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Sustainable Energy Consumption in Residential Buildings

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Preface: When Less is More

Climate change and energy security represent two of the most pressing problems for current and future generations. As residential buildings account for around 30 per cent of final energy demand in Germany, this sector has been receiving increasing public attention. At the moment, policy makers rely on two strategies for reducing the emission of carbon dioxide (or CO_2, a greenhouse gas) while meeting the energy demands of private households.

The first strategy raises the proportion of renewable energies in the production of electricity and heat for households. The second strategy seeks to make energy use in residential buildings more efficient. (Often these strategies are used in combination.) Studies have yet to be conducted on German household preferences for particular technologies or services to reduce energy consumption. And studies on households in other countries have yet to consider trade-off preferences regarding, say, heating systems and thermal insulation.

The research project Social, Ecological and Economic Dimensions of Sustainable Energy Consumption in Residential Buildings (SECO@home, Website: www.zew.de/seco) closely examined decisions on energy consumption made by private German households.

The aim of the empirical study was to answer the following questions:

- What are the determinants of the diffusion of energy-efficient household appliances and what is the impact of the energy label design?
- What factors determine investment in energy modernisation measures for heating and what role does gender play specifically?
- What are promising strategies for policy makers' and companies to help improve energy efficiency in German households?
- What is the impact of specific regulatory and company strategies to improve energy efficiency in households and reduce CO_2 emissions?

Several methods inform the empirical analysis. SECO@home conducted a representative survey using innovative questioning and statistical techniques to identify tenants' and property owners' preferences for specific low carbon products. Survey analysis provided insights into consumers' behaviour regarding more sustainable energy consumption, and is viewed as a substantial contribution to the field. The study also analysed survey information on observed technology choices econometrically. Furthermore, a qualitative study approached the topic of home heating from a social practices perspective, focusing on the dual role of gender and technology.

The inter- and transdisciplinary project ran from March 2008 to November 2010 and was supported by the funding initiative From Knowledge to Action -

New Paths Towards Sustainable Consumption (see the Federal Ministry of Education and Research [BMBF] at the Website: http://www.sozial-oekologische-forschung.org/de/947.php). The consortium was co-ordinated by the Centre for European Economic Research (ZEW), and included the University of St. Gallen, the Fraunhofer Institute for Systems and Innovation Research (ISI), the Öko Institut and the German Institute for Economic Research (DIW). The project team received regular and valuable feedback from an advisory board made up of leading specialists in the field of consumer behaviour and energy saving.

The members of the advisory board were:

- Bödeker, Jan Maurice, senior researcher, ifeu Institute for Energy and Environmental Research, Heidelberg GmbH
- Denkhaus, Dr. Ulrich, Germanwatch, Bonn/Berlin
- Geißler, Michael, director, Berlin Energy Agency GmbH
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- Weigl, Fred, Association of Energy Consulters (Bundesverband Gebäudeenergieberater, Ingenieure, Handwerker - GIH), Stuttgart

The project's final workshop took place at the Evangelische Akademie Loccum in late September 2010 and provided an opportunity to present the project findings to a broader audience. Numerous experts from the fields of politics, administration, business and professional associations, as well as from research and science attended the event and took part in the lively discussions. Points of debate ranged from funding instruments and energy market liberalisation to the German government's current energy plan. On the basis of the project results, all experts agreed that the road to more sustainable energy consumption in residential buildings was not hampered by a lack of will on the part of the consumers. Still, we should note the additional costs that often accrue for households when improving a building's thermal performance. Even though the building sector offers large energy saving potentials, energy saving measures are not always associated with a positive cost-benefit-ratio, especially in the short term.

Effective policies are those that impove security for planning and investing in CO_2 saving measures and services in private housholds, and strengthen companies' ability to offer products (and services) that meet consumer preferences. Effective policies should also help policy makers and companies gear their strategies to consumer needs.

This book includes the core findings of the SECO@home project. Though each contribution stems from different authors and institutes, all follow the common conceptual approach described in chapter 1. This approach may be characterised as an attempt to integrate the economic, social and psychological aspects of more sustainable consumption. Chapter 2 presents findings from econometric analyses of factors driving adoption of energy-efficient household appliances based on observed behaviour data already collected in a large representative survey. Chapter 3 presents the results of the new SECO@home household survey alongside the findings of two different conjoint experiments: on TVs and on heating and insulation. On the basis of these empirical analyses, chapter 4 develops strategies for firms and policy makers to improve energy efficiency in residential buildings. Chapter 5 estimates the environmental impacts of selected strategies. Chapter 6 presents the results of a qualitative study on the gender aspects to home-heating choices.

We have just begun to understand how households make decisions about sustainable consumption; much remains to be studied at the theoretical and empirical level. A well-developed theory of sustainable energy consumption must be able to explain learning processes, habitual behaviour, lock-ins and path dependency.

Our work would not have been possible without the support of the project advisory board. We would like to thank its members for their valuable and constructive comments, and we look forward to working with them again when we elaborate the findings of SECO@home. We also would like to give special thanks to Beatrix Immig and Patrick Pilarek for assistance in the editing process and to the SECO@home research assistants Caroline Bulla, Laura Piotter and Philipp Baltes for their technical assistance and fine work in formatting this book.

The Editors
February 2012
Klaus Rennings, Bettina Brohmann, Julia Nentwich, Joachim Schleich, Thure Traber, Rolf Wüstenhagen

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1 Introduction and Theoretical Framework

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Bettina Brohmann, Tim Clamor, Stefanie Heinzle, Klaus Rennings, Joachim Schleich and Rolf Wüstenhagen

1.1 Introduction

Consumption is a key lever to achieving more sustainable development. Unsustainable consumption is a major cause of global environmental deterioration, including overexploitation of renewable resources and pollution caused by fossil fuels. The European Environmental Agency report "Household Consumption and the Environment" (EEA, 2005) identifies the need areas of food, housing, personal travel and mobility as well as tourism as the four major areas of household consumption with the highest negative environmental impacts.

The current trends are worrying. Real per capita GDP in the EU-27 member states has increased by approximately one quarter in the last fifteen years. For the period through 2020, household consumption expenditures are expected to continue to grow approximately at the same rate as GDP, or 2-3% annually. Technological innovations have reduced the energy and material used by most products, yet increasing volumes of consumed goods have offset these gains: Household energy consumption contributes to almost 30% of the total final energy consumption and its energy demand is increasing more rapidly than that of all other sectors except transportation.

This paper will focus on consumption behaviour in residential buildings. It will provide an overview of the literature on individual consumer decisions about sustainable energy consumption. We rely primarily on economic studies, in particular on those employing discrete choice models but we also include contributions from socio-economic literature. With a view to later chapters, our overview concentrates on the determinants of sustainable energy consumption with regard to household appliances, heating systems and green electricity.

We are well aware that institutional setting partly determines individual energy consumption. Consider tenants. They may have landlords who are uninterested in energy-saving investments or for whom energy costs are unimportant. Still, all forms of energy consumption require individual decisions, be they conscious or unconscious.

Our objective is to analyse individual decision making so as to make it more transparent.

The paper begins with a definition of sustainable consumption. We then review the general economic, social science and psychological literature on individual decisions about energy demand and the general factors that influence sustainable energy use. Section 3 will present methodological contributions on the subject. A review of the literature on household appliances, heating systems and green electricity will follow. Finally we draw some conclusions and present some hypotheses regarding the three applications, and briefly discuss research needs.

1.2 Definitions of Sustainable Consumption

"Over the last decade or so, there has been a wealth of social and natural scientific debate about the environmental consequences of contemporary consumption and there is, by now, something of a consensus. It is clear that lifestyles, especially in the West, will have to change if there is to be any chance of averting the long-term consequences of resource depletion, global warming, the loss of biodiversity, the production of waste or the pollution and destruction of valued 'natural' environments" (Shove, 2003, p. 1).

The Brundtland Report (WCED, 1987, p. 43) provides the classic definition of sustainable consumption: "[T]he use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the lifecycle, so as not to jeopardise the needs of future generations" (OECD, 2002, p. 16)

Sustainable consumption is seen as a process involving negotiation and consensus-building; in some cases this process competes with conventional market operations. For new consumption strategies to be established, all actors must be willing to engage in discourse. Hansen and Schrader (1997, p. 455) point out that the normative judgment of sustainable development and sustainable consumption "has to be given additional legitimacy by […] societal discourse" and *practice*.

Sustainable consumption has to be understood as a societal field of action. It can be characterised by three interacting areas:

- the individual area of action (divided into two sub-areas): a demand-side area, which includes consumption activities in the context of households and professional procurement activities (of both large-scale private-sector companies and the public sector); and an informal area, in which private consumers undertake informal activities (e.g. unpaid household work) not oriented to the market and thus not visible ba demand levels;
- the supply-side and structural area of action, which includes the activities of companies and also governmental bodies to provide sustainable products, services and information;
- the socio-political area of action, which includes the activities of governmental bodies, organisations and associations to form the general framework for governance in both the individual and supply-side (or structural) area of action. Societal factors of consumption behaviour such as visions and moral concepts are formed in this area of action.

The three areas are interrelated: Consumer behaviour is based on individual decisions, while individual behavior largely depends on supply-side measures, appropriate infrastructure (e.g. the availability of energy-efficient household equipment) and socio-political factors (e.g. the existence of energy taxation, emissions trading systems or eco-labels).

Eberle, Brohmann and Graulich (2004) look at sustainable consumption as a more ecological but also socially responsible way of buying and using goods and services. Individual and societal consumption behaviour is influenced by a variety of contextual factors: specific lifestyles, social environment (neighbourhood, favoured peer groups), infrastructure, habits and routines (Shove and Warde, 1998; Empacher, 2003; Shove, 2003).

There is consensus among experts that the implementation of more sustainable consumption practice requires not only awareness among consumers but also changes in social and economic structures. Consumption is a "socially constructed historically changing process" (Bocock, 1993, p. 45). Several authors (e.g. Fichter, 2005; van Vliet, 2002) stress the need for new product policies and the important role played by consumers: "People are not simply end-consumers entirely isolated from the production process" (van Vliet, Chapells and Shove 2005, p. 17). "They participate in the organisation of production-consumption cycles" (van Vliet, 2002, p. 53).

On the one hand, every purchase is a vote for or against certain production conditions (including environmental effects as well as social conditions); on the other, "the existence of a suitable supply" (Hansen and Schrader, 1997, p. 463) is crucial for the transition to more sustainable consumption. "The creation of an awareness that an ignorant 'business as usual' attitude does not only promote inaction but constitutes an active immoral act is hence a necessary prerequisite for a change towards sustainable consumption" (Hansen and Schrader, 1997, p. 459). Empirical data show that this awareness already exists in some Western societies. For instance, 75% of German consumers believe that users are able to put considerable pressure on producers.

In this sense, every consumer also serves as a "co-producer" (Hansen and Hennig, 1995). The widespread debates in the early 2000s on consumption as utility production – as in the field of behavioural economics (Belz and Egger, 2001; Belz, 2001; Scherhorn, 1994) – reveals numerous factors to be considered in a strategy for change. As noted by Jackson (2005) (quoted in Kaenzig and Wüstenhagen, 2006, p. 295), sustainable behaviour is "a function of partly attitudes and intentions, partly of habitual responses, and partly of the situational constraints and conditions under which people operate." A variety of models and theories address decision making in the consumption sector. They originate from three disciplines in particular: (Behavioural) economics, social psychology (environmental psychology) and sociology (cultural anthropology, sociology of technology). Their contributions will be briefly described in the next section.

1.3 Economic, Social and Psychological Approaches to Explaining Consumer Decisions

The observations and data in the previous section point to the need for changes in our patterns of consumption. In order to achieve such changes, it is crucial to identify and understand the determinants of sustainable consumption patterns and individual decision making (OECD, 2002; Belz et al., 2004; van den Bergh, 2008). Existing theoretical and empirical studies either focus on purely economic or purely psychological explanations. This dichotomy has been criticised as of late and there have been attempts to overcome it (van den Bergh, 2008). Rational decisions are not the only determinants of consumer choices. Factors such as awareness, knowledge and social influence also play an important role, particularly for environmentally conscious consumption. An understanding of these determinants is necessary if one hopes to implement policy measures encouraging more sustainable consumption (OECD, 2002). More empirical data is needed to determine which specific circumstances or factors are decisive for sustainable consumption and how to characterise the consumer groups most likely to adopt sustainable practices.

In the following section, we present the classic economic explanatory models and their extensions. Thereafter we discuss sociological and psychological models.

1.3.1 Economic Approaches

1.3.1.1 Rational Choice Theory and the Consumer Preference Theory

Rational choice theory is a traditional method used by economists and sociologists to analyse a multitude of microeconomic decision making situations (Smith, 1991). Its focus lies on individuals and their plans for self-realisation. Social behaviour is explained as a collection of individual decisions and characteristics. Basically, this theory holds that individuals act rationally when they seek to maximise their benefit. Benefit maximisation is limited only by exogenous factors.

In economics, rational choice theory consists of four major elements: income, prices, preferences and the assumed behaviour of benefit maximisation. Consumers can make two types of decisions about a good or a bundle of goods. Either they choose to maximise their benefit within the limitations of their budget or they try to reach a given level of benefit at minimum costs. In both cases, consumption is a function of income and price (van den Bergh, 2008). Provided that preferences remain stable, consumption decisions are determined by income or price alone, and, as a result, can be prioritised rationally for any given consumer, though they cannot be compared among different consumers. This view is predicated on the assumption that “more is better” (Sanne, 2002). It also assumes that individuals have complete information about their preferences, their income and the prices of goods (Welsch and Kühling, 2009).

Decisions about costs and benefits consist of two components. First, we decide *ex ante* about expected benefits. This is called *decision utility* (Jackson, 2005). After making a decision, we then evaluate the result in terms of benefit quality or personal satisfaction. This is called *experienced utility* (Jackson, 2005). According to Welsch and Kühling (2009) and others, however, certain feelings and cognitive influences can bias judgements in the decision process, leading to an imperfect maximisation of benefits. This is one limitation of traditional rational choice theory.

1.3.1.2 The Theory of Bounded Rationality

In his first work, Simon (1959) criticised the classic microeconomic model of rational choice theory for its fixed assumptions. Rational choice theory always assumes that individuals will seek to maximise their benefit and that individuals are fully informed (Zintl, 1989; Jackson, 2005; Welsch and Kühling, 2009). Simon (1972) developed the theory of bounded rationality to provide a more realistic account of the decision making process. The theory of bounded rationality subjects individual rational behaviour to two restrictions: environment and the ability to assess consequences and results of actions. In situations that are more complex or change quickly, the explanatory power of the classical model is limited (Simon, 1959). Complexity may stem from uncertainty or changing circumstances and is typical of labour and consumer markets. The characteristics of these markets do not match the classical model assumptions and, therefore, these models cannot be used. Empirical experiments in the fields of micro- and macroeconomics have shown that even in relatively simple situations individuals do not behave as rationally as predicted by rational choice theory (Green, 1994).

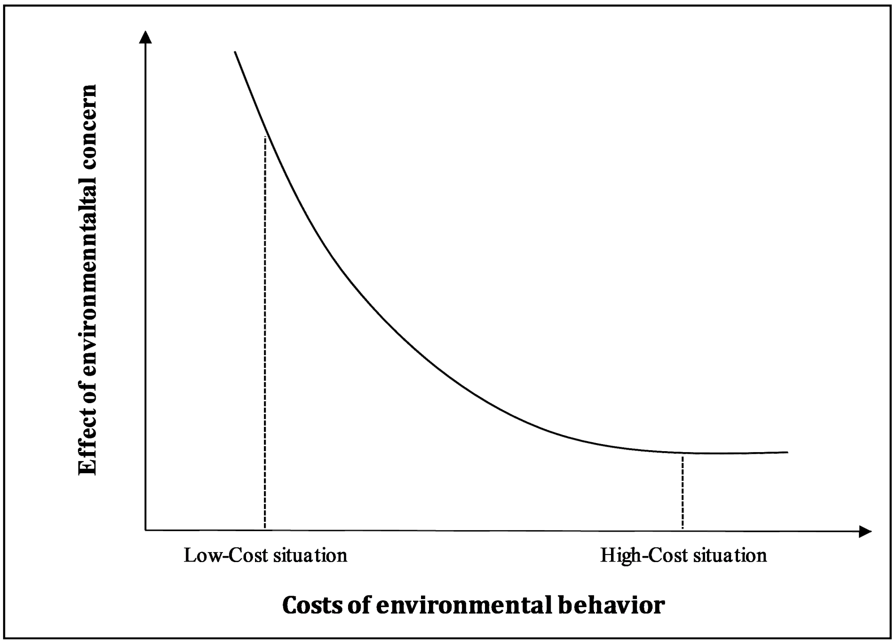
In consumer markets, changes can be very rapid, particularly with regard to the selection of products available. This leads to information asymmetries between producers and consumers, making it more difficult for consumers to assess the personal and environmental consequences of their consumption decisions correctly.

Another criticism of rational choice theory is that it ignores cognitive influences such as values and attitudes. These play a significant role in consumer decisions because consumption involves not only the satisfaction of needs but also the self-realisation of the consumer. Yet it is debatable whether consumers see every consumption decision as an opportunity for self-realisation, especially in the case of sustainable consumption. Therefore, when trying to explain consumption patterns, economic researchers must also take findings and methods from psychological and sociological research into account. Particularly with regard to the various cognitive factors that influence consumer decision making, it is important to incorporate findings from all the research disciplines mentioned above. In the realm of sustainable consumption, psychological and sociological aspects may be particularly pertinent to understanding individual consumption decisions.

