also installers and maintainers and that the scheduling of these tasks needs to take into account cultural, environmental and economic efficiency objectives if they are to prove successful. More generally we need to take a look at how domestic consumers are involved in fitting, adjusting, monitoring and using a whole raft of everyday environmental innovations. As we have shown, the *precise* configuration of efficiency devices and associated routines can make a great deal of difference to the amount of a resource that ends up being consumed. Reshaping demand involves asking questions about the exact sizing of energy, water and waste storage capacities, their relation to consumer's standards of comfort and cleanliness and the flexibility of ceiling setting opportunities around these.

A second issue relates to the script-setting abilities of different actors in the supply chain. The long-embedded institutional logics of reliability, protection and control continue to pervade utility decisions

relating to demand-side strategies. The technologies of storage and efficiency reflect these logics and are scripted in ways which may present over-prescriptive models of how consumers are able to behave. For instance the utility tendency to take control of resource management and absorb uncertainties of flow means that we can imagine situations in which opportunities for more locally defined resource management are lost. While the addition of new stores into networks can mean the stepping up of usage across supply chains, despite the label as efficiency devices because it is a new thing to fill-up.

Regulators have a powerful position in macro-ceiling setting, but also influence ceiling setting elsewhere in supply chains. For instance, regulations on cistern sizes in the UK send out messages which support add-on demand-side management measures that depend on other actors initiatives, while in the Netherlands and Sweden there is a greater investment in long-term equipment changes and consequently more embedded ceiling setting. Not only are utilities influential in shaping the management of networks so are the designers and regulators responsible for defining the configuration of demand side technologies, as are the builders and planners who make spaces in our homes for these objects.

It is not surprising that utilities are threatened by the changing network relations and flows implied in the shift to demand-side management. After all we see some unusual situations emerging in which it becomes profitable to encourage non-consumption and where consumers have sometimes significant influence over the flow of resources to the home. A further complication is the sometimes long payback time on efficiency device installations and the risks that consumers will change suppliers or leave the area without adequate 'returns' to the utility in terms of financial contributions or repayment in terms of loyalty. Such threats are encouraging many utilities to script devices even more tightly than before to regain control of networks, especially in some households. Another policy consideration would be to reflect on the alternative scripts of efficiency and storage which reflect the personal, physical and institutional ceilings of a range of other organisations and individuals. As utility networks fragment, regulators and policy-makers need to understand the sorts of devices which are being introduced by new providers and intermediaries and reflect on their capacities to both restrict and enable resource flows and consumer activity.

To summarise, demand approaches involve a stretching of responsibility and activity along supply chains and implicate both providers and consumers in shaping how energy, water and waste are controlled, contained, constituted and used in the home. We have shown how DSM can be a useful framing concept and management approach if it is redefined more broadly to include: utility sectors as a whole, the multiple expectations and activities of consumers, the diversity of providers. This chapter has revealed the limits of conventional approaches to network management in understanding how these processes operate and in ensuring that different interests are represented in discussions of how demand should be organised. New modes of supply chain management, which reflect on energy and waste flows, the timing of demand, the capacities of sub-level stores, and the re-interpretation of consumer roles, will reveal new opportunities, with implications for the sustainable management of infrastructure provision. There are also implications for utility and consumer policy in recognising that a trade-off may need to be made between the respective significant moments and expectations of service, of both users and providers. For instance, how far is it possible to encourage consumers to accept the risks of a less guaranteed supply without compromising comfort or building a new power station. More specifically we can learn more about the thresholds at which such compromises might be possible and treat consumers not just as operating in a rational economic way but within their own personal thresholds relating to comfort and their past experiences of utility provision.

8 - SUSTAINABLE HOMES & INTEGRATION

Heather Chappells & Elizabeth Shove

8.1 Introduction - Domus and Sustainable Homes

The final theme in our Domus research investigates Sustainable Homes, in which we see the mixing and matching of different providers, technologies and consumers in new household networks. Our aim is to analyse a variety of these networks from across the UK, Netherlands and Sweden, to find out what they reveal about the *integration* of new environmental innovations and social practices in sustainable homes. While studies of sustainable homes and lifestyles are abundant across the three Domus countries, these have failed to tackle some of the important socio-technical dimensions of environmental building projects. For instance, they concentrate on individual technologies bought into play for sustainable living without looking at the interdependence and integration of these with social and institutional practices. Much existing research also neglects to explore the shift from mainstream utility provision, which characterises many new housing developments, towards multi-grid approaches which splinter responsibility for energy, water and waste services. Exploration of the new networks found in sustainable homes can tell us a great deal about the changing logics of service provision and about the new relationships of socio-technical dependency which these imply.

In this report, we begin by looking at what existing studies and policy approaches tell us about the development of more sustainable modes of living and identify the implications for infrastructures of water, energy and waste. From this review and drawing on information from our inventory of sustainable housing schemes we identify *initiation* and *autonomy* as two of the key dimensions by which we can begin to distinguish sustainable schemes. This includes a discussion of the different sorts of initiators who are involved in sustainable housing schemes and the diverse levels of autonomy of developments - in relation to both (dis-)connection from technical 'mains' systems and from 'normal' society. By mapping these socially and technically on/off dimensions of sustainable housing schemes on a grid, we provide a starter-framework for our analysis of integration. This framework is refined in the subsequent stages of our research, in which we undertake an in-depth review of relationships of *(inter-)dependency* between providers, consumers, technologies and institutions. Such an analysis, which looks at case study sustainable building projects from the three Domus countries, reveals the sub-levels of our framework of autonomy and initiation. We find that there are often discreet processes at work in the configuration of sustainable household networks which influence the *integration* of environmental innovations and social practices. Finally we show how these new forms of integration have particular consequences for policy at the local, national and European level.

8.2 Sustainable Homes - Existing Studies, Experiences & Policy Initiatives

Sustainable homes, green buildings, eco-neighbourhoods and low impact developments are just some of the names given to the types of schemes we are interested in for this theme. Within these sorts of developments we find a range of diverse people attempting to reorganise some aspects of energy, water or waste provision in ways which they consider to be more sustainable. Property developers, housebuilders, utility companies, local authorities, regulators, planning authorities, designers and households themselves have their own particular reasons for becoming involved in such infrastructural reconfiguration. These organisations have also made various attempts to:

describe what these sustainable developments should look like, to understand what they mean for everyday behaviour and practices and to predict how they might help provide greener housing models for the future. So, what have the existing studies and experiences of sustainable living told us so far and what have they failed to consider in relation to the critical infrastructures which provide the means by which we heat our homes, clean our bodies and go about our everyday practices?

In all three Domus countries, there is a long history of communities who have developed alternative forms of living involving the reorganisation of some aspects of utility provision. In the UK, one of the most publicised examples is the Centre for Alternative Technology in Wales, which was developed in the early 1970s as a "living community to test emerging alternative technologies" (CAT, 1998), although many more examples exist (see Bunker *et al*, 1998; Raman *et al*, 1998). In the Netherlands one of the longest standing projects has been Ecolonia a neighbourhood developed in the 1980s to test and demonstrate the application of sustainability principles to local planning (National Housing Forum, 1997). While in Sweden, eco-villages have been developed in which small-scale water and energy systems are developed as alternative forms of living in rural areas (Klintman, 1998). In each of these communities the provision of energy, water and waste services involves some form of self-provision and management. The wires, generators, bins, grids, pipes and disposal sites which characterise these developments are often vastly different from those we might see in more conventional housing developments. Each arrangement of service provision is carefully configured to conform to the specific objectives of the initiators involved alongside other physical, technical, social, institutional and financial considerations. The land available, the compatibility of particular technologies, the resource flows which converge in particular places at certain times, the lending arrangements and payback times for particular investments and the amount of effort individuals are willing to expend in maintaining heating systems, are all influential in shaping the organisation of these sustainable homes.

During the 1990s, renewed interest in sustainable housing developments and their water, energy and waste infrastructures has emerged from all quarters. Research institutions have developed programmes to look at the economic, environmental, technical and social aspects of sustainable living (see EPSRC, ESRC, EU Sustainable Cities Programmes). Building establishments have developed new guidelines for appropriate energy, water and waste technologies at different scales - individual homes, small clusters and larger housing estates (see BSRIA, 1997). Housing organisations have focused on building water and energy efficiency into new homes and retrofitting older housing stock to both save tenants money and ease pressure on local resources (see National Housing Forum, 1997; Hastoe Housing Association, 1997). Local authorities and municipalities have embarked on programmes to 'green' their entire cities, towns or villages (see Leicester City Council, 1998). Financial organisations now support green building projects and provide mortgages which reflect the different payback terms for more ecologically sound innovations (e.g. the Ecological Building Society in the UK). National and European Government have produced guidelines and developed programmes for more sustainable urban and rural development with strong rhetorics of 'integration' (DOE, 1996; VROM, 1990; European Commission, 1999).

This impressive array of guidelines, research programmes, professional interest, technical advice and financial support gives an idea of the political importance of finding more sustainable forms of living but there are still a number of questions as to what sustainable homes will look like and how exactly they will be integrated in relation to social practices, technical infrastructures, and institutional arrangements. If we consider the different approaches to investigating sustainable homes more closely, we can identify what they can tell us and what might be missing from such accounts.

At the level of the city, neighbourhood or community, planning researchers have considered what the form and function of sustainable households and macro infrastructures might look like (Blowers,

1994). Such strategic research contemplates the ways in which planners, building regulators and property developers might work together to improve the built-form and function of our inner cities, suburbs or rural communities so they are 'built to last' (URBED, 1995). Such a programme of action would typically involve the on-going maintenance and improvement of local economies, social organisation and quality of life and environmental resources and implicitly involve energy and water efficiency and improved waste management alongside other objectives such as local employment initiatives and integrated transport networks (see Gwilliam, 1998). These strategic approaches take a broad view of the sustainable neighbourhood, settlement, community or city - their agenda is set at a macro level. To complement such research we suggest that it is also important to look at the micro-organisation of domestic systems of provision in sustainable housing schemes. As we go on to show an in-depth exploration of household infrastructures helps to unearth the core issues which influence what can and cannot practically be achieved in contemporary sustainable building schemes.

A quite distinct programme of research is being undertaken by building researchers and engineers into the potential for specific technologies to fit into the picture of ecological living at a range of different scales (BISRIA, 1997; CIRIA, 1999). Energy efficient appliances, solar panels, combined heat and power systems, reedbed sewage systems and greywater recycling systems are just some of the environmental innovations which are being tried and tested across Europe. Many of these pilot projects and best practice case studies have demonstrated the technical capacity of systems found in sustainable homes but have failed to consider the social aspects of sustainable living and issues of day-to-day management, use, and on-going maintenance (Barton, 1998; Wolsink et al, 1998). As we have shown in our previous theme chapters with our studies of storage, efficiency or monitoring devices, technologies can be used as a proxy for investigating wider aspects of sustainable living. In this theme we also consider the scripts which come with particular packages of technologies as a way of investigating the social and technical characteristics of sustainable living and their integration.

Another feature of work on sustainable homes has been the tendency to assume that a perfect model of green homes exists and that it is a purely physical construction. In an attempt to challenge this way of thinking, Guy and Osborn (1997) have developed a typology of green buildings which are not just physically but also socially constructed. Their analysis of discourses of environmental innovation in both residential and commercial sectors suggests that there are many different styles and meanings of green buildings - they can be smart, ecological, aesthetic, comfort or community oriented - each model coming with its own particular sub-set of features relating to image, scale, technologies or strategy. Such a typology has resonance for many of the developments we describe in this report. Like sustainability itself, sustainable housing comes with a range of possible interpretations as to meaning, form and function.

Not only are green buildings different, so are the individuals who live in them, buy them, build them and maintain them. Representations of 'green' households often depict people who seek 'alternative' or 'hippie' lifestyles or envisage a neat split between bottom-up or top-down modes of sustainable living. Listening to what different people who initiate or live in sustainable homes have to say about their everyday lives and their reasons for being part of a sustainable scheme reveal a multitude of diverse living experiences, motivations and expectations. So far, many of these accounts have come from pioneers of sustainable living and are important not just in revealing the processes involved in more sustainable everyday lives, but also in revealing the types of technical or institutional barriers involved in sustainable innovation (Vales, 1994; Fairlie, 1996). These accounts partly illuminate what it means to live in a sustainable community but need to be supplemented with stories from other social groups, for instance, lower income consumers in inner-city green housing schemes or first-time buyers who move into a new home complete with in-built water and energy efficiency. This research does not claim to present a more representative set of stories of sustainable householders,

but it does attempt to recognise the diversity of people who occupy, design and develop sustainable housing. Looking more closely at how different households perceive their homes and the choices they are offered for living more sustainably reminds us that some options are foreclosed, others are highly prescriptive, and many may not be easily transferable. Decisions on what should be incorporated in sustainable homes need to be made very carefully to reflect not just the most efficient technical option but also the specific histories, financial situations, convenience and comfort levels and existing infrastructures of diverse household groups.

Such distinctions between sustainable housing and the people who live in and maintain them are also relevant in a national context. Different models of sustainable living may be more relevant in different countries dependant on particular histories, policies and innovations. Cross-sectorally too, individuals and communities may have particular relationships with the services that energy, water and waste provide in each of the Domus Countries. Particular forms of energy or water provision may be preferred in some places more than others for a whole host of cultural or institutional reasons, as highlighted in our differentiation chapter. Therefore, we need to be cautious about the sorts of associations with different flows of resources and relationships between utility providers and domestic consumers that we make and recognise their specific contexts. The extent to which the dynamics of utility reorganisation have influenced the development of sustainable homes in these countries is also an interesting issue to explore.

In combination, the research which already exists is extremely useful in helping us to build up a picture of the social and cultural meanings, technologies and practices, and institutional and strategic arrangements that are embedded within different forms of sustainable homes. Despite this there is still a sense of incoherence in relation to what the provision of services and the domestic infrastructures of the sustainable home might look or how they might be organised and integrated by different groups of people. Our investigation can tell us a great deal about the degrees to which sustainable housing schemes are challenging conventional 'grid' relationships and the extent to which these attempts are being obstructed by conventional policies and organisations of infrastructure provision. So far in our themes, we to have looked at particular sets of technologies as a focus to draw out social relations, now we go a step further and ask about the integration of consumers and technologies in sustainable home schemes. In other words, having built up the frame of our Domus logo, we now begin to colour in the home to create a more integrated and complete picture of the relationships between domestic consumers and utility systems.

8.3 Differentiating Sustainable Building Projects - Initiation & Autonomy

The starting point for our sustainable building research was to consider the basis on which we could differentiate the projects we had identified in the Domus inventory and select cases for further investigation. The first element we needed to capture related to variation in the *initiation* of sustainable homes. Initiators range from those who are seeking to alter their own household sustainability (as individuals or part of small communities or co-operatives), to groups who are initiating sustainable homes but not living in them (these include architects, housing associations and municipalities). In those projects where the initiator is 'remote', in the sense that they do not live in the homes, we may find wide variations in social and technical organisation and integration than in 'self-initiated' projects. The involvement of new providers of utility services in sustainable homes will also be explored. It appears that utility companies themselves have little to do with the management or even supply of energy, water and waste in some sustainable homes, while in others their roles are being negotiated, with new grid relations and providers emerging as a challenge to conventional household-providers relations.

The diversity of sustainable building initiators is also linked with the second element of variation we need to capture in our cases - that is the level/type of *autonomy* sought and/or achieved by initiators of sustainable homes (in relation to a baseline of conventional on-grid central utility provision). Autonomy can be interpreted in many different ways[38]. Our suggestion is that cases can be plotted in terms of their social/technical dimensions of autonomy, as a starting point for the analysis at least *(see Figure 1)*. In terms of *social autonomy* we need to capture whether participants in sustainable housing see themselves as 'normal' or whether they regard themselves as somehow special cases, whose aim is to remove or close-off from normal social relations. With *technical autonomy* it is a physical relationship to utility grids we intend to capture, whether people are actually disconnected. It is important that both social and technical autonomy are seen as relative categories in our research, we are trying to capture the variation in these levels, not assign cases to strict typologies. Therefore, Figure 1 should be interpreted as a scale of autonomy or of connectedness/disconnectedness.

Figure 1 - Social/Technical Dimensions of Autonomy & Initiation

	Technically Off >>> >>> Technically On	
Socially On >>> >>>Socially Off	Type 1 - Aim to be self-reliant & develop low-tech/ alternative technology removed from conventional systems. e.g. Eco-Community Communes who provide their own fuel, food, water & closed to outsiders.	Type 2 - Aim is self-sufficiency but are still (mainly) connected to conventional technical systems. e.g. Self-Build Communities Aim to provide own fuel and waste systems but still actually attached to grids.
	Type 3 - Aim is not self-sufficiency & conventional social relations maintained, but development includes technically off-grid features e.g. Housing Associations Aim to fit with local social identity, but have self-managed systems.	Type 4 - Conventional social and technical connections are maintained and reinforced with high-tech solutions. e.g. Future Home Builders Smart homes with high-tech control systems linking utility functions.

To summarise, autonomous in our cases can be:

i. **Socially Off** - In these cases autonomy would be defined as strong sense of social and cultural detachment from mainstream life. The initiators aim would be to remove and empower themselves by creating more self-sufficient sustainable homes/lifestyles which are closed to the outside world.

ii. **Socially On** - Here initiators would see social autonomy as something which could be achieved or enhanced by maintaining conventional relationships and social ties. The ambition would not be one of self-sufficiency or distinction from the outside world.

iii. **Technically Off -** Initiators are actually getting off grid physically and extracting from conventional technological systems. One way in which they might achieve this is by replacement with smaller-scale, decentralised technologies e.g. greywater recycling systems, wind generation etc.

[38] A number of definitions of autonomy (in relation to utility services) have been noted in the UK. For instance, BSRIA (Building Association) make the claim that "The term autonomous does not imply total independence from the mains. In the vast majority of cases it is environmentally and financially preferable to maintain a mains link and it should not be assumed that total disconnection from the mains (physical autonomy) is essential". In other cases, the meaning of autonomy was equated with getting physically off-grid (Centre for Alternative Technology Interview).

iv. **Technically On** - Initiators seek to keep connected to grids using the latest technical equipment to optimise connections. The ambition is not one of technical disconnection with high-tech systems seen as important in achieving technical autonomy.

8.4 Conceptual Relationships to Explore - (Inter-)Dependency and Integration

Initiators and consumers of sustainable homes are faced with a range of choices in selecting the new technical and social frameworks within which they want to live. Unlike many 'normal' homes where conventions for these social and technical elements are already well established the decision to build greener in some way implies a range of new choices. One way of conceptualising these choices is as a range of *dependencies* or *interdependencies* which need to be negotiated. Behind the decision to be on or off grid in social and technical terms and autonomous in a broad sense, are a much more intricate set of relationships between technologies, providers, consumers and institutions. In this instance, we are interested in five of these relationships:

i. The interdependence of technologies e.g. does the choice of one technology link with others?

ii. The interdependence of technology to provider/consumer e.g. does the inclusion of certain technologies imply changing dependencies between providers and consumers?

iii. The social dependency involved e.g how far do initiators or residents of sustainable homes seek to distinguish themselves or connect with others both inside and outside the project?

iv. The institutional and policy dependence of different approaches to sustainable living e.g. what are the planning, regulatory, funding and policy dependencies of different initiators?

v. The dynamics of dependency e.g. maintaining the level of on-off gridness or adaptations to dependencies and thresholds over time.

By concentrating on these relationships of dependency as a frame for unpacking our case study findings, we can reveal the forms of *integration* emerging between environmental technologies, initiators and households across both resource sectors and countries. Specifically, our final analysis will enable us to reflect on some of the following questions concerning socio-technical integration in sustainable housing infrastructures:

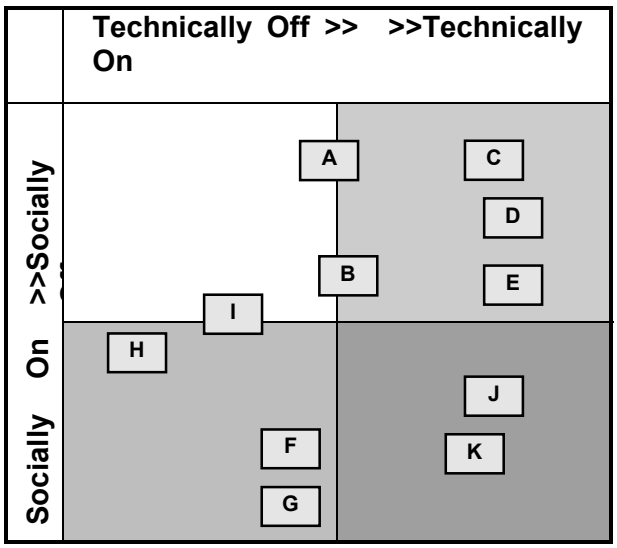
- What are the levels and forms of social and technical integration found in sustainable building schemes across sectors and countries?
- Does being a self-initiator or remote initiator makes a difference to the levels and ease with which social and technical integration can take place?
- How far are technical and social autonomy are mutually reinforcing, for instance, do you have to be truly socially off-grid to be successfully technically off-grid?
- Which key social, technical and institutional components are involved in people getting off grid and achieving their desired level of autonomy and how do these relate to particular personal, collective and financial thresholds?

By answering these questions we can begin to evaluate the scope for adaptations at the policy level which might make it easier for different groups to achieve their preferred level of social and technical integration.

8.5 Selecting & Plotting Cases - Capturing Variation in Socio-Technical Integration

From the Domus inventory report we identified a number of sustainable building projects from the UK, the Netherlands and Sweden, and plotted these schemes across our grid of autonomy *(see Figure 2).* More detail on each of the projects is given in the annex of this report, under the heading of sustainable homes projects. The intention was to begin by capturing a range of sustainable projects differentiated on the basis of their type of initiators and the levels of social and technical autonomy they implied. This was evaluated from our preliminary investigation of cases for the inventory, our knowledge of schemes and previous contacts with initiators. In the UK, we interviewed initiators of five projects, including the water off-gridders of three self-built homes in the City of Leeds (A), a development of five earth-sheltered houses in rural Nottinghamshire (D), two environmentally inspired housing association projects of around thirty homes in inner city Liverpool and Birmingham (F,G) and the architecturally inspired 'green and intelligent' home of the future (J). In the Netherlands, four projects where selected for study, including three initiated by housing co-operatives set up by residents (B,C,E) and the state-of-the-art solar homes in Amersfoort (K). While in Sweden, two municipality-led ecological building projects were chosen (H,I). In this report all of the developments represented new forms of housing development, not retrofit projects, although these were also being introduced in all three countries.