1.3.1.3 The Low-Cost Hypothesis

Diekmann and Preisendörfer (1992) developed the low-cost hypothesis after studying personal environmental behaviour. According to their hypothesis, the influence of environmentally friendly awareness, attitudes and other psychological factors on environmentally friendly behaviour is higher in situations where costs for the individual are low than in situations where costs are high. Here, costs refer not only to monetary costs but also to the costs of benefit minimisation or maximisation due to cognitive dissonance and additional transaction costs. In their analysis, Diekmann and Preisendörfer (2003) provide empirical proof of the low-cost hypothesis using data from a study of German household behaviour with regard to recycling, mobility, consumption and energy and water conservation. Figure 1.1 is a simple graphic showing how the effect of environmental concern decreases as the costs of environmental behaviour increase. A practical conclusion from the low-cost hypothesis is that people are willing to behave green as long as it is cheap to do so (assuming there are no private benefits from sustainable consumption). As Diekmann and Preisendörfer observe, "The stronger the cost pressures of a situation, the less fruitful is the attitude-behavior approach taken from social psychology" (2003, p. 226).

Fig. 1.1. Influence of environmental attitudes in low and high cost situations



Source: Diekmann und Preisendörfer (2003)

After Diekmann and Preisendörfer's paper was published, there was much discussion about their findings. In particular, many criticised the methods of measurement and allocation for low- and high-cost situations (Lüdemann, 1993). Nevertheless, researchers continued to apply the low-cost hypothesis, and their studies confirmed the relationship between environmental attitudes and environmental behaviour (Diekmann and Preisendörfer, 2003). In their study on energy consumption, Black et al. (1985) concluded that personal norms are applied in situations in which little time and money is needed, e.g. regulating room temperature or switching off lights. However, decisions on larger investments like the acquisition of solar panels or a new heating system are mostly driven by (rational benefit) maximising behaviour.

The empirical evidence on the *low-cost hypothesis* is ambiguous. For example, Best (2007) examined the *low-cost* hypothesis using the example of recycling. He came to the conclusion that participating in a recycling programme does not depend significantly on costs. The strong influence of environmental awareness is, however, supported by his study.

Tyler et al. (1982) developed the defensive denial hypothesis, which can be seen as an additional confirmation of the low-cost hypothesis. In their study on energy savings, Tyler et al. discovered that people tend to exclude or suppress their environmental concerns or attitudes if costs are high. In doing so, they try to avoid cognitive dissonances and to strengthen their self-esteem. The defensive denial hypothesis thus describes a psychological mechanism that weights psychological factors like attitudes or norms less in situations with high costs than in situations with low costs. Both theories mentioned above show the limits of rational choice theory in the field of environmentally friendly consumption.

1.3.1.4 The Customer Benefit Hypothesis

The theory of *customer benefits* originated in the literature on 'green' marketing but it has also been used to study environmentally friendly product innovations (Kammerer, 2009). The theory states that consumer decisions are made not on the basis of products but on the basis of product characteristics, especially those with special benefits. In the case of environmentally friendly products, innovations are particularly decisive for a competitive advantage (Kammerer, 2009). These findings are confirmed by Cleff and Rennings (1999) in their study on determinants of environmentally friendly innovations in processes and products. A difficulty arising from these considerations is the question whether consumers are willing to pay more for product differentiation if the products are already environmentally friendly. In this case a competitive advantage can be realised monetarily, yielding another important incentive for companies to develop innovative, environmentally friendly products. Many empirical analyses in the late 1980s and early 1990s confirm a higher willingness to pay (WTP) for environmentally friendly products (Peattie, 2001). From these studies researchers developed a green consumer profile defined by the following demographic characteristics. The typical green consumer is well-educated, wealthy, and female, between 30 and 49 years of age and has children. As Peattie (2001) points out, this view has been criticised by a number of American and European studies, which came to contradictory results concerning the relation between demographic characteristics and environmentally friendly or sustainable consumption. Van Liere and Dunlap (1981) noticed a positive correlation between educative level and environmentally friendly consumption behaviour. In contrast, an analysis of Samdahl and Robertson (1989) found a negative correlation. Contradictory findings can also be found in research about the impact of age, whose correlation with environmentally friendly consumption has been shown to be partly positive and partly negative (Torgler et al. 2008). After reviewing these considerations Peattie (2001) draws the following conclusion: "Socio-demographic attempts to profile the green consumer have not always yielded strongly indicative results, and the results produced in one study have been repeatedly contradicted in another" (Peattie, 2001, adapted from Wagner, 1997).

As this conclusion makes clear, the relationship between green consumers and green buyers continues to be debated. Not all consumers apply their environmentally friendly attitudes by buying ecological products, and, not all consumers can be categorised by socio-demographic characteristics. Yet without this categorisation certain product differentiations for this group will be difficult to achieve. As empirical analysis has shown, demographic characteristics alone do not suffice.

1.3.1.5 Habits and Social Reference Groups

Besides rational considerations, the distinction between high or low costs and the customer benefit hypothesis, Welsch and Kühling (2009) point out another important influence on consumer behaviour. Using the model developed by Janssen and Jager (2002), they study the effect of routine behaviour and social reference groups. Janssen and Jager (2002) try to explain the diffusion and speed of environmentally friendly innovations under various conditions. They note that there is heterogeneity among consumers and that this heterogeneity affects their behaviour in two ways. One way is economic use of cognitive resources. In this respect the model is similar to the bounded rationality theory and to the satisficing approach by Simon (1972). The other way is that consumers not only want to satisfy needs based on their individual preferences; they also want to derive their benefit from comparison with social reference groups. Consumer decisions depend on the varying degree of those two influences. Welsch and Kühling (2009) develop four different consumption behaviour patterns with regard to environmentally friendly consumption: repetition, imitation, social comparison and weighing of interests. Repetition and imitation need the least cognitive resources as consumer decisions from the past are repeated or those of social reference groups are simply co-opted. Consumers apply these patterns until they can no longer satisfy their needs. At this point, consumers apply the other two patterns – social comparison and weighting of interest – which require more cognitive effort. (Repetition and weighing of interests occur on an individual level while imitation and social comparison use the social environment as a reference value.) Based on these four consumption patterns, Welsch and Kühling (2009) divide goods according to decision importance and according to the significance/visibility of the good. In the case of environmentally friendly consumption, examples of goods with a high level of decision importance and high significance/visibility are cars and solar panels, which display the influence of social environment. Organic food or renewable energy sources, however, display low levels of significance/visibility and decision importance. This approach shows the influence of habits and social reference groups on environmentally friendly consumer goods.

1.3.2 Socio-Psychological and Socio-Ecological Explanatory Models

Besides the above economic models, other scientific disciplines have also explored environmental consumption decisions. The necessity of interdisciplinary collaboration becomes apparent when it comes to explaining consumer and manufacturer behaviour. The special contribution of the other sciences is to enhance the explanatory models of economics, which are limited to rationality, with various social psychological aspects of human behaviour. Jackson (2005) mentions three major differences between the models of rational expectancy-value theory (EVT) and enhanced EVT. First, preferences in the enhanced EVT are also reflected in areas outside market transactions. Second, enhanced EVT considers revealed preferences. Third, it takes into account social influences, morals, habits and other aspects affecting behaviour. Enhanced EVTs include the means-end chain theory, the theory of reasoned action and the theory of planned behaviour.

Van den Bergh (2008) shows that empirical studies have yet to employ this connection. Kahn (2007) studied the influence of environmentally friendly attitudes on everyday consumption of certain means of transport (by choice and intensity of use). He found that, in addition to the socio-economic explanatory variables applied in consumption theory, attitudes have a significant influence on consumer behaviour. Consumers exhibiting high environmental awareness and positive attitudes towards the environment tend to use public transport more often, use less fuel and buy more environmentally friendly cars (Kahn, 2007). Further studies that make this connection in the field of environmentally friendly and sustainable consumption are Balderjahn (1988), Mainieri et al. (1997) and Torgler et al. (2008).

In understanding this connection, we first explain the means-end chain theory, as it has the closest link to the economic concepts mentioned above. Then, we focus in detail on the theory of reasoned action, a well-known psychological model developed by Ajzen and Fishbei (1980), which has been applied to study determinants of different behavioural patterns, including consumer decisions. The third model to be presented will be the theory of planned behaviour (Ajzen, 1991).

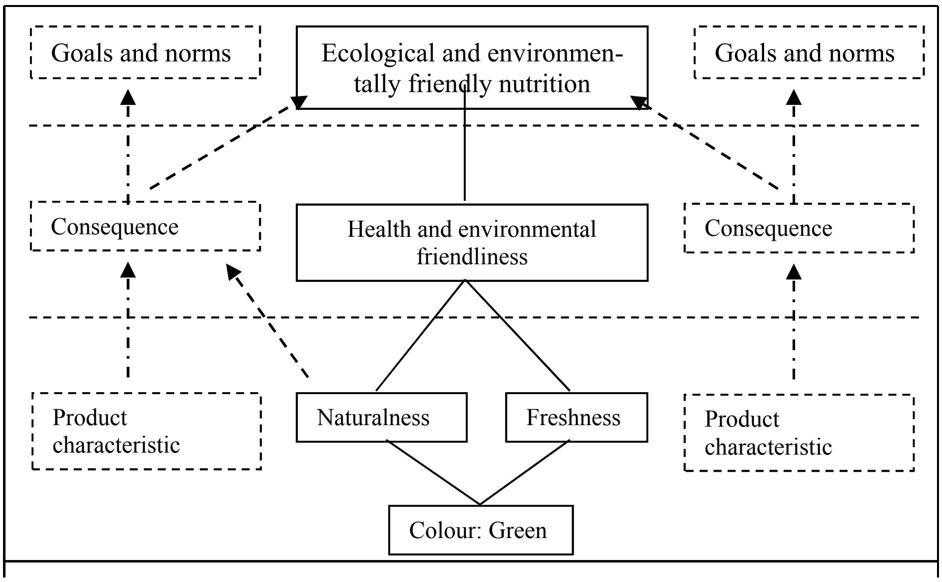
Finally, we explore the socio-ecologic concept of lifestyle. This idea links economic concepts and a general socio-psychological approach via socio-demographic characteristics. Empirical studies of lifestyle collect data on behaviour, attitudes and socio-demographics. The studies then assign consumers to different lifestyle categories based on this information.

1.3.2.1 The Means-End Chain Theory

The means-end chain theory relates to the customer benefit hypothesis explained above. The difference is that benefit is not derived from product characteristics. This theory assumes that consumers are goal-oriented when making purchasing decisions. This is to say, consumers benefit from consumption insofar as it helps meet larger goals arising from various personal, social and moral norms. Among those are the pursuit of happiness and health, social group identification and the avoidance of negative environmental effects. The means to achieve these goals are expressed by product characteristics with individual consequences for the consumer. Consumers rank products according to whether they contribute or do not contribute to achieving their personal goals. If a product does not contribute to achieving their goals, consumers will not buy it. The means-end chain theory is also related to rational choice theory and consumer theory, except for two major differences, which we discuss below.

The means-end chain theory can be explained in detail with an example from sustainable consumption. When consumers buy an organic or environmentally friendly product, they focus on certain characteristics. One of those characteristics might be green packaging. Green packaging may elicit a variety of associations. Green is the colour of nature. It stands for freshness and naturalness. It suggests healthy, ecological and environmentally friendly nutrition. Environmentally friendly nutrition is the goal to be achieved by the purchase. Figure 1.2 depicts the underlying causal connections:

Fig. 1.2. Correlations and effects between product characteristics and norms according to means-end chain theory



Source: Based on Jackson (2005)

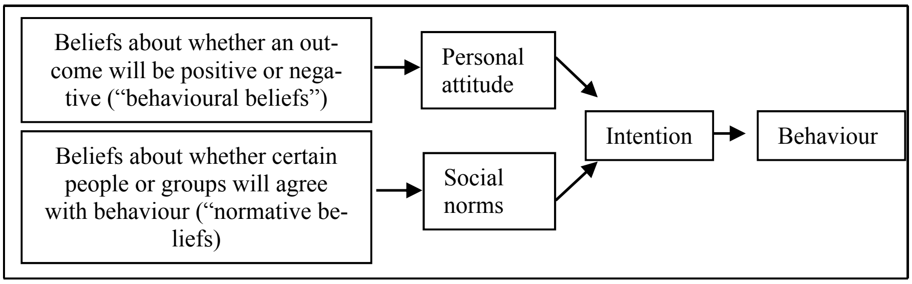
The main difference to the rational choice approach lies in the stronger qualitative focus. Like socio-psychological models, the means-end chain theory does not consider consumer preferences exogenously, which is to say, it does not assume that consumer preferences are stable. Rather, it attempts to determine the values and attitudes that determine consumption decisions and to identify which attitudes lead towards specific consumption decisions based on product characteristics. Furthermore, it loosens the criteria of pure self-interest and benefit maximisation (Jackson, 2005). All of this points to a connection between rational approaches and socio-psychological models. This model can be used not only in marketing but also for explaining environmentally friendly behaviour and the values and attitudes that determine it. Next we present the popular models of Ajzen and Fishbein (1980) used to show the connection between ideological views and applied behaviour.

1.3.2.2 The Theory of Reasoned Action and the Theory of Planned Behaviour

The basic psychological model for understanding and predicting human behaviour and for identifying its psychological determinants is the *theory of reasoned action* developed by Ajzen and Fishbein (1980). The key assumption of the theory is partly based on rational choice theory and states that humans behave rationally if they consider all information carefully (Ajzen and Fishbein, 1980). According to this theory, individuals see all aspects of their behaviour as the result of their intention to achieve an action, including the consequences. Hence, volitional control extends to behaviours that follow from intentions (Jackson, 2005). For the theory of reasoned action, behaviour is neither unpredictable nor shaped by subconscious motives. According to Ajzen and Fishbein (1980), intentions are shaped by two decisive determinants. The first is an individual's attitude to the behaviour. An attitude can be positive or negative and is used to assess and apply behaviour. The second is social norms, which pressure people into conforming to a given "subjective norm". Between those two levels there can be significant discrepancies depending on the particular decision-making situation or behaviour. In these cases individual weighting is the key decision-making factor. According to Jackson (2005), there is some debate about the legitimacy of the distinction between these determinants, but Ajzen and Fishbein (1980) still consider the distinction valid where individual decision making is concerned. Two sets of attitudes influence individual decision making: personal attitudes and social attitudes.

Personal attitudes are shaped by personal beliefs, known as "behavioural beliefs" (Ajzen, 1985). For example, people who believe their behaviour will have a positive outcome will also have a positive attitude towards it. By contrast, social attitudes are based on social norms, known as "normative beliefs". They reflect the extent to which individuals believe that their behaviour will be considered positive by people in general or by certain groups (Ajzen, 1985). Figure 1.3 illustrates how behavioural beliefs and normative beliefs work in concert to determine individual behaviour.

Fig. 1.3. Theory of reasoned action



Source: Ajzen and Fishbein (1980)

Let us take a closer look at the theory of reasoned action by considering its application to a specific behaviour: the purchase of organic products. In this example, behavioural beliefs might reflect the sum weighting of certain options: views about a product's positive effect on health, willingness to pay a higher price or beliefs about the positive effects on the environment. These attitudes constitute the behavioural beliefs that inform the purchase of organic products. By contrast, normative beliefs reflect the sum of views about principles and opinions in reference groups and their social environments regarding behaviour. In our example, these beliefs might be about whether peers highly value the purchase of organic products. Ajzen (1985) has developed a conceptual account of compliant behaviour. The first stage consists of personal opinions towards the planned behaviour and assumptions about peer expectations towards the planned behaviour. The next stage is the formation of an intention based on these beliefs. The final stage is the execution of the intention. There is another important fact to take into account, particularly for empirical analyses: Factors such as socio-demographic circumstances, desire for performance or personal characteristic features are only integrated into the model as "external variables" (Ajzen and Fishbein, 1980). These may influence personal opinions and attitudes or their weighting, but according to Ajzen and Fishbein (1980) there is no necessary connection between external variables and a particular behaviour. What is more, different behavioural patterns presuppose different factors, and behavioural patterns can change over time. The determining factors used in the theory of reasoned action are inferred from external variables and the behaviour to be predicted. The factors are not themselves an object of study.

The theory of reasoned action has been used to explain various behavioural patterns, including the behaviour of voters, behaviour in family planning, female choice of profession and consumer behaviour (Ajzen and Fishbein, 1980). The latter is of significant importance for this paper. For all the criticism of rational choice theory, the theory of reasoned action is the first approach to use normative values in understanding behaviour. It provides researchers with a tool to explain the influence of social environment on personal behaviour from an integrated theoretical perspective. Still, the theory does not provide any specifics about how to model influences, about habits, about cognitive considerations or about emotional factors. Furthermore, it does not include factors that lie outside individual will. According to empirical studies (Hines et al., 1987; Welsch and Kühling, 2009), these factors rank high when it comes to analysing environmentally friendly behaviour. For instance, outside temperatures and building characteristics influence household energy consumption, while the number of household members and the possibility of waste separation influence recycling behaviour. This view emphasises factors that might cause environmentally aware people not to act on their beliefs (Kaiser et al., 1999). Another difficulty lies in the method of analysis and the approach to beliefs and intentions in interviews. Special attention must therefore be given to the accurate and precise measurement of personal beliefs, belief determinants, belief weighting, social norms and individual intentions.

There have been attempts to modify the aforementioned theories to account for the limits of deliberate behaviour. Ajzen (1991) developed the theory of planned behaviour to account for situations in which individuals have a limited degree of volitional control. The theory's aim is to determine the external and internal factors causing the limitation. The internal factors include individual differences, willpower, personal emotions and the availability of required information and abilities. The external factors include time restrictions and the dependency on behaviour of peers. All these factors can interfere with the relationship between intentions and actual behaviour. The theory of planned behaviour understands behaviour as the pursuit of a goal whose attainment is uncertain. It uses an additional variable – perceived behavioural control – to account for uncertainty. This variable represents assumptions about the difficulty of realising a planned behaviour. Ajzen (1991) gives two reasons why the inclusion of the new variable into the existing theory can determine behavioural success, to the extent that behaviour equals intentions. First, the successful realisation of intentions directly depends on how strong individual beliefs are about the likelihood of success. To take an example from our case: Before individuals pursue environmentally friendly behaviour, they must be convinced that the behaviour will truly have a positive effect on the environment. This is a typical problem that arises with sustainable behaviour: the environment is so complex that individuals have difficulty seeing the effect of their actions. Sometimes perceived control is seen as an indicator of a real behavioural control. As long as this perception is true, intention correlates with behaviour. The addition of the perceived behavioural control variable, therefore, does not contradict the results of the previous theories. In the literature, this very theory is used to gain insights into environmentally friendly behaviour. These include studies on recycling behaviour, energy consumption and choice of food (Jackson, 2005). But most of these studies fail to measure the actual behaviour and instead concentrate on the relationship between attitudes and planned behaviour under the assumption that there is volitional control.

1.3.2.3 The Socio-Ecological Lifestyle Concept

Besides the traditional economical and socio-psychological approaches to consumption decisions, more transdisciplinary approaches began to emerge in the 1990s trying to connect multiple fields. One approach is the social-ecological lifestyle concept. It attempts to explain certain behavioural patterns better than the socio-demographical in classical economics or the very general approaches in social psychology. The starting point of the concept is a group-specific point of view. (The approach is located somewhere between the microeconomic and the macroeconomic.) The term “lifestyle” lacks strict definition and uniform meaning. This might explain the sometimes synonymous use of the terms “lifestyle”, “conduct of life” or “way of life” in everyday language. Hunecke (2000) provides clear definitions: “Lifestyle” refers to behaviours that distinguish a certain group from another. “Conduct of life” refers to values and norms in everyday situations. “Way of life” is a catchall term summarising the standard of life, the quality of life and lifestyle. According to Hunecke (2000) the best definition is found in Müller (1997), since it illustrates the connection of socio-demographics with cultural value systems: “Lifestyles could be seen as spatiotemporally structured patterns of conduct of life that are dependent of resources (material and cultural), the setup of family and household and the value system” (Müller 1997, p. 376).

Economic and material resources are generated by professional situation, income or social background. In contrast, cultural value systems are created by socialisation in different groups. Lifestyles might change quickly, but they are not fads, as they are strongly connected to the stable self-identity of individuals (Hunecke, 2000). This can also be seen in the methodology of the lifestyle concept. This methodology consists of five parts: values and attitudes, cultural personal preferences, behaviour, way of life and social structure (ibid.). Another helpful theoretical basis is found in Enneking et al. (2007). They apply a model developed by Reusswig (2002) with three dimensions: performance, mentality and situation. **Situation** refers to education, income or profession. **Mentality** includes the attitudes and values of an individual. **Performance** comprises lived behaviours. Enneking et al. (2007) believe that, together, these dimensions can explain gaps between attitudes and actual behaviour in sustainable consumption patterns, providing a comprehensive view of consumer behaviour. Due to the different operationalisations and concepts of the lifestyle approach – depending on the subject and the attendant problems – we believe that it can be applied in a variety of ways. The concept of lifestyle has yet to be used widely in the area of sustainable consumption. But given the transition from a three-class-society to a society in which various groups distinguish themselves from another by means of a variety of pluralistic ideas, values and attitudes, the lifestyle concept appears to offer new insights (Enneking et al., 2007). According to Enneking and Franz (2005), there are two different strategies for applying the concept to sustainable consumption patterns: interviews with groups selected according to attitudes and behaviours and interviews with sustainability-related groups selected according to lifestyle.

According to Enneking (2005), milieus range from “traditionalists” (or “conservatives”) to “experimentalists”. Traditionalists want security and order first and foremost. They seek to conserve traditional values and oppose innovation. In contrast, experimentalists live spontaneously and are open to new lifestyles and cultures. The largest group, lying between traditionalists and experimentalists, is the middle class. The middle class strives for some wealth and is determined and performance-oriented (Enneking, 2005). These milieus are being used in studies on sustainable consumption patterns of the German Federal Environment Office to identify consumer types (Wippermann et al., 2009). The studies show that the milieus "established", "conservative" and "post-materialist" have the highest WTP for ecological products. These groups have higher social standings and do not show a particular orientation. All groups have a high level of education and income. Their members are middle-aged and older and they show a certain degree of environmental awareness. The results indicate that education, income and environmental awareness are important influencing factors.

These preliminary remarks suggest that the lifestyle approach can deliver many new insights into sustainable consumption. Especially here, the broad understanding it provides can help explain the discrepancies between attitudes and behaviour. Furthermore, the approach is well suited for determining group-specific implications that could influence consumption patterns.

1.3.3 Conclusions from the Theoretical Observation of Sustainable Consumption Behaviour

As we have seen in the previous sections, identifying determinants and their (at times ambiguous) effects in the field of sustainable consumption can be difficult. The complexity is also demonstrated by the number of disciplines that make use of this analysis. Furthermore, approaches that focus on the connection between environmentally friendly attitudes, environmental knowledge and realised behaviour have produced a variety of conclusions. There is a clear discrepancy between attitudes and behaviour. In trying to account for that discrepancy, rational choice theory, the theory of reasoned action and the theory of planned behaviour all reach the limits of their explanatory power. Economical theories do not take into account effects of attitudes and cognitive influences, while the other sciences neglect socio-demographic aspects. Empirical studies show that the discrepancies become especially apparent in low cost situations. This is why a combination of several disciplines, as found in the lifestyle approach, seems best suitable. Accordingly, the SECO@home project seeks to determine the effect of certain factors relating to the environment – e.g., environmental knowledge, environmental awareness, environmental attitudes – on the WTP for environmentally friendly everyday products across various demographics.

1.4 Methodological Approaches

1.4.1 Revealed and Stated Preferences

Economic approaches collect information on individual preferences in two different ways. In a revealed preferences approach, individual or household preferences are measured by observing consumer behaviour. Individual consumer decisions provide information about the attributes of a specific product (Bühler, 2006). For example, the difference in prices between residential buildings in noisy areas and those in quiet areas may be a good indicator of the negative value of noise. The revealed preferences approach can only be used for ex-post analysis, since it depends on prior framework conditions and can only be applied to products that have already penetrated the market (Knapp, 1998).

In contrast to the revealed preferences approach, which observes actual choices made by decision makers in real market circumstances, the stated preferences approach examines preferred choices made under different hypothetical scenarios in experimental markets (Danielis and Rotaris, 1999). The main benefit of this technique is that it allows for testing under experimental conditions (Timothy, 2008). The stated preferences approach (using conjoint analyses) is particularly recommended for the study of environmental behaviour and for the study of individual behaviours vis-à-vis new technologies yet to penetrate the market (Train, 2003; Hensher et al., 2005).

Conjoint analysis is based on work by Luce and Tukey (1964), and in the past few decades it has undergone much advancement. Today conjoint analysis attracts the attention of theorists and field researchers as a method of studying preferences (Gustafsson et al., 2003). Green and Rao (1971), McFadden (1974) and Green and Srinivasan (1978) introduced the method into the marketing literature in the 1970s. Early conjoint-analysis work modelled behavioural processes in order to comprehend how consumers form preferences (Green and Rao, 1971; Norman and Louviere, 1974). Later work in marketing emphasised predicting behavioural outcomes (e.g., choices) while focusing on statistical methods and techniques (Louviere and Woodworth, 1983). Today it is widely used for marketing research and product design surveys and has gained particular acceptance in the past decade as advancing computer technology has helped simplify its application (Hair et al., 1995).

The basic idea of this method is that preferences for one specific stimulus derive from a combination of attributes. The underlying assumption of this method was described by Lancaster (1966): “The good, per se, does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility.” The overall utility of a product or service is the sum of the utilities assigned to its separate attributes or part-worth utilities. Accordingly, the more respondents distinguish among attributes, the wider the range in part-worth utilities and the higher the overall utility of an attribute (Orme, 2006).

Conjoint analysis is a technique designed to analyse and predict consumers’ responses by measuring the importance and degree of preference individuals attach to each of the attributes. In one of the most applied techniques, the choice-based conjoint analysis or discrete choice, consumers are asked to choose a set of criteria from numerous presented sets. Although the market usually requires trade-offs between different characteristics, consumers typically avoid the evaluation of conflicting attributes during market research. By contrast, choice-based conjoint analysis or discrete choice forces consumers to decide which characteristics are most important and allows them to make trade-offs among product attributes. This makes it possible to measure preferences in simulated quasi-realistic decision or purchasing situations, as decision-making criteria are not presented separately but simultaneously (Orme, 2006; Lilien et al.., 2007; Huber, 2005). Furthermore, choice-based conjoint analysis usually selects only a limited number of attributes on which to base the decision. The simplification in the conjoint analysis mirrors the one in the market, as most decisions in the market are also based on remarkably few dimensions (Huber, 2005; Olshavsky and Grandbois, 1979).

1.4.2 Comparison of Conjoint Analysis Methods

In the literature, a vast variety of different conjoint models have been discussed at length (Green and Srinivasan, 1990). Nevertheless, only some models have gained broader acceptance in practice (Carroll and Green, 1995). Today, the methods applied most are discrete choice or choice based conjoint analysis (CBC), adaptive conjoint analysis (ACA) and the traditional full profile methods (Orme, 2003). Because discrete choice is regarded as being better than traditional full profile methods, the alternatives came down to discrete choice or ACA. Researchers decided for discrete choice analysis since it leads to more realistic decision situations in competitive contexts. In discrete choice, respondents have to choose between products from a restricted product set or evoked set by rating complete stimuli. Preferences are derived from the most beneficial products respondents choose in the restricted set (McFadden, 1974). ACA, in contrast, is a multistep approach where respondents personally evaluate the attributes and dimensions. On this basis, their indicated preferences are used to create individual pair comparisons between stimuli in the decompositional step that follows (Backhaus et al., 2006). The choice task in discrete choice can be seen as more immediate and concrete than the abstract rating or ranking sets applied in ACA and therefore offers respondents greater simplification (Huber, 2005; Olshavsky and Grandbois, 1979). Essentially, discrete choice is a group-based analysis based on aggregation. By using hierarchical Bayesian (HB) estimation, researchers can estimate part-worth utilities at the individual level, and by using Latent Class analysis, they can simultaneously delineate relatively homogeneous segments (Orme, 2007). The major reason for choosing the discrete choice approach was that the rating and ranking approach of the ACA method does not represent the real buying situations consumers face, since they are not obliged to make trade-offs between profiles. Moreover, rating or ranking profiles can become difficult and tiring for respondents, potentially resulting in random responses. In short, because discrete choice integrates a relatively small number of attributes, it provides more precise results. Furthermore, it is regarded to be a comparatively simple and natural task, making it easier for respondents to comprehend (Orme, 2007).

1.4.3 Discrete Choice Model

Discrete choice models are based on random utility theory. Each respondent faces a choice among two or more possibililties in a choice situation and chooses the one with the highest utility (Huber and Train, 2000). The utility is assumed to be related to the valuation of specific attribute levels by the respondents, who are presumed to be heterogeneous in their attribute preferences. If there is heterogeneity among individuals, hierarchical Bayes models can significantly improve the preference analysis compared with the results of traditional aggregate models. Within a Bayesian framework, the distribution of coefficients (part worths) across the population is estimated and then combined with choice data to derive posterior or conditional estimates of individual values. In this way, hierarchical modelling can be used to link information about the distribution of coefficients across all respondents with information about the choices made by individuals to obtain estimates of individual values (Allenby and Rossi, 2003).

The hierarchical Bayes model is written as a series of hierarchical algebraic statements, whereby model parameters at one level of the hierarchy are explained at subsequent levels. In other words, the method combines aggregate and individual-level specification of parameters. At the higher level, individual part worths are described by a multivariate normal distribution, characterised by a vector of means and a matrix of covariances. At a lower level, probabilities of choosing particular alternatives are governed by a multinomial logit model (Sawtooth Software, 2009). Individual part worths are assumed to have multivariate normal distribution,

$$\beta_i \sim Normal\ (\alpha, D)$$

where:
β_i = a vector of part worths for the i^{th} individual
α = a vector of means of the distribution of individual part worths
D = a matrix of variances and covariances of the distribution of part worths across individuals
The probability of the i^{th} individual choosing the k^{th} alternative in a choice task is

$$\frac{exp\left(x_k^{i\beta_i}\right)}{e_j exp\left(x_j^{i\beta_i}\right)}$$

where: p_k
p_k = the probability of an individual choosing the k^{th} in a particular choice task
x_j = a vector of values describing the j^{th} alternative in that choice task.

To estimate the probability of the i^{th} individual choosing the k^{th} alternative, part worths (elements of β_i) are added up for the attribute levels describing the k^{th} alternative. This step yields the i^{th} individual utility for the k^{th} alternative, exponentiates that alternative's utility, performs the same operations for other alternatives in those choice tasks and, finally, obtains the percentage of the results for the k^{th} alternative by the sum of similar values for all alternatives (Sawtooth, 2009). In a Bayesian framework, α and D are considered to be stochastic and are estimated by conducting several thousand iterations in a process known as Gibbs Sampling. Another name for this procedure is the "Monte Carlo Markov Chain". This makes sure that the multivariate normal mean vector, the covariance matrix and each set of part worths are randomly updated based on other current parameter estimates.

To derive the final individual estimates for the part worths, the last several thousand iterations are saved and the parameter estimates from these iterations are averaged. At the lower aggregate level, it is assumed that a logit model governs the probability a respondent will choose a particular alternative, given his or her individual part worths (Sawtooth Software, 2009).

1.4.4 Discrete Choice Design

Discrete choice analysis involves multiple steps. The first is to compile a list of drivers that may influence a customer's buying decision. The necessary information can be derived from qualitative market assessment, customer interviews, case studies, industry data, focus groups or other information resources (Verma et al., 2008). For example, for a washing machine, the relevant drivers might be brand, equipment version, water consumption, energy consumption, energy-efficiency rating and price (Sammer and Wüstenhagen, 2006). It is crucial that respondents understand all determinant drivers. Moreover, the list of drivers must include all critical choice drivers relevant to the respondent. At the same time, the number of drivers must be realistic and few enough to be tractable (Verma et al., 2008). The next step is to specify attribute levels. According to the study of Sammer and Wüstenhagen (2006), attribute levels for water consumption might be, say, 39 l/wash cycle, 47 l/wash cycle and 58 l/wash cycle. The next step is the construction of choice experiments and the visual or verbal presentation to the respondents, from which they have to select their preferred choice set. Sammer and Wüstenhagen (2006) presented three descriptions of washing machines to customers in a series of 21 choice sets. For each set, the respondents were asked to choose among three presented options, in addition to a "none" option. The integration of the "none" option conforms with the economic theory of consumer demand, which requires that buyers have the option of refusing (Wang et al., 2007). After the survey is completed, a detailed analysis of the survey results follows. The results from a discrete choice analysis include a set of preference scores, known as part-worth utilities, which accurately forecast the relative importance of, and preferences for, each value of every attribute. For our study, this information could then be used to acquire knowledge about the relationship between the purchase decision and the preferences of consumers regarding individual energy consumption. In this way, it is possible to develop better knowledge about which criteria influence consumers to adopt more sustainable energy use patterns (ZEW, 2008). The outcomes might also be used as a market simulator engine, insofar as they gauge the market demand impact precipitated by a change in the value of one attribute (Gantry, 2007).

1.4.5 Research Needs: Integrating Firm and Energy Policy Perspective

While most existing studies compare alternative technologies in specific market segments (e.g. air conditioner *x* vs. air conditioner *y*), it is also important to approach the question from a broader perspective. What are the best ways for consumers to save energy or reduce CO_2 emissions? Options include energy-efficient air conditioners, better insulation, or behavioural changes such as closing shutters during the day.

Table 1.1 Comparison of marketing and energy policy approaches

	Marketing approach	Energy policy approach
Perspective	Firm	Options for energy policy
Idea	Comparison of alternative technologies for specific market segments	Comparison of alternative options for energy saving in different market segments
Result	What attributes are important for the market diffusion of a certain product?	What alternatives maximise contribution to policy targets (e.g. CO_2-reduction)?

The valuation and comparison of these strategic policy options should be particularly interesting to policy makers, while technology comparison will be relevant for firms that supply a specific market segment. Hereafter, we call technology comparisons “the firm perspective” (or “the marketing approach”) and the broader perspective “the policy perspective” (or “the energy policy approach”). We see the integration of both approaches as a substantial improvement in the methodology. Table 1.1 shows the main differences between the perspectives.