Figure 2 - Plotting Cases - Dimensions of Autonomy & Initiation



Sustainable Projects
A = Allerton Park
B = Groene Dak
C = Polderdrift Association
D = Hockerton Housing Project
E = De Bongerd
F = Harlow Park Ecolite Homes
G = Black Country Housing
H = Myrstaken
I = Solbyn
J = Integer Homes
K= Amersfoort

For each of these projects we visited the homes to interview initiators/consumers and to look around the sites. For several of the Dutch/UK cases co-working visits were also arranged to compare some of the projects. During each visit a range of issues where discussed, as a means of unpacking our relationships of dependencies.

i. Interdependence of Technologies

Our first set of questions related to the technical features of the sustainable homes and the history of choices behind each. We focused our investigations on how these choices interlocked and whether environmental innovations came as piecemeal or part of a package.

ii. *Interdependence of Provider and Technology*

The second objective was to find out about the interdependence of technologies to their (co-) producers. We concentrated on the changes to routines which accompanied the introduction of some of the new technologies and asked about the processes surrounding their maintenance, use and replacement to highlight the degree of dependency negotiated between different actors.

iii. *Social Dependency*

Here we were interested in the extent to which initiators or consumers see themselves as normal or different from mainstream society and whether this is seen as desirable. For instance, how open or closed are the projects to the 'outside' world. We also wanted to find out about the internal degrees of reliance on other project participants and how these were communicated and negotiated.

iv. *Institutional/Policy Dependency*

Connected with social dependencies are the institutional and policy dependencies of providers and consumers of the homes. We were interested in the degrees to which respondents are thwarted or supported by existing 'mains' systems and structures. For instance the regulatory, planning, funding and building procedures associated with the developments and how this shapes the setting of social and technical thresholds (payback times for investment, acceptable levels of comfort and convenience and margins of compromise etc.).

v. *Dynamics of Dependency*

Finally, we asked interviewees about the dynamics of changing dependencies and connected thresholds. The shifts in grid connections over time are reviewed in relation to past, present and possible future developments. The logics behind these changing dependencies can be linked to a range of changing institutional, social and technical parameters.

8.6 Breaking Down (Inter-) Dependencies in Sustainable Building

In the sub categories below we discuss the different (inter-)dependencies which emerge drawing on examples from the different types of sustainable homes. In many cases the dependencies we are interested in are revealed around stories of 'breakdowns' or sites of 'conflict'. For instance, the simple replacement of a lightbulb can bring into view a range of technical and social dependencies, or the conflict around garden areas which can highlight the tensions between private and public space. In addition we can pay attention to the symbolic indicators of socio-technical dependencies, by paying attention to a range of visible features of the different homes.

(i) Interdependence of Technologies

During our interviews we identified the basic pack of ingredients which seem to be synonymous with any building project labelled as sustainable. These included technologies such as extra insulation, high-efficiency boilers, advanced glazing systems, reduced capacity cisterns, water saving taps/ showerheads, and some form of recycling containers. In addition the homes contained a range of more novel, experimental or sophisticated technologies. In 'remotely' initiated projects these included the sun pipes for natural light in the Black Country Project, and the introduction of grey water systems in four of the Harlow Park Homes. In the Integer demonstration home many innovative and state-of the art features were included, which were not found elsewhere, including the latest kitchen appliances and smart metering systems. Although the scope for these to be transferred to the new-build homes was uncertain:

> *"Some of the technologies are relevant to social housing, some to private housing and some only of interest as possible opportunities in the future" (Integer interview)*

In the 'self-starter' projects many more experimental technologies were featured, such as the reedbeds of Hockerton and Allerton Park and the composting toilets of Groene Dak. Many of these required the careful design of houses and surrounding land to ensure there was enough space for storage. In many self starter projects the importance of linking technology to spatial design of homes was stressed, with technologies and buildings locked in a system of dependency related to issues of orientation, storage area and slope.

In almost all of the projects particular trade-offs were made. In many cases households were left to choose their own kitchen appliances, and this often involved careful consideration of whether to buy the most energy efficient appliances or to take into account embodied energy and stick with old appliances until they wore out. In other cases, the integration of some technologies negated the use of others. For instance, in the Groene Dak Project the initiators thought they could link high efficiency furnaces and solar heaters but were unable to do this because the furnaces could not be linked to the solar collectors they had chosen. Another common trade-off was the choice of either rain water of greywater techniques, while some self-providers did incorporate both types of system for different uses, many other initiators were strongly in favour of one system or the other. With other issues emerging around the scale of water re-use, for instance the households at Polderdrift in the Netherlands shared a rainwater system between eight households, while those at Allerton Park in the UK each had their own supply tanks. The selection of new water technologies required perhaps the most careful planning to meet the particular social needs but also to ensure that the optimal amount of water is produced from whichever arrangement of technologies is chosen.

The choices of technologies, whether tested or experimental, simple or complex, old or new, need to be carefully evaluated by initiators to take into account their 'fit' with other household devices, systems and structures. One way to unpack these relationships of technological inter-dependency is to consider what happens when a technology breaks down and think about the 'back-up' systems which can be implemented. In many of the self-started projects there was resistance to dependence on mains back-up unless it was absolutely necessary, leaving many new technologies to stand-alone. For example, in the Allerton Park Homes the rainwater system for drinking water was initially set-up to provide all the water needed for the families. This technological independence was challenged one winter when the pipes froze, leaving the options to sit it out and wait for the thaw, or to revert back to mains supply. Two of the three households chose the latter option and in doing so re-asserted the inter-dependency of mains water systems with those of self-supply. In the Hockerton project, for heating systems two 'back-ups' are in operations. During cold winter nights when the solar energy systems fail to provide enough heat there is a mains supply of electricity to boost temperatures, alternatively the back-up 'technology' is to put on an extra jumper.

In many of the 'remote' initiator projects the heating systems were the main point of contention. Despite the reassurance of initiators that central heating systems would not be required as a back-up to passive ventilation or solar technologies, many tenants insisted on the inclusion of radiators. The provision of 'booster' technologies in almost all of the projects we visited illustrates the logic that although not required in formal guidance on acceptable standards of heating comfort, technologies become locked together because of social pressure. These examples of breakdowns also help to illustrate the level of 'trust' or dependency people are willing to invest in new technologies and the degree to which this is reflected in the arrangement of back-up systems available if systems fail. Technologies are also chosen carefully to meet the needs of different groups, for instance in Zwolle the technological options selected were the result of discussions of "eco-possibilities without losing comfort".

(ii) Interdependence of Providers/Consumers and Technologies

Conflicting logics of dependency between technologies, providers and consumers can be found

throughout our case schemes, and can be illustrated around one simple example of a 'breakdown' e.g what happens when an energy efficient lightbulb needs replacing? In the Harlow Park Development the replacement of the lightbulb brings into play new dependencies between the housing association and the tenant, because of the inclusion of a fixed light fitting in the house design. The brochure handed out to tenants explains that:

> *"Your home has special fittings for low energy light bulbs. These are not the same as you would buy in the shops for a traditional fitting, but will be considerably cheaper and last 3-5 years. Please speak to your Housing Officer about buying replacement fittings, and for advice on lampshades" (CDS Housing, 1999).*

In this case, even changing a lightbulb is no longer the sole responsibility of the tenant, but needs to be negotiated with a provider, who by fixing a technical device has effectively 'locked' consumers into a new relationship and strengthened the tenant - housing association - lightbulb dependency. Such scenarios of lock-in are found mainly, but not exclusively, in 'remote' initiator schemes. In the Black Country Housing Project, which we plotted at a similar level of socio-technical dependency as Harlow Park in Figure 2, the overriding logic of tenant-provider relationships is described as one of "intervention without removing choice" and it is true that in terms of "lightbulb logic" tenants are able to choose whichever devices and shades they desire. This is not a consistent logic, however, and is open to provider interpretation. The greywater systems installed at the same site are fitted without the tenants prior knowledge, an intervention with considerably less consumer choice given that systems are already embedded in the fabric of the home.

Other 'remote-starter' projects present an equally complicated picture of the interplay of technical and social dependency. In the Integer Homes, for example, there are dual logics in operation, with the key concepts of 'pre-fabrication' and 'ease of adaptation'. On the one hand a number of pre-programmed water features come ready-made in a bathroom module, which would be difficult to replace or modify. On the other, there are access hatches all over the house so that tenants and repair people can easily adapt wiring and a range of different light fittings. This 'green and intelligent housing' model may offer the least scope for replacing technologies, but does offer a large variety of programmable options within the technologies embedded in the infrastructure of the home. In all of the examples, it appears that the level of desired integration is dependent on the logics of providers and the degree to which they want to control certain aspects of sustainable living and 'lock-together' technologies and consumers.

There is also a distinction to be made in relation to the level to which technologies are physically 'fixed', which leads us into some cross-sectoral issues in dependency. The negotiation of waste grids, for instance, which are relatively mobile in comparison with water and energy, seem to involve more open processes of discussion between tenants and providers. Households can either choose to deal with waste collection themselves, as in visiting the local bring sites, which is often the case for smaller self-build developments or as in most cases, negotiate with the local authority for a suitable collection service. In Harlow Park this involved four waste stores built into the project with collection by the local council, in Zwolle underground containers were supplied with chip cards for tenants. Either way there appears to be more flexibility in relation to what households choose to do with their waste.

(iii) Social Dependency

Our third relationship of dependency focuses on the social rationales and networks of sustainable building projects. In terms of social rationales, the most socially-off scheme was Allerton Park in the UK, where the decision to achieve more autonomous lifestyles related to a complex set of cultural, social and environmental beliefs. One of the initiators explains how the group had a number of shared beliefs and values, including:

"mistrust of the system, search for radical alternatives, individualism, and the environmental notion of keeping everything in our own valley"

In contrast the strongest socially-on story came from the Integer Project in the UK, where the logic was to provide low cost alternative housing as part of a wider plan to develop new 'greener and more intelligent' approaches to housebuilding in the UK. The commercial prospects raised by the development of these schemes were also at the forefront of initiators minds. In other "in-between" projects a diverse range of logics existed. One of the main logics of self-starters was "to do something different", so we heard the former resident of Groene Dak explaining that others should not follow but develop their own variations on sustainable living. The adoption of what were seen as socially-off notions by 'straight' actors such as utilities was seen by these groups as weakening the spirit of independence in green projects. In Myrstaken and Solbyn in Sweden, the logic of initiation was a similar mix of ecological and social objectives, but the notion of developing a strong sense of community was felt more strongly in the latter of these schemes where residents had been involved together in the planning process. This sense of 'recreating' a strong sense of community was further supported by the Zwolle initiators who wanted it to be "as it was in the early days, meet your neighbours in the corner shop".

The on-site arrangements of sustainable households also reveal a great deal about the ways in which social dependencies are being renegotiated around the provision of water, waste and energy services, among residents themselves and their previous service providers. In many of the self build homes such as Hockerton deals or contracts are made to reinforce dependencies for instance, if an irresponsible family goes off and leaves the tap running which would drain the reservoir then they would be financially penalised as each households water use is metered. In this case the households had set up a maintenance and services company and a trading company to strengthen the internal dependence of the residents and clearly demarcate responsibilities. In other cases such as Zwolle, the choice of individual rainwater systems is seen as fairer to avoid small families suffering from over-use by those with large numbers of children. The self-management of systems means that water-use contracts do not need to be drawn up. Social dependencies are often negotiated even before people come to live in the projects, for instance in Polderdrift residents are screened by the Association before being accepted to assess whether they are willing to participate in collective action.

Other social arrangements in co-operative developments are less contractual, for instance in Zwolle, there was no obligation to buy 'green' appliances or products for your home, but there was some degree of 'informal' pressure by fellow tenants, with the brochure describing what it is like to live at De Bongerd leaving residents in no doubt as to non-acceptable forms of behaviour:

"Living in De Bongerd is ....to smuggle your tanning bed, microwave and other 'wrong' devices into your house during the night"

This notion of informal management is also developed in the Black Country Scheme, where the housing association had encouraged tenants to get to know each other without formalising these dependencies in a residents association. The objective here was to have a more intensive form of management than in other housing schemes but to base this on informal negotiation, so for instance "negotiating noise levels with their neighbours", rather than complaining to the Housing Association. This creates new tenant-tenant dependencies, although in other instances the housing association will intervene, for instance in negotiation with utilities over the introduction of prepayment meters. In other organisations such as Myrstaken and Solbyn tenants had come together voluntarily to form their own strategic groups for dealing with different aspects of site management and to effectively share time, knowledge and physical strength. In the Integer and Amersfoort homes there was no desire to develop off-grid housing in either a technical or a social sense, at least not for the lower-income social housing tenants who would be moving into properties in the future. The maintenance of grid links and

social dependency on previous suppliers was a fundamental part of the project plans with utilities firmly involved in implementing and monitoring the schemes, for example, through sophisticated metering technologies.

Public space is another arena where we can see social dependencies being negotiated, especially in the decision to choose communal or private gardens. In almost all the schemes a compromise is made with some private areas supplemented by a shared garden. However, the degree of 'openness' of these spaces and the struggle to protect private areas reveals the degree of social integration sustainable households are prepared to accept. In Harlow Park the tenants initially rejected the idea of a communal space in favour of more private space. To persuade them that a communal garden was a 'good' idea, the housing association arranged a visit to a similar housing scheme in Manchester, which convinced the tenants to some degree. Although the high fencing around the individual garden areas and the lack if interest in managing the shared garden are a testament to the social independence these family groups seek to maintain. In the Polderdrift scheme initiators agreed to give people more private space on the proviso that no obtrusive fencing or hedges would be constructed, in reality a number of such boundaries have appeared.

Self-starters often distinguished themselves from other communities. A common social referencing system used was to talk about 'normal' consumers or 'straight' world as set apart from their world. In Hockerton this was emphasised when talking about the other construction project they were involved in and how greywater was "too extreme" and reedbeds "too much" for conventional homes. This method of social distinction was also used by one of the residents of the Polderdrift Association in the Netherlands, who explained that:

> *"You can't flush everything into the sink because chemicals can damage the biological treatment in the reedbed filter, but you shouldn't do that in conventional systems either, so normal people could live here"*

In the majority of these housing projects householders saw themselves as different. With many setting this out in their initial project objectives, for instance in Groene Dak sustainable living meant "the realisation of homes for those households other that the traditional family".

This trend of self-distinction was less pronounced in some of the housing association projects in the UK. In these communities, despite the efforts of initiators to try and 'push' green identities onto tenants, there was resistance to being seen as 'different'. For instance, in the Black Country Development and the Harlow Park Development, the residents were seen to be proud of their new 'green homes', but strongly resisted any overt attempts to make them stand out from their neighbours. In the Ecolite development this was seen in the rejection of the architect's canopies above the front doors, which stood out in inner-city Liverpool and in the assignment of timber framing to the back of the homes only. Unlike many of the co-operative housing developments of the Netherlands and Sweden there was no apparent desire by social housing residents in the UK to set themselves apart from conventional housing schemes.

If we think some more about the relations of the projects to the outside world, the visual and symbolic representations of the sustainable homes and the multiple interpretations of these not just by residents but also by neighbours are important. The Russell Family who lived in the Integer home for a week described the house as "aesthetically and symbolically making a statement about the environment". While neighbours regarded it as an eyesore and complained it would block out the light from their homes. Despite the endeavours of the Hockerton residents to 'fit' with the local community they are still regarded by many neighbours as 'outsiders', with a considerable amount of local resistance to their proposals to build a wind turbine, a strong visible symbol of sustainable living. These local resistance's raise the issue of social dependence in a wider sense and the negotiation of social integration between households and their neighbours.

The siting of projects and the extent to which they are closed or open, near or far from the 'outside' world are also important in considering social dependencies. In Zwolle, we heard how the houses had been planned to be 'open to the surrounding community', in comparison to other projects such as Groene Dak, which was a more self-enclosed development. In the former development the housing co-operative invited neighbours from the surrounding estates to discuss the project, with the aim of making the 'conventional' households more comfortable living next door to an eco-development. This was seen as a partial success, although many neighbours still complained about the appearance of the site, which contrasted with the 'neat' and 'tidy' arrangements of their homes. In the Swedish examples, the intention was to "as far as possible reach a closed and self-supplying village", although it was not clear if this was in a social of technical sense. Finally, in Hockerton, the houses were built in an isolated spot and earth sheltered to 'hide' them from unwanted attention and make them less obtrusive, but they also chose to locate the site near enough to civilisation, noting how they depended on local schools and services. In this sense isolation is a negotiated issue, and the residents rejected the approaches of other communities such as the Centre for Alternative Technology, which they saw as too remote to meet their requirements.

(iv) Institutional/Policy Dependency

The self-provision of some utility systems in the sustainable building schemes means that many new institutional dependencies became negotiated *within* the project communities. For instance in the setting up of new legal entities and maintenance agreements, much in the same way as previous contracts had been with mains utility providers. In many cases though the independence initiators had hoped to achieve from conventional utilities and other institutions and the freedom to choices associated with this have not been realised. One example, is the insistence in the UK that any small renewable generator who wants to sell excess energy back to the grid (often a necessity in terms of cost-effectiveness of new systems) needs to pay to register with the electricity grid. In this case reversing conventional relationships is not as straightforward as it seems and had encouraged many initiators to drop the renewable generation aspects of schemes which they had originally planned. Another example of the dependence on conventional utility systems comes from Groene Dak, the residents had agreed that they would separate their plastic waste for utility collection, only to find out later through a newspaper report that plastics were mixed together anyway later in the waste disposal chain.

Another problem emerged in relation to the resistance of plumbing and building contractors, who were often reluctant to work with the 'new-fangled' innovations in households. In Harlow Park the architect describes how the building contractors "resisted almost everything that was different from conventional homes" e.g. bin stores, canopies and the communal garden. In Hockerton, the electricians wanted to revert to 'normal' wiring with PVC and in Groene Dak, similar stories with piping were told. In these examples another set of interdependencies emerge, that between 'conventional experts' (builders, plumbers and electricians) and the 'green' experts on the project, many of whom were already knowledgeable or trained in these trades, but others who had to learn fast to find new suppliers and compromises to ensure the projects stayed on track. As the Zwolle Housing Association remind us:

> *"Living at de Bongerd is....To build a close relationship with your troublesome rainwater pump and with the plumbers"*

The dependence on conventional repairers or maintainers varies among different types of homes. In the case of the Integer Homes social relations are maintained and reinforced with high-tech solutions. One of the elements of this is that many of the technologies chosen (for the show home at least) are relatively state of the art and the dependence on outside 'experts' for maintenance is strong. As the consumer researcher on the project reveals, there is an important issue concerning who is around when things go wrong, and a possible lack of local 'fixers'. The sophistication of systems and the

amount of expertise associated with them also helps to shape the dependency between sustainable dwellers and external institutions.

Other tensions emerged in relation to building regulations and the lack of integration of these. In Hockerton there was frustration with the responses of many utilities to support add-on measures such as 'hippos' rather than challenge the current water regulations to make lower capacity cisterns a legal requirement. The frustrations over the inadequacy of building regulations were particularly strong in the UK cases, where one housing association representative described them as appalling - "the lowest common denominator". In many cases the barriers presented by poorly defined or limiting building regulations, had led initiators to incorporate 'illegal' installations or applications into their projects. Like the housing group who went ahead and installed a water recycling system even after the water regulator stated "over my dead body" when presented with plans, or the inclusion of lower capacity cisterns which are not yet officially specified.

There was also a distinction in relation to institutional negotiations between smaller self-starter communities and larger 'remote' starters. For instance, in sustainable building projects like Integer the strength of initiator partnerships between architects, property developers and building research groups, enabled high level pressure on the Government to force regulatory change. The initiator interviewed describes how they "decided to go to the top, the housing minister and the Prime Minister" to get change and to bypass the resistors. This is a sharp contrast to the residents of Groene Dak who "were not allowed to talk to people in power", and had to mediate all interactions through mainstream Housing Corporations, who they felt were 'diluting' their ideas. The initiator we spoke to describes how everything in the beginning was a struggle from 'breaking into the city plan' to correctly orientate the houses for solar energy, to getting agreement to transport water between houses. The 'dilution' of ideas was also noted by initiators of Polderdrift, who had started off with ambitious plans, such as using rainwater for showers but ran into resistance from the conventional Housing Association who represented them. In another UK case, the housing association explained that change was beginning to happen in relation to the manufacturing industry, describing how a few years ago they had struggled to find a brick manufacturer which met their high environmental standards, but with the introduction of EU regulations the British brick manufacturing industry was now "having to play catch-up".

A final word on institutional dependencies relates to funding. Many of the conventional mortgage lenders for housing schemes in the UK are reluctant to fund sustainable building schemes, especially those which are too socially and technically-off, and hence seen as too risky an investment. The Allerton Park scheme was only possible with the help of the specialist Ecological Building Society. While other schemes such as Hockerton were largely self-funded. Non-conventional sources of funding to support such schemes are still one of the main barriers to achieving autonomy in the UK at least. Other funding requirements need to be negotiated with many diverse institutions, with a range of small 'pots of money' available from companies such as utilities, but often only for the experimental elements of sustainable homes such as water recycling units or solar collectors. In effect utilities are interested in sustainable building sites as real world 'test- beds' for their research and development departments. In the Amersfoort development the entire housing estate was also seen as a testbed project, with future schemes unlikely given the high level of subsidies involved. One final aspect of finance related dependency are the payment systems for resources. For instance, in Polderdrift despite residents managing to reduce the volume of their waste going to central sewage systems by 85%, they paid the same sewage bill as everyone else. As we saw in our differentiation theme, such 'blanket' payment systems are becoming less common as more utility services are metered or charged by volume collected, but they nevertheless present a significant institutional challenge to making sustainable systems pay.

(v) Dynamics of Dependency

One of the elements not captured in Figure 2, is the dynamics of sustainable housing projects. Social and technical relations are constantly on the move in these schemes and the recent reshuffling of utility organisations also indicates changing possibilities for grid relations. In assessing the dynamics of dependency in sustainable housing infrastructures we began by considering the changes that the are made in relation to the conventional 'one-pipe' or 'one-wire' or 'one-bin' systems. In Figure 3, we show the extent to which different sustainable building projects can be seen to fragment grids[39].