1.5 Decisions for Concrete Environmental Technologies

In this section we focus on empirical evidence regarding two specific technologies of sustainable energy consumption in residential buildings: domestic appliances and micro-power.

Stated preference surveys analysing the choice between different product or services alternatives, such as the choice between different means of transportation (e.g. Bhat and Castelar, 2002), have existed for a relatively long time. Most energy-related stated-preference surveys address issues related to transport, in particular the choice between cars that run on sustainable energy sources and cars that run on less sustainable energy sources. In their study of Swiss automotive customers, Sammer and Wüstenhagen (2007) analysed the effects of the energy label (introduced in Switzerland in 2003) on purchasing decisions. Their research, which was based on conjoint analysis, has shown that the energy label does have a measurable effect on the likelihood that Swiss automotive customers will purchase energy-efficient vehicles. (For other energy-related preference surveys related to transportation, see Brownstone and Train, 1998; Brownstone et al., 2000; Sándor and Train, 2004; and Horne et al., 2005).

1.5.1 Empirical Studies in the Field of Household Appliances

Some conjoint analyses have been conducted in the field of energy-related household decisions and are closely connected to the present study. Regarding the energy efficiency of domestic appliances, Sammer and Wüstenhagen (2006a, 2006b) examined the impact of EU energy labels on consumers when choosing among washing machines and light bulbs with different degrees of energy efficiency.

Table 1.2. Empirical studies in the field of household appliances

Authors	Year	Title	Country
Sammer and Wüstenhagen	2006a	The Influence of Eco-Labelling on Consumer Behavior – Results of a Discrete Choice Analysis for Washing Machines	Switzerland
Sammer and Wüstenhagen	2006b	Der Einfluss von Öko-Labelling auf das Konsumentenverhalten – ein Discrete Choice Experiment zum Kauf von Glühlampen	Switzerland
Moxnes	2004	Estimating Customer Utility of Energy Efficiency Standards for Refrigerators	Norway
Revelt and Train	1998	Mixed Logit with Repeated Choices	United States
Matsukawa and Ito	1998	Household Ownership of Electric Room Air Conditioners	Japan
Dubin and McFadden	1984	An Econometric Analysis of Residential Electric Appliance Holdings and Consumption	United States

Their study investigated the relative importance of eco-labels compared with other product features in consumer purchasing decisions and showed a significant willingness of customers to pay for A-labelled energy-efficient products. Moxnes (2004) conducted a conjoint analysis in the field of domestic appliances and estimated individual utility functions for customers who recently bought a refrigerator. Moxnes offers a common argument against efficiency standards, maintaining that they prohibit optimal product choices and thus reduce customer utility. But his analysis finds that efficiency standards for refrigerators can increase utility for the average consumer. Another study on refrigerators, by Revelt and Train (1998), examined the impact of incentive payments on the purchases of energy-efficient refrigerators. Revelt and Train studied the relative importance of rebates or loans for the adoption of high-efficiency refrigerators in US households. They used stated-preference data to estimate the effect of loans relative to the effects of rebates. They concluded that loans have a larger impact than rebates. A study explicitly related to air conditioners was conducted by Matsukawa and Ito (1998), who measured the effects of the purchasing price on the total number of air-conditioner units in the household. Their empirical findings showed that the price of an air conditioner does indeed impact greatly on the actual number purchased. (For another study related to residential electric appliances, see Dubin and McFadden, 1984.) Table 1.2. gives an overview of conjoint studies conducted in the field of energy-related household appliances.

1.5.2 Empirical Studies in the Field of Heating Systems

Karrer (2006) evaluated the most relevant product attributes of combined heat and power (CHP) plants from a customer's point of view. By means of a conjoint method, he evaluated the attributes that generate customer value. The results showed that environmental and safety aspects are predominant in a customer's product judgments. One interesting finding was that respondents preferred owning a CHP plant to contracting or leasing it. Vetere (2008) investigated preferences for solar thermal installations in Swiss hospitals. Vaage (2002) described the structure of the energy demand in a household as a discrete/continuous choice and, on this basis, established an econometric model suitable for the data available in the Norwegian Energy Surveys. This study drew on the work of Nesbakken and Strøm (1993), who used the 1990 Energy Survey to create a discrete/continuous model of energy demand in Norwegian households. 1.3 gives an overview of conjoint studies conducted in the field of heating systems.

Research on UK households (Martiskainen, 2007; Dobbson and Thomas, 2005) indicates that micro-power may be an initiator of behavioural change, since people who install micro-generating technologies are more likely to be and become aware of their overall energy use.

Table 1.3. Empirical studies in the field of heating systems

Authors	Year	Title	Country
Karrer	2006	Customer Value dezentraler Energieversorgung - Relevante Leistungsattribute von BHKW und deren Implikationen fürs Marketing.	Switzerland
Vetere	2008	Conjointanalytische Untersuchung der Kundenpräferenzen im Business-to-Business Marketing für Solarthermie	Switzerland
Jaccard and Dennis	2006	Estimating Home Energy Decision Parameters for a Hybrid Energy-Economy Policy Model	Canada
Vaage, K.	2002	Heating Technology and Energy Use: A Discrete / Continuous Choice Approach to Norwegian Household Energy Demand	Norway
Nesbakken and Strom	1993	Energy Use for Heating Purposes in the Household	Norway

1.5.3 Empirical Studies in the Field of Green Electricity

Why does diffusion of sustainable consumption patterns fail to occur? This is the question posed by the WENKE2 project (Clausen, 2008), a BMBF-funded project that surveyed two renewable energy consumer groups (solar thermal and green electricity) and randomly chosen pedestrians about their motivation for buying and using sustainable technologies.

The results for green electricity indicate that broad environmental concern is the most important reason for buying green electricity, followed by a political interest and involvement.

Green electricity buyers are less price-sensitive than a comparable group of non-buyers. When asked about the price difference between conventional and green electricity, none of the surveyed groups could estimate it accurately.

Clausen (Clausen, 2008, p. 28) concludes that the weakest point in the marketing of green electricity may be that the public has yet to receive realistic information about prices. Whilst green electricity buyers overestimate the price fourfold, non-buyers assume on average a ten-fold higher price for green electricity.

Table 1.4. Empirical studies in the field of electricity

Authors	Year	Title	Country
Burkhalter et al.)	2007	Kundenpräferenzen für leistungsrelevante Attribute von Stromprodukte	Switzerland
Goett, A.	1998	Estimating Customer Preferences for New Pricing Products	United States
Cai et al.	1998	Customer retention in a competitive power market: Analysis of a Double-Bounded plus follow-ups Questionnaire	United States
Goett et al.	2000	Customer Choice Among Retail Energy Suppliers: The Willingness-to-Pay for Service Attributes	United States
Blass et al.	2008	Using Elicited Choice Probabilities to Estimate Random Utility Models: Preferences for Electricity Reliability	Israel
Beenstock et al.	1998	Response Bias in a Conjoint Analysis of Power Outages	Israel
Dagsvik et al.	1987	Residential Demand for Natural Gas	Netherlands

Next to newspapers, “friends and acquaintances” were given as the most important source of information, supporting the importance of social relationships in the dissemination and stabilisation of sustainable consumption. (For more on social marketing, see for instance Martiskainen, 2007; and Mc Kenzie-Mohr 2000. Eberle et al. 2004 provide an overview of conjoint studies in the field of electricity.)

A recent conjoint analysis of the preferences of Swiss electricity customers supports the findings of Clausen (2008). Burkhalter et al. (2007) have shown that average customers pay special attention to energy mix, energy cost and location of electricity production, whereas other attributes, such as electricity supplier, pricing model, eco-certification and contract duration, play a subordinate role. Goett (1998) examined pricing type, contract duration and supplier type. His main findings were that a fixed price was preferred over time-of-day and seasonal rates and long-term contracts were less preferred than short-term ones. Cai et al. (1998) analysed price, outages, integration of renewable sources, support of conservation programmes and customer services. Their findings showed that the number of outages was by far the most important service attribute. Blass et al. (2008) estimated consumer valuation of residential electricity reliability in Israel. They found that knowledge of consumer willingness to pay for reliability is an important component of a rational planning strategy for capacity investment in the generation and transportation of electricity, as well as a key factor in determining an optimal electricity pricing schedule. Goett et al. (2000) extended the conjoint-type research of Cai et al.(1998) based on these previous studies. Specifically, they examined a larger set of attributes, including sign-up bonuses, amount and type of renewable, billing options, bundling with other services, reductions in voltage fluctuations and charitable contributions. Their main result is of interest for this study: Customers are deeply concerned about renewable energies. Their estimates suggest that customers are willing to pay, on average, 2.0 cents per kWh more for a supplier that uses 100% hydro than for a supplier with no renewable sources, and 1.45 cents more for 100% wind than for no renewables. (For other energy-related preference surveys related to electricity, see Beenstock et al., 1998; Dubin and McFadden, 1984; Dagsvik et al.,1987.)

Truffer et al. (2002) identify a social dilemma among (potential) green electricity buyers: People are willing to pay more for green electricity only on the condition that everyone else is involved and committed. They also find that in general few people are familiar with green power systems and infrastructure. This underscores the importance of labelling and independent verification, which Truffer et al. (2001) recommended based on the results of a focus group study.

1.6 Conclusions: Hypothesis and Research Needs

The focus of this paper is on the individual decisions of consumers, and their relationship to sustainable consumption. Consumer behaviour is based on individual decisions, and it depends largely on economic incentives, supply-side measures and appropriate infrastructure (e.g. consumer benefits from investments into energy-efficient equipment, or the availability of energy-efficient household equipment) and on socio-political factors (e.g. the existence of emissions trading or eco-labels). Consumer behaviour consists of daily "micro-decisions" that construct our self-identity, or lifestyle. Thus behaviour can only be understood in a specific context of beliefs, norms and values. If we are to understand sustainable consumption, we must analyse this context.

From a review of the empirical literature on the diffusion of energy-efficient activities we derive the following general hypotheses:

1. Characteristics of the household (occupants):

All studies under review indicate that sustainable energy use (including purchases) in residential buildings is significantly influenced by income. Evidence on the role played by education, age, household size and ownership is inconclusive, however. The general message is "it depends". The causal relation largely depends on a specific regulatory framework (e.g. in Germany ownership has a positive effect on sustainable energy use while in the US its effect is negative), or on particular circumstances. Education may increase awareness of environmental problems but it may also lead to unsustainable behaviour such as travelling; old people may be less interested in environmental problems but they may also have more time to spend on purchasing new equipment; big families have more to gain from saving energy but they have less money to invest in energy efficiency equipment. (Results of gender differences are discussed below).

2. *Characteristics of the residence:*

Housing size and the adoption of energy-efficient measures can be expected to correlate positively. This is confirmed by most studies, although it is not significant in all. The age of a residential building can also be expected to correlate positively with the diffusion of energy-efficient measures, since efficiency measures in old buildings stand to save more energy than those in new buildings. In addition, one econometric study provides evidence that urban households have easier access to information and markets and thus lower transaction costs than rural households.

3. *Characteristics of measures (technology):*

In general, the studies under review find that transparency regarding the costs of energy use (and the energy performance of the product) correlates positively with energy-saving behaviour. This has been shown for measures such as energy bills or energy labels. The effect of information also depends on the credibility of the source: the response of households to information on energy-saving measures is stronger if the information is provided by a state regulatory agency rather than by a utility.

4. *Economic factors:*

Energy prices play an important role and correlate positively with sustainable energy use. The higher the energy prices, the more likely households are to save energy.

5. *Attitudes/preferences towards the environment:*

Although sustainable consumption seems to require changes in framework conditions (prices, infrastructure etc.), the analysis of individual behaviour in response to supply factors and regulation is crucial in specific contexts. Still, no concrete hypotheses can be derived from the literature. Although there is some agreement that attitudes and lifestyles are relevant, it has yet to be shown that these factors are significant determinants of energy consumption.

Economic approaches collect information about individual preferences in two different ways. In the revealed preferences approach, individual or household preferences are measured by observing consumer behaviour. The individual consumer decision provides information about the attributes of a specific product. For example, the difference in prices between residential buildings in noisy areas and those in quiet areas may be a good indicator of the negative value of noise. Hence the revealed preferences approach can only be used for ex-post analysis, as it depends on framework conditions and can only be applied to products that have already penetrated the market. In contrast to the revealed preferences approach, which observes actual choices made by decision-makers in real market circumstances, the stated preferences approach examines preferred choices made under various hypothetical scenarios in surveys or at experimental markets. The benefit of this technique is that it allows for testing under experimental conditions. The stated preferences approach (using conjoint analyses) is particularly recommended for the study of environmental behaviour and for the study of individual behaviours vis-à-vis new technologies yet to penetrate the market. In our paper we want to explore research needs regarding stated preference surveys for sustainable energy consumption in residential buildings.

While most of the existing stated preference studies compare alternative technologies in specific market segments (e.g. air conditioner *x* vs. air conditioner *y*), it is also important to approach the question from a broader perspective. What are the best ways for consumers to save energy or reduce CO_2 emissions? Options may include energy-efficient air conditioners, better insulation for the house, or behavioural changes such as closing shutters during the day. Assessment and comparison of these strategic policy options should be especially interesting to policy makers, while technology comparisons will be relevant to firms that supply a specific market segment. In this paper, we call technology comparisons "the firm perspective" (or "the marketing approach") and the broader perspective "the policy perspective" (or the "energy policy approach"). We see the integration of both approaches to represent a substantial improvement in the methodology.

Finally, we derived several hypotheses from the literature regarding three specific technologies of sustainable energy consumption in residential buildings: Domestic appliances, micro-power and green electricity.

A number of conjoint analyses closely related to the present study have been conducted in the field of household energy-related decisions. For instance, studies examining the impact of EU energy efficiency labels on consumers when choosing between washing machines and light bulbs have found a significant willingness on the part of consumers to pay for products with an "A" rating. Other findings show that respondents viewed environmental certification as a favourable product attribute, although, for the typical respondent, the importance of other product attributes outweighed that of environmental certification. Another study analysed the impact of incentive payments on the choice of energy-efficient refrigerators by residential customers. It concluded that loans have a larger impact than rebates. A study explicitly related to air conditioners showed that the price of an air conditioner greatly affects the actual number of air conditioners purchased.

In the field of heating systems, results from the literature survey showed that environmental and safety aspects are decisive in customers' product judgments. One interesting finding was that respondents preferred owning a CHP plant to contracting or leasing.

Regarding green electricity, a recent study shows that green electricity buyers are less price-sensitive than a comparable group of non-buyers. When asked about the price difference between conventional and green electricity, none of the surveyed groups could estimate it accurately. Next to newspapers, "friends and acquaintances" were given as the most important source of information, supporting the importance of social relationships in the dissemination and stabilisation of sustainable consumption.

A recent conjoint analysis of the preferences of electricity customers backs these findings. It shows that customers pay special attention to the criteria of energy mix, cost and location of electricity production, whereas other attributes, such as electricity supplier, pricing model, eco-certification or the duration of the contract play a subordinate role for the average private client. Generally, the literature indicates that renewable energies rate high among customers.

Another study found that a fixed price was preferred to time-of-day and seasonal rates, and that consumers prefer not being locked into a long-term contract. Another result from the literature survey: the number of outages may be the most important service attribute. Knowledge of consumer willingness to pay for reliability is an important component of rational planning strategy for capacity investment in the generation and transportation of electricity, as well as a key factor in determining an optimal electricity pricing schedule.

However, the literature also mentions a social dilemma among (potential) green electricity buyers: People are willing to pay more for green electricity only on the condition that everyone else is involved and committed. The problem of higher fees for green electricity is that they allow for free-riding. Another finding from the literature survey is the importance of labelling and independent verification.

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2 Analysis of Existing Data: Determinants for the Adoption of Energy-Efficient Household Appliances in Germany[1]

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2 Analysis of Existing Data: Determinants for the Adoption of Energy-Efficient Household Appliances in Germany

Bradford Mills and Joachim Schleich

2.1 Introduction

Major household appliances account for 35 % of total European Union (EU) residential end-use electricity consumption (Bertoldi and Atanasiu, 2009). Refrigerators and freezers alone account for 15 % of residential electricity end-use, with washing machines accounting for 4 % and dishwashers, electric ovens and clothes dryers accounting for approximately 2 % of total residential end-use, apiece. Improving energy efficiency via faster diffusion of energy-efficient appliances is perceived as a key option to achieve EU energy efficiency and climate policy targets (European Commission, 2011a). Notably, increasing the energy efficiency of household appliances is crucial for realizing the European Council Action Plan for Energy Efficiency target of 27 % residential energy-savings over expected baseline growth by 2020 using cost-effective technologies (European Council, 2006). Likewise, higher energy efficiency typically translates into lower fossil fuel use and lower carbon emissions. According to the recent road map of the European Commission, the EU aims to reduce greenhouse gas emissions by 25 % from 1990 levels by 2020, and by 80-95 % by 2050 (European Commission, 2011b).

The EU appliance energy consumption labelling scheme has been a key component of past efforts to increase the diffusion of energy-efficient appliances (Bertoldi and Atanasiu, 2009). Labelling schemes are often promoted as a cost-effective measure to overcome barriers related to information and search costs, or to bounded rationality on the part of appliance purchasers (Sutherland, 1991; Howarth et al., 2000). In this case, the labelling scheme is designed to make consumers aware of the relative energy-efficiency of appliances and associated potential cost savings through the provision of observable, uniform and credible standards. The generation of this consumer information is, in turn, expected to create market incentives for appliance manufactures to design more energy-efficient products, and may reinforce price-induced technological innovation. For example, Newell et al. (1999) find that the mean energy efficiency of water heaters and air conditioners offered in the US rose significantly once a labelling scheme was introduced in 1975.