Sustainable Building Project	No. of Grids	Description
A - Allerton Park	7	Rainwater to drink - Greywater to Flush - New Sewage network - Conventional Electricity - Mains Top-Up Water - Composting - Duo Bin System LA Run
B - Groene Dak	9	Waste Recycling - Self-Sewage - Solar Hot Water - Wastewater Recycling - Mains Water - Rainwater for washing machines - Composting - Wastewater treatment - Mains Electricity
C - Polderdrift Association	8	Sewage to mains (85%less) - Drinking Water in - Collective Rainwater for Washing Machine - Greywater for flushing - Solar Collectors - Mains electricity top-up - Conventional Waste - Compost
D - Hockerton Housing Project	9	Sewage to Reedbed - Rainwater for Drinking - Rainwater for Gardening - Waste Water for Household Use - Mains Electricity for Night - Passive Solar Energy for Day - Home Composting - Recycling to local bring site - LA Waste Collection
E - De Bongerd	7	Rainwater systems - Reedbed - Some Solar generation - Gas and Electricity mains - Recycling - Composting
F - Harlow Park Ecolite Homes	6	Mains electricity - Mains Water - Greywater - Renegotiated waste - Home composting - Rainwater tubs for gardening
G - Black Country Housing	4	Mains electricity - Mains Water - Greywater for toilet - Waste Recycling by LA
H - Myrstaken	7	Earth toilets for Sewage - Reedbed Recycling for Waste Water - Wood Stove - Solar Roof - Composting - Waste Collection - Independent Well for Drinking
I - Solbyn	5	Municipal and Independent well water - Earth toilets - Municipal Sewage System - Wood Stoves -
J - Integer Homes	8	* Difficult to know for 'real' homes - Demo house has 3x mains Grids plus - Rainwater - Greywater - Composters - Solar - Wind - for small generation.
K- Amersfoort	3	In demo homes - solar collectors for all energy (zero energy home) - greywater recycling for toilet flushing - mains water

In most cases households lived in conventional homes prior to moving to sustainable sites and were connected to the three mains grids of energy, water and waste, with the possibility of some other limited fragmentation especially in relation to waste recycling or composting. The figure shows how the move to sustainable homes implies a range of new grid dependencies to negotiate. What is not shown is that as the projects develop we can begin to see how these connections are strained and adapted. For instance, the first breakdowns of the water system in Allerton Park, cause a significant shift from a technically-off to a technically-on position, as some residents connected to the mains. In the Groene Dak development the technical dimensions also shift significantly, in this case over a five year period, with the reconnection to mains systems, most notably in the case of sewage. In this case

[39] It is also possible to fragment these grids even further if we consider the distinction between hot and cold water supply for instance, or that collected and used for watering the garden, or the separation of waste into different components going to different sites.

when the residents found that the waste from their composting toilets was useless for re-use on their gardens they took the unconventional route of disposing it in their wheelie bins for collection by the municipality. The social dependencies in this scheme had appeared to shift the most, the rationale changing from one of individualised provision to preferences for centralised and institutionalised provision, where residents should not have to be bothered with "dealing with smelly bins".

These changing dynamics of adaptation also reflect the thresholds of activity, the extent to which consumers are willing to live with the 'hassles'' associated with their new forms of service provision. In many cases there is a readjustment period where residents feel prepared to stick with new systems despite their idiosyncrasies, but after a particular point they cross the threshold or ceiling of their tolerance and negotiate new arrangements or reconnect to old systems. These thresholds are important in assessing the scope for the longevity of systems and the possibility of putting into place compromise systems, which might avoid the full-scale return to more environmentally damaging systems, but also ease some of the more serious irritations of the sustainable system.

Alongside the shifting institutional and personal thresholds of provision, we can also use this figure of splintering grids to reflect on the financial negotiations of grid dependency. Figures for the changing costs from mains systems to new grids indicate the level of investment that initiators are willing to make and the timescales involved in these. The price of greywater and rainwater schemes in many of the projects cost between £500 to £2000. In the Allerton Park development the rainwater system costs were near the lower end of this scale as the system had been constructed from cheaper components, here the initiators noted that the savings on each households water bill would be around £150 per annum, which gives some idea of the range of payback possibilities. The Harlow Park homes cost 2.4% more than conventional homes of this type, but it was estimated that the £50 a year savings in energy bills would make this investment worthwhile.

Furthermore, the degree to which different initiators negotiate their personal or collective dependency on particular infrastructures is also interesting. For instance decisions may have to be made over the proportions of solar compared to mains electricity which influences the percentages of dependencies on different grids, shifting the balances of autonomy and ultimately the perceived personal and collective legitimacy of the housing scheme. If green energy remains in a higher proportion to that from the mains then that may be regarded as keeping with the overall energy objectives of the project, but shift this balance and initiators may be compelled to reconsider their sustainable credentials. The expectations of savings in the schemes were often lower than expected in the first year which disappointed initiators and residents but they hoped to improve these ratios over time. For instance in Zwolle first year water savings were 25-30% with an expectation of 40-50%, while in Hockerton the household interviewed had reduced energy usage by 80% but hoped for further reductions once new equipment was bought on-line.

This splintering of grids illustrates the range of new negotiations which need to take place around new sustainable building projects in relation to traditional systems of provision. The prevalence of new systems leads us to consider the re-allocation of dependency to multiple grids and think about what these dynamics of decentralisation might mean in relation to changing issues at the micro-scale of the household, such as degrees of reliability on different grids and distributions of maintenance efforts among individuals. Another issue to consider is how these patterns of splintering reflect the dynamics of the macro utility world. For instance, in the case of Allerton Park the decision to introduce rainwater systems was partly attributed to residents objections to the privatisation process. While the connection to solar panels in the Amersfoort development was only financially plausible because of the energy companies interest in new forms of generation and as part of the wider renewables policy of the energy company involved.

8.7 Integrating environmental innovations and social practices

The overall aim of undertaking this analysis of sustainable housing schemes was to understand the ways in which environmental technologies and social practices are becoming integrated in UK, Dutch and Swedish households and how this relates to particular institutions, initiators and infrastructures of provision. Now that we have unpacked the layers and forms of dependency which characterise such schemes it is possible to summarise some of the key relationships of integration which have emerged from our case studies.

Levels and forms of social and technical integration across sectors and countries

The first point to make is that our grid of social and technical dimensions of sustainable homes is far too simplistic. Although we have attempted to capture more variation in initiation and autonomy of sustainable homes, this grid still fails to represent the diversity of forms and levels of social and technical integration in sustainable building schemes. We found a range of projects in which initiators strove to do things differently and to define their own parameters for sustainable living. Each scheme that we looked at had a unique array of technologies and equally diverse social objectives and arrangements. From the light fittings to the logic of water or energy saving or the setting of comfort parameters, we heard new stories in each home we visited. Such observations reflect the diverse interpretations of what sustainable homes might look like and the range of social and technical service packages which can bring this about. Despite this variety of forms of integration there were some similar features to be found at a broad level which help to clarify some of the more generic features of social and technical integration in sustainable housing schemes. In addition we can make some observations on the sorts of sectoral and national features of social and technical integration.

In relation to the sorts of technical choices being made in sustainable schemes it appeared that the base level of environmental innovation is similar in form - energy efficient light bulbs, recycling bins and water saving devices - were integrated in developments as a matter of course. However, the level of these was somewhat varied, as was the embeddedness with the structures of the home and the organisation of associated household practices. There was also a degree of cross-country variation in the choice of technologies, in the Netherlands and Sweden we saw more institutionally integrated technical forms (low capacity cisterns and in-built bins) than in the UK where more add-ons were identified (cistern devices) except in self-provider communities where the model adopted in other European countries was advocated.

At the level of social interaction, despite variation in the form there was an expectation that some communal activities would take place. Often these centred around the maintenance of communal spaces, such as clearing up gardens once a month or attending residents meetings. The extent to which such activities were an essential part of everyday life varied among the projects. But the forms of social integration and partnership between members of the developments was seen an important aspect of most sustainable building schemes. The levels of interaction were formalised in self-provision schemes but remained informal in many others. Perhaps the only exception to this need for social integration with neighbours was the proposed development of Integer housing where social systems were contained within the confines of the dwelling, rather than an expectation of interaction with others as with many conventional housing developments.

In terms of the choices of sectoral infrastructures, initiators of projects usually had separate logics for dealing with energy, water and waste aspects of sustainable living. There was a temporal aspect to these decisions, with initiators who had tried say water saving moving on to try out energy saving at a later date. The intensity of interest in different infrastructures reflecting both the need to try something new and the particular frustrations experienced with previous systems. The conventional grid connections and level of decentralisation of water, waste and energy arrangements also influenced

the scope for integration of these systems in projects - with some forms of energy and water autonomy particularly difficult in the UK but more easily accepted in Sweden, where wind turbines in rural areas and local water systems are already well-established.

In summary we can say that forms and levels of integration in sustainable housing systems are widely variable and simplistic models which try to capture these dimensions fail to capture this diversity. For some technologies different countries have distinct approaches to the forms of integration which are seen as desirable reflecting building regulations and standards. While the sectoral choices of sustainable housing initiators reflect personal experiences, knowledge of other schemes and the desire to try different forms of integration over time.

Initiation and integration

Being a self-starter or a remote-starter involves different sorts of processes in configuring the desired level of social and technical integration and in maintaining these systems once they are initiated. In self-starter schemes we found a higher level of social dependence between different households. From the conception of projects participants were involved in negotiations over technological choices, investments, daily routines and maintenance contracts, many of which involved significant changes to previous lifestyles, practices and infrastructures. Being able to directly voice their expectations of what their sustainable homes might look like did not necessarily mean that social and technical integration was more easily achieved. Other institutional, social and technical factors were at play which meant that agreements outside the more self-contained networks of scheme itself were often more difficult to negotiate. Internally too, the 'starter' group of initiators was often joined by other occupants over time, which meant the constant renegotiation of responsibilities and some tensions emerged. The stories we heard reminded us of the extent to which sustainable schemes may seek to be socially and technically autonomous and reach some level of agreement between initiators, only to have their hopes dashed by their connection to networks which stretch far away from their homes or of the degree to which integration is temporally influenced, with the constant need for adaptation to meet the demands of newcomers or the changing thresholds of provision.

In remote-starter projects the expectations of households who would eventually live in the schemes were often assessed by consumer surveys, tenant feedback groups or personal interaction with initiators. Often the tenants had little experience or knowledge of what an integrated sustainable home would look like, and it was left up to initiators to decide what would be best for these households. In this sense the issue of what social and technical integration should mean is less contentious and is pre-defined. Rather than negotiation over every aspect of sustainable living, we see tenants' being given some choices - maybe over the colour of the bathroom or the inclusion of central heating, while other decisions are made on their behalf - the inclusion of energy efficient lightbulbs or water recycling systems. Other systems which are seen to belong more to the world of socially-off self-starters are often seen as inappropriate - composting toilets, recycled drinking water. The carefully configured choices of initiators, maybe with some tenant input, is shaped to fit the particular social group which will be living in the property and are largely low-hassle, fit and forget options. In these remote starter projects socio-technical resistance's are effectively minimised by choosing largely uncontested technologies which minimise changes to social practices, as such there are less institutional or social challenges to deal with and integration in initiation is easier to achieve. Less certain is the degree of integration in practice, although the often discreet and low-maintenance of these features are highlighted, there may be surprises in store as consumers move into properties as our analyses of the range of interactions even with technologies as simple as hippos or energy efficient lightbulbs has shown.

To summarise, the desired level of autonomy for initiators is easier to achieve for remote-starters, but this is linked to the choice of technologies (those which are largely renowned, safe, uncontested), the

lack of knowledge of how consumers will deal with the new systems, and the more conventional relationships with authorities and institutions which such initiators have. These schemes largely replicate already well established systems of provision, where social relations and technical choices are already negotiated, established and accepted to some degree. As consumers move into homes these 'certainties' may be challenged.

Autonomy and integration

In respect of our questions about how far social and technical autonomy are mutually reinforcing, it appears that while there is a strong sense of unconventionality maintained by socially off households a significant degree of flexibility and willingness to adapt is retained in relation to technical off-ness. Compromises in relation to the independence of technologies from conventional grids are often made, weakening the technical autonomy of the project, but the sense of social distinctiveness from mainstream society appears to be maintained. In general we noted a trend towards the weakening of technical autonomy over time as some attempts to get off grid failed to meet household expectations or turned out to exceed financial or personal thresholds. For instance, we saw in the Groene Dak development how the off-grid sewage composting and water recycling systems shifted towards on-grid alternatives, in Hockerton how the degrees of autonomy from energy grids was soon downscaled as planning difficulties for the wind turbine emerged, and how in Allerton Park two households reconnected to the mains water grid after their water supply froze. The renegotiation of technical, personal and financial thresholds highlighted that there was no hard and fast rule about socially-off also meaning technically-off, with households willing to adapt their plans without feeling any particular loss of integrity, as long as other systems remained intact.

Those initiators who tried to maintain socially-on relations did experiment with technically-off schemes but these were seen as more radical project alternatives and there was scepticism over how well such projects would work. For instance in the greywater schemes in housing associations there was a great deal of scepticism both internally and externally over how such systems would work. The inclusion of innovations which might shift such schemes to more socially and technically off positions was often seen as important in giving the project a particular identity, in making it stand out from other schemes, without the failure or risk that larger scale implementation might imply. Often the technically-off innovation was configured as far as possible to minimise household interference e.g. the greywater systems in the Black Country and Liverpool.

There is also a sectoral element to the issue of integration of socially and technically off, linked to the availability of technologies to get off-grid in each sector, the particular relationships households had with particular resources and the institutional arrangements. For instance, in our Hockerton and Allerton Park examples, the residents were socially and technically water-off but rejected the use of expensive, high-tech self-supply energy systems such as PV, as they felt these were not technically 'normal' enough, in the sense that they were too complicated for more widespread implementation. The conventions of being technically and socially off, and what this might mean for green identities of sustainable builders, are evidently more complex than our crude grid of on-off relations implied. With many mediations taking place in relation to the 'smartness' of the specific technology being debated, the degree of technical and social 'normalness' the households see themselves as fitting into, and sectoral issues such as the relative ease of getting off-grid for energy water and waste. This latter relationship being complicated further by institutional dependencies such as having to pay to connect small-scale electricity supply to the grid if you want to optimise the system performance by selling back to the grid.

To summarise, our original grid needs to be seen in a much less defined way, socially off and technically off are not mutually reinforcing (although this might be challenged at the extremes e.g. real rural off-gridders living off the land would rely only on local water). Technically and socially on

relationships are more subtle, but the inclusion of technically offs is often only as novelty. Another issue here is the degree of difference from conventional lives e.g. in Liverpool the new sustainable homes were a significant change from convention - perhaps just as much as Hockerton in the relative sense of what people had before - even having unusual light bulbs might be considered as socially-off. Therefore socially and technically off are contextual and are socially constructed categories.

Key components of integration and relation to personal, financial and institutional thresholds

As we have already touched upon, there are particular institutional, social and technical components which are involved in achieving desired levels of integration. In a cross-country context, we heard from several initiators in the UK about how the planning and building regulations were an obstacle to configuring particular aspects of sustainable homes - cistern size regulation, siting of wind turbines. We also heard how this contrasted to the Netherlands and Sweden where regulatory and planning systems were more proactive and integrative - for instance water and energy efficiency is often built-into new developments as a matter of course. This national variation does not mean that contests are absent in Sweden and the Netherlands, but there is a clearer base-line of standards to meet. In the Netherlands however, we heard how the initiators of one of the oldest sustainable building projects had fought to be allowed into the planning procedures, with systems only more recently being more open. In a number of cases it was the physical characteristics of energy, water and waste which surprised the initiators of projects and highlighted the inadequacy of social and technical systems to cope, for instance when water freezes or sewage compost proves tricky to deal with. The overly-prescriptive configuration of technologies (or lack of careful comfort, cleanliness or convenience matching prescriptions) also proves an impediment to integration and the achievement of sustainable everyday lives. The extent to which consumers want to be able to make choices over how much bath water to use, their lighting arrangements or the inclusion of a microwave for quick and convenient meals will all influence the success of sustainable housing schemes in reaching their desired levels of integration.

Often thresholds changed quickly over the development of projects. The initial decision of Hockerton initiators to build in systems to sell energy back to the grid rapidly rose in cost as utilities revealed the true cost of linking to the grid. The decision to include central heating in Harlow Park homes was a response to tenant's perceptions of what would be comfortable, their memories of former damp and cold tenements and the desire to fit in with conventions of neighbours, despite the housing association assurance that such 'supplementary' heating was unnecessary. At an institutional level we saw how water regulators in the UK set thresholds of what was acceptable for water recycling innovation, and also how utilities raised the threshold of energy generation by introducing a requirement for a smart meter that pushed the infrastructure cost beyond the financial limitations of the household.

To summarise, grids are constantly on the move and the ease of integration will change. The impediments to integration come in many shapes and forms.

8.8 *Policy Implications* - Facilitating social and technical integration

The final objective of our research on sustainable homes was to evaluate the scope for adaptations at the policy level which might make it easier for different groups to achieve their preferred level of social and technical integration. Integration has been a core rhetoric for policy makers dealing with sustainable housing issues since the early 1990s. A brief review of the key policy literature reveals a number of statements which imply that the development of sustainable homes requires more integrative thinking at a range of social, technical and institutional levels - strategic development planning, building design, sectoral regulation, consumer involvement, financial support etc. The UK government suggests that sustainable housing developments should involve: integrated design (such

as energy efficient layout, CHP and recycling) looking at long-term, indirect and secondary effects; sensitivity to the needs of individuals and communities (including access to services and affordability) and integrated planning including partnerships with a range of organisations (DETR, 1998). The European Commission also calls for integration among public sector activities and sees national and EU policies as catalysts for integration between agencies concerned with the economic, social, cultural, technological and environmental aspects of urban development at city, sub-regional and regional levels (European Commission, 1999). These calls for integration are mirrored in policy documents from all of the Domus countries and in a range of governmental, planning, regulatory and technical reports. How these rhetorics of integration reflect the realities of sustainable housing development can now be considered in the light of our analysis of those initiators and households who are attempting to get to grips with the social and technical possibilities for reorganising the energy, water or waste infrastructures which form the backbone of sustainable living.

Having tapped into a range of housing projects and considered some of the facets of integration which emerge from these we can look more closely at how the infrastructures of provision in the Domus countries and across Europe facilitate different forms and levels of sustainable living. To do this we asked ourselves how, in the light of our findings, consumers and providers can go about putting together the bits and pieces which result in the more sustainable organisation of domestic energy, water and waste infrastructures. This involves looking at the many ways in which different sorts of consumers and providers can get involved in configuring the sustainable home (through negotiating, purchasing, designing, using, maintaining) and considering the sorts of impediments they might come up against (regulations, personal and financial thresholds, structural constraints). Such an approach can tell us a great deal about the possible policy areas which would need to be approached to allow consumers to achieve their required levels of integration. For a start many current regulations over the provision of water or electricity make it difficult for initiators to try out new forms of provision, and as we have seen to go off-grid. It is not easy to integrate new technologies with the conventions surrounding water systems or building structures.

In relation to purchasing decisions there are now a range of off-the-shelf products which can be incorporated in sustainable homes in each of the three countries. Energy efficient lightbulbs, low-flow shower equipment, rainwater collection butts are available at a number of mainstream retail outlets, while other more specialist stores exist where it is possible (with the right physical and financial means) to buy off-the-shelf rainwater or greywater recycling technologies and pick up some technical advice about their installation and operation (for instance the Green Shop and Construction Resources in the UK). Such traders in sustainable technologies have also presumably done much of the hard work of ‘environmental’ ‘moral’ ‘equitable’ ‘technical’ and ‘social’ evaluation, which takes off some of the pressures of household decision-making. In general however, it may be difficult to explicitly identify the environmental standard of a product or system or to assess just how efficient it is or how it will fit with the overall infrastructure of the home and the social practices of occupants (whether it will give enough light or the right amount of water flow). Many other household products (appliances and devices) are purchased or acquired in other ways, for instance municipalities or housing associations may make bulk purchase decisions or households may inherit their equipment from previous occupants or bring it from former homes. As we have seen each of these pieces of equipment comes with a particular script which initiators of sustainable homes also need to take into account.

More tricky issues emerge when we consider the in-built structures and fixtures and fittings of the home itself. Whether households are the self-builders or remote-builders of a project there are various stages of decision-making which need to be made at the planning stage, even before permission is granted by local authorities or municipalities to construct the home. In their roles as sustainable builders’ initiators have to consider: the resource savings that will be made with their particular choice technologies and building materials, how these fit with the overall objectives of the building project and

the other organisations and individuals involved, the sorts of building regulations and planning guidelines at a national and local level, and the fit of the project with the local community. It is at this stage and throughout the entire construction phase of the project that a number of significant problems emerge. First we saw how in the Netherlands and the UK the process of breaking into the planning system even to argue ideas for developments may be difficult. Even if consultation is successful there are likely to be particular features of schemes which are targeted as undesirable - the wind turbine at Hockerton or the water recycling system at Allerton Park. These particular features often become the focus for on-going struggles with planning officers or regulators. In many cases they are seen as essential for the achievement of technical and social integration in projects and become a particular source of tension between local planning institutions not least because they can undermine the integrity of a project. The lack of clear guidance on what is acceptable for a sustainable housing project and the variation between different local institutions was a problem for initiators who might follow ecological building guidelines but still find resistance.

In parallel to negotiating the built-form of homes initiators also have to become utility service providers which brings them into conflict with another range of long-embedded institutions. The particular arrangement of grids in particular areas and the specific sectoral arrangements in different countries clearly have a bearing on the ease with which new utility formations can be put into place. In Sweden for instance eco-villages can negotiate with municipalities at the local level where small scale water supply is an accepted feature of the utility map. In relation to the electricity industry in both Sweden and the UK there are greater obstacles to overcome to be able to act as a provider in their own right. For instance to make the operation of electricity generation more economically feasible and environmentally efficient it makes sense to sell excess energy to the grid, this is only possible in the UK with a set of metering equipment that costs around £2000. As sustainable utility providers struggle to put into place new decentralised utility systems a number of elements raise the financial thresholds and often in these cases the conventional utilities are the winners, protecting grids from small-scale entrepreneurs.

The actual use of a sustainable home also needs careful thought and where initiators are remote more consideration of how consumers interact with their everyday objects and build routines around these is necessary. In a number of cases the scripts which come with the infrastructures of provision and the technologies of households may prove to be overly prescriptive. For instance, will the occupants of some of the housing association developments be comfortable with the sort of lighting provided by the energy efficient light bulbs they are locked into, or be able to handle the new cleaning regimes associated with the use of greywater systems for toilet flushing? The ways in which particular technologies lock consumers into such practices needs to be understood. In addition, the personal demands and thresholds that consumers have will need to be looked at, as we have shown breakdown scenarios are a good way to capture these. In energy breakdowns the use of an extra jumper may be acceptable for so long, the freezing of a water system as a one-off, but sooner or later the personal thresholds of convenience, comfort and cleanliness kick-in and destabilise particular systems. In many of our cases remote initiators sought to introduce as many ‘passive’ technologies as possible, which operated independently of the actions of households (until replacement), for instance built-in lightbulbs or water saving devices. The introduction of more active technologies, from rainwater butts or compost bins in the garden to self-managed reed bed systems introduced a range of more complex social dependencies to negotiate. Despite the constant reminders to consider the micro-routines of households in devising guidelines for sustainable technologies, these are still largely overlooked.