The effectiveness of the energy labelling scheme in driving reductions in residential energy consumption depends on two outcomes. First, consumers have to be aware of the classification system. Second, the labelling system has to influence consumer purchase decisions. In this paper we examine the determinants for the choice of seven major kitchen and washing appliances based on a unique data set of more than 20,000 households in Germany. Specifically, we empirically explore both consumer knowledge of the EU Energy Consumption Labelling Framework for major kitchen and clothes washing appliances and the factors that influence consumer choice of class-A energy-efficient appliances. Since only households that are aware of the energy labelling scheme may respond to survey questions on the energy class of the appliance, the analysis of determinants of consumer choice of energy-efficient appliances may suffer from knowledge-based selection bias. Thus, we jointly estimate the determinants of knowledge of the energy- labelling scheme with the determinants of class-A appliance choice.

The remainder of the paper is organised as follows. Section 2 provides an overview of the literature on the determinants for the adoption of energy-efficient measures in general, taking into account the fact that the diffusion of such measures may be motivated by economic factors as well by attitudes towards the environment.

Section 3 describes the EU Energy Labelling Framework and its implementation in Germany. Section 4 presents the statistical model and the specification of factors potentially associated with both knowledge of appliance energy class and choice of class-A appliances. Study data is outlined in section 5 and estimation results are presented and discussed in section 6. The paper then concludes by distilling policy implications for enhancing the adoption of energy-efficient appliances.

2.2 Determinants for the Adoption of Energy-Efficient Appliances

Incentives for households to adopt energy-efficient appliances may be twofold. First, from an economic perspective, utility-maximising households are assumed to aim at minimizing the costs for services like cooling of foods or drying of laundry. Hence, besides the initial purchasing expenditures, the energy performance and associated energy costs of appliances over time are expected to be relevant criteria for technology choice, along with other characteristics like size, design, reliability or other operating costs. Second, since purchasing energy-efficient appliances results in lower resource use and lower emissions of local and global pollutants, environmental degradation is reduced. Thus, in economic terms, the adoption of an energy-efficient appliance also creates a public good in terms of a cleaner environment.

Existing studies on the adoption of energy-efficient measures in households are typically based on different, partially over-lapping, concepts from economics (including behavioural economics), psychology (including the marketing-related literature on consumer behaviour) and sociology. Preferences towards the environment are usually elicited via contingent valuation studies. Survey-based analyses on the diffusion of energy-efficient activities typically include factors related to the following categories:

1. characteristics of the household (occupants)
2. characteristics of the residence
3. characteristics of the measure (technology)
4. economic factors
5. weather and climate factors
6. information diffusion
7. attitudes/preferences towards the environment

(See, for instance: Dillman et al., 1983; Olsen, 1983; Walsh, 1989; Long, 1993; Scott, 1997; Brandon and Lewis, 1999; Dzioubinski and Chipman, 1999; Barr et al., 2005; Carlsson-Kanyama and Linden, 2007: or, in particular, Sardianou, 2007):

Household characteristics include disposable household income, age, gender, education, occupation, marital status, family size, number of children and home ownership. Information on residence is captured via age of the house, house type, number of rooms and size of residence (in m^2) and access to energy carriers (i.e. connection to electricity, distance heating or gas grids). Characteristics of the measure are, for example, size, design, reliability, service quality, energy performance, other operating performance (e.g. water use for dishwasher and washing machines) or suitability in existing technical infrastructure. Economic factors consist of energy (and other input) prices, purchasing/capital costs and – if there are support mechanisms in place –rebates and taxes/subsidies. Weather and climate factors are usually captured via cooling/heat degree days affecting the economic benefits associated with energy-efficient measures. Data on categories (1) to (5) - and possibly (6) - may be directly observed, while information on (7), i.e. attitudes/preferences towards the environment (including cultural factors like religion, or lifestyle) needs to be elicited in surveys either directly via appropriate questions related to the relevance of concerns for the environmental (stated preferences) or indirectly via observed or stated actions and behaviour like recycling activity, membership or support for environmental lobby groups, voting behaviour, etc.

In light of the interdependencies among those factors (and categories), the relevance of individual variables (or concepts) cannot always be clearly identified or distinguished. For example, the level of education is expected to affect the level of disposable income, or households' attitudes towards environmental degradation.[2]

[2] See Shen and Saijo (2007) for a recent econometric analysis of the impact of household socioeconomic characteristics on environmental concerns. Torgler and Garcia-Valinas (2007, section 2) provide a recent overview of factors affecting individual attitudes towards preventing environmental damage. For an international comparison of the effects of gender, age and parental status, see Torgler et al. (2008).

To the best of our knowledge, no studies exist which specifically explore the impact of those factors on the actual diffusion of energy-efficient household appliances based on survey data. Hence the findings for energy-saving measures in households in general may serve as proxies. Among others, Curtis et al. (1984) point out that energy-savings measures may be distinguished into (i) low-cost or no-cost measures that do not involve capital investment but behavioural change (e.g. switching off lights, substituting compact fluorescent lamps for incandescent light bulbs) and (ii) measures that require capital investment and involve technical changes in the house (thermal insulation of built environment, double- or triple-glazing windows). Purchasing a new appliance usually does not require technical changes in the house, but purchasing expenditures may be high.

As for the impact of income, results from most studies imply that higher income is positively related with energy-saving activities/expenditures, e.g. Dillman et al. (1983) and Long (1993) for the US, Walsh (1989) for Canada, Sardianou (2007) for Greece, and Mills and Schleich (2010) for Germany.[3] Thus, richer households are less likely to face income or credit constraints for investments in energy efficiency. Further, environmental concerns may increase with income (Fransson and Garling, 1999). Similarly, income elasticity of willingness to pay for environmental benefits is found to be positive (Kriström and Riera, 1996). Empirical findings for Canada by Young (2008) suggest that richer households also tend to be associated with a higher turnover rate for household appliances, providing greater chances for energy-efficient appliances to replace older, less energy-efficient appliances.

With regard to the impact of education levels on energy-saving activities, the empirical evidence is rather mixed. Among others, the econometric analyses by Hirst and Goeltz (1982) for the US, by Brechling and Smith (1994) for the UK and by Scott (1997) for Ireland confirm that higher levels of education are associated with greater energy-saving activities. Reasons include, for example, that a higher education level reduces the costs of information acquisition (Schultz, 1975). Likewise, education, as a long-term investment, may be correlated with a low household discount rate and, thus, be positively associated with energy savings measures. Such measures often require higher up front cost for investment, while savings in energy costs materialise in the future. In addition, attitudes towards the environment as well as social status, lifestyle (Lutzenhiser 1992, 1993; Weber and Perrels, 2000) or belonging to a particular social milieu group (Reusswig et al. 2004) tend to be positively related with education. Similarly, Torgler and Garcia-Valinas (2007, p. 538) cite several sources suggesting that higher education levels are associated with higher levels for environmental protection. In contrast, the analyses by Stead (2005) (based on a survey in the EU 15 member states on appliances in general and lighting) and by Mills and Schleich (2010) (the diffusion of energy-efficient light bulbs in Germany) do not imply a statistically significant impact of education levels. Likewise, the recent survey on attitudes towards the

3 However, Curtis et al. (1984) find no statistically significant correlation of energy-saving activities with income in Canada (Province of Saskatchewan).

environment in Germany finds no statistically significant impact of education (BMU, 2006).

Most existing studies find that higher energy prices accelerate the diffusion of energy-efficient technologies or are associated with higher expenditure for energy-saving measures (e.g. Walsh, 1989; Long, 1993; Sardianou, 2007; Mills and Schleich, 2010). As suggested by economic theory, higher prices for energy services (such as heating and cooling) render energy-efficient measures more profitable and should thus result in a higher take-up of these measures.

According to Walsh (1989), who finds that older household heads are less likely to carry out energy efficiency improvements, such investments yield a higher expected rate of return for younger investors. For household appliances (and light bulbs) this argument may be less relevant than for thermal insulation of the built environment. Further, as suggested by Carlsson-Kanyama et al. (2005), younger households tend to prefer up-to-date technology, which is usually more energy-efficient. Lower take-up of energy-efficient technologies by elder households may also interact with older people's fewer years of formal education and lack of information on energy savings measures. For example, survey results by Linden et al. (2006) for Sweden indicate that younger people have better knowledge about energy-efficient measures than older people. Clustering individuals into different types, findings by Barr et al. (2005) for the UK and by Ritchie et al. (1981) and Painter et al. (1983) for the US suggest that "energy savers" are older. Addressing environmental concerns directly, the studies by Whitehead (1991) and by Carlsson and Johansson-Stenman (2000) – cited by Torgler and Garcia-Valinas (2007) – found that willingness to pay for environmental protection decreases with age, arguably, because a shorted expected remaining lifetime results in lower expected benefits from environmental preservation compared with younger people. Torgler and Garcia-Valinas (2007) for Spain and Torgler et al. (2008) for 33 Western European countries also observe a negative correlation between age and environmental attitudes/preferences. Similarly, according to Howell and Laska (1992) – also cited by Torgler and Garcia-Valinas (2007) – younger people in the US are more concerned about the environment than older people. For Germany, the reverse appears to be true (BMU, 2006). However, as Torgler and Garcia-Valinas (2007) point out, age effects need to be decomposed into a lifecycle effect that stems from a particular stage of life and into a cohort effect that results from belonging to a particular generation with generation-specific experiences, socialization and economic conditions (e.g. "flower power generation" versus "baby boomers"). Thus, depending on the timing of the survey, age may turn out to have quite different effects on the adoption of energy-efficient measures. Further, the relationship between age and the adoption of energy savings measures may not be linear and is likely to depend on the measures considered. Also, the impact may differ across countries.

Household size is expected to be positively related to the adoption of energy-efficient appliances because more intense use would lead to faster replacement (e.g. Young, 2008). Similarly, the more persons there are in the household, the more profitable it is to acquire information on the energy performance of appliances and to purchase energy-cost saving appliances. The literature, however, appears to provide mixed results. For example, empirical results by Curtis (1984) imply higher energy-saving activity for households with two to four members than for other household sizes, while the impact of household size on energy-saving expenditures in the study by Long (1993) is negative. For similar reasons, the number of young children in the household is expected to increase diffusion of energy-efficient appliances like washing machines or dryers. In addition, since parents may be more concerned about local and global environmental effects for the sake of their children's wellbeing (Dupont, 2004), the number of children may be positively related to the adoption of energy-efficient technologies. However, the study by Torgler et al. (2008) does not find a positive relation of parental effect on preferences.

Renting rather than owning a residence has been found in a number of previous studies (e.g. Curtis et al., 1984; Walsh, 1989; Painter et al., 1983; Scott, 1997; or Barr et al., 2005) to inhibit the adoption of energy-saving technologies, since it is difficult for residence owners to appropriate the savings from investments in energy-saving technologies from tenants (Jaffe and Stavins, 1994; Sutherland, 1996). As Black et al. (1985) emphasise, this user-investor dilemma holds true particularly for energy-saving measures requiring large capital investment like thermal insulation of the outer walls, roofs or attics.

Since households with larger residences have on average more appliances and higher levels of energy consumption, they are likely to have greater interest in, and knowledge of, household energy consumption and consumption saving technologies, particularly if the cost of information gathering is relatively fixed. Larger residences may also have greater economic incentives to invest in energy-saving technologies if appliance use rate is greater. Some studies like Walsh (1989) or Mills and Schleich (2010) find the expected positive relation between housing size and the adoption of energy-efficient measures, while others, such as Sardianou (2007), find no statistically significant correlation.

Unless recently refurbished, older houses should have higher potentials for (profitably) energy savings measures. Thus, the age of a dwelling is expected to be positively related to the diffusion of energy-efficient measures. This argument is particularly true for measures improving energy efficiency in the building environment. Because of shorter lifetimes it should be less relevant for household appliances, which typically last for around ten years or less (OECD, 2002).

Location may also affect the adoption of energy-efficient measures. In particular, urban households may have easier access and thus lower transaction costs than rural households. Likewise, larger cities (or utilities in larger cities) tend to be more active in terms of implementing and promoting environmental policies, including policies to raise awareness. On the other hand, citizens in smaller cities and hence more rural areas may have stronger preferences towards the environment. Thus, in general the sign of the relation is ambiguous. Loomis et al. (1993), Carson et al. (1994) for the US, and Veisten et al. (2004) for Norway report a positive relationship between urbanisation and willingness to pay for environmental amenities based on contingent valuation methods. Relying on survey data (for Spain) Torgler and Garcia-Valinas (2007) conclude that individuals in urban areas exhibit stronger attitudes towards preventing environmental damage. The econometric analyses by Scott (1997) for the observed diffusion of several energy-efficient technologies in Ireland also suggest a positive relation.

In general, information diffusion relates to the level and quality of knowledge about (i) energy-efficiency measures, of (ii) energy consumption (patterns) and costs for existing and new technologies as well as (iii) knowledge about the environmental impact of the particular technology alternatives. From an economic perspective rational household behaviour presumes that households are well informed about the technological alternatives and their associated the costs (including energy costs). For example, information on energy operating costs is typically transmitted via energy bills, where frequency, design and other marketing elements may be relevant. For Norway, Wilhite and Ling (1995) report that more frequent and more informative billing lead to energy savings of around 10 % (cited by Sardianou, 2007). Information on the energy performance of technologies (of appliances in particular) is typically transferred via energy-consumption labels. Information about energy-efficient technologies is often transmitted via campaigns by local, regional, national and international administrations or institutions, by energy agencies, consumer associations, technology providers and their associations, or by utilities. Scott (1997) finds that lack of adequate information on energy-saving potentials to be a barrier for several energy efficiency technologies in Irish households.

From a behavioural and transaction cost perspective, what matters is not only the availability of information but also the *credibility* of the source (Stern, 1984, p. 43). For example, Craig and McCann (1978) find that New York households' response to information on energy savings measures was stronger if the information was provided by a state regulatory agency than by a utility. Along similar lines, Curtis et al. (1984) find that a greater variety of sources is positively correlated with energy-efficient activities. Even if households were perfectly informed and the incentive structures were appropriate, the concept of bounded rationality suggests that cognitive limits on the ability to adequately process information may prevent optimizing behaviour (Simon, 1957, 1959). Consequently, some profitable opportunities for improving energy efficiency are neglected. For example, households may not be able to use the available information on specific energy consumption per time or load, utilization rate, energy cost savings for the useful lifetime of the technology and initial purchasing costs for an appropriate lifecycle cost assessment (Schipper and Hawk, 1991).

While information may improve the level and the quality of knowledge, improved information need not necessarily result in sustained energy savings. While energy savings resulting from technology choices tend to have long-term effects, behaviour-related savings may only be transitory (e.g. Abrahamse et al., 2005). Likewise, for households' purchasing decisions to reflect their preferences towards the environment, they also need to be aware of the environmental consequences of the choice alternatives (e.g. Danielson et al., 1995).

In addition to economics, households' decisions for energy savings measures may be driven by social or psychological factors. For example, Barr et al. (2005, p. 1440) conclude in a more general context that "environmental behaviours must be placed within a broader conceptual context, in which environmental action is not conceived in isolation, but in holistic terms that make explicit the embedded relationships between lifestyles and specific behaviours." According to Sardianou (2007, p. 3783), empirical studies capture these social or psychological effects by exploring the impact of cognitive variables such as values, beliefs or attitudes towards energy conservation (Gardner and Stern, 1996). Social factors, in particular social norms (i. e. expectations about appropriate behaviour) may influence households' energy efficiency activities. Factors identified in the literature to have an impact on energy efficiency activities include the legitimacy of environmental problem, seriousness (environmental pressure; resource scarcity), personal exposure, the belief that one's own action has an impact (public good character) and personal benefits from action (private good character).

Most studies do not allow for a distinction between the relative contribution of factors related to the cost savings and attitudes towards the environment. Although Brandon and Lewis (1999) find that environmental attitudes and beliefs are relevant, financial considerations are at least as important.

In any case, attitudes towards environment may lead to good intentions, but they do not necessarily translate into action. Social norms, lack of information about the implications of alternative actions on the environment, or institutional factors may act as barriers towards actual implementation (Van Raaij and Verhallen, 1983).[4]

2.3 The Energy Labelling Framework

According to the EU Directive on Energy Labelling of Household Appliances ("Labelling Directive") (CEC, 1992) the retail trade is obliged to provide certain household appliances with energy labels at the point of sale. Among other data the label includes standardised information on electricity. Originally, the seven efficiency classes ranged from the green class-A label for the best performance to the red class-G label for the worst performance. In Germany the Directive became national law effective in January 1998 for refrigerators, freezers and their combinations, for washing machines, for tumble driers and their combinations, in March 1999 for dishwashers, in July 1999 for lamps and in January 2003 for electric ovens and air-conditioning appliances. After September 1999 new fridges with classes D to G and freezers with E to G were no longer allowed. The Directive (CEC 1992) also foresees a labelling scheme for water heaters and hot-water storage appliances, but the EU has (as of early 2008) not yet crafted a implementing directive that defines the labelling classes for water heaters and hot-water storage appliances. For the other household appliances such implementing directives were published by the EU in 1994 for refrigerators, freezers and their combinations, in 1995 for washing machines, dryers and their combinations, in 1997 for dishwash-

4 Also note that because of a hypothetical bias, willingness to act or pay may be overstated in contingent valuation studies, which would explain part of the presumed gap between intentions and the behaviour actually observed.

ers, in 1998 for lamps, and in 2002 for electric ovens and air-conditioning appliances. Thus, while Germany was one of the last EU member states where the "Labelling Directive" became national law, appliances with EU labels were present in the German market prior to 1998, not least because appliance manufacturers had to comply with the provisions of the directives in other EU member states. However, even in member states where the EU appliance scheme became national law early on, evaluations for refrigerators and freezers suggest that compliance with the labelling obligation in the retail sector was rather poor, i. e. a large share of refrigerators and freezers were incorrectly labelled (Winward et al., 1998). For Germany, Schlomann et al. (2001) find that the highest share of completely and correctly labelled large household appliances are found in large scale specialist stores or hypermarkets, while for retail stores specializing in kitchen or furniture the level of compliance was generally poor.

EU-wide early evaluations on the effectiveness of the labelling scheme for refrigerators and freezers (Waide, 1998) and also for washing machines and washdriers (Waide, 2001) conclude that the scheme has increased the market share of energy-efficient appliances. However, some portion of efficient appliance uptake occurred, independent of the incentives created by the labelling scheme. Since the counterfactual level of adoption cannot be determined, it is difficult to quantify the actual contribution of the scheme to the diffusion of energy-efficient appliances. However, the current paper provides an important snap-shot of factors associated with knowledge of the labelling scheme and purchase of class-A appliances at the end of 2002, four years after official implementation of the labelling directive for most major appliances in Germany.

2.4 Study Framework

The analysis of determinants of consumer choice of energy-efficient appliances is potentially subject to serious knowledge-based selection bias when only households aware of the energy labelling scheme respond to survey questions on the energy class of the appliance (see Figure 1). Positive responders may have different observed and unobserved attributes, particularly with respect to awareness of energy use and concerns about environmental impacts that potentially bias parameter estimates of the determinants of class-A energy-efficient appliances. However, such knowledge-based sample selection bias can be controlled for by jointly estimating the determinants of class-A appliance choice with the determinants of knowledge of the energy class of the appliance (e.g. van de Ven and van Praag, 1981).

2.4.1 Statistical Model

Formally, the latent relationship between household attributes and choice of a class-A appliance is:

$$y_i^* = x_i B + u_{1i} \tag{1}$$

where y_i^* is a latent measure of household preferences for the class-A appliance, x_i is a row vector of household i characteristics, B is the parameter vector to be estimated, and u_{1i} is a residual term. The observed outcome is:

$$\begin{aligned} y_i &= 1 \quad \text{if} \quad y_i^* > 0 \\ y_i &= 0 \quad \text{if} \quad y_i^* \leq 0 \end{aligned} \tag{2}$$

The purchase decision is only observed if the energy-class of the appliance is known by the respondent. Respondent latent knowledge of appliance energy class is modeled as:

$$s_i^* = z_i \Gamma + u_{2i} \tag{3}$$

where s_i^* is a latent measure of household knowledge of the appliance classification, z_i is a row vector of household i characteristics, Γ is the parameter vector to be estimated and u_{2i} is a residual. Observed response to the survey question on energy-class on the appliance is:

$$\begin{aligned} s_i &= 1 \quad \text{if} \quad s_i^* > 0 \\ s_i &= 0 \quad \text{if} \quad s_i^* \leq 0 \end{aligned} \tag{4}$$

Estimation of class-A energy-efficient appliance choice with the sub-sample of respondents who provide a response on appliance energy class is equivalent to:

$$E(y_i^*) = x_i B + E(u_{1i} \mid x_i, s^* \geq 0). \tag{5}$$

Assume $u_1 \sim N(0,1),\ u_2 \sim N(0,1),\ \text{and}\ \rho = \text{corr}(u_1, u_2)$, then

$$E(u_{1i} \mid x_i, s^* \geq 0) = \rho \lambda_i \tag{6}$$

where $\lambda_i = \theta(z_i \Gamma) / \Theta(z_i \Gamma)$

λ_i is the inverse of the Mills ratio, i.e. the ratio of the normal density function $\theta(.)$ over the cumulative distribution function $\Theta(.)$.

If the error terms of the energy-class choice equation and the energy-class knowledge equation are correlated then $E(u_1) \neq 0$ and the regression results will be biased. Unbiased parameter estimates can be recovered either by including $\hat{\lambda}_i$ as a predicted variable in the probit energy-class choice equation (following Heckman [1976]) or more efficiently by estimating the maximum likelihood of the bivariate normal distribution $F_2(u_1, u_2)$ and the probability of sample exclusion $F(u_2)$ underlying the data generating process as:

$$\prod_{i=1}^{N_1} F_2(x_i B, z_i \Gamma; \rho) \prod_{i=N_1+1}^{N} F_2(-x_i B, z_i \Gamma; \rho) \prod_{i=N+1}^{M} F(-z_i \Gamma) \qquad (7)$$

where 1 to N_1 are observations for which the energy-class of the appliance is known and a class-A appliance is chosen; N_1+1 to N are observations for which the energy-class of the appliance is known and a class-A appliance is not chosen; and N_1+1 to M are observations for which the energy class of the appliance is not known. This maximum likelihood estimator is employed in the current application.

2.4.2 Model Specification

Knowledge of the energy labelling scheme is measured by household responses on the question of the energy-efficiency class of their refrigerators, freezers, refrigerator and freezer combination units, dishwashers and washing machines. Specifically, respondents who indicate that they own a certain type of appliance but do not provide a labelling scheme classification of between A and G on the questionnaire are categorised as unaware of the energy-rating of the appliance.

Residence characteristics

Residence characteristics may influence both the knowledge of labelling scheme and the choice of class-A appliances. In the empirical model, particular attention is paid to the age of the residence. Households living in residences built after 1997 are much more likely to have purchased a refrigerator, freezer, refrigerator-freezer combination unit or a washing machine after the official implementation of the energy-labelling scheme in January 1998. Hence theses households are also more likely to have been exposed to the labelling scheme when purchasing the appliance. Similarly, households in residences built after 1998 are much more likely to have purchased a dishwasher after the official implementation of the energy-labelling scheme in March 1999. Discrete indicators for residences built in 2002, 2001, 2000, 1998-1999, 1996-1997, 1993-1995, 1990-1992 and 1985-1989 are included in the knowledge of energy-class specification. New detached residences are especially likely to be equipped with new kitchen and laundry appliances, which is why a separate indicator for detached residences built after 1997 is also included in energy-class specification. The same set of indicators on the year of residence construction is also included in the class-A appliance choice specification. Households in more recently constructed residences may be more likely to purchase class-A appliances since the share of appliances sold that are class-A has trended upward over time (Europe Economics, 2007).

Renting rather than owning a residence has been found in a number of previous studies to inhibit the adoption of energy-saving technologies, since it is difficult for residence owners to appropriate the savings from investments in energy-saving technologies from tenants (Jaffe and Stavins, 1994; Sutherland, 1996). However, in Germany the vast majority of tenants supply their own appliances and pay for electricity usage. Thus, the influence of tenancy on benefit appropriation may be rather limited for class-A appliances. Further, renters change residence more frequently than owners and may have purchased appliances more recently as a result, which would increase the likelihood of tenants knowing the energy class of appliances relative to residence owners.

Households with larger residences have on average more appliances and higher levels of energy consumption. As a result, larger residences are likely to have greater interest in, and knowledge of, household energy consumption and consumption saving technologies, particularly if the cost of information gathering is relatively fixed. Larger residences may also have greater incentives to invest in energy-saving technologies if appliance use rate is greater. Thus residence size (measured by floor space in square meters) is included as a variable in both the knowledge of energy class and choice of class-A appliance equation specifications.

Household characteristics

Characteristics of the household in both the knowledge of energy class and class-A purchase equation specifications include family size and if children under six years of age are present. The intensity of major appliance use increases with the number of persons in the household, making it more profitable to both acquire information on the energy class of appliances and to purchase class-A appliances. The use of washing machines may be especially high in households with children under six years of age because they have disproportionately high laundry needs. A quadratic specification of age of the main household income earner is also included in both equation specifications. Older household heads may find it more difficult to process information on new technologies. Elderly households may also be less likely to have recently purchased a new appliance, especially when compared with young families that have just established a household. An indicator for retired heads of households is also included in both specifications. Retirees may have more free time for shopping and, therefore, potentially greater awareness of the attributes of appliances after controlling for age. Whether retirees are more or less likely to purchase class-A appliances after controlling for other factors is left as an empirical question.

Higher education reduces the costs of information acquisition (Schultz, 1975), making it more likely that a person understands the class of an appliance when exposed to sticker information. Education may also be positively related to the purchase of a class-A appliance. Cost-savings from the purchase of a class-A appliance occur over several years, but the additional purchase costs occur up front. Education, as a long-term investment, may be correlated with a low household discount rate and, thus, be positively associated with class-A purchase. Unfortunately, the survey provides limited information on the education of the highest income earner and the specifications only include a discrete indicator of secondary school attainment.

An indicator for households headed by senior officials, senior managers or highly skilled professionals is also included in both the knowledge of class and class-A purchase equations. The influence of job type on consumer knowledge of appliance energy classes is unclear a priori. On the one hand, senior managers and skilled professional may better understand information on appliance energy classes. On the other hand, the higher opportunity cost of time for this group of workers may reduce willingness to invest in information. Class-A appliance choice may also be influenced by job type if senior managers and skilled professional are better able to calculate the potential profitability of class-A appliances. Household income often has a major influence on the adoption of residential energy-efficient appliances. Environmental concerns and awareness may increase with income (Fransson and Garling, 1999), which could lead to greater knowledge of appliance energy classes. Similarly, the propensity to purchase class-A appliances may increase with income levels because the income elasticity of willingness to pay for environmental benefits is positive (Kriström and Riera, 1996). An indicator of whether the household resides in East Germany is also included in the specification, since that part of the county underwent rapid social change and residents may be disproportionately likely to have recently changed residence. East German residents have also been found to have generally lower levels of environmental awareness (BMU, 2004).

Owning more than one of the same type of appliance may also be an indicator for a more recent purchase of that appliance type and, thus, positively associated with knowledge of energy class. Similarly, the market in Germany has trended away from the purchase of separate refrigerators and freezers toward combination units. This suggests that refrigerators and freezers in households with a combination unit may be older. For refrigerators and freezers an indicator is included for concurrent ownership of a combination unit, while for combination refrigerator-freezer units an indicator is included for concurrent ownership of a refrigerator or freezer. An indicator of household personal computer ownership is also included in both the knowledge of energy class and class-A choice specifications as a proxy for ease of information access and receptivity to new technology. An indicator of ownership of a class-A appliance of another type is also included in the class-A choice equation specification, but not the knowledge of class specification, since the propensity to purchase class-A appliances may be strongly correlated across appliance types.

Two variables expected to correlate positively with appliance energy class awareness are included in the knowledge of class specification, but not in the class-A choice equation. The first variable is an indicator for household provision of information on annual electricity consumption that proxies for household awareness of energy use. The second variable is the share of other households in the same region with knowledge of the appliance energy class as a proxy for potential regional spillovers in energy class awareness resulting, for example, from regional information campaigns by state energy agencies, retailers or consumer groups. Finally, regional power prices are included in both the knowledge of class and class-A choice specifications, since higher electricity prices may increase energy awareness, the value of investing in information on energy-saving technologies and incentives for the purchase of class-A appliances.[5]

2.5 Data

The dataset comes from a mail survey of private-sector household energy consumption conducted in December of 2002 as part of a multi-topic survey of an existing representative panel of German households (Schlomann et al., 2004). Overall, 20,235 households (75 %) responded to the mailed questionnaire. Survey responses were generally of high quality. The sample sizes for households that own the appliance being analysed and supply information on all covariates are 15,526 households for refrigerators, 12,943 households for freezers, 6,993 households for refrigerator-freezer combination units, 12,814 households for dishwashers, and 19,014 households with washing machines.

Figure 2.1 displays the share of households that were able to provide information on energy class for each appliance type, as well as the share of appliances that were of energy-class A. Knowledge of appliance energy class is low for all appliance types, ranging from 24 % for households with a washing machine to 16 % for households with a dishwasher. It is worth noting that the level of knowledge generally increases with the length of time since the EU implementation directive on the energy-efficiency classification scheme for the appliance, with the implementation directive for washing machines put in place in 1995 and the directive for dishwashers put in place in 1999. Lack of purchase of an appliance after the implementation of the energy classification scheme is obviously an important factor in the observed low-levels of knowledge of the energy-class of household appliances. Specifically, the lifespan of appliances in general ranges from 10 years for dishwashers to 17 years for electric ovens (NAHB, 1998). Thus, approximately one-third to one-half of households can be expected to replace an appliance due to lifespan in the period between the beginning of 1998, when energy-efficiency classification schemes were officially implemented for most appliances in Germany, and the end of 2002, when this survey was conducted.[6]

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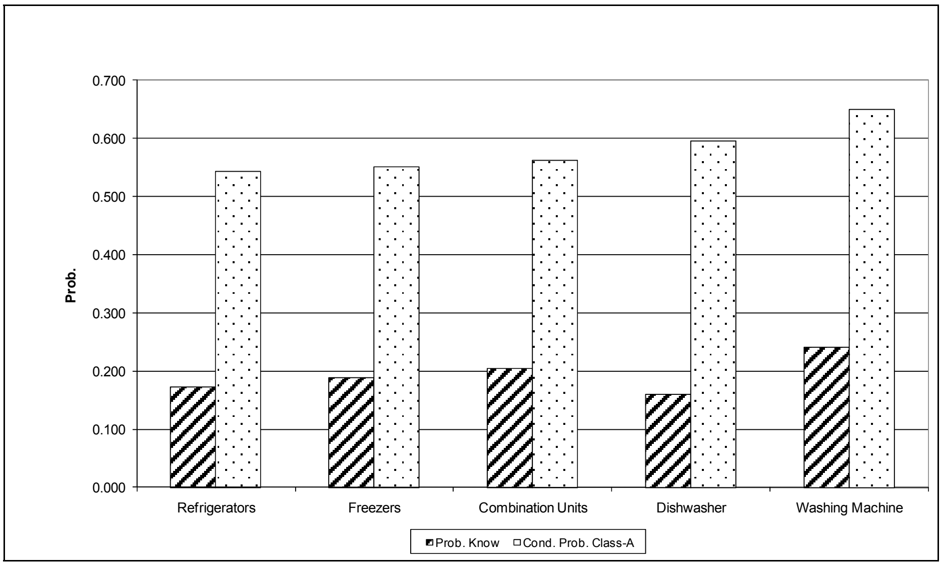
5 Regional power prices are based on the average prices for other survey households in the same Federal State. Calculations produced infeasible prices for some households. Federal State averages are based on households with calculated prices in the Euro 0.10 to Euro 0.20 per kWh range.

6 Formation of new households and purchases for reasons other than replacement of an existing unit will, however, also increase the share of appliances purchased in the 1998 to 2002 period.

Fig. 2.1. Knowledge of energy label and conditional probability of class-A appliance choice



Among those households that know the energy class of the appliance, washing machines show the highest rate of class-A purchases, at 65 %, while refrigerators have the lowest rate of class-A purchases, at 54 %. As discussed, observed and unobserved heterogeneity between those who know and those who do not know the appliance energy class suggests that these rates of class-A purchase may not be representative of expected rates of purchase for the whole sample.

Descriptive statistics (not reported here in detail) indicate that combination refrigerator-freezer units tend to be more prevalent in recently built residences than are separate refrigerator and freezer units, confirming the recent market trend towards combination units. However, residences with combination units also tend to be smaller than those with separate refrigerator and freezer units, suggesting combination unit purchase decisions may be partly motivated by space considerations. Second, dishwashers appear to be luxury items, as they are disproportionately present in more educated and higher-income households relative to other appliances in the study.

2.6 Results

Estimation results for the knowledge of energy class equation and class-A choice equation are presented in Table 2.1 and for the choice of class-A appliances equation in Table 2.2. To improve readability we only report results in terms of statistical significance and signs. We now turn to the discussion of the findings for the individual appliances.

Table 2.1. Estimation results for the knowledge of energy class equation

Know Class of Appliance	Refrigerator	Freezer	Frig-Freezer Combination	Dishwasher	Washing Machine
Rent residence	+		++	++	++
Floor space	+				
Residence built:					
2002	++	++		++	++
2001	++		+	+	++
2000	++	++	++	++	++
1998-1999		++		+	
1996-1997					
1993-1995				--	
1990-1992	--	--	--	--	--
1985-1989					
Post-1997 detached house					
Retiree	++	++	++	++	++
Number of persons	++	+		+	++
Children in household					
Age					
Age2	--	--	-	--	--
Secondary school	+	++	++		++
Management position	-	-			
Income class	++	+			++
East Germany			++	+	
Regional power price	++	++		++	++
Own a PC	++	++	++	++	++
Know power consumption	++	++	++	++	++
Region class knowledge	++	++		+	+
Rho	++				+

Note: -- = negative *p=0.05* , - = negative *p=0.10* , ++ = positive *p=0.05* , + = positive *p=0.10*

Refrigerators

As expected, a household's knowledge of the refrigerator's energy class is associated with several residence characteristics that proxy for recent purchase of an appliance. Specifically, renters and households living in residences built in 2002, 2001, or 2000 are more likely to know the energy class of the household's refrigerator.[7] The likelihood of knowing the energy class of the refrigerator is also higher for larger and rented residences (both at the *p=0.10* level).