Finally, we have shown how sustainable homes often require new levels of maintenance and bring consumers face-to-face with some challenges. Training for consumers as co-maintainers of systems needs to be considered in light of our findings. All to often the emphasis in guidance for sustainable

technology and building maintenance highlights the need for training programmes for plumbers, house builders, electricians and other assorted experts. What these suggestions fail to recognise is that it is the consumers who are the daily operators of systems and who need to learn how to deal with breakdowns or on-going maintainable regimes. That is not to say that new networks of support services are redundant - as they too have a part to play in the servicing regimes of households. One of the issues which emerged was the struggle to convince conventional 'experts' such as builders, plumbers and electricians to work with new 'greener' materials. This resulted in the negotiation of dependencies and practical tasks between external 'experts' and internal 'experts'. The latter group often ended up taking over some of the contractors work, by finding retail outlets or by helping with tricky installation work. The issue of re-educating or re-training 'conventional' trades people is important in this context. Policy and trade organisations have a role to play in defining appropriate levels of skills and dependencies which may be required for sustainable building projects. There is also a need to recognise the co-dependence of old and new experts in an arena where many new responsibilities need to be negotiated.

To summarise, in the realm of sustainable homes policy makers at the national, European and local level should consider:

⇒ The importance of the micro-routines of households in maintenance, replacement and use and how the consumers role as co-provider can significantly shape the level of social and technical integration achieved and sustained;

⇒ The critical role of not only environmental standard-setting for design, refurbishment and service provision, but also the comfort, cleanliness and convenience standards which are connected to these;

⇒ The importance of the scripts which come with sustainable technologies and buildings and the capacities of these to shape consumers activities, but also the residents ability to misread or subvert these;

⇒ The ways in which self-made expertise and conventional expertise (plumbers, heating engineers, electricians) can be improved and given credence in relation to the installation and maintenance of domestic infrastructures so that support networks are optimised;

⇒ The extent to which sustainable initiators and consumers can break into conventional utility grids needs to be looked at more closely and initiatives which enable access and co-operation worked out. The role of mainstream utilities in offering sustainable service packages (maintenance contracts, equipment upgrades, integrated monitoring packages) to support sustainable housing schemes could also be reviewed;

⇒ Building regulations and planning guidelines are currently inconsistent and unclear and it appears that more flexibility may be needed to enable sustainable home builders to add more environmentally innovative options into their plans and improve possibilities for autonomous water, waste and energy provision;

⇒ The degree of flexibility that is embedded within sustainable households in terms of both social routines and technical modification needs to be carefully considered by initiators and facilitated by institutions to ensure that changes to sustainable living can be made over time as the occupants change or new technologies emerge.

It is evident that the potential for innovative developments and the far-reaching involvement of consumers in new systems of sustainable housing with their embedded infrastructures of provision is great. The challenge is to ensure that the diversity of forms of social and technical integration

represented in these schemes are recognised and carefully evaluated, not just in respect of environmental or technical standards but also in terms of personal thresholds and the capacities of different households to maintain and adapt to these new technical and social infrastructures of provision.

9 - CONCLUSIONS

Bas van Vliet & Gert Spaargaren

9.1 Introduction - Overview of the Domus project

The Domus project was primarily initiated to search for new routes for greening domestic consumption. Existing concepts for greening domestic consumption were either too much focused on the technical side (designing sustainable household technology), the process side (viewing households as a throughput system of energy and resources), or the behavioural side (viewing householders as trapped in social dilemma's). As an alternative, the Domus project emphasised the role of citizen-consumers serving and being served by several infrastructures of consumption that play a significant role in the provision of natural resources to householders. Within existing conceptual frameworks, water, waste and energy infrastructures have rarely been analysed together as comparable systems of provision. Neither have the relations between consumers and these systems of provision been taken as a focal point for studying the greening of domestic consumption.

Although the focal point of the research was the interrelation between citizen-consumers and utility sectors, factors such as national and EU policies regarding the environment and the sectors of energy, water and waste were also taken into account as they provide a relevant context to our study of – changing – utility-consumer relations. Figure 1 shows the simplified scheme of the relations that were considered of relevance for the study of citizenship involvement in the ecological modernisation of utility sectors. In the following, we will summarise what has been found in our study of these relations, starting with the national policy studies.

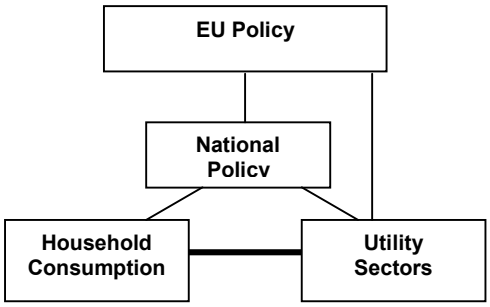


Figure 1: Set of relations under study

National Policies

From the national policy reviews we can conclude that a huge variation exists between the three countries in terms of the actual institutional make-up of utility sectors. However, the trends in terms of the overall economic and environmental development can be said to be fairly similar on a general level. The most eye-catching trend in all sectors and countries is what is referred to in the British national report as *global-localisation.* The term refers to the globalising forces, such as the international liberalisation of service markets and the emergence of the Single European Market, which are also pushing utility companies to re-embed themselves at the urban and regional level whilst simultaneously attempting to piece together truly trans-national utility systems.

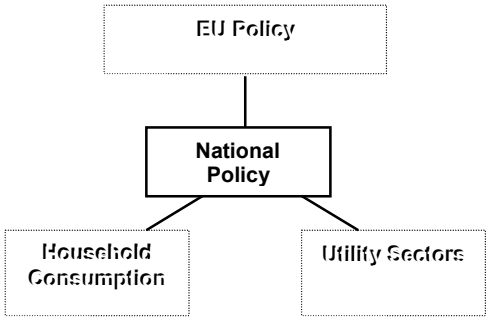


Figure 2: Relations captured in the

The ***electricity sector*** in all three countries is ahead in terms of processes of liberalisation and privatisation, although there are huge differences between the countries concerning the time paths. In Sweden and the UK, domestic consumers are now able to choose between electricity providers, in the

Netherlands this will probably be the case in 2003. All electricity sectors are involved in demand-side management activities, advanced monitoring and differentiation of services and tariffs, partly to keep their traditional customers or attract new ones, partly to avoid the investments in new infrastructure.

The ***water sectors*** in the three countries show considerable differences both in the organisational structure and with respect to the roles they play in environmental policy. Water scarcity is hardly at stake in Sweden, hence there are few investments in water saving technologies or publicity campaigns. Municipal water companies supply drinking water to most households. The public water sector in the Netherlands has successfully introduced a number of water saving technologies in households and is now experimenting with dual water systems in new residential areas. For the time being, privatisation has been avoided, but a more market oriented approach and a system of bench marking to increase efficiency is close to implementation. In addition, there is a growing tension between drinking water companies who are merging with "multi-utility" companies and those urging to keep "water to water", in other words trying to merge with water boards responsible for sewerage, waste water treatment and water management. The common trend is however an increase of the institutional scale for water supply. In Britain the privatised water sector is seeking to avoid investments in new infrastructure and supply capacity and trying to lower demand by installing meters, thereby meeting strong social opposition to water metering. The UK has significantly lagged behind other European countries in the promotion of very simple environmental initiatives, such as water saving cistern devices, with regulators now trying to redress this.

Privatisation of parts of the ***waste treatment system*** can be seen in all countries, while the main responsibility for waste collection is still in the hands of municipalities. Waste sectors in all three countries show contradictory tendencies with respect to issues of scales of waste management and consumer involvement. On the one hand, there are projects initiating small scale treatment of domestic waste, including all kinds of home or community composting and local recycling centres, while on the other hand there have been huge investments in large scale incineration plants (mainly due to the prioritisation of incineration over landfilling in EU and national waste policies). The latter development has caused a shift in the logic of treating domestic waste as an environmental problem to viewing it as a valuable resource for incineration and sometimes energy production. As our research suggests, this could possibly encourage over-production of waste at the household level, rather than recycling or re-use.

EU Policies

The EU policy review could offer some explanation for the variation found between the three member states. A review of sector-related EU policies has taught us that the relevant directives not so much prescribe the institutional set up and regulation of the sectors involved, rather they sketch the boundaries of the playing field in which national sectors might evolve. In addition to directives dealing specifically with water, energy or waste, more general EU policies appeared to be of equal importance. For instance the directives on free competition within and between member states of the Union have severe implications for all industries, including utility sectors. Water and waste policies are also included in EU environmental policy and are therefore subject to more general principles when it

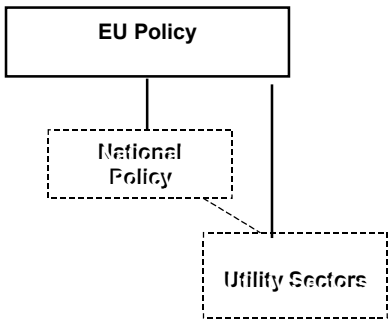


Figure 3: Relations Captured in EU

comes to organisation of these sectors. With the absence of any over-arching 'utilities policy' in the EU it is sometimes difficult to identify where policy implications might be best directed.

Consumer – Provider relationships

The interrelation between domestic consumers of energy, water and waste services and their providers – the focus of our study – has been narrowed down into our problem statement on *citizenship involvement* in the ecological restructuring of these three systems of provision. To operationalise such consumer involvement it was decided to select a number of new green developments and innovations in the fields of water, waste and energy service provision and then try to assess whether consumers were indeed involved in subsequent stages of the innovation process, how this involvement was mapped out (for instance, in installation, use or maintenance) and in which fields (either technical, economic or political). A great deal of this work was already completed in our inventory of innovations in the three countries concerned. From our extensive list of cases, we could assess which of the innovations were initiated by consumers themselves or by other actors in the field and which of the innovations required some form of active consumer involvement in order to work properly or, on the contrary, could do without any special input from the user. A more in-depth study of relations within a selection of these innovations was done in thematic case studies, as outlined in section 3 below.

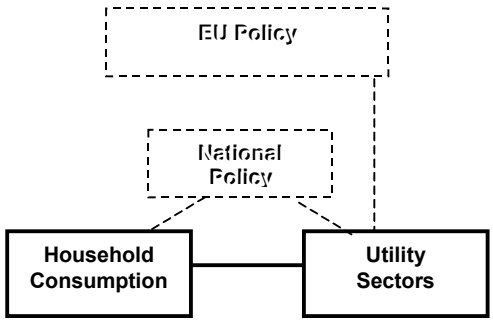


Figure 4: Relation captured in thematic case studies

9.2 Theoretical considerations

In addition to our finding that there are rapidly diversifying routes of innovation with implications for multiple forms of consumer involvement, there was a need to take our analysis further. The theoretical work which focussed on Systems and Modes of Provision, Ecological Modernisation and Demand Side Management, provided us with the tools to take our story to a higher analytical level.

Soon after the start of the project, the term "utility sectors" proved to be insufficient as it excludes all other forms of energy, water or waste service provision except those provided by the classical utility companies. As the project has been undertaken in a period of ongoing changes types and modes of provision, we chose an approach which allows for an analysis of all forms of provision rather than that related to classical utilities alone. This approach enables us to bring the consumer more fully into networks and proves more useful when it comes to understanding changing responsibilities between providers and consumers. As an alternative to "horizontal" approaches towards consumption in which consumption is mainly viewed as the ways in which consumers relate to each other, the systems of provision approach is a "vertical" approach, it deliberately includes consumers as actors that matter in chains of provision of goods and services. In distinguishing modes of production, provision, use and access, we were better able to analyse and define the new roles of citizen-consumers that are now emerging in the utility arena.

The results of this research show that the systems of provision approach indeed provides a powerful tool to analyse the variation of citizenship involvement in the provision of water, waste and energy services. Citizenship involvement in utility services varies depending on the modes of access and use

to innovations that are shaped by their modes of provision, which can be either domestic, state, or market modes of provision, but which in practice usually encompass a combination of these.

This project has extended the system of provision approach not only with these insights into modes of provision, access and use in utility sectors, but also with their relation to network based services as a whole. Due to their specific features of sunk costs, natural monopolies and captive consumers, network based provision of energy, water and waste services differs greatly from commodity sectors that have been studied earlier within a systems of provision framework, such as those of food systems (Fine and Leopold, 1993, Warde, 1997). A typical feature of network based systems of provision is that they connect actors both horizontally (consumers to consumers) and vertically (chains of actors in provision) to each other through infrastructures of pipes, cables and wires. In applying the theory to network based systems the approach of systems of provision proved to be valuable in such horizontal-vertical network contexts as well.

Network bound systems have been studied earlier in the field of the sociology of technology or technology dynamics. Especially Hughes' contribution on large-scale technological systems, building on empirical material of electricity systems is relevant in this context (Hughes, 1987). This school of thought has convincingly added the human dimension into conventional technology debates by including actors' practices within their definitions of technological systems, paths of development (trajectories), momentum of change and so on. Although consumers have slowly gained attention in this approach (as in Constructive Technology Assessment in Rip et al, 1995), the Domus project can contribute to this with its specific consumer perspective towards change in technological systems.

The conventional Demand Side Management approaches taught us about the kinds of logic that have emerged in utility sectors in dealing with resource ceilings and environmental demands. This contribution of this project both to the theory of systems of provision as well as the concept of DSM, is to develop an understanding of the ‘co-providing consumer’ and an extension of the basic scheme of DSM with a consumer perspective. This refocus on the consumer raises the possibility for interesting new approaches to demand management by providers and regulators.

The focus on ecological modernisation theory led us to highlight processes where ecology in one way or the other becomes an influential argument in challenging modes of provision, access and use of water, waste and energy, both from provider and consumer perspectives. This was of great value in assessing what to look for when making up an inventory of environmental innovations. The theory does not present a distinct set of criteria for judging processes as being either ‘ecologically modernised’ or not. Rather, it describes the many ways in which environmental criteria can be taken on board in various modernisation processes at different levels within systems of provision. Instead of dealing with the vague and generic question of whether the liberalisation of utility sectors is either good or bad for the environment, the theory has helped us to focus on processes of environmental innovation within the various systems and modes of provision, how they have now come into play, and how they fit with consumers conventions and lifestyles.

From the early eighties onwards, ecological modernisation theory mainly dealt with the spheres of production and has only recently been applied to spheres of consumption. The systems of provision approach has helped further refine the theory of ecological modernisation by linking production and consumption processes. In essence, this study has now put more ‘cement’ into the latter approach by building a model that centres around the practices of domestic consumption and links actors' lifestyles to network based systems of provision as well as to modes of use, access, and provision of environmental innovations.

This body of theoretical literature and especially the concept of *co-provision*, has helped to reformulate our initial ideas on consumer involvement in the ecological restructuring of household related utility sectors. For one, utility sectors have been conceptually broadened to mean systems of provision, as our inventory of cases alone revealed there are many more actors involved in environmental innovation and in shaping within the ways in which water, energy and waste services are provided to consumers, than we might have first imagined. Secondly, the theoretical framework we have developed has helped us to formulate the most crucial themes in analysing our empirical material: environmental innovations connected to infrastructures of energy, water and waste.

9.3 Thematic Case studies

To obtain a more theoretical understanding of consumer-provider relations and also to avoid a loose selection of cases that cannot be analysed afterwards due to unbridgeable differences, the project team chose a thematic approach to its empirical material. The analysis of empirical data started with defining the key issues with respect to network based systems of provision and the environment as they emerged from both our inventory of cases and the national policy reviews.

The three themes of Monitoring and Power, Product and Tariff Differentiation and Scales and Modes of Provision were identified as the main themes to categorise the cases which were gathered in our inventory. The three themes relate for a large part to the crucial processes that have been prescribed in the theory of Ecological Modernisation. First, to bring ecological considerations into the decision-making framework within the institutions of systems of provision there should be some kind of knowledge about resource use, which is captured in the theme of monitoring and power. Second, a distinction should be made between 'green' and 'grey' options, which in turn should be connected to differentiated tariffs so as to 'economise ecology'. Thirdly, essential parts of the system of provision should be substituted or replaced with sustainable options. The ways in which these options are integrated within existing systems of provision is dealt with in the theme of scales and modes of provision.

The second sub-set of themes (DSM and Sustainable Homes) were also an outcome of our initial empirical work (the inventory of cases and national policy reviews) as well as our theoretical findings. A large number of cases dealt with efficiency measures in distribution or consumption of water, electricity and waste services. They include for instance the diffusion and installation of low energy light bulbs, night storage heaters, low flush toilet cisterns, smaller waste bins, low volume water taps and so on. A common logic behind such processes of technology diffusion was Demand Side Management, a utility driven approach to optimise the use of their infrastructure networks. We decided that the role of consumers in such approaches deserved closer elaboration, which is done in a separate theme on Demand Side Management and systems of co-provision.

Sustainable homes emerged as a separate theme as many of our cases were combined within building and housing projects that were labelled as being 'sustainable' or 'environmentally sound'. In addition to the other themes in which single cases were analysed, it was decided to add as a level of analysis the integration of social, technical and institutional dependencies in systems of provision, and their consequences for relations between consumers and providers as a main subject.

Both the theme of DSM and Sustainable homes deal specifically with consumer involvement in systems of provision, and develop new co-provision perspectives from what are usually seen as from either a provider perspective (DSM) or a consumer perspective (Sustainable Homes). Demand Side

Management strategies are utility driven strategies that need the "help" of citizen-consumers as they are supposed to be at the "demand" side of the networks. Sustainable homes, are often built and used by (groups of) citizen-consumers but have more recently increasingly been provided by municipalities, utilities and housing associations. The level of consumer involvement therefore varies considerably between our cases of sustainable homes, ranging from self sufficient and off-grid provision to high tech provision that is based on connections to existing or new socio-technical networks.

Each of the five themes has been developed with an own theme-specific line of analysis. The result is 5 analytical chapters, which each rely on a specific mix of empirical and theoretical material. The first conclusion of the empirical exercise is that the themes indeed proved to be crucial in the discussion about the new relationships between consumers and providers of energy, water and waste services. However in many ways it became apparent that they play a different role in revealing the relations between consumer and providers than was expected at beforehand.

Monitoring and Power

Much more can be said about monitoring rather than just assessing that knowledge of resource consumption as a first step in the process of greening domestic consumption. Processes of monitoring are linked to a complex set of power issues and mutual expectations about consumer and provider actions. Monitoring is not just about providing information to consumers and/or providers which is all too easily assumed to be an incentive for desired (environmental) action. Monitoring is instead a process of quantifying, labelling and carefully evaluating the relation between consumers and providers. Some of the most dramatic changes in the power-relations between specific consumers and providers can be observed in cases where meters are introduced for the first time, as in our cases of water metering and waste monitoring. Other cases which we refer to as 'refining of monitoring' seem to be based on the assumption that more or ‘better’ knowledge leads to desired and specified action from the consumer. Consumer rationales behind monitoring however are mostly ignored as most monitoring schemes follow a provider logic and a language of flows and numbers instead of being adjusted in some way to reflect consumer’s needs like comfort, cleanliness and convenience. Most of the monitoring cases also revealed the inequality in which visibility is created. Consumers are made visible to providers whilst this is not necessarily the other way round. In most cases consumers only enhance their knowledge about their own consumption levels and not about providers and provision.

Product and Tariff Differentiation

The theme of Product and Tariff Differentiation revealed that green identities among consumers can be divided into (a) ecological, (b) environmental, (c) green economic identity and (d) green social identity. Consumers in each of the three sectors may hold more than one kind of green identity. We have shown how identity through consumption is much more than just a question of use-values in the narrow, utilitarian sense or merely a question of social prestige. All the forms of identity are closely tied to personal selection of self-image and lifestyle. From the provider side, identity creation or image building is becoming increasingly important and differentiation is an important tool to use for this purpose.

Scales and Modes of Provision

The theme that started as renewal as it mainly dealt with cases of renewable resources, was transformed from applying a rather descriptive perspective into a more analytical one. The crucial

issues about renewables in utility provision and consumer involvement turned out to be the scales and modes of provision, access and use in which renewables come to domestic consumers. Our first finding was that where environmental innovations mean a down-scaling of service provision in technical sense, in none of our cases it implied a disconnection (neither in technical, nor in social terms) from the main grids, waterworks or waste systems. Furthermore, consumer involvement in systems providing water, waste and energy services will likely but not necessarily increase with the introduction of smaller scale innovations like PV cells, rain water systems or composting bins. Such innovations result in an opening-up of the uniform one-way infrastructures into two-way infrastructures with additional functions. Thirdly the technical or geographical scale of environmental innovations are not the main denominator for the level of consumer involvement. Rather scales of management, modes of provision, access and use might be more significant for consumer involvement. Lastly, the current highly diverse landscape of scales and modes of provision of water, waste and electricity does not seem to indicate any easily predictable future of new and standardised systems or modes of provision.

Demand Side Management and systems of co-provision

A Demand Side Management approach can be much more useful if it is redefined more broadly to include utility sectors as a whole, the multiple expectations and activities of consumers, and the diversity of providers. Exploring the DSM theme has revealed the limits of conventional approaches to network management in understanding how these processes operate and in ensuring that different interests are represented in discussions of how demand should be organised. New modes of supply chain management, which reflect on energy and waste flows, the timing of demand, the capacities of sub-level stores, and the re-interpretation of consumer roles, will reveal new opportunities, with implications for the sustainable management of infrastructure provision. There are also implications for utility and consumer policy in recognising that a trade-off may need to be made between the respective significant moments and expectations of service, of both consumers and providers. More specifically we have identified the thresholds at which such compromises might be possible and where consumers are not just treated as operating in a rational economic way but within their own personal thresholds relating to comfort and their past experiences of utility provision.

Sustainable Homes and Integration

Forms and levels of social and technical integration in sustainable housing systems turned out to be widely variable and existing models that try to capture these dimensions consistently fail to capture this diversity. For some technologies different countries have distinct approaches to the forms of integration, which are seen as desirable reflecting building regulations and standards. The sectoral choices of sustainable housing initiators reflect personal experiences, knowledge of other schemes and the desire to try different forms of integration over time. The desired level of autonomy for initiators is easier to achieve for ‘remote-starters’, but this is linked to the choice of technologies (those which are largely renowned, safe, uncontested), the lack of knowledge of how consumers will deal with the new systems, and the more conventional relationships with authorities and institutions which such initiators have. These schemes largely replicate already well established systems of provision, where social relations and technical choices are already negotiated, established and accepted to some degree. As consumers move into homes these ‘certainties’ may be challenged.

9.4 Concluding on the problem statement

The thematic case study research has given us many more insights in the ways consumers are and will be involved in the ecological restructuring of systems providing them energy, water and waste services. Combined, these themes help us to address and reflect on the central objective of the Domus project, which was to:

> *'provide policy makers at EU, national and local level with an inventory and evaluation of possible and feasible ways in which citizen-consumers are willing and able to become involved in the environment-induced modernisation of public utility infrastructures and organisations in different countries of the European Union'.*

We have framed our answer as to how we have met this research objective around five key insights we have gained while undertaking the research. They will be given below together with their implications for consumer involvement and service provision.

One – Fragmentation of utility grids and policies

Our first insight was gained during the review of national policies regarding utility sectors in the Netherlands, Sweden and the UK. The privatisation of utility networks and liberalisation of utility markets that was seen in all countries and sectors, be it in different degrees and time paths, could be equated with a process of 'splintering' in the delivery, development and management of networks. The logic of nationalisation that has prevailed since the start of the 20th century, is slowly being replaced by one of global-localisation. Fragmentation of utility systems of provision not only includes the physical splintering of formerly uniform networks, but also the fragmentation of policy towards former utility sectors and markets of service provision. Monopolised regional markets for electricity have been or will be 'splintered' into markets with several new providers and products.

As the splintering manifests itself through reduced cross-subsidies, erosion of nationally 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 might emerge. However, the splintering of monopolist markets could also offer consumers a choice between providers and services where there was no choice before. Whether the fragmentation of network based systems of provision will support one scenario or the other depends on the (national) policies that guide the liberalisation and privatisation of utility networks.

Two – Diversifying Modes of Provision

The inventory of environmental innovations within utility sectors of energy, water and waste revealed the increasing diversity of possible modes of provision, access and use in which these innovations reach citizen-consumers. The same technological system or device that could meet our criterion of environmental innovation – such as PV panels or wind-generated energy – could find its way to consumers though market modes of provision, state provision or informal provision, by buying it on the market, participating in a green electricity scheme, leasing it from a utility or having it installed by a housing corporation. Although we have seen clear examples of utility companies trying to keep all innovation in their own hands, there are still many newcomers on the market of energy, water or waste provision, especially where it comes to environmental renewal.

Three – Consumer involvement: Co-providing consumers

The issue of consumer involvement in environmental innovation is explored in our theme studies on Monitoring, Differentiation, Scales and Modes of Provision, DSM and Sustainable Homes. The themes

were not all new to the world of utility services, but introducing consumer involvement as the central focus in each of these themes has not been done before.

We may conclude that the organisation of consumer involvement has been diversifying in all sectors and countries. Since uniform, monopolist and large-scale provision of services is gradually being replaced by diversified service provision in terms of scales or products and tariffs, citizenship involvement may take a number of different forms compared to the single form of consumer representation in utility provision we know from the past. For instance, consumers may now act as co-providers in the services that were formerly the exclusive domain of utility companies. Energy production such as solar panels and wind power, waste treatment such as composting and recycling or water supply by means of grey water recycling are being looked at as consumer tasks or discussed in terms of shared responsibilities. Apart from production, the implementation of efficiency measures, the responsibility for choosing between services and using the services in the least environmentally damaging way, the provision of knowledge about consumption levels and its timing, have all increasingly become matters of interest for consumers. Co-provision encompasses all practices of consumers actively participating in the (sustainable) management of fragmenting utility networks.

In only in a small number of cases of environmental innovations, did citizen-consumers engage themselves in the provision of grey-water systems or solar panels in order to become less dependent on the main networks. Instead, most of the innovations were provided through housing associations, utility companies or municipalities, sometimes with and sometimes without the direct involvement of citizen consumers. Furthermore, the innovations do not result in less dependency from main providers, but rather a different and indeed closer relationship between providers and consumers. Citizenship involvement in the environmental restructuring of utility services therefore does not imply self-provision or self-sufficiency by consumers but rather co-provision and multiple mutual dependencies between consumers and providers.

Four – Environmental reconfiguring of provider-consumer relations

Although the main objective of this research suggested a focus on change in the relations between consumers and providers *as a consequence of* environmental restructuring of utility sectors, the question may rise whether the changes that have been identified in these relations are all a consequence of such environmental induced change. Part of the answer in this respect is that it turns out to be very difficult to separate processes of fragmentation, environmental renewal, privatisation and liberalisation and to assess the exact contribution of these processes to the overall and indeed substantial changes in the relations between consumers and providers. One of the problems one is confronted with as researcher in this respect, is the fact that the central object of research is an integral part of the heightened dynamics or the process of acceleration change which characterise this period. This having been said, we offer as a result the insight that in general the changing relations between consumers and providers do not impede the greening of domestic consumption but instead offer new opportunities for consumers to "green" their lifestyles. Citizen consumers are thereby increasingly being addressed as individually accountable consumers of services, instead of being a member of a group of end-users of a public service. In other words, from a providers point of view, the role of citizen-consumers is conceived of primarily in terms of their behaviour as consumers. Also questions of ‘empowerment’ are dealt with by providers from a consumerist perspective. On the other hand, when it comes to citizen-consumers willing and able to become involved in the ecological restructuring of these services, we witness many cases in which citizen-consumers refer to their involvement in terms of citizenship and citizenship-rights in modern society. When deciding to join or

initiate a sustainable homes project, when choosing green electricity or becoming a member of a windmill co-operation, people act as political agents whose role in the process is not explained sufficiently or satisfactorily when referring only to their rights and interests as consumers. This discrepancy can be explained by the fact that the services we are talking about – more than other services or commodities – link individual consumers to environmentally relevant issues like global warming, waste pollution and water scarcity in a way as described by some sociologists in terms of life(style) politics (Giddens, 1994). While providers successfully transformed end-users into individual consumers of their services, *environmental innovations* seem to trigger debates on citizenship and public concerns too (as exemplified in the case of a green electricity campaign picturing a Polar Bear cub on a – due to global warming – diminishing ice floe).

This research has shown that any analysis based on clear cut divisions between private and public domains in production *and* consumption will offer only partial and superficial understanding of actual processes happening in present-day societies, especially when it comes to the former public utility sectors of waste, energy and water services. Citizen-consumers increasingly (are asked to) play their double roles as consumers pursuing value for money and as citizens taking responsibility for global environmental problems in terms of 'environmental' life-politics.

Five – Role and implications for EU policy making

All developments that have been referred to above, such as liberalisation of utility markets and the fragmentation of networks and policies, are in one way or another initiated or facilitated by EU policy making. The Domus project started with the idea of providing policy makers at the level of EU insights in the consequences for domestic consumers of horizontal, generic policy making on competition, opening of monopolised markets and environmental policy. We can now say that indeed, the impact of EU policy on the relations between consumers and providers is significant, but highly indirect, following several paths and modes of provision through several bodies of policy making and systems of provision. This is for a matter of fact not different from the intentions of EU policy making, which is not intended to directly knock on consumers' doors. However, some implications for consumer-provider relations may not be foreseen and/or not preferred. For instance, citizen-consumers might not be able to properly make up their (green) choice as there are too many competing claims or lack of information. To repair such situations, it would make no sense to recommend EU policy makers to get more into detail and try to regulate what can't be regulated at this level. Given the common acceptance of the principle of subsidiarity, it would not be the task of the European Commission to assess in detail what is "green provision" and what is not, but it could well be its task to design and implement common procedures to provide citizen-consumers transparency in network-based systems of provision from where such claims originate.

ANNEX A: CASE DESCRIPTIONS

The cases that are referred to in the theme chapters are presented here in alphabetical order.

Actie Zuinig stoken / Zuinig Aan

Since the early eighties, Energy Companies in the Netherlands have been stimulating their consumers to monitor their domestic energy consumption by means of a weekly feedback scheme. At the start of the heating season (around 1 October), households obtain a table to weekly register their gas and electricity meters. Every week until the end of the season (end of March), consumers can compare their own scores with the figures published for that week in either the local newspaper, the Internet or Teletekst. The figures are provided by the utility companies and are based on outdoor temperatures, during that week (for gas) and average 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% in the 1987-1988 season, but decreased afterwards to 23% in 1989 and 14% in 1989-1990.

The scheme combines the instrument of self-monitoring with advises for energy saving in the house. 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 appear to participate only for 2 to 3 subsequent seasons (Loois and Drabbe, 1991).

Amersfoort – Nieuwland Solar Power Projects

The new expansion area of Amersfoort (Nieuwland, 4500 houses) is one of the major building sites appointed by the national government to fulfil the housing needs of the coming decades. The regional Energy Company (REMU) has chosen the area to apply and experiment with solar electricity generation[40]. The largest project is called the 1 MegaWatt project. Earlier on, 19 owner-occupied and 50 rental homes were covered with solar panels and two so-called energy-balanced homes were constructed. All projects will be presented below.

1 MegaWatt project

In the Waterkwartier district of the Amersfoort Nieuwland expansion area REMU has introduced solar power on a large scale in a residential district. The project experiments with the way in which solar panels can be integrated structurally and architecturally into the design of the houses. It deals with questions like what demands does large-scale solar energy make on the urban development structure of a district and how do residents experience the use of solar energy on a large scale?

The project consists of the installation of more than 12,000 m² of solar panels on 500 houses and a number of public utility buildings in the Waterkwartier district of Amersfoort-Nieuwland. It is expected that these panels will be capable of generating 1,000,000 kWh annually, which is equivalent to the average electricity consumption of more than 300 households.

[40] The following is for the main part based on information by Remu on its website: www.remu.nl, '1 MW PV-project in Nieuwland; Amersfoort (English version)'. Additional information came from an interview at Remu (March 1999) and Sylvester (1998).

Objectives

With the 1 MegaWatt PV project REMU is seeking to achieve the following objectives:

- To illustrate the impact of using solar power at district level.
- To reduce costs by applying solar power on a large scale.
- To illustrate possible management constructions and conditions.
- To acquire know-how and experience regarding electrical engineering and architectural aspects.
- To increase the acceptance of solar-power applications by local authorities, urban development specialists, project developers, housing associations, architects, contractors and residents.
- To contribute to the REMU objective of generating at least 3.2 percent of electricity supplied in the year 2000 by sustainable means.

Planning

The 1 MW PV project is an initiative of REMU and has been developed in collaboration with Novem, the Amersfoort local authority, Overeem and the BOOM environmental research and design agency. The selected project location was Waterkwartier and after the first exploration of possibilities it was decided to aim for an installed capacity of 1 megaWatt. Based on an average of twenty square metres of solar panels per house and a peak capacity of 100 Watts per square metre, this would require some 500 houses. In 1994 this was set out in a specification. The urban development of the district was structured in line with this target level. The land was parcelled out in such a way as to render as many roof surfaces as possible suitable for installation of solar panels. The specification also stated that all designers and project developers involved should co-operate in the implementation of the solar power project.

Implementation

REMU commissioned the simultaneous use of solar power in this area, i.e. the 1 MW PV project. REMU participates in project team meetings organised by Overeem. In addition, REMU consults with individual project implementers concerning the structural integration of solar panels and on management and maintenance aspects. To this end a core team has been assembled, consisting of people from REMU, Novem and the Ecofys research and consultancy agency. The complete project comprises eight sectors on which a total of nine developers are working. Construction of the first sector started in November 1997 and the last sector will be completed before the year 2000. Sale of the houses progressed quickly and in general the interested parties responded favourably to the use of solar energy. A proportion of the buyers deliberately chose a house with solar panels on the roof for environmental reasons.

Solar panels

Almost eighty percent of the solar panels were purchased from Shell Solar Energy in Helmond. A little over fifteen percent were purchased from BP Solar in Middlesex (UK). Solar panels were also supplied by Colt International in Cuijk for movable sunblinds and for integration in the walls and by RBB in Montfoort for roof tiles. Almost 75 percent of the solar panels were ordered after a European tender.

Ownership and management

To allow investigation of the effects of the various forms of ownership and management, approximately half the installations will remain the property of REMU. Agreements have been made with the developers concerned, which among other things set out the arrangements made concerning 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 will be remunerated by REMU 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 will become the property of the residents. Agreements have been concluded for this purpose with the developers concerned, in which the legal and financial arrangements are set out. The solar power generated is fed to the REMU mains and the residents receive in return the normal domestic user tariff. Evaluating its ownership of the roofs, REMU stated that this will not have a follow-up elsewhere. There is too much construction expertise needed, which is not available within an Energy Company (interview REMU, 1999)

Technical and Social Monitoring

The solar power installations are all monitored at the overall level, i.e. a record is being kept remotely for all installations of the amount of solar power generated daily. This system can also monitor the operation of the installations and immediately reveal any failures.

Approximately fifteen installations are being monitored in detail in order to provide more information on the efficiency of the installations and to allow investigation of the effects of the various integration methods on the production of electricity. Finally a social monitoring programme has been established in order to ascertain how the residents experience this form of utilisation of solar energy.

Two Energy balanced houses

A double residence has been constructed in Nieuwland, where the annual energy consumption is covered fully by solar energy. One of the semi-detached units is used for normal habitation. The other unit is equipped as an Information Centre for Sustainable Energy.

Background
To construct an energy-neutral house it is not enough to apply just a single technique. It takes a combination of modern techniques and energy systems, combined effectively with each other. REMU's aim with this demonstration is to give additional impetus to the use of sustainable energy in residential construction. The balanced energy houses were constructed in 1997 and 1998 on behalf of REMU. The houses are of the semi-detached type. In the half used as a house an extensive measurement programme is being carried out. The other half houses the Information Centre for Sustainable Energy, where the public can see which techniques result in an energy balance. The project has been supported by Novem, Senter and a number of suppliers and manufacturers.

Objectives
With the construction of the balanced energy houses REMU is seeking to achieve the following objectives:

- To stimulate sustainable, low-energy, residential construction and the use of sustainable energy.
- To acquire experience with solar-power systems linked to the mains.
- To collect data on the production and use of energy in these houses and to make the data known to other parties initiating action in this area
- To acquire knowledge concerning combinations of new energy techniques

Implementation
The construction of the balanced energy houses was co-ordinated by a construction team consisting of REMU and the two architects. A separate 'roof-integration working group' was created for integration of the solar-energy systems, consisting of REMU, the architects, the consultants, the suppliers of solar collectors and solar cells and the supplier of the aluminium sections.

Structural design

The design of the balanced energy houses is based on three principles: reduction of energy consumption, use of sustainable energy and use of building materials from sustainable sources. A central element in the structural design is the atrium: a large open area at the heart of the building which allows the sun to shine deep into the house. All the living functions are situated around the atrium. The relatively high structural mass of the house ensures accumulation of the solar heat radiating into the building and hence a stable indoor climate.

Roof construction

The solar roof is a very conspicuous feature of the exterior of the houses. Various types of solar system have been incorporated: solar collectors, 'normal' solar panels, double-glazed transparent panels, single-glazed transparent panels, ordinary double glazing and sunblinds. A particular feature is that, despite the combination of these various elements, with various thicknesses, an even roof surface has been achieved. Aluminium profile sections from the German manufacturer Schüco were used for this purpose. The collectors are covered by panes of glass fitted in the same sections. Where necessary, the sections have been designed with a thermal gap.

Heating

A combination of various techniques is used for the heating in the houses. Important features for passive solar energy are the atrium, mentioned earlier, combined with the structural mass, the compartmentalisation of the house and the distribution of glass surfaces in the outside walls. Solar collectors (14 m² per house) combined with a differentiated storage system and an electric heat pump provide for the use of active solar energy. The storage system consists of a storage cylinder for hot tap water (300 litres), a storage cylinder for space heating (500 litres) and a ground water layer at a depth of approximately twelve metres for long-term storage. When the house demands heat, this is provided directly from the collectors, or from the storage cylinder, or from the ground water layer. An electric heat pump satisfies the rest of the heating requirement. Heating is provided at a low temperature through flexible piping in walls and floors. The ventilation of the houses is combined with heat recovery. If necessary, supplementary heating of tap water is provided by an electric water-heater in the kitchen.

Electricity supply

Electricity is generated by 78 m² of solar panels per house in standard versions and 15 m² in the form of transparent panels located above the atrium. These panels are connected to five inverters to provide 230 Volt alternating current. The inverters are connected to the mains electricity supply. Above the front door are two single-glazed transparent panels that form an awning. These panels are connected to a storage battery to power the exterior lighting.

Energy balance

The coefficient of energy performance of the balanced energy houses is 0.56 (the national standard in 1998 was 1.2). This low value results from the use of passive and active thermal solar energy, use of a heat pump for space heating, effective insulation and heat recovery during ventilation. The production of electricity has not been taken into consideration in this coefficient. The solar panels provide on average approximately 7,500 kWh of electricity per house annually. This corresponds with the calculated electricity requirement of the heat pump (estimated at 4,000 kWh annually), the other installations such as pumps and the tap-water heater (500 kWh) and the normal domestic lighting and appliances (3,000 kWh). This means that the production and consumption of energy are in equilibrium.

Other environmental measures

In addition to energy measures, various other environmental measures have been taken in the houses. The consumption of drinking water is reduced by means of water-saving taps, short pipework and the installation of a water-saving shower head. In addition, rain water is collected in a 2,500 litre reservoir for flushing the toilet, washing clothes and watering the garden.

Lime mortar was used for the brickwork. Light facade structures and timber cladding were used between the brick side walls. The outer walls and the roof are insulated with cellulose insulation material made from waste paper. The window and door frames are made of domestic larch. Natural paint was used for the paintwork.

Communication

The balanced energy houses have an important function as a model. One of the two houses has been equipped as an Information Centre for Sustainable Energy. The materials used are on display here, so that the visitor can obtain a picture of how the energy balance is achieved. Information is also provided by means of exhibitions, video films and tours through the Nieuwland district. This includes information on REMU's other sustainable-energy projects. As a result of the construction of the balanced energy houses various written and audiovisual products have been made, which are available from the information centre.

Nineteen owner-occupied houses with solar power

In the Lage Hoven district in the Nieuwland development area of Amersfoort Thomasson Dura has built 28 luxury owner-occupied houses. REMU has installed solar roofs on nineteen of these.

Background

REMU wishes to investigate which possibilities exist in the owner-occupied housing sector. This is an application that makes special demands on the relationship between the owner of the solar panels and the owner of the house. This project shows that ownership relationships can be structured. Currently the cost of solar power is still a significant obstacle to large-scale use in residential construction. One possibility of reducing the cost of a solar roof is to mass-produce the roof as a prefabricated element. This was also investigated in this project.

Objectives

With this project REMU is seeking to achieve the following objectives:

- To acquire an insight into the possibilities for series prefabrication of solar roofs. To acquire an insight into the legal aspects associated with the implementation of solar-power projects in private housing construction.
- To contribute to the REMU objective of generating at least 3.2 percent of electricity supplied in the year 2000 by sustainable means.
- To stimulate the use of sustainable energy in residential construction.

Implementation

The preparations for the construction and completion of the houses started in 1995. The last houses were completed in 1998. A project group headed by REMU was set up for purposes of implementation of the solar roofs. The group also included the architect, Thomasson Dura and the installer associated with the project. The solar-power installations remained the property of REMU, including after completion of the houses. Novem made a financial contribution to the solar-power project.

The solar-power installations

The solar roofs on the nineteen houses were constructed in three variants. There are five roofs with 27 panels each, seven roofs with thirty panels each and seven roofs with 33 panels each. The solar panels are connected in series in groups of three to form a string. This means that the solar roofs consist of nine, ten and eleven strings respectively. Each string supplies a direct current of 99 Volts and maximum 3.1 Amps. The strings of each house are connected to an inverter. The inverter converts the direct current into alternating current. At an operating voltage of 99 Volts the inverter can provide a maximum power of 2,500 Watts. The inverter is located in a compartment at the front of the houses. A display installed in the access door to the inverter compartment indicates the operation of the installation. The electricity generated is fed to the mains. The total output of the nineteen solar roofs has been calculated as 48,000 kWh per annum.

Roof Construction

The solar roofs consist of a timber substructure with a condensation-inhibiting foil, an insulation package, an air gap and a water-repelling foil, finished with a masonite sheet, battens and tile laths. The solar panels are mounted on this structure using special aluminium sections. This assembly system was tested for resistance to wind and thermal shock, impermeability to water and durability.

One of the objectives of the project was to investigate whether it was possible to prefabricate the entire roof structure in a workshop. The supplier of the roof structure arranged a test set-up for this purpose and carried out a trial operation lifting roof sections with solar panels already fitted. This method was tried on one of the nineteen roofs. This revealed two predominant objections. In the first place it emerged that the fragile aluminium sections and the solar panels easily sustained damage during transport. In the second place it emerged that the roof elements did not fit together accurately enough for the aluminium sections to match up correctly. This caused a great deal of additional work during assembly, thus cancelling out the logistical advantage of prefabrication. In the case of the other eighteen solar roofs, only the timber roof box was prefabricated, after which the profile sections and the solar panels were installed on site.

Ownership

The houses are private property, while the solar panels are the property of REMU. The relationship between the owner of the house and REMU has been set out in agreements with Thomasson Dura and with the individual occupants. For the house-owner the solar panels act as a waterproof roof covering. The house-owner pays nothing for the construction and maintenance of this structure. In return the owner must prevent the panels from being overshadowed and may not make any changes to the solar roof. For instance, the owner may not fit a dormer window. REMU has a right of superficies (building right) in respect of the roof, so that the solar panels can be accessed in the event of faults occurring. REMU is also responsible for any leakage. If it is decided for legitimate reasons to replace the solar panels with roof tiles, this will be wholly for the account of REMU during the first five years. In subsequent years the house-owner will pay a proportion of those costs, such proportion increasing annually. If it is decided to remove the solar panels after fifteen years, this will be wholly for the account of the house-owner.

Other energy measures

The houses are oriented towards the sun, in such a way that extensive use can be made of passive solar energy. This results in relatively low consumption of natural gas for heating. The houses are optimally insulated and heated with high-efficiency combination boilers. The houses are also fitted with

a Kantherm ventilation system with heat recovery. This system extracts ventilation air through an aluminium cartridge. The cartridge takes up the heat from the outgoing stale air. After a short period the flap in the unit is rotated so that the airflow is reversed. The stored heat is now transferred to the fresh air supply and blown into the building. This system is capable of recovering approximately ninety percent of the heat from the ventilation air.

Fifty rented houses belonging to the SCW housing corporation

Woningcorporatie N.V. SCW manages approximately 17,000 houses in Amersfoort and the surrounding area. In the Nieuwland development area of Amersfoort the corporation has completed a project comprising 114 rented houses. At the request of REMU, SCW has made fifty of these houses available for the use of solar power, combined with solar collectors and passive solar energy. A financial contribution has been made to the project by Novem. With this project, the first of its kind, know-how and experience is being gained concerning the implementation and management of combined solar-energy systems in social housing. The fifty houses are located in the south-eastern part of Nieuwland. Construction was started in 1994 and the project was completed in June 1996.