[7] Discussed relationships are statistically significant at the p=0.05 level unless specifically noted.

A number of household characteristics also influence knowledge of refrigerator energy class. Specifically, the likelihood of knowing the energy class increases with household size and with household income level. Knowledge of refrigerator energy class is also higher for households headed by a retiree and by a person with a secondary school or higher level of education (*p=0.10* level). Younger households are also more likely to know the energy class of the refrigerator, since results from the quadratic specification of age of the household head imply the likelihood of knowing the appliance energy class declines exponentially after 18 years of age. The result, again, suggests that recent purchase during new household formation plays a key role in awareness of the energy classification scheme. Somewhat surprisingly, households with heads in senior management positions are less likely to know the energy class of the appliance (*p=0.10*).

Household knowledge of refrigerator energy class shows a strong positive response to higher regional energy prices. Ease of access to information and energy-use awareness also appear to be important. Knowledge of energy class is more likely when the household owns a personal computer, when the household knows its annual electric bill, and when the regional share of other households with knowledge of the energy class of their refrigerator is high. Knowledge of the energy class of the refrigerator is lower, however, if the household also owns a combination refrigerator – freezer unit. Again, as the market has trended towards combination units, concurrent ownership of a combination unit may imply the refrigerator is older. Finally, the estimated correlation coefficient between the knowledge of refrigerator energy class and class-A choice equation error terms is positive and significant, implying that parameter estimates generated from separate estimation of the class-A choice equation are likely to be biased.

Overall, there are fewer statistically significant associations in the class-A choice equation for refrigerators than in the knowledge of energy class equation. Renting rather than owning the residence increases the probability of class-A refrigerator purchase (*p=0.10*). The probability of class-A purchase also increases with the size of the residence (*p=0.10*). Parameter estimates for residences built in 2002, 2001 and 2000 are all positive, however only the year 2000 estimate is significant at conventional levels.

Turning to personal characteristics, households headed by retirees (*p=0.10*) and individuals with secondary school education are more likely to purchase class-A refrigerators. Households with middle-aged heads are also more likely to purchase class-A refrigerators, since in the quadratic specification of household head age the propensity for class-A purchase increases up to 48 years of age and then declines. Concurrent ownership of a combination refrigerator-freezer unit decreases the likelihood of class-A refrigerator purchase. However, the likelihood of class-A purchase increases strongly with the purchase of a class-A appliance of another type by the household. The significant influence of purchase of other class-A appliance likely implies that there are factors influencing the general propensity to purchase class-A appliances that are not fully captured in the current specification.

Freezers

The estimation results for knowledge of energy class of freezers are, for the most part, the same as for refrigerators, with recently built residences, retirees, size of household (*p=0.10*), age, schooling, income, regional electricity prices, knowledge of household electric bill and regional rates of knowledge of freezer energy class playing important roles in freezer energy class awareness. Two differences in the freezer and refrigerator results are worth noting. First, tenancy status of residence and residence size do not influence knowledge of energy class for freezers. Second, the correlation coefficient for the knowledge of energy class and class-A appliance choice equations is not statistically different from zero for freezers, implying that unobserved heterogeneity in knowledge of appliance energy class may not be an important source of bias in the estimation of class-A appliance choice for freezers. Only two parameter estimates are significant in the class-A freezer choice equation. These are residence sizes and ownership of other types of class-A appliances, both of which show significant positive associations with the choice of class-A freezers.

Table 2.2. Estimation results for class-A choice equation

Purchase Class-A Appliance	Refrigerator	Freezer	Frig-Freezer Combination	Dishwasher	Washing Machine
Rent residence	+			++	
Floor space	+	++		+	
Residence built:					
2002			+		
2001					
2000	++				
1998-1999					
1996-1997					
1993-1995					
1990-1992					
1985-1989					
Post-1997 detached house					
Retiree	+				
Number of persons					+
Children in household					
Age	++				
Age2	--				
Secondary school	++				
Management position					
Income class					++
East Germany					-
Regional power price				+	++
Own a PC					
Own other class-A	++	++	++	++	++

Note: -- = negative *p=0.05* , - = negative *p=0.10* , ++ = positive *p=0.05* , + = positive *p=0.10*

Refrigerator-freezer combination units

Estimation results for knowledge of the combination refrigerator – freezer unit energy class are also similar to those for refrigerators. Renters, recently built residences, retirees, younger households (*p=0.10*) and households headed by someone with a secondary school or higher level of education are more likely to know the energy class of the combination unit. Owning a PC and knowing the household annual electrical bill also increases the probability of knowing the energy class of the combination unit. Several differences in the results relative to refrigerators are worth noting. In the case of combination units, residence size, regional rates of household knowledge of energy class and regional electricity, prices do not influence knowledge of energy class. Yet the probability of knowing the energy class of combination units is significantly higher in East Germany. The correlation coefficient for the error terms is also not significantly different from zero in the combination unit case. As with freezers, few parameter estimates are significant in the class-A choice equation for combination units. Households in residences built in 2002 are more likely to choose class-A units (*p=0.10*), as are those households that own more than one combination unit and who own another type of class-A appliance. Ownership of a separate refrigerator or freezer or combination unit reduces the likelihood of owning a class-A combination unit.

Dishwashers

Covariates in the knowledge of dishwasher energy class equation largely show the same relationships as in the refrigerator model, with the following groups more likely to know the energy class of the dishwasher: renters, households in recently built residences, larger households (*p=0.10*), younger households, households headed by a retiree, households living in East Germany (*p=0.10*) and households owning a PC. High regional energy prices also increase knowledge of dishwasher energy class, as do household knowledge of its energy bill and high regional rates of knowledge of appliance energy class (*p=0.10*). The correlation coefficient for the model error terms is not statistically significant in this case.

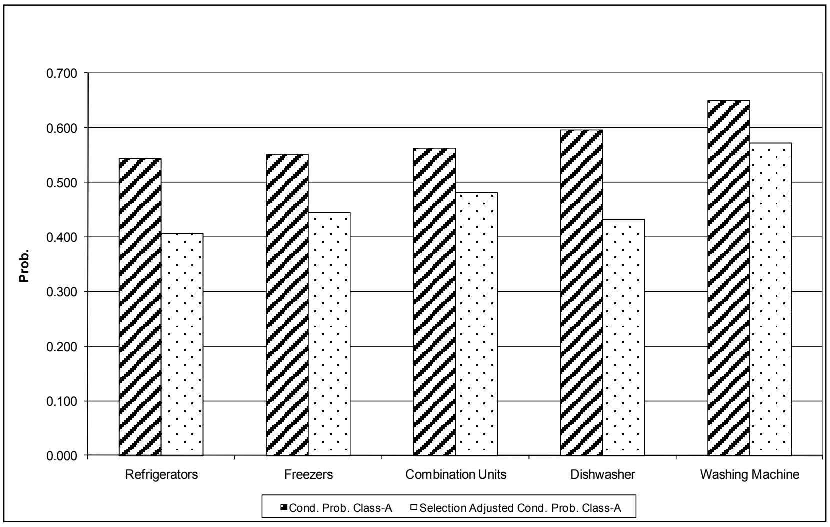
Few parameter estimates in the choice of class-A dishwasher equation are statistically significant. The propensity to purchase class-A dishwashers is higher in rented residences and larger residences (*p=0.10*). High electricity prices also increase the propensity to purchase class-A dishwashers at the *p=0.10* level and, as usual, the propensity to purchase class-A dishwashers increases when the household owns another class-A appliance.

Washing machines

The results for the knowledge of the energy class of washing machines are largely consistent with those for other appliances. Households that rent the residence and households in more recently built residences are more likely to know the energy class of the washing machine, as are larger households, households headed by a retired individual, households headed by an individual with secondary school education, younger households and households with higher levels of income. The likelihood of knowing the energy class of the washing machine also increases with higher regional electric prices, knowledge of annual electric bill by the household and the regional share of households with knowledge of the energy class of their washing machine. The error terms' correlation coefficient estimate is significant at the *p=0.10* level. Again, there are considerably fewer significant covariates in the choice of class-A dishwasher equation. Household income, regional power prices and ownership of other class-A appliances are positively related to choice of a class-A washing machine, while the size of the household and residence in East Germany show a weak (*p=0.10*) positive relationship with class-A washing machine purchase.

Finally, the conditional probabilities of purchasing a class-A appliance with and without correcting for the selection bias are displayed in Figure 2.2. Clearly, without correcting for the knowledge bias, the conditional probability of purchasing a class-A appliance would be overestimated.

Fig. 2.2. Conditional probability of class-A appliance choice with and without selection correction



2.7 Conclusions

The results generate a number of implications for the refinement of energy-efficiency labelling schemes and other policies to promote the adoption of energy-efficient household appliances. Perhaps most obvious, given the relatively long average life of most major household appliance, is that the information provided in energy labels will enter consumer purchase decisions very slowly. This long lag period must be accounted for in the formulation and evaluation of energy-efficiency labelling schemes. The fact that renting is more strongly associated with knowledge of appliance type than with choice of appliance energy class is consistent with the expectation that more rapid turnover in housing and appliances will increase the diffusion of labelling programme knowledge. Programs to disseminate energy class label information can take advantage of this window of opportunity for information acquisition during housing relocation by supplying energy class labelling information in market rental and sales forums or when a household registers with local authorities upon moving to a new residence.

While proxies for recent appliance purchases are arguably noisy, the data provide evidence that for most appliances conditional propensities to purchase class-A appliances increased rapidly between mandatory implementation for most appliances in the beginning of 1998 and the survey at the end of 2002. With the current cross-sectional dataset, the portion of this shift motivated by increased supply of class-A appliance due to energy efficiency technology advances on the part of manufactures cannot be separated from the portion due to increased demand for class-A appliances caused by the EU labelling scheme.

The results also suggest that consumers respond to economic incentives, since knowledge of energy classes increases with regional energy prices for most appliances. Thus policies that internalise the social costs of energy consumption such as energy taxes can spur energy use awareness and, ultimately, adoption of energy-efficient appliances. The finding also suggests that provision of economic information on the likely economic benefits of energy-efficient appliances as currently discussed in the context of the revision of the Labelling Directive can further influence purchase decisions. The current label scheme provides no information to the consumer on the relative efficiency of appliances. Therefore, consumers do not know how much more efficient in terms of energy savings a class-A refrigerator is than a class-B refrigerator. Hence, labels may be redesigned to display differences in energy use associated with the various label categories. For example, rather than using "A++" to signal a better energy performance of a refrigerator compared with a class-A refrigerator, a label of say "A-50 %" could be given to a refrigerator using only half the energy of a class-A refrigerator. As pointed out by Heinzle and Wüstenhagen (2009), however, the type of labelling scheme may affect the willingness to pay for appliances with higher energy efficiency classes. Similarly, label information could also be extended to include data on energy costs. Since people are subject to "framing", the way this information is conveyed may also affect the adoption of energy-efficient appliances. For example, using an experimental design, Faure (2009) finds that the willingness to pay for energy-efficient refrigerators is significantly higher when the energy cost differences of different energy classes are presented as costs rather than savings. Greater awareness of the potential contributions of energy-efficient appliances to household energy conservation will also increase the efficiency of tax and other policies to align marginal energy consumption decisions with marginal social costs. Similarly, consumers may be offered rebates or other financial incentives to purchase energy-efficient appliances that transfer some of the associated social benefits to them.

As mentioned, scope also exists for improving the correct presentation of information under the current directive. Increased awareness of household energy use and access to information through personal computers are also likely to influence consumer purchase decisions and should be incorporated into future energy classification scheme information awareness campaigns. Such efforts include publishing (and updating) online lists of energy-efficient appliances by energy agencies, consumer groups or others. The results also suggest that there are regional spillovers in appliance energy class awareness. More specifically, awareness of an individual household increases when the share of other households aware of the energy class of the same appliance is high in the same Federal State. As noted, this regional spillover may stem from household to household transfer of knowledge within the regions. However, regional advertising campaigns to increase awareness of the labelling scheme could also generate the observed spillovers. Investments in such regional advertising campaigns were, to our knowledge, limited. But disentangling underlying causes of observed regional spillovers in awareness is an area for further research.

Simulations based on model results suggest that household characteristics in the current dataset have surprisingly little impact on the purchase of energy-efficient appliances. Yet, within households, the propensity to purchase class-A appliances is strongly correlated across appliance types. Focusing adoption incentives on one common appliance type may therefore have substantial spillovers with other types of energy-efficient appliances. However, the observed correlation of class-A choice across appliances may also stem from unobserved factors underlying common class-A appliance purchase propensities within the household. Further research is needed to account for heterogeneity in environmental attitudes, psychological factors and social norms in class-A purchase decisions (Kahn, 2007; Gilg and Barr, 2006; Barr et al., 2005; Wilson and Dowlatabadi, 2007). For example, Brandon and Lewis (1999) find that environmental attitudes and beliefs are as relevant as financial considerations for household energy conservation. Incorporating these aspects would delineate the role of perceived environmental benefits in household energy-efficient appliance purchase decisions, and thus complement the attribute-based approach presented in this paper.

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3 Results of the SECO@Home Household Survey and Discrete Choice Analysis (Conjoint Studies)

3 Results of the SECO@Home Household Survey and Discrete Choice Analysis (Conjoint Studies)

3.1 Consumer Survey on the New Format of the European Energy Label for Televisions – Comparison of the "A-G Closed" and the "A-X%" Scale Format[8]

Stefanie Heinzle and Rolf Wüstenhagen

3.1.1 Introduction

The 92/75/EEC "Energy Labelling Directive for Household Appliances", adopted in 1992, requires retailers to display a compulsory label for fridges, freezers, washing machines and several other product categories. The labels show the level of energy consumption at the point of sale (COM 778, 2008). By providing accurate, relevant and comparable information, consumers are given the opportunity to rate the energy efficiency of labelled household appliances more easily (European Parliament, 2009a). The purpose of the introduction of the label was to influence consumers' choices in favour of more energy-efficient appliances (OJL 297, 1992). It also gives producers an incentive to manufacture appliances that consume less energy and helps them get better returns on their investments (COM 778, 2008). In an impact assessment, the European Commission estimated that energy labelling contributed to annual energy savings in the order of some 14 Million tonnes of CO_2 emission reductions per year between 1996 and 2004 (COM 778, 2008).

Since its introduction in the nineties, the label has not kept up with the state of the art. An update of the scale became necessary because many products have already reached the highest energy efficiency class and labelling criteria were not adjusted dynamically. For many product categories, few appliances existed on the market with an energy efficiency class below D. For refrigerators and washing machines, almost all the appliances available for purchase were in an energy efficiency class higher than C (Energieinstitut, 2009; CECED, 2005). That is why in 2003 the entire scaling system was expanded to include new energy efficiency

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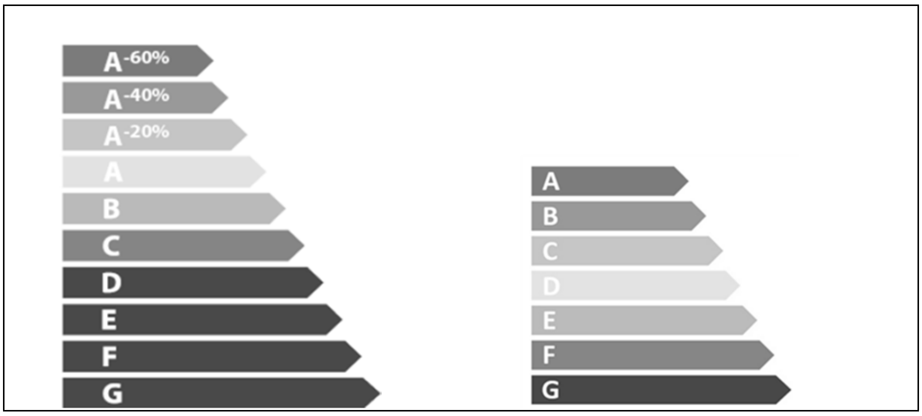
8 Several sentences from this section are drawn from Heinzle and Wüstenhagen (2012) without explicit citation.

categories on top of class A (A+ for washing machines, A+ and A++ for refrigerators and freezers). The introduction of these new classes attempted to make the most efficient products on the market identifiable for consumers again (Anonymous, 2008). However, that scheme was regarded as only a temporary arrangement until a comprehensive revision of the energy labelling classes had taken place (OJL 170/10, 2003). The extension of the scale was criticised as being non-transparent and difficult to understand. Critics said that it became difficult for consumers to select the best class A product because there was no explanation as to how much better the product was compared with the entry level of the same class (Anonymous, 2008). With too many appliances crowded into the top of the scale, the EU Energy Label has become a victim of its own success (ANEC, 2008). Different stakeholders and political authorities have reached a consensus that a revision of the Energy Label was needed (Stø and Strandbakken, 2009). The EU Commission has been working for several years on a revision and the need for introducing a new system was published in the Energy Efficiency Action Plan in 2006 (COM 545, 2006): "To increase the informational value of the EU labelling scheme, the Commission will revise, beginning in 2007, Framework Directive 92/75/EEC to enlarge its scope, if this is shown to reinforce its effectiveness, to include other energy-using equipment, such as commercial refrigeration. The existing labelling classifications will be upgraded and re-scaled every 5 years or when new technological developments justify it, based on eco-design studies, with a view to reserve A-label status for the top 10-20 % best performing equipment."