Objectives

With the implementation of this project, REMU is seeking, together with SCW, to achieve the following objectives:

- To acquire experience with the use of solar power in a group of rented houses.
- To promote the acceptance of solar-energy applications by local authorities, town planners, project developers, architects, contractors, housing corporations and residents.
- To contribute to the REMU objective of generating at least 3.2 percent of electricity supplied in the year 2000 by sustainable means.
- To undertake research into the combination of solar power, thermal solar energy and passive solar energy.

Roof Construction

Solar collectors and solar cells have been integrated into the energy roof. The collectors (5.6 m² per house) are situated next to the ridge. Immediately below them are the solar cells (22.5 m² per house). A row of windows below the solar cells provides direct solar radiation into the houses and forms a separation between the energy roof and the tile roof lower down. The energy roof was extensively tested at BDA in Gorinchem under the supervision of the Ecofys research and consultancy agency. The tests focused on impermeability to water, wind load, thermal shock and durability. In addition, calculations were performed by TNO on the moisture level in the roof and a fire test and field test were performed. The installation of solar panels in the manner tested has been approved by the guarantee institute for residential construction (GIW).

Electrical design

A total of 2,214 solar panels with a total surface area of 1,107 m² have been installed on the fifty houses. Each panel has a peak output of fifty Watts at a current strength of 3.1 Amps. The panels are connected in series eighteen at a time to form a so-called string. This produces a peak capacity of 900 Watts per string at an operating voltage of 297 Volt DC. The strings are connected in groups of fifteen or sixteen to an inverter which transforms the direct current into alternating current, which it supplies to the mains. Eight inverters have been used in the project. These are installed in spaces that are accessible to REMU personnel from the outside. The total output of the system in an average year is 82,500 kWh.

Heating and hot water

The provision for space heating and hot tap water includes a total of 280 m² of solar collectors installed in the energy roofs. A solar/gas combination unit has been installed on the first floor of each house. This uses the heat supplied by the solar collectors and supplements it as necessary with a built-in gas burner. The capacity of the gas burner is fifteen kilowatts. The solar collectors provide a saving of approximately 23 percent on energy consumption for heating and hot water. The size of radiators in the houses has been calculated on the basis of an operating temperature between 55 and 70°C. The system has received the 'cleaner combustion gas hallmark'.

Energy performance

The national energy performance standard (EP standard) at the time of implementation of the project was 1.4. A more exacting EP standard of 1.2 was set for the houses in Nieuwland. From measurements it now appears that, thanks partly to the use of the solar/gas combination unit, the energy performance value for the mid-terrace houses that predominate in the project is 0.9. Moreover this does not yet take account of the saving resulting from the use of solar power.

Other Environmental measures

Apart from the solar-energy applications, various other environmental measures have been taken in the houses. A type of concrete made with crushed rubble rather than gravel has been used; additional insulation with mineral wool and high-efficiency glass has been used; kitchen cupboards are made from birch plywood; less environmentally harmful paint has been used and various water-saving measures have been taken, such as water-saving taps, a toilet with interrupted flush, a water-saving shower and rainwater collection.

Ownership and management

At the request of REMU the housing corporation made the roof available for the use of solar power. The two parties entered into an agreement in this regard granting a right of superficies (building right). This includes agreements on management and ownership. The solar-power roof is the property of REMU. SCW has included in the rent agreements supplementary provisions regarding access to the roof and the solar-power installations. The solar collectors and the solar/gas combination units are the property of Gasrent Stegas B.V. and are rented by SCW.

Monitoring

A monitoring programme has been established for the systematic collection of various data on experience with the installations. In the first place data are collected on management, supply and consumption. These are automatically recorded via the community aerial system (CAI) and using CAI modems. Social monitoring is also carried out, whereby data are collected on residents' appreciation of the systems used.

The social monitoring among tenants of 'solar-roofed houses' that was held during the first two years of occupancy (Sylvester, 1998) showed that the most important reasons why people moved to these houses were factors such as size, location, the rent price or the garden. Environmentally sound provisions only ranked fourth or lower. Moreover, the results showed that only 39% of occupants think that the PV panels form an important aspect of their house. Possibly the PV panels are not really considered as part of the house as the electricity is not used by the household itself, but directly transported to the grid. Drawing up from earlier research, Silvester (1998, p.8) suggests that appreciation of environmental provisions does not only depend on presumed environmental or economic benefits, but also on the visibility of the provisions. Visibility in this sense refers to the personal benefits that can be derived from the solar panels, rather than the sight of it on the roofs.

The social monitoring was held among tenants of homes with a solar roof, tenants of homes with a high efficiency heater and tenants in a neighbouring residential area as a reference group. The majority of the whole group (76%) thinks it would be good to have more solar panels in the area although only few (24%) think that it would be an aesthetic improvement. Where the solar panels are integrated in the design of the homes, in stead of being attached to existing homes, this is much more appreciated. Almost none of the respondents (N=107) would disapprove if energy companies would decide to install solar panels and collectors on as many roofs as possible. A small group (18%) is prepared to pay more for solar-generated electricity, but the group living in the solar homes is significantly more prepared to do so (29%).

The monitoring focussed on (changed) environmental behaviour as a result of living in an environmentally sound home. The hypothesis was that occupants of solar homes would, after some experience, behave more environmentally sound than the reference group. Indicators for environmentally sound behaviour were gas and electricity consumption and water consumption. After two years of occupancy in the solar homes however there were no significant differences between occupants of solar homes and the other groups. Differences in lifestyles and family size among the respondents turned out to be much more explaining for the environmental behaviour than whether or not solar panels were installed on the roofs of these homes (Sylvester, 1998).

Automatic Water meters in East Anglia

East Anglia is the driest part of the UK and suffers considerable water stress. The regional water company of East Anglia (UK) tries to lower water demand by installing water meters. In 1994, the company started with an Automatic Meter Reading programme (AMR) as the company wanted more accurate meters with a longer life. They would replace mechanical meters that are often under-recording (usually in the customer's favour). The first generation of automatic meters could be read through radio contact in the street. Occasionally, however meter readers still have to peer into the boundary box. Next step is a 'drive-by meter', which still means that the reading is quite infrequent. The final stage in automatic metering is a fixed network, which doesn't involve any local utility people. With the fixed network one can read the meters every quarter of an hour and can theoretically introduce tariffs reflecting the timed use.

There is some locational rationale to the development of such metering programmes if it could persuade people in areas with less assured supply to use water in slack periods. There are also possibilities for District Metering Zones (of a size of some 7,000 properties) which enables the company to assess leakage by measuring the supply to an isolated zone and deduct it with the total metered amount of water at 3 am (which is expected to be almost zero).

The metering programme of East Anglian Water is driven by three rationales: reading consumption levels, billing consumers and assessing leakage (interview East Anglian Water, 1999). The Government bans pre-payment meters. Now that meters are free there is a very high demand for it. Currently East Anglian Water has installed 1.7 Million water meters.

The combination of metering with tariff differentiation has not yet been taken up. With automatic meters however one could theoretically install a display for consumers and charge them with different tariff rates for different times of the day. These kinds of metering systems could be introduced in areas of severe water stress, such as East Anglia (interview East Anglian Water, 1999).

Bath Metering Scheme

In 1996, a research team from the Department of Architecture and Civil Engineering at Bath University set out to construct a new type of metering system as a source of environmental/energy efficiency information for domestic energy users, which they labelled as the “green” meter. The objective was to develop:

> *‘a smart meter which enables people to learn about and monitor their energy consumption and for us to see whether such a device will prove successful as a medium for promoting reductions in domestic energy use’*

The 'green' meter that was developed was an extension of the existing gas and electricity meters and, through a display in the kitchen, allowed householders to see how much energy they were consuming, to monitor internal and external temperatures, and to receive energy advice. This was delivered from an expert system residing on a remote computer with which the green meter communicated each night. The expert system contained a database of information about each household that was used to construct a profile which was then matched to energy advice. Actual consumption patterns were monitored and used to generate highly specific advice on issues such as the most appropriate heating times or the efficiency of existing hot water cylinders. Also, in order to simulate the effects of the introduction of variable energy pricing, participants were encouraged to reduce their demand by offering them bonus points which were redeemed for cash at the end of the project.

The origins of the system were in the previous EPSRC funded research on the “monitoring the city” project. This earlier project had monitored 150 households within the city of Bath and tested out different forms of environmental feedback to try and influence energy consumption. It became clear that four main themes evolving from this previous research were heavily influential in shaping and underpinning the content of the new meters research:

- New policy contexts relating to the *environment* and *sustainability* would require massive overall reductions in domestic energy use;
- Energy consumption had become less *visible* to domestic consumers;
- Giving people feedback on their consumption could promote changes in their behaviour;
- Interactive, on-line and personalised feedback provided by *information technologies* promoted the greatest energy reductions.

These themes led the bath team towards their conceptualisation of a new metering system which should promote sustainability by being “smart, personalised, physically visible and psychologically important to the householder”. The team believed that they could use existing hardware to technically construct their new system and were thinking about the customer interface and the types of information that would best be displayed on this to generate maximum environmental benefits.

The system was installed in 20 households in the City of Bath and data was collected over a period of 15 months in order to assess the impact of the meters on energy consumption. In parallel with this, the existing technical/regulatory framework for meter design was investigated in order to identify the most appropriate way of facilitating the widespread implementation of green metering technology. A survey was also carried out to highlight the preferred options in terms of the design of the green meter and its user interface.

Getting consumers involved

Twenty households were needed for the testing and assessment of the green meter and a number of streets in Bath. Three hundred and fifty households were approached and by the middle of February 1997 the final experimental group of twenty households had been selected and confirmed their willingness to participate in the project.

System Development and Installation

The main element of the green meter was the display and it was decided that this should be a touch screen mounted in the kitchen. This was a hand-held computer with a small touch screen display which could be programmed to log gas and electricity consumption on a continual basis with the display being updated after a cubic foot of gas or 10 watt hours of electricity were consumed. This allowed the Newton to calculate the rate of consumption and was sensitive enough to respond within 10 seconds if, for example, a kettle were boiled.

The existing meters were replaced with new electricity and gas meters. Communications between the meters and the Newton was by mains signalling using a purpose-designed system. Internal and external temperatures were collected from sensors mounted in the living room and on an outside wall. This configuration was installed in the 20 households and connected to a PC in the university using existing domestic telephone lines. The Newton was programmed to call the PC each night in order to download data and receive updated information for display.

The user interface was designed to be as intuitive as possible with the main display showing the date and time, internal and external temperatures, and current energy consumption. This was shown as a bar that rose and fell as energy was consumed and was sandwiched between two other bars representing the maximum and minimum consumption levels that had been achieved since the meter was installed. There was also a numerical display which could be set to show consumption in kilowatt hours, or the equivalent cash value. An 'odometer' feature which allowed the user to set the display to zero and record consumption over a set period was also implemented and there was graphing facility that allowed householders to create a visual display of energy consumption. Two different periods could be overlaid on the same graph in order to facilitate direct comparisons. At the bottom of the screen there was a box displaying a customised 'tip of the day'. An on-screen button gave access to two other screens that provided customised energy advice and details of any bonus points earned. These bonus points were used in order to simulate a situation where energy providers implemented a demand management system based on variable energy pricing.

The meters were up and running by February 1998. Monitoring and feedback continued for a period of 15 months until the end of the project. Despite some teething problems, the installations proved reliable with an in-service rate of around 90%.

Information on the socio-economic status of the householders was collected during the initial survey. This information was then used to construct a household profile which was entered into a database that was used by the expert system to deliver personalised advice. The system matched the profile to appropriate energy tips which were then delivered during the daily exchange of data.

The systems that were installed cost around £2,000 each but discussions with manufacturers have indicated that, if significant quantities being produced, that cost should drop to under £500.

Consumer Information

Preliminary Interviews and Data Collection

All twenty households were visited in order to assess the following: room layout, position and number of power and telephone points, the type of gas and electricity meter currently in place, the position and number of radiators and fires, the type of space and water heating systems and details of all major appliances. Further information was gathered about any existing insulation or draught-proofing, double or secondary glazing, the presence and position of thermostats and whether any energy saving light bulbs were installed. Socio-economic and demographic data were collected via a questionnaire-based interview which established the number of residents, their ages and employment status, the tenure of the property and the education and income of the householder. At this stage respondents were also asked whether they already engaged in any energy conserving activities within their homes. These case notes formed the basis for the profiles which would determine how the green meters would be calibrated to provide household-specific feedback and information over the course of the project.

Feedback Delivered (profile specific information)

All the data collected from the home visits was examined in relation to energy efficiency advice and a catalogue of messages designed to be delivered via the green meter was developed. The participants only received advice and information relevant to their particular lifestyles and situation, an important advance on the more generic information usually available to the public. As the project progressed energy consumption was monitored in detail and, in conjunction with the household profile data, this meant that specific patterns of behaviour could be identified. Feedback which pinpointed household relevant options for change, for example relating to specific heating times, could then be provided to encourage households to increase their energy efficiency.

Feedback Delivered (bonus points)

As a way of simulating the variable pricing of energy, householders were given the opportunity of earning bonus points. With a point being worth 1 pence, each household was allocated 2,500 points at the start of the project in order to cover the costs they had borne with respect to telephone calls and the electricity costs of running the equipment. In January 1999 the research team started sending out messages which offered additional bonus points if specific energy targets could be achieved.

Findings of the Project

Qualitative Results

The public interviews took place in October 1998 and the interviews with the participating households in April 1999. The main options included the size and layout of the display screen, the method of interacting with the device, the way in which the information was delivered (via a purpose-built display, on a domestic television, or on a PC), and where in the home the information could be accessed. The public group was generally receptive to the concept of the green meter. Analysis showed the majority preference, in terms of the basic control and look of any system, was a wall mounted display with touch screen controls, similar to the Newton-based system being tested, but with a larger A4 display screen. However, 30% were happy with the smaller Newton screen.

The participating household's opinions differed only with regard to display screen size as over 50% reported being happy with Newton although three older members of the group reported difficulties with reading some of the graphics on the small screen. The participating households liked the wall-mounted display and reported how easy it had been to glance at the display in passing. Similarly, the touch screen controls were generally found to work well. The remote control and television screen

display was the next favoured option for both groups. Analysis of the public sample revealed that this option was favoured by older respondents (60% of people choosing it were from the over 60 years age groups) possibly reflecting this age group's familiarity with similar controls on their television sets.

If a system like the green meter was to become commercially available it may well be that add-on extra services would enhance its viability. To establish if this was the case, respondents were asked what optional features they would interest them. The results showed that the addition of extra features was not a major concern to either group with only 25% of the participating households and 45% of the public being interested in having extra services, weather information being the most popular. Both survey groups were also asked whether a green meter would be an incentive to them to change their fuel suppliers, as increased competition in the fuel market might make such offers a future option for securing or keeping customers. The two groups differed on this issue with 70% of the public stating that a green meter would tempt them away from their current supplier whilst, after over a year of using the system, only 40% of the participating households said the meter would be such an incentive to them. Furthermore, 75% of the participating households said they would not be prepared to pay any rental or one-off payments for the meter but nearly half of the public said they would consider paying for the device.

The final interviews with the experimental group shed more light on these differences. Although there was general support for the concept of the green meter, in practice most households felt the system could be improved with better graphics, or appliance specific monitoring. Use patterns, as recorded empirically through our modem connections and as reported by the respondents, indicated that the novelty of the device wore off. Respondents said that the meter represented one-off learning for them and so became redundant after a fairly limited period. By the end of the project only 12% were still looking at their displays on a daily or weekly basis. Despite this, the majority of the respondents stated that they had found the meter useful, particularly liking the energy efficiency tips with 20% claiming to have learnt new ways of being more energy efficient. In terms of actual changes in behaviour there was only a minority group of 25% who claimed to have altered their behaviour, typically citing more careful use of appliances. The remainder either maintained that there was little they could do as they were already very energy conscious (25%) or that they were not motivated by the financial savings possible and rated their comfort above energy efficiency.

Quantitative Results

Throughout the project, data on gas and electricity consumption was being collected from all the properties and it is therefore possible to identify any reductions that took place. Consumption data was plotted against degree day data in order to give results which could be directly compared despite differences in the weather. Although with a sample of only 20 households it is impossible to generate statistically significant results, some interesting trends emerged. One way of examining at the data is to look at the results when the green meters had just been installed. It may be that there were improvements which occurred at this stage but which were not sustained through the entire period. There is evidence that this did indeed occur with 20% of the households reducing both their base and their heating loads with 100% of households reducing either the base or the heating loads in the six weeks after the meters became live.

Industry Reactions – Pathways to Implementation

Resistances

One of the problems that became apparent was the attempt to develop a system for domestic

consumers: “We started to phone companies to find out what technology was actually available, if you were an industrial customer yes you could have whatever you wanted but for domestic customers this was not the case”. The main problem seemed to be that the bath team was attempting to re-direct information from the meter and temperature sensors (both of which were readily available), around the home towards consumers. Collaborators from Newcastle University’s Centre for Urban Technology showed the bath team how meter manufacturers were describing the “unlimited” potential of their new systems and were talking about the possibilities of enhanced customer information displays and in-house communications. However, many of the companies approached could not understand what it was the bath team was trying to do and their reasons for this. Resigned to the fact that an ‘off-the-shelf’ in-house communications system was not available, the team contracted the work to a small communications company who configured customised circuit boards to adapt to the bath system requirements for information on the consumer side of the meter.

Future potential

- The user-led model developed in the project represented a quite different approach to the dominant style of metering systems being developed in industry. Conventional approaches focused on the abstraction of information from the household for use by the utility companies with energy savings not being a priority. In contrast the user-led model kept the information and advice within the household and energy savings data was carefully tailored to particular households' needs and circumstances. Industry sources felt that this more bottom-up approach was likely to be a much more effective way of reducing energy consumption.

- The technologies involved in the user-led model needed to integrate information from a range of sources, each controlled by different, and sometimes competing utilities. The more widespread implementation of the system would require overall control of technical standards and the release of information. Therefore, the existing regulatory framework could restrict commercial opportunities to implement the system.

- In a market where real energy prices are falling, there was concern that there was little economic incentive for households to reduce consumption. However, the project illustrated that users had a wide range of motivations for saving energy that were not simply economic. The project demonstrated that successful implementation requires careful selection and targeting of those users who have the most potential to manage their energy consumption using the system.

Conclusions

This project has demonstrated that it is feasible to build a robust green meter that can provide householders with customised information and feedback on their energy consumption. It has also clarified the interface and design options which are preferred by individuals and has confirmed that a device with an A4 colour touch screen, mounted in the kitchen and dedicated to providing energy advice alone is the most appropriate option. One deficiency in the equipment that was installed was that respondents could not monitor individual appliances. There are currently stand-alone devices that can be located between an appliance and its electricity supply and, if this information were integrated with the green meter, the device would be significantly more useful.

Evidence from both the qualitative and the quantitative data has not indicated that the installation of green meters will necessarily lead to general reductions in energy consumption. Changes to the energy market are currently driving the price of energy down and, as savings can be made without any effort at all, there is less incentive to engage in active energy conservation measures. Even offering

bonus points had relatively little effect as most householders felt that the savings which could be made were of less importance than their own comfort and convenience.

However, there is evidence that when the meters were first installed they led to a heightened awareness of how energy was being consumed and this resulted in energy reductions. This would support the view that a green meter should be installed for a limited period of time (perhaps three or four months) but, once these immediate benefits are achieved the meter could be removed, as further reductions are unlikely. Such an approach could be adopted by energy advice centres or by utilities who might be interested in providing this service, either individually or in collaboration with government, as part of a programme to support green energy tariffs. It is also important that an installation is targeted to those households that have the capacity to make significant savings and who have positive attitudes towards energy conservation, for either economic or environmental reasons.

Comfort Card

EnergieNed, the umbrella organisation of the Dutch energy companies has started an experiment in which 100-200 households will be provided a gas meter with a pre-payment system. 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 unnecessary. To make sure that people don't unexpectedly run out of gas, a spare amount of a hundred cubic meters is available in the prepayment meter. One of the participating energy utilities is Obragas in Helmond (NL) that issued so-called Energy Comfort cards to 100 households (representative for the Dutch population). Since the start in October 1998, these households did not need to pay monthly prepayments or energy bills anymore. In stead they can see directly the financial consequences of energy consumption. Some householders even check the pay-meter before and after having a shower to see that they just have used energy for an equivalent of, say, 26 cents.

Expectations were 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 comes to its end in December 1999. All participants take part in the pilot on a voluntary basis. According to its provider, prepayment will also in the future remain a voluntary option of paying for gas. (Obragas, 1998).

Composting schemes - Large Scale

Since 1994, organic waste that is produced in Dutch households has been collected separately from other domestic wastes. Since then, 96% of all Dutch households are supposed to use a separate outdoor (wheel) bin and a kitchen bin to store every waste that is compostable (referred to as – literally – Vegetables, Fruits and Garden waste). This national scheme was a result of the Parliamentary decision to ban land-filling in the long run as a way to dispose of domestic waste and to stimulate re-use, recycling and incineration (in that order) in stead. Because organic waste is humid, it hardly burns and lowers the temperature in incinerators. Apart from energy-inefficient, the lower temperatures cause incomplete burning of the salty contents which in turn results in the emission of toxic fumes like dioxides.

From the start of this large-scale waste separation scheme, there has been a remarkably high participation of householders and municipalities[41]. However, problems have emerged in high-rise

[41] Figures of organic waste collection in the Netherlands: 1,5 million tons of organic waste is collected at 96% of all Dutch households. It is composted in 25 plants, producing 0.6 million tons of compost. In 1996, 59 % of all organic waste is

buildings and small apartments where there is no place to store an extra bin. During Summers, there have been many complaints by residents concerning smells and flies. For a number of city centres the City Councils decided not to collect organic waste (anymore) as it was expected that residents would not participate in the scheme anyway. An evaluation report covering the period from 1993 to 1996 stated that the quality of collected organic waste is fairly good but slightly less in municipalities where 'duobins' were applied. Collective containers in cities gave poorest results. This is explained by the fact that users of collective containers are more anonymous: they can not be traced down as easy as in the case of individual bins (Milieumagazine, 12-98, p.13)

Some new developments resulted in a renewed debate after some years of relative silence. A study on health risks of organic waste bins that are stored indoors concluded that asthmatic people bear a higher risk of getting diseases from storing organic waste in their kitchen. Recently, some City Councils of larger cities openly criticised the rigidity of the national obligation to collect organic waste separately, which does not in any way take into account specific problems of the greater cities. In about the same period, the city council of Groningen decided to install underground public containers in the city centre for all waste streams. Only after collection the waste is separated in a humid, organic fraction and a fraction for incineration. The organic fraction will be fermented and utilised for electricity generation. This decision was taken after years of problems with the quality of separated organic waste, and accelerating costs of organic waste collection in small streets of the city centre. There are more actors in favour of a more central solution to problems of waste separation at household level. An environmental consultancy (CE) concluded an evaluation of the scheme with the assessment that the nationally adopted composting scheme is almost as expensive as incineration, while the resulting compost is by far not as profitable as glass or paper. The advice is to separate waste only after collection at a central level, since the technology is already on the market (CE in Milieumagazine, 12-98, p. 14).

The call for diversification of the scheme on the basis of household size and urban or countryside livings becomes louder, as well as the call not to ban land-filling. The abolition of land-filling formed the very basis for the composting scheme, but new insights in the environmental impacts of land-filling have now emerged (PZ-Newsletter 11, 1999). One is that due to intensive biological decay of landfills the ground water aquifers underneath are less polluted than ever expected. The second is, ironically, that these processes of decay will stop when the input of organic waste components is minimised. Moreover, the processing of biogas from landfills relies very much on the input of organic waste.

If these debates lead to changes in waste management, householders can be prepared to switch their waste behaviour all over again. Thus far however, the Ministry of Environment has declared that there is no reason to abandon the national scheme of organic waste collection.

Composting schemes* - *Community Composting

In 1993 a housing association (HSB) in Sweden initiated a composting scheme for one of Ystads residential areas, Lyktan, consisting of 64 apartments. This was done out of environmental motives as well as a way to keep the prices of waste management down. HSB chose a 80.000 Crowns composting plant which would pay itself back in a few years as a lower quantity of rest waste would mean lower costs for waste management. After a good start, the composting plant broke down and was closed in September 1994. The reason was that according to the assistant households did not separate their waste properly. Users said the technique was the problem as it turned out not to be

collected separately from other waste streams. There are considerable differences in waste separating behavior. Residents of big cities produce only 31 kilo of separated organic waste, while those of the smallest cities produce 134 kilos per year (Milieumagazine, 12-98, p. 10; p. 15).

tolerant for minor human errors. After a year the manufacturer agreed to repair the facility and adapted it to make it possible to pick out waste that is not supposed to be in. Residents complained about smells and the quality of information and feedback. Some of them think that if the composting plant were not applied at such a large scale, people would behave more responsibly. A composting facility at each house entrance would make people known if one did not do the waste separation properly.

Composting Schemes - Home Composting

Like rain water butts, composting heaps or bins have been present for ages in (kitchen) gardens. Individual composting bins have made their comeback as well. A number of municipalities in the Netherlands are providing composting containers to householders with a garden for free or against reduced prices. Using a composting bin requires changes in waste sorting behaviour, even if householders are already used to separating waste for collective treatment. For instance cooked food cannot be composted in a bin while it is no problem for a central composting facility.

In Eccleston, Lancashire (UK), 100 free compost bins were distributed on a first-come-first-served basis at the end of May 1998, by the Government run environmental campaign group Going for Green (see Going for Green/Tidy Britain Group, 1998). All those taking a compost bin were also given a bucket and asked to record how much kitchen and garden waste they put into the bin, to try and evaluate reductions in waste to landfill. The scheme was advertised through the local press and with posters around the village. There was a great deal of interest in the scheme, with more people wanting bins than were available.

The objectives of the scheme were in line with the wider remit of National Going for Green, to try and encourage individual households to act to reduce their own waste arisings. In this case, this will be achieved by encouraging households to remove organic waste from the household waste stream and re-direct it to gardens for re-use.

The decision by GfG and the local management group to pursue the composting scheme was triggered by local landfill problems (e.g. nuisance from flies the preceeding summer) and the fact that it was a relatively cheap option. The management group also hoped to generate income from the Landfill Tax, with payments for waste diverted from landfill.

The bins are large green compost bins, with a sliding door at the base to see how well the compost is doing and to access it when it needs removing. The base is open and stands directly on the ground, advice was given to households to stand them on soil for access by worms and to position them in sunny spots to aid the decomposition of waste. When the bins where given out there was an information sheet provided by the manufacturers telling people what to put in it. A 'kitchen bin' (bucket with a lid) was also supplied to make it easier for people to collect waste before taking it to the external compost bin. Households were required to monitor how many of these kitchen bins they filled each month.

A small survey[42] among composters in Eccleston revealed that the introduction of the compost bins in Eccleston represented a significant challenge to long embedded routines. Many of the households were conscious of the need to re-routinise their behaviour. For instance, one composter explained that "It's important to get into the habit, with teabags, for a while I got back into the habit of throwing them in the bin, which is just getting back into the habit of a lifetime". Despite the recognised difficulties of re-routinisation most of the households believed that they could change their habits in time, and did

[42] A total of 10 households were interviewed, 5 of these where composters who were in some way connected with the GfG Campaign (e.g. members of the management group or volunteers in the shop) and the other 5 were 'ordinary' households.

not see the activity required for composting as any more difficult than to prepare their waste for the wheelie bin. Most felt that their lapses were temporary and that once they got the hang of it composting would be just as easy as their previous routines. Many households had also noted that they now had to put their wheelie bins out for collection less in some cases only once every two weeks, compared to once-a-week, effectively substituting wheelie bin for composting bin effort.

A strong story emerges of a dislike of waste which extends not just to composting but also energy and water efficiency (e.g. anger of one composter at visible water wasters in her street). The value of compost as a feeding agent for soil was also an important element in choosing to make compost for some composters, especially as many had large gardens which needed considerable 'feeding' with soil. Several of the older composters claimed that they did not really care about the environment (as a global issue?) and dismissed responsibility for environmental activity to younger generations, seeing it as their problem. There was also frustration that younger people, often the children of composters did not behave well in respect of waste habits, frequently older generations taking control of their children's waste habits. In relation to home composting compared to other scales one composter explained how she wanted to see the "produce of their labours". Although not as clearly stated by other composters many households spoke of producing something useful.

Another interesting issue related to the degrees to which composters were willing to modify their practices to accommodate new systems of provision and improve them. For instance, composters developed their own, often unique, ways of making and re-using compost and it appears that there is no limit to the experimentation and adaptations some people are prepared to make. For instance the interviewee who often microwaved compost before reusing it on the garden to ensure that unwanted weeds were destroyed, or the keen composter who frequently found things lying around the neighbourhood, including a partly decomposed jumper which she appropriated for use in her compost bin.

Many of the composters had expectations of what the composting scheme would be like, usually involving the production of a dry, rich compost at the end of the year. In reality, many were concerned that the compost was too wet and felt that the design of the bin was problematic.

While composters connected to the GfG networks were able to seek 'expert' advice from the GfG co-ordinator or reassure themselves through informal networking with other composters, those households who were less connected to these networks were often unsure about whether they were doing it right or what to do next. The practical difficulties of introducing a new waste management system into the home are revealed in the uncertainties and problems which composters described. For instance, many were concerned that the design of the bin would make the extraction of the compost difficult and that the compost looked too wet to be of use in certain garden applications e.g. "I'm a bit nervous about taking it from the bottom, I'm worried about getting the slider out and about whether it's really 'cooked'".

The degree to which composters were willing to accept particular challenges to their particular standards of Comfort, Convenience and Cleanliness also indicate the scope for composting and how modifications might be necessary. All the households chose to put their bins if not 'out of sight' at least as far as possible away from the house so they were not bothered by smells. This also applied to the so-called 'kitchen bin' which was usually found outside the back door rather than in the kitchen itself. As long as the bin was "well out of the way" people were prepared to accept the smell. There is however an element of compromise in that the bin needs to be out of the way but also convenient enough so that it is used regularly.

In environmental terms, many of the people who were composting also tried to recycle other items a task sometimes frustrated by the lack of convenient facilities in the area. Some composters felt that

the only thing left that represented significant waste from their households were plastics, which took up a lot of room in their wheelie bins and those connected to GfG were frustrated by the lack of action by the council in helping to set up a plastics recovery scheme.

Like in Eccleston residents of a number of municipalities in the Netherlands have obtained composting bins for free or against reduced prices (Baarn, Vlieland, Sevenum, Meijel, Helden, Beuningen, Den Bosch). Two years after introduction in Baarn, 891 householders out of 1250 householders still used the bin. On average, they compost 200 kilos of waste per household every year. All of these households use the compost in their own garden. From an evaluation of home-composting in Den Bosch a profile of the home-composting consumer can be made: a typical home composter has a small family but a big garden (> 50 m2), produces lots of garden waste, likes to work in the garden and sees composting as an integrated part of it (IPH, 1998, p. 19). It is a profile that would very much fit the Ecclestone composters as well.

EcoTeam programme

The EcoTeam Programme is an initiative of an international environmental organisation called Global Action Plan for the Earth 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 quantitative goals applicable to households. The goals are ambitious: 65% reduction of waste disposal, a 30% reduction of electricity, natural gas and water use and as 40% reduction of fuel consumption for transport. GAPs main assumption is that many people want to help create a better environment, but they often do not know where to start. Furthermore, people hold the opinion that on the whole 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 Workbook. As a guide, the Workbook contains loads of tips and ideas to reduce consumption or 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 EcoTeam 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 waste by standing on the scale and carrying refuse bags produced in one week.

The meetings subsequently concentrate on six themes: garbage, gas, electricity, water, transport and consumption (mainly shopping behaviour). The 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, and how water is produced and waste is collected and treated. In some cases EcoTeams get something done at the level of providers. In Nijmegen for instance, waste reductions by Ecoteams resulted in financial savings for the municipal waste facility. These savings were transferred to a waste management project in Africa (interview GAP Gelderland, 1999). The co-operation that members experience from providers in general is however quite disappointing. Utilities are not very

much co-operative in general and especially not 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 are 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 nor actively approached (interview GAP Gelderland, 1999). This picture of EcoTeam members fits well in the demographic and sociographic 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% has an household income higher than NLG 40.000. The household size was small: the biggest share of the sample (35%) consist of two-persons household 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 is needed for environmental change. This seems already much too ambitious. By September 1998, a total of 8350 households (out of around 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 (Harland and Staats, 1997, p. 16). This, at least is the conclusion of a survey among ex-participants two years after being involved in the Ecoteam. Harland and Staats (1997) recommend to lower 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 successes of the program, next to the monitoring of consumption. Moreover, GAP is rather reluctant to change the programme (interview GAP Gelderland, 1999).

Green Electricity Schemes in the Netherlands

In 1995, Energy Company PNEM was the first to introduce “Green Electricity” in the Netherlands. Apart from ordinary electricity, consumers were offered a choice for a higher prices electricity that is generated out of renewable resources, such as wind, solar or hydro power. There is no separate electricity grid, but in stead there is the guarantee to customers that all payments for green electricity will be allocated to sustainable generation. Independent organisations such as WWF and other environmental NGOs obtained the supervision over green electricity schemes and supervise the claim that no more green electricity is sold than generated.

At the introduction, the product of ‘green electricity’ was received with scepticism, especially by the environmental and consumer movement. Initially, there were questions about the link between the commitments energy companies already made with the government (the so called MAP covenants) on the percentage of sustainable generated electricity and these green electricity tariff schemes. Were consumers asked to pay for the commitments energy companies had to comply with anyhow? Other comments were that ‘green electricity’ schemes represent just the opposite of the polluter-pays

principle. The green, conscious consumer had to pay extra for sustainable energy, while the fossil energy users were cheaper off. In this way, 'green electricity' is seen as the harbinger of a liberalised energy market in which the government can not determine the share of sustainable energy generation anymore. Whether or not energy companies will use sustainable resources, it is argued, will then be dependent of a small group of environmentally conscious (and wealthy) consumers.

The energy sector reacted that green electricity revenues would be used for *extra* investments in sustainable generation, above the MAP commitment of 3,2% sustainable electricity generation in the year 2001 (Nieuwstroom 2, Jan. 1998). Furthermore, the argument that the polluter does not pay was refuted by pointing that it is nothing new: consumers also pay a lot more for other sustainable products like organic food. The last argument has not been countered. At least until 2001, energy companies have made arrangements with the government on their use of sustainable resources. After liberalisation of the (European) energy market, there are still possibilities for governments to demand a minimum of 'green' generation from companies. For environmental reasons, it is still allowed to give priority in the dispatching of electricity produced from renewables, waste and from combined heat and power. This allows EU-member states to ensure the sale of environmentally friendly electricity, even if costs are higher.

By 1999, all electricity distributing companies in the Netherlands offer Green Electricity to their clients, under various banners (Eco-Stroom, Natuurstroom and Groene Stroom). Eco-stroom has become a brand name for green electricity provided by eight Energy Companies, mainly in the Western parts of the Netherlands. Green electricity is mainly generated with wind power, as the western provinces have the most favourable conditions for that. Eco-stroom is provided to customers under uniform conditions and guarantees, and has a uniform logo and newsletter for all its customers. A special arrangement in the Eco-stroom scheme is that customers may choose to cover all, but also parts of their yearly electricity consumption with 'green electricity'. Therefor Eco-stroom is offered in packages of 600 kWh. The number of clients for Eco-stroom was 10,672 (good for 19,098 MWh/year) in December 1997 (Nieuwstroom, January 1998). The total number of clients in 1999 for all green electricity schemes was 120,000 in 1999, which equals 250 million kWh (Boeree, 1999).

The other products (Groene Stroom and Natuurstroom) are offered by other main energy companies in the Southern and Eastern parts of the Netherlands (PNEM/MEGA and NUON respectively). Especially in the south, wind power is not the most viable option to produce green electricity. Moreover, PNEM conceives PV not as an alternative in the near future, for it is too costly to meet the demand of green electricity. Therefor PNEM decided in 1997 to build biomass incineration plants to fulfil its (future) green-electricity demand of 50,000 households. The generators will be fuelled with wood and other organic materials. The product is sold as 'green electricity' with the argument that plants assimilate the same amounts of CO2 during their lifetime as is emitted when incinerated. The net CO2 balance is zero and therefor this kind of electricity production is considered a sustainable resource use. The decision to build a biomass generator to produce 'green electricity' has gained much criticism among environmental and consumer organisations.. They suggested that the name of 'green electricity' should be reserved for wind, solar or hydro power only and that including biomass as a resource for generating green electricity will make the product less green than its name suggests.

After the abolishment of eco-tax for green electricity, consumer prices vary between 2 and 5 cents per kWh, which make up a total of 60 to 150 guilders per year for the 'greening' of an average electricity consumption of 3000 kWh/year. It is expected that this will result in a further increase of green electricity consumption in the Netherlands. Because of an announcement of yet another rise of the regulating energy tax for normal electricity on 1 January 2000, energy companies expect a high increase of demand of green electricity for green electricity will be even cheaper than normal electricity. However, they will put new green electricity customers on a waiting list, as the demand of

green electricity will be higher than supply. Other energy compnies announced to raise the price for green electricity up to a level above normal electricity for the same reason (Volkskrant 30-11-99).

To prevent that energy companies in areas with little possibilities for – for instance – wind power cannot comply with their commitments on sustainable generated electricity, a Green Label system was introduced in 1997. This enables energy companies to trade in green generated electricity among each other. Energy company A may buy 'green' generated electricity from company B and gets a certificate indicating the amount and costs of generated green electricity. This certificate or green label will be registered on the balance of company B as CO2 reduction for which the company has made a commitment with the Ministry of Economic Affairs. Moreover, the green label system offers possibilities to sell green electricity that is not generated in the own region[43].

Analysis from a consumer perspective

Green electricity offers consumers an option to choose for green alternatives where there was no such choice before. The only choice consumers had was the choice between night and day tariffs, which is not really an environmental induced option. The offering of green electricity may make people consider electricity production and distribution in a way they were not encouraged to do before. The choice offered makes consumers more involved in the system of provision of electricity generation. Because it is a voluntary choice, one may expect that firstly the already environmental conscious consumer will buy green electricity. By using green electricity this consumer may feel better for he or she is contributing to a greener world. But for others, who need more reasons for paying more, there is not much to offer. Normally, green electricity is generated far away from where it is consumed, just as conventional generators are out of sight of most consumers. Choosing for green electricity does not offer many possibilities for social distinction. It is interesting that for companies green electricity is recommended as a way to upgrade the company's public image, or as a way to compensate for environmental unfriendly activities. Companies that use green electricity obtain a 'green electricity' sign to be attached on the façade of the building.

Household consumers who use green electricity, however, cannot in any way show off their compassion to the environment. A project by Energy Company Nuon seems to fulfil this need and at the same time introduces the instrument of social pressure to choose for green electricity (Natuurstroom). Within special energy projects for primary schools, parents of schoolchildren are requested to consider green electricity. For every three families that agree on the scheme, Nuon installs one PhotoVoltaic panel on the roof of the school building. With this idea, people can actually see what they pay for, because most schools are in the middle of the neighbourhood.

Concluding

Green electricity is a market-conform way of greening electricity generation, and may well be presented as a replacement of the agreements energy companies made with the government. These agreements (MAP) will end in 2001. The transition to a more liberalised energy market means that whether energy companies will produce sustainably, will depend more on the choice of consumers than before. At the same time, there will be less room for governments to force energy companies to do so.

Green electricity schemes thus show that consumers may be more involved in the way electricity is produced. However, thus far only the well-to-do consumers have voluntary chosen for green electricity. They represent only 6% of electricity consumption by households. The scheme is weak in rewarding consumers for their efforts. Except for a individual certificate provided by the energy

[43] As a consequence, although not all 'green electricity' customers brochures refer to biomass as a resource for green electricity, the system of green labels makes it possible that in fact all green electricity clients may contribute to it.

company after the first subscription to the scheme, there is not much to see for household consumers who express their willingness to change electricity supply.

Grey water systems

Grey water systems re-use wastewater for other practices that do not need highly purified water, such as toilet flushing or washing machines. In most cases grey water is derived from the wastewater of washing machines, showers, bathtubs, washing basins and kitchen sinks. Like rain water systems, grey water systems are either individual or shared with a small number of houses.

Smart Plumbing & Water Dynamics, (UK)

These are two grey water systems, to be used in single households, hotels, and dormitories and the like. They consist of a separate plumbing system for waste water from sinks and baths and for grey water to toilets and outdoor taps. In between, there is a collection tank, a filter and desinfection unit and a pump to bring the grey water up to the storage tank from where the grey water is transported to toilet cisterns. The system providers promote the systems as fit-and-forget technology without any health risks. An experimental group of users, employees of the Ministry of Environment, however were not at all satisfied after 6 months of using the system. There was much more maintenance effort required than expected. Besides, the desinfectant (chlorine) reservoir had to be refilled much more often than indicated. All of the experimental group members asked the provider to take away the system again after half a year of usage.

Reed bed systems (NL)

There are a number of examples of grey water systems in the Netherlands where a reed bed filter is used to purify wastewater from washing machines and sinks (Among others in Polderdrift (Arnhem) Groene Dak (Utrecht) Oudelandshoek (Dordrecht), Waterland (Groningen)). The reed bed functions as a vertical filter consisting of a plastic layer, sand, gravel, inlet- and drainage pipes, and reed bed plants (Helofyten) and usually measures some 12 to 25 square meters. Waste water floods over the reedbed, and is treated by micro-organisms attached to the plants' roots. After a stay the water is drained from the reedbed and led either to a pond or directly to toilet buts. Reedbed filters were mostly used by farmers for treating waste water from cleaning milk tanks. From the 1990s on, they are also applied sustainable homes projects, in many cases in combination with rainwater collection systems or composting toilets (Groene Dak). If there is a combination with a composting toilet, there is no sewer system needed as there is no waste water from the toilet and all other wastewater is treated on-site.

To obtain an optimum in scale, most reedbed filters treat the wastewater from more than one household. However, the reedbed filter is always close to the households, in many cases as part of a common garden. Adaptation in household practices is minimal, according to respondents in Arnhem. They have to be extra careful in what substances they dispose off through the sink (no turpentine or paint, no chloride, no aggressive liquids in general) as these substances will slow down or even stop the biological treatment process. Maintenance of the system is organised collectively (interview Polderdrift, 1997). Residents in Groningen stated that most important advantages of the grey water system were its environmentally soundness and its small-scale. In general, they think the system helps to make people more conscious of wastewater treatment, drinking water consumption and the use of detergents (Van Baren et al, 1998).

Reedbed filters are provided as part of sustainable homes projects and installed and maintained by specialised professionals. From the side of the sewer system professionals there has been some hesitation with regard to health risks and smells, but after some years of good experience with

reedbed filters, there are not many objections left except for the costs of such a system. After all, reed bed systems do not substitute for the sewer system, as waste water from toilets is still te be transported and treated in the conventional system.

Residents of Polderdrift have argued that their wastewater charge should be lowered, as they produce less wastewater than other households without a greywater treatment system. They had to negotiate it with the waste water agency in the region (interview Polderdrift, 1997).

Household water systems

Ever since the 1960s, when water saving became an issue in the Netherlands, dual water systems have been proposed as a way to save highly treated drinking water. And every time the idea came up, water companies as well as national policy makers in this field rejected the idea for various reasons (Installatie, 1985, VROM, 1993, Van Vliet, 1995). First, a number of water companies just stated that water saving is not an issue at all: if surface waters is used as a resource, water saving would only raise the costs of producing drinking water. Other water companies, utilising ground water as a resource 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 has always been conceived as non-economic and above all threatening safety and health. The latter argument was mainly put forward by national policymakers and the association of water companies in the Netherlands: VEWIN. One of the main 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 (VROM, 1993). This principle should protect citizens for consuming unsafe or unhealthy water simply by not providing it. A dual water system would introduce the risk of making inappropriate links between the two systems.

Since the last five years, most of these arguments against dual water systems have been challenged, due to a) developments in housing and physical planning and b) due to structural changes in the Dutch water sector itself.

a) Developments in housing and physical planning of new building sites

New building sites in the 1990s look quite different than neighbourhoods that were built before that time, especially in its design and use of water in the neighbourhood. Natural groundwater levels are more and more 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, both designers and inhabitants have increasingly valued the aesthetics of water in the living neighbourhood.

But if redundant water is not led away from the area, what to do with it? National anti-desiccation policy made designers think of decreasing the paving of parking plots and sidewalks in order to let the water infiltrate in the soil. In wet areas, the problem of too high groundwater levels is normally solved with pumping the redundant amounts of water to ditches, canals and rivers. Nowadays it is more common to think of water management as to keep water in the area as long as possible. A number of household water projects may be seen as an outcome of this change of thinking. Although the official policy still held to its principle of one water quality for all purposes (Beleidsplan Drink- en Industriewater, 1995), many water companies started to experiment with a dual water system, utilizing rain water or surface water from the direct neighborhood of the residential sites for household practices like toilet flusing, laundry and gardening in stead of leading it away.

b) Institutional changes in the water sector

Another explanation for the emergence of household water projects is that of 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 have (and will most probably remain to have) a natural monopoly in the region they serve, especially in the case of domestic consumers. However there is an increasing pressure on water companies to reduce production costs as well as to reduce water winning from ground water resources. A 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 liberalization and received a broad support from Parliament and the responsible Minister. However, the report was not a plea for liberalisation as such, but mainly a study on possibilities for cost reduction in the water sector. Either when water companies became part of multi-utilities or remain independent, in both cases most water companies feel the need to renew their policies towards a more client-oriented, commercial approach. In stead of issuing specifications alone, there is a will to listen to wishes expressed in consumer markets and by municipalities (interview WMO, 1999). Municipalities came with wishes on water management in new-built areas and asked water companies to think with them in project groups as seen in Leidsche Rijn and IJburg (interview GWL, 1999). Household water projects mostly came out as a result of such collaborative thinking.

As being forced to work in a more commercially sound way, some water companies see household water projects as a 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 in 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 household water projects might be that water companies are eager to remain involved in water related services. Experiments with individual rain water supply may be a threat to water companies, as half of domestic water consumption would be covered by rainwater supply, which means a loss of half of water company's supply. Household water can be seen as an answer to it. Like rainwater, household water is an environmentally sound alternative for drinking water use in practices where drinking water is not really needed. The difference is that the second water quality is still provided by the water company.

Since the pursuing of the first household water projects in the Netherlands, there is a lively debate going on regarding the environmental benefits and particularly compared to the costs of household water systems. Preliminary outcome is that each single 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 in the area (Van den Burg et al, 1999).

There are now 6 new residential sites where a household water system is installed and that obtained the status of experiment by the Ministry of Environment. It means that the projects are closely monitored on environmental, social and health aspects.

Consumer responses to household water systems

Although most household water projects have partly been motivated with referring to the "wish of our customers (residents)" (see Vaessen, 1998, among others), studies to public acceptance of household water systems are still to be done. Most projects are still being developed, so there are not yet many experiences with consumers actually using the system. Most water companies have planned to do a social monitoring or evaluation of public acceptance after the first inhabitants have moved into their new houses (Leidsche Rijn, Wageningen Noord-West, IJburg, Meerhoven). A study commissioned by

GWL (Gemeentewaterleidingen Amsterdam) (Van Duikeren, 1997) offers some insight in public acceptance of a dual watersystem 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 are not affected. Half of the respondents is prepared to pay the same price for household water as for drinking water and 20% is 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). It must be said that these results are derived form 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.

Household water that is to be provided in Meerhoven (municipality of Eindhoven) has been tested in washing machines. The result was that there was no significant difference noticed between household water and tap water in any of the tested aspects of colour, wear and tear, strength or ash contents. Because household water quality differs greatly between the locations where it is applied, these results only count for Meerhoven (H2O, 1998, 6, pp. 43-44). A test of household water in existing households, using the second plumbing system that was installed for rain water use also produced positive results (interview Groene Dak, 1999)

Kronometern

A Kronometern is a technical device to monitor energy consumption of all sorts and presents it in the units of Swedish Crowns per hour. The system is developed within the framework of an energy saving project of Borlänge Energy. By the year 2000, the municipality intends to reduce energy consumption by 15%.

The initial purpose of the Kronometern was that the product would be a tool for energy advice, i.e. that the user would get an idea of how much energy his or her household used in the unit of crowns per hour. Kronometern consists of two units: a registration unit and a presentation unit. The registration unit is a meter terminal that meets the new requirements of the liberalised electricity market. It is designed to register the measured values from the electric meter, district heating meter and water meter. As examples of these functions can be mentioned:

- Registers metered values from electric meter, district heating meter and water meter
- Communicates via the electric network with the PU and other nods in the network. RU exists in two versions, one for communication on the (A-band) electric network, and one on the C-band, the public band.
- Information is stored in hourly boxes (real time clock with backup power, calendar.)
- Handles tariff bills and control of outputs
- Stores 35 days of hourly values
- Prepared for receiving signal from the alarm system (extra inputs)
- Prepared for working as a power guard.

The Presentation Unit connected in a conventional socket in the building, presents the information received by Registration Unit and other nods in the power networks. Via PU, the user gets information

about the current energy costs in the household, presented in the unit crowns per hour, and an indication of what tariff that prevails at the moment (normal or low). Moreover, the customer may get accumulated information, i.e., information about the energy cost from a certain point of time. The user can also do some adjustments, such as the price for normal and low tariff.

The system will be able to give reports via the Internet. This means that the energy company and real estate company gets a monitoring product that enables significant cost savings for monitoring of electricity use. Since the system will report via a combination of electric network and tele network, this means that the system is entirely independent of where in the country the electricity supplier and user are located. The K-system gives energy and real estate companies substantially increased possibilities of competition, both nationally and internationally (Johansson, 1999 and interview Lindroth, 1999).

Monitoring the frequency of waste collection

The monitoring of domestic waste disposal can be done in several ways, either by weight, by volume or by measuring the frequency of waste collection. The latter is in fact one way of measuring the volume of waste, since the sizes of the wheelie bin are known. Householders in Grubbenvorst choose the size of their wheel-bin (40 to 240 liters) and pay a fixed charge added with the costs of 13 collection times per year. Every extra offering of the bin will be charged, depending on the bin size (IPH, 1995, p. 21).

Monitoring frequency of offering is also possible in a 'bring' system. This concerns a combination of a neighbourhood waste collection / storage system with the electronic registration of use. The collection system consists of underground containers for different waste fractions (paper, organic waste, glass, textiles). One container is reserved for the remaining fraction. Opening the latter requires an individual chip card. Every opening of the container devaluates the card with one point. The card can be reloaded at the town hall after payment. The frequency of use is registered by the waste collecting agency to know when it is time to empty the container. The monitoring in this case is a two way process: customers know (and pay) per amount of waste disposed and waste collection agencies can estimate the volume of waste to process. Moreover they can plan schemes of waste collection in a more efficient way.

Providers of the system do not expect customers will reduce their domestic waste production but they think the system will urge users to better sort out and separately dispose off their waste. The system is new in two ways: it is a ‘bring’-system for all waste streams while the rest of the country is still being served at the door (at least for organic and remaining domestic waste). Besides it is a pay-per-use system in stead of a fixed rate system.

Rain water collection systems

Rain water systems are quite old already. 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. These 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 when 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 at the attic, which puts restrictions on 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 to 2000 litres for individually used systems to 17.000 litres for collectively used systems).

The gravity system has as a disadvantage that only small tank sizes are possible, as bigger tanks would require a heavier construction of the house. Small tanks need more and more frequent topping ups of tap water, which is less water saving. The costs of such systems are therefor relatively high.

Systems that need electric pumps obviously have as a disadvantage the use of electricity (0,1 kWh/ m^3 (WoonEnergie, 1995) up to 0,8 kWh/m^3 (Interview Groene Dak, 1999) while energy-use of producing and supplying drinking water is estimated at 0,5 kWh/m^3 (WoonEnergie, 1995)) This makes rainwater systems costly and less environmentally sound. Apart from that, the rain water systems that are in use have a good record in the Netherlands: rainwater is very good for washing clothes because of its low Calcium content. Therefor, less detergent is needed. Householders who use these systems state they very much like the idea to use 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 main Dutch manufacturer of pipes (WAVIN) has recently introduced a complete rain water system to be applied at household level. The underground plastic tank of 2000 litres is filled with rainwater from the roof and pumped to a second plumbing system into the house. Before entering the tank the rainwater passes a vertical filter which has to be maintained and cleaned every 6 months. However, in practice the filter requires much frequent cleaning by the users because the rain water tank only very slowly filled up (interview De Bongerd, 1999). The manufacturer claims a possible water saving of 50%, if toilet use, laundry, and some of the cleaning will be done with rain water. In practice, however, one user claimed only 25-30% savings in the first year of usage. This may be due to some technical starting up problems. The costs of a complete system is NLG 6000 (interview De Bongerd, 1999), while the water savings reach approximately 48 m^3 per year (Wavin, 1998). With a water price of approximately NLG 2 / m3, there is a maximum saving of NLG 96 per year. Householders in the Bongerd obtained a 50% subsidy on the rain water system, which reduces the payback period to about 30 years. When water prices rise and when charges for water treatment will be linked to the drinking tariff, this can be further reduced (Wavin, 1999).

Sunpower system

SunPower is an all-in product of 4 certified PV panels and inverters including the installation on the roof for a price of almost NLG 5000 (2272 EURO). The expected electricity production is 300-350 kWh per year, which amounts about 10% to 15% of average electricity consumption of one household. The real price of 4 panels is much higher, but subsidies of the Ministry of Economic Affairs and the energy companies together lowered the price with NLG 2700 (Remu, 1999). The SunPower system offered by energy companies is close to the goals that Greenpeace wanted to achieve with its Solaris project, launched one year earlier. Greenpeace wanted to show that there is a significant consumer market for PV energy and opened an information and reference desk that lists consumers' subscriptions for solar panels. In March 1999, there where enrolments for 15.000 panels. The goal of the Solaris project was to create a breakthrough in the market and to get the price per panel lower than NLG 1000 (Greenpeace, 1999).

The Sunpower system can now be purchased from any major energy company in the Netherlands, under the same conditions and subsidies.

Sustainable Homes Projects

Project A - Allerton Park - UK

Allerton Park is a self-build development of three houses in a suburb of the City of Leeds in Yorkshire. They are achieving social and technical off-gridness, especially in respect to water and sewage systems. The interview was with Heimer Salt one of the initiators.

Project B - Groene Dak - Netherlands

Ecological housing project in Utrecht initiated by residents themselves with 66 households. Not trying to be technically off (apart from small experiment with sewage - composting toilets etc.) and largely based on encouraging energy and water savings through more careful use in combination with lots of saving/conserving measures - taps, showerheads, insulation etc. The interview was with Michel Post one of the initiators and a former resident of the project.

Project C - Polderdrift Housing Association - Netherlands

A housing development initiated in 1992 when a municipality competition was held to come up with ideas for a sustainable building site. There are 40 houses, but only 5 of the original initiators have stayed. The logic is for low rent houses for families and the elderly with lots more space. The interview was with two of the initiators of the scheme.

Project D - Hockerton Housing Project - UK

This is the development of 5 self-build earth sheltered houses which are initiated by the families themselves. The homes can be seen to be socially off-grid with intentions of gaining autonomy from water and energy systems, but they are still (mainly) connected to conventional technical systems. The interview was with Nick White, who helped build the development and has lived there for 12 months.

Project E - Zwolle Sustainable Homes - Netherlands

This is a development of 36 properties developed by a housing co-operative in the town of Zwolle in the Netherlands. The homes have rainwater collection and some solar heat collectors. They are connected to grids and see themselves as connected to their neighbourhood. The interview was with Harry Hamstra who lives there and is the secretary of the organisation.

Project F - Harlow Park Ecolite Homes - UK

The Ecolite Development was initiated by the CDS Housing Association in Liverpool, to meet the needs of tenants who had campaigned for improved housing for 10 years. The new homes are on the same site in Toxteth an inner-city community where space is at a premium. There are 23 Homes arranged around a communal garden. Interviews were with Ingar Leitch, the Development Officer of the site for CDS and Natalie Bagnould the architect responsible for the development. No tenants where available to talk to, as many were just in the process of moving into the homes.

Project G - Black Country Housing Association - UK

The 15 home Bryce Road Development by the Black Country Housing Association in Dudley, West Midlands, is phase one of a scheme to build lower environmental impact housing at a low cost. The houses have just been completed and residents have now moved in. The interview was with Richard Baines at Black Country HA who is also the co-ordinator of the Green Futures Partnership which is an international network of consultancies involved in green housing research.

Project H - Myrstaken - Toarp eco village - Sweden

Ecovillage of 37 households run by the housing co-operative with sunroofs, composting, locally generated water and sewage. Residents have now lived here for 5 years. The scheme was initiated by municipal politicians, planners and architects.

Project I - Solbyn - Sweden

The forerunner and blueprint for the Myrstaken Project, also municipality initiated but with a greater degree of involvement from future residents.

Project J - Integer Housing - UK

Integer is a group of architects, building professionals and housing organisations who are building the 'green and intelligent' houses of the future. Fitting more closely to socially and technically on model of autonomy connections are maintained and reinforced with high-tech solutions. The Integer show-house is a smart home with high-tech control systems linking utility functions. Interviews with one of the developers of the project (BRE) and visit to the show home, plus an interview with Dr Leslie Haddon at LSE who has been undertaking the consumer research for the Integer Homes and has provided transcripts of an interview with a family who lived in the home for a week. 'Real' Integer homes are now being built at selected sites around the UK.

Project K - Amersfoort - Netherlands

This development in the Amersfoort district of Nieuwland includes a zero-energy balance solar demonstration home and a large-scale development of over 500 homes where different solar and other environmental technologies have been trialed.

Telemetering Helmond

Telemetering is a feedback system on energy and water use via the television set at home. It is experimented in Helmond at 29 households in new-built, energy-efficient homes. Apart from conventional water, electricity and gas-meters there is a separate unit collecting data from these three meters. These data are sent via a two-way TVcable 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 consumption of water, gas and electricity on Teletext.

Assumed advantages for consumers were:

- No meter-reading visits anymore;
- Direct feed-back on consumption, 'which will almost automatically influence behaviour' (according to the leaflet);

The 29 households were given a weekly feed-back on gas, electricity and water consumption during three Winter months (1997-1998). The information is presented to consumers on 5 TeleText pages:

The research included a pre-metering (T1) of gas, water and electricity consumption at the experimental and a control group, a mid-term metering (T2) after which conservation tips were given to half of the experimental group and a 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 reduction goal of either 5, 10 or 15%. The latter was done as from literature on feedback for energy consumption it is known that the combination of giving feedback with personal goal setting is much more effective than giving feedback alone. The tips after (T2) on

energy or water saving were simple one-liners like 'having a bath = 120 litres, taking a 5 minutes shower = 57 litres' and only appeared when the goals were not achieved. The Teletext pages presented actual consumption figures and compared them with aspired levels of consumption and visualised achievements or non-achievements with a smiling, a neutral or sad-looking face. Also cumulative gas, electricity and water consumption were presented as well as an estimation of the yearly costs given the current accumulated level of consumption.

The reduction goal householders choose was 8,4% on average. Comparing the consumption of gas, electricity and water of the experimental group on T3 with T1, a reduction was established of 18% for water, 23% for gas and 15% for electricity.

There are no significant 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 results at households who had set lower goals were 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 tips that were given after T2 could not be significantly assessed.

The householders of the experimental group appreciated the feedback very much. They were mainly interested in the comparison between current levels and aspired levels rather than in real consumption levels (Vollink and Meertens, 1999).

According to Obragas, many households made an internal competition in energy saving and sometimes they even competed with their neighbours. Customers emphasised and rewarded the fact that they knew at forehand what to expect on their energy bills (Obragas, 1999). The telemetering experiment ended after three months, much to disappointment of the householders. However it appeared to be an expensive and technically vulnerable system for the utility company, which decided not to give it a follow-up in the short term.

Water Metering in Amsterdam

The drinking water system of Amsterdam is based on the principle that access to drinking water is a citizens' right (interview GWL, 1999). This idea stems from some 100 years ago, when the municipality decided for the sake of public health to invest in a waterworks for the whole city. Following this principle, all residents should have a free and unlimited access to the pipes of the municipal water utility. Therefor residents of Amsterdam do not pay for the amounts of water they use, but for the public service in the form of taxes. 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 supply is based upon the size of the home one is living in. Rooms bigger than 6 m2, bathtubs, kitchens and garages all count as 1 unit. Residents pay according to the amount of units they possess or rent. Over the years, many residents have complained about this system, as they think it is unfair to pay a fixed tax, while their presumed actual water consumption is lower than average. The watercompany is taken to court 15 times every year by residents for similar claims but lost only one case (interview GWL, 1999).

The city council of Amsterdam decided in February 1998 to gradually introduce individual watermeters for all 427.000 household connections to the municipal watercompany (GWL). This decision was motivated by the principle of pay-what-you-use and by environmental considerations (GWL, 1998). The project will take some 30 years and costs about 500 million guilders (227 million Euro). It will take such a long time because the plumbing systems in buildings and homes are not fitted for installing water meters. 85% of Amsterdam homes are located in apartment buildings where water pipes are crossing vertically through the individual homes. The installation of individual water meters requires a total refitting of water pipes so that it becomes an individual system. The watercompany is only

responsible for the plumbing system outside the houses and buildings. For changing internal systems, GWL is dependent of the activities of house-owners and housing associations. Especially redevelopment projects would be the best point in time to change the plumbing systems The period in which every house is expected to be redeveloped is 30 years.

The first meters will be installed in new houses which are already prepared for water meters. 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. However, actual figures of water consumption per capita per day are rather unreliable. They are based on the figures of water production by GWL (which are known), divided by the number of residents of Amsterdam (which is not at all a hard figure). GWL works with the figure of 156 litres per capita per day, which is high compared to the Dutch average of 128 litres pcpd. In any case, if the metering project was for water saving only there are many more and cheaper ways to obtain the same result. However, the social and political pressure to install meters became too hard to neglect (interview GWL, 1999). Most consumers responded positively to the project and many of them think they will eventually pay less for their water use. However, after introduction it will turn out that large families in small houses will get a much higher waterbill, while small families in big houses will be better off. The City Council already anticipated on this effect and promised to come up with a temporary provision for the low income groups that will suffer most from the introduction of water meters.

The metering project is not only a radical technical operation, it is also means a radical change in the relation between GWL and its customers. Thus far, there are no known customers for GWL, and consequently there is no such thing as a client desk or consumer policy division. The metering will make the customers known to GWL and GWL to its clients. One of the reasons to consider a merge with the energy company in the region is that GWL will get access to a valuable database of clients as well as a client desk (GWL, 1998 and interview GWL, 1999).

The role of water consumers towards the water provider will also change dramatically. In stead of being an entitled user of a public service, householders will become water clients. Although consumers will not really get a choice between products or providers, they will pay for what they use and may feel more inclined to call upon the provider of the drinking water if something is wrong.

In a survey commissioned by the water company, residents where asked whether they would actually use the watermeters themselves for monitoring their own water consumption. A 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 bill to rise after installation of a water meter. 31% thinks is will be the same and another 31% said it will be lower (NIPO survey in GWL, 1998).

Windmill co-operatives

Windmill co-operatives have been established since the early eighties. In most cases a windmill co-operative consists of household consumers who are share-holders of one or more windmills that have been installed by the co-operative itself. Produced electricity is transported to the electricity grid and is sold to the energy distributor in the area. Most of the times the profits out of the exploitation of a windmill are re-invested in installation of new turbines, as most members of wind mill co-operatives state that they do not see this as a financial but rather as an environmental activity. In the Netherlands, there are currently 6000 consumers associated in 20 co-operatives responsible for the exploitation of 50 wind turbines (ODE, 1998). Since these windmills are located on the most optimal wind locations which is by definition not in residential sites, and its electricity transported over the grid, technically the scheme may well be compared to green electricity schemes. The main difference with green electricity schemes is the fact that consumers co-operatively own the wind turbines and their

payments for the scheme are not done via their electricity bill but through an investment and pay back scheme of their own association.

The windmill co-operative Lundavind in Sweden has a strong resemblance to the Dutch co-operatives, except that the initial idea for starting a co-operation came from the local energy company and asked for members via a leaflet enclosed with the energy bill. There were no worries about getting all of the 900 shares sold as the Electricity Company had guaranteed to buy the shares that the public hadn't bought. However, enough consumers were interested and the Energy Company symbolically bought one share. A Vestas 600 kWh turbine was installed in the neighbourhood. The manufacturer is responsible for maintenance and get paid a yearly fee. A weekly check is done by one of the members and three members have a electronic connection to the turbine to check whether the turbine is running properly.

Several members of this co-operative said their motivation was financial and not only environmental. The Swedish electricity market is much more open for individual consumers than it is in the Netherlands, which means that they can switch over to any other energy provider in Sweden. However the members of Lundavind windmill co-operation are obliged to remain customer of the regional Energy Company. A switch over to another company obliges one to sell one's shares in the co-operative.

The Delabole windfarm in Cornwall (UK) is yet another example of consumer's effort in generating wind energy. A private person, formerly a farmer sought alternatives to a nuclear power station plant that was planned in the early 80s. After 8 years of research and set-backs and hurdles crossed by a combination of public awareness of the greenhouse effect, proven economic wind turbines and the privatisation of electric industry, the family was able to set up WindElectric Ltd with National Power and the Energy Board as investing shareholders. He managed to get private loans from neighbours, and funding from the European Community, energy companies and a Non Fossil Fuel Scheme that was ironically enough intended to support nuclear generators. Eventually he could install ten 400 kW wind turbines close to the village where he lives. Households in the neighbourhood are not directly connected to the wind power generators. In a country with a wide spread national grid, any attempt to make own grids at community level would be non-paying. The produced energy is led to the general grid and meets the annual needs of about 3000 households.

Everyday life practices are said not to be affected in any sense (interview Delabole, 1998). There are no devices to tell the users when the power is generated by wind or from the grid as this would be too expensive.

ANNEX B: LIST OF INTERVIEWS

UK - Anglian Water, J. Gunstead & R. Duerden, 17-3-99

NL - De Bongerd, H. Hamstra, Zwolle, 9-3-1999

UK - Delabole Windfarm, M. Edwards, Cornwall, 29-7-98

UK - Eastern Electricity, Mr. J. Hill and S. Copley, 2-2-99

NL - GAP Gelderland, K. Kleinhesselink, Wageningen, 1999.

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

NL - GWL (Gemeente Waterleidingen Amsterdam), Groot and Rolls, Amsterdam, 12-3-99

UK - Hastoe Housing Association, M. Rowbottom, 16-3-99

UK - Hockerton Housing Project Ltd., Mr. White, Hockerton, 12-8-98

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

S - Lindroth, Sweden, Spring 1999.

UK - Northern Electric, Mr. Brass, Newcastle, 12-3-99

NL - Nuon-water, Mr. R. Klijn, Velp 23-1-98

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

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

NL - Polderdrift, Arnhem, 7-10-97

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

UK - Renewable Energy Company, Ms. C. Summers, 12-1-99

NL - Shell Solar, Van Laarhoven, Helmond, November 1997.

UK - Southern Water, Mr. J. Crooke, Brighton, 21-1-99

UK - Sutton Borough Council, Ms. P. Spirling, Carshalton, 19-1-99

NL - WMO (Waterleidingmaatschappij Overijssel) , Van den Berg, Zwolle, 29-1-99

S - Ystad, Spring, 1999

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