Fig. 3.1. Illustration of energy efficiency classes of both label options



Although the need for rescaling was explicitly mentioned in the 2006 action plan, in spring 2009 the European Commission presented a proposal to change the current A-G scale used to rate televisions, fridges, freezers and washing machines by introducing additional levels for products considered to be labelled beyond A (A-20 %, A-40 %, A-60 % etc.) (ECEEE, 2009). The rationale behind this proposal was that no reclassification of products would be needed and that this system could easily be adopted by all EU countries. Fig. 3.1 illustrates the energy efficiency classes of the label options “A-G closed” scale format and “A-x%” scale format. The next paragraph will shortly review the pros and cons of both label schemes.

3.1.2 Pros and Cons of the Two Label Schemes

At the time of the survey, the well-known “A-G closed” scale format in combination with regular updates was one of the two options being evaluated by the European Commission. Besides members of the European Parliament, consumer and retail organizations such as BEUC, ANEC, BRC, FCD and the European Council for an Energy-Efficient Economy (eceee) were in favour of maintaining the current A-G layout, provided that a dynamic system were implemented to review the thresholds of the various classes every few years. For example, only a predefined percentage (e.g. 20 %) of the available products on the market would reach the highest A grade (ANEC, 2008). Therefore, a product that would be placed at the top of the scale in 2009 could be reclassified into a lower efficiency class the next year. That means that a label with the new rating would be changed after every rescaling of the energy efficiency scale. At the same time, the label would have to remain simple and clear, with no changes to the A-G scale. This option would require the inclusion of a date on the label indicating how long the energy efficiency class would be valid (Anonymous, 2008). Opponents of this approach criticise that even if this rescaling process took place regularly, during the transition phase there might be overlap of old and new labels for the same product category (Anonymous, 2008). Supporters of this scheme claim that a different system would only cause confusion for customers and would undermine their ability to choose appliances with higher energy efficiency, whereas the well-known A-G scale would be clear, comprehensive, comparable and easy to understand (ANEC, 2008; Topten, 2009). Proponents of this approach were also supported by research that shows that 90 % of consumers in Europe were aware of the label (MORI, 2008a) and that the “A-G closed” scale was much easier to understand than any other alternative tested (MORI, 2008b).

The new label format proposal by the European Commission was based on the A-G scheme with additional predefined classes (e.g. A-20 %, A-40 %, A-60 %) above class A (“A-x %” scale format). The main feature of this system was that the energy efficiency class of a particular appliance would remain unchanged over time. For product categories that already use the two A+ and A++ ratings the energy efficiency class A+ would correspond to A-20 % and A++ would correspond to A-40 % (European Union, 2009). The highest class arrow on the label would be shown in dark green and the lowest class would be shown in dark red, as used in the current A-G label (European Union, 2009). When a higher class on top of the energy class A is introduced, the colours are shifted upwards (COM 778, 2008). One benefit of this new label format over the temporary A+ and A++ system is the ability to compare classes at a glance. Provided customers understood the general concept, they would be able to judge how much better an A-20 % or A-40 % appliance is (e.g. 40 % more efficient than a current A-labelled product). Additionally, there would be no need for retailers to attach an updated sticker on the appliances in the store (ECEEE, 2009). However, opponents of this system mention that it would leave consumers and retailers more confused and the label would prove less effective in meeting its objectives (ANEC, 2008). Additionally, the question of what would happen in the long term still remains since critics regard any further extension of the scale to be counterproductive (Energieinstitut, 2009). As consumer organisations point out, consumers would only see the energy efficiency class in product advertising, in mail order catalogues and at online sites. If, for example, a product were advertised promoting the energy efficiency class A, consumers who are familiar with the A-G scheme might not know how many classes exist beyond A and thus could conclude that an appliance given an "A" rating is the most energy-efficient (Verbraucherzentrale Bundesverband, 2009).

The two environmental organisations, BUND and DUH, supported the concerns of consumer groups regarding the proposed introduction of additional classes. These two organizations claimed that consumers needed to be assured that an A-labelled device is actually the most efficient product on the market, and they believed that the already existing A-G system was the better choice, provided that a dynamic system of reclassification were in place. They demanded that only a predefined percentage of about 20 % of the available products on the market be labelled "A" and that all letters of the scale be assigned (BUND/DUH, 2009). Regarding industry and Commission critiques of concurrent label versions, BUND and DUH recommended that validity period information be more comprehensive and clearly printed on the label. They mentioned that validity periods have been established in other areas too, e.g. TUV labelling for consumers. They did not see the introduction of such validity periods as a barrier for the European Energy Label, provided people receive thorough information about the system (BUND/DUH, 2009).

3.1.3 Objective of this Study

The purpose of this paper is to provide empirical evidence on the effect of both labelling schemes on consumer decisions about televisions. Whereas fridges and freezers, washing machines and dishwashers have been labelled for more than a decade, televisions have not been included in the European Union labelling scheme. Within the last couple of years, the TV market has undergone a continuous and dramatic technological change, moving from traditional cathode tubes to flat-screen TVs. The additional trend towards increasingly large screens has resulted in very high power consumption during viewing times (GfK, 2008). Televisions, therefore, are high-energy appliances, and as such they stand to benefit from the European energy labelling scheme. This is what makes TVs an interesting object of study.

The goal of our research was to measure the difference in effect between the label schemes using realistic choice-based conjoint experiments. Based on our findings, we then wanted to define how best to move forward from a policy and marketing standpoint. Our choice-based conjoint experiment was designed to answer the following question: *Which label is more effective in making energy efficiency a relevant attribute in customer decisions regarding new televisions?*

3.1.4 Methodological Considerations

3.1.4.1 Theoretical Framework

An energy label helps consumers to rate the energy efficiency of a household product with credible and comparable product performance data. The energy label aims to mitigate potential inefficiencies resulting from imperfect information distribution about energy use and is thus related to Akerlof's (1970) work on information asymmetry. Within information economics, a typology exists that distinguishes between search, experience and credence attributes. The distinction between search and experience attributes was defined by Nelson (1970) and was further developed by Darby and Karni (1973) who added the credence category to factor product qualities that remain generally unobservable, even after purchasing. The term *search attribute* refers to those characteristics of a product (e.g. size or colour) about which consumers can get information before they buy, whereas experience attributes refer to those attributes revealed only through use. Credence attributes cannot be fully evaluated even after use. The key difference between the categories is the level of information customers possess or could cheaply acquire versus that possessed by sellers. The energy consumption of an appliance is therefore usually a credence attribute of a product, which, in turn, can lead to negative externalities of asymmetric information. As consumers are usually not able to identify the energy consumption level before their purchase decision, they have to trust the manufacturer. The risk of adverse selection can be overcome by the introduction of a third-party-certified energy label, which converts the credence attribute into a "quasi search attribute". Unlike a search attribute, a quasi-search attribute cannot be evaluated by the consumer but only by a third party (Hüser and Mühlenkamp, 1992).

3.1.4.2 Choice-based Conjoint Experiments to Measure Customer Preferences

As energy labels have yet to be introduced for televisions, no market data was available about revealed preferences when the study was conceived. Because it was not possible to observe people's actual purchase decisions, our study required a market research technique to measure stated preferences. In contrast to the revealed preferences approach, which observes actual choices made by decision-makers in real market circumstances, stated preferences are derived from preferred choices made under hypothetical scenarios in experimental markets (Danielis and Rotaris, 1999). The stated preference approach (by means of a conjoint analysis) is particularly recommended for environmental behaviour and for individual decision behaviour towards new technologies yet to reach extensive market penetration (Hensher et al., 2005).

Conjoint analysis is based on the work of Luce et al. (1964) but has been further developed in the last few decades into a preferences study method, and now draws the attention of theoreticians and field study researchers (Gustaffson et al., 2003). Green and Rao (1971), McFadden (1974) and Green and Srinivasan (1978) introduced the method into marketing literature in the 1970s. Early conjoint analysis work modelled behavioural processes to comprehend how consumers form preferences (Green and Rao, 1971; Norman and Louviere, 1974). Today it is largely used for marketing research and product design surveys; it has gained broader acceptance in the last decade with the advancement of personal computers, which help simplify its application (Hair et al., 1995).

The method's basic idea is that preferences for one specific stimulus consist of contributions from different attributes. The underlying assumption was summarised by Lancaster (1966): "The good, per se, does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility." The overall utility of a product or service results from the sum of the utilities assigned to its separate attributes or part-worth utilities. Choice-based conjoint analysis is a technique designed to analyse and predict consumers' responses by measuring the importance and degree of preference individuals attach to each attribute. Consumers are asked to choose a set of criteria from numerous presented sets. Although the marketplace usually requires trade-offs between different characteristics, market research typically spares consumers from having to choose between conflicting attributes. But studies that force consumers to decide which characteristics are most important can measure preferences in realistic purchase situations, since decision-making criteria are presented simultaneously (Orme, 2006; Lilien et al., 2007; Huber, 2005). Conjoint analysis usually selects only a restricted number of attributes on which to base decisions. The simplification is designed to mirror market conditions, where choice dimensions are remarkably limited (Huber, 2005).

3.1.4.3 Estimation of Individual Parameters

A choice-based conjoint (CBC) experiment considers a quasi-realistic buying situation where consumers choose between one or more products from a restricted product set (evoked set). Respondent preferences can be derived from products choices in the restricted sets (McFadden, 1974). In a next step, hierarchical Bayesian (HB) analysis can estimate utility at the individual level (Allenby and Rossi, 2003). Hierarchical Bayesian analysis is regarded as a state-of-the-art method for estimating utilities from CBC Studies. It delivers significantly improved preference analysis compared with traditional aggregate models (e.g. multinomial logit analysis). While earlier methods combined data for individuals and were criticised for obscuring important aspects, a Bayesian framework can be used to analyse choice data at the individual level. (For a more detailed discussion of hierarchical modelling, see Rossi and Allenby, 2003; and Huber and Train, 2001).

3.1.5 Experimental Design

We used a between-subjects design where two different independent experimental groups were developed. Respondents were split up into two samples whose only difference was label format: Sample 1 was “A-G closed” scale format and sample 2 was “A-x %” scale format. Because the set of attributes and levels for both subgroups was identical, the differences in the preference structure between the two subgroups could be traced back to the different label versions.

3.1.5.1 Selection of Decision-Relevant Product Attributes and Levels

The first stage in the design of the study involved the identification of the most important television attributes and their levels. In order to select decision-relevant product categories we conducted expert interviews (e.g. retailers) and reviewed marketing documents (e.g. catalogues, Websites). The attributes and the attribute levels that were presented in the choice tasks are listed in Table 3.1; a typical choice task is displayed in Fig. 3.2. and Fig. 3.3. The chosen brands and equipment versions represent the spectrum of the German television market. The price range we chose represents a continuum from low to high prices of comparable TV sets usually available in Germany. For the attribute levels of the energy label, we chose to include the four highest classes for both label versions as described above. We decided not to include the attributes size and technology (e.g. Plasma, LCD) in order to guarantee the independence of the attributes from each other and to avoid unrealistic bundles of attribute levels due to random combination.

3.1.5.2 Questionnaire Design

We used a computer-generated, choice-based conjoint design. The choice tasks were randomly calculated with the software programme Sawtooth and were presented in full profile (i.e. for each set of alternatives, all attributes appeared). The randomised design accounted for the design principles of minimal overlap, level balance and orthogonality (Huber and Zwerina, 1996). All respondents received 12 choice tasks involving comparisons of different televisions with various attributes. For each choice task, the respondents had to choose their preferred television from four different alternatives.

Table 3.1. Attributes and attribute levels in the choice tasks

Attributes	Attribute levels	
	Sample 1 "A-G closed" scale format	Sample 2 "A-x%" scale format
Brand	Samsung Sony Philips TCM of Tchibo	Samsung Sony Philips TCM of Tchibo
Equipment version	Simple* Medium** High-Tech***	Simple* Medium** High-Tech***
Energy label	A B C D	A-60% A-40% A-20% A
Purchase price	499€ 649€ 799€ 949€	499€ 649€ 799€ 949€

Equipment version:* Simple: HD-Ready, 1x HDMI, Response time 8, contrast ratio 5000:1** Medium: HD-Ready, 2x HDMI, USB, response time 6, contrast ratio 10000:1 *** High-tech: Full-HD, 4x HDMI, PC connection, USB, response time 4, contrast ratio 50000:1

3.1.5.3 Sample Characteristics

This study is based on 2124 choice observations. Each of the 177 respondents (all of whom were German) were given 12 choice tasks. Sample 1 (label version "A-G closed" scale format) includes 1080 choice tasks and sample 2 (label version "A-x%" scale format) is based on data from 1044 choice tasks.

These respondents were recruited by a professional marketing research company (GfK), which conducted computer-assisted personal interviews (CAPI) in 2009. The target population of the study consisted of the general German population. The sample was drawn by quota sampling, taking into account distribution of the target population by state (German Federal Land), city size, household size and sex. Setting quotas using these indicators is a standard procedure to draw representative samples in professional market research. Table 3.2. shows how the two subsamples compare with the overall population.

Fig. 3.2. Sample choice task for sample 1

The European Union is planning to introduce a new label for televisions. The label will look like this:

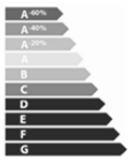
The colour "green" indicates low energy consumption; the colour "red" indicates high energy consumption. If these were your only options, which would you choose? Choose by clicking one of the buttons below:

Brand	Philips	Samsung	Sony	TCM of Tchibo
Equipment version	High-Tech***	Medium**	Medium**	Simple*
Energy efficiency class	A	B	C	D
Price	949€	799€	649€	499€
	○	○	○	○

Equipment version:
* Simple: HD-Ready, 1x HDMI, Response time 8, contrast r tio 5000:1
** Medium: HD-Ready, 2x HDMI, USB r sponse time , contrast ratio 10 00:
** High-tech: Full-HD, 4x H MI, PC connection, USB, res onse i e 4, contrast ratio 50000:1

Fig. 3.3. Sample choice task for sample 2

The European Union is planning to introduce a new label for televisions. The label will look like this:



The colour "green" indicates low energy consumption; the colour "red" indicates high energy consumption. If these were your only options, which would you choose? Choose by clicking one of the buttons below:

Brand	Philips	Samsung	Sony	TCM of Tchibo
Equipment version	High-Tech***	Medium**	Medi-um**	Simple*
Energy efficiency class	A-60%	A-40%	A-20%	A
Price	949€	799€	649€	499€
	○	○	○	○

Equipment version:
* Simple: HD-Ready, 1x HDMI, Response time 8, contrast ratio 5000:1
** Medium: HD-Ready, 2x HDMI, USB, response time 6, contrast ratio 10000:1
*** High-tech: Full-HD, 4x HDMI, PC connection, USB, response time 4, contrast ratio 50000:1

Table 3.2. Description of sample characteristics

Characteristics	"A-G closed" scale format		"A-x%" scale format		German population[a]
	N	%	N	%	%
State (German Bundesland)	90	100%	87	100%	
Baden- Württemberg	8	8.9%	9	10.3%	13.1%
Bavaria	14	15.6%	17	19.5%	15.3%
Berlin	4	4.4%	4	4.6%	4.2%
Bremen	1	1.1%	0	0.0%	0.8%
Brandenburg	1	1.1%	1	1.1%	3.1%
Hamburg	1	1.1%	0	0.0%	2.2%
Hessen	7	7.8%	6	6.9%	7.4%
Mecklenburg-Western Pomerania	1	1.1%	2	2.3%	2.0%
Lower Saxony	14	15.6%	8	9.2%	9.7%
North Rhine – Westphalia	21	23.3%	18	20.7%	21.9%
Rhineland-Palatinate	2	2.2%	5	5.7%	4.9%
Saxony	2	2.2%	6	6.9%	5.1%
Saxony-Anhalt	4	4.4%	2	2.3%	2.9%
Saarland	1	1.1%	3	3.4%	1.3%
Schleswig-Holstein	2	2.2%	1	1.1%	3.5%
Thuringia	7	7.8%	5	5.7%	2.8%
City size					
n= 1- 19,999	39	43.3%	32	36.7%	41.8%
n= 20,000 – 99,999	26	28.9%	25	28.7%	27.4%
n= 100,000 – 499,999	17	18.9%	21	24.1%	15.0%
n > 500,000	8	8.9%	9	10.3%	15.9%
Household size (persons)					
1	27	30.0%	31	35.6%	39.4%
2	39	43.3%	34	39.1%	34.0%
3 or more	24	26.7%	22	25.2%	26.6%
Sex					
Female	45	50.0%	38	43.7%	51.0%
Male	45	50.0%	49	56.3%	49.0%
Civil status					
Married	43	47.8%	35	40.2%	43.8%
Unmarried	47	52.2%	52	59.8%	56.2%
Household monthly income					
Under €1,500	24	26.7%	26	29.8%	35.0%
€1,500-€1,999	15	16.7%	9	10.3%	15.6%
€2,000-€2,599	22	24.4%	8	9.2%	14.4%
Over €2,600	16	17.7%	26	29.9%	27.3%
n/a	13	14.4%	18	20.7%	7.5%

[a] Federal Statistics Office of Germany (2009a, 2009b, 2009c).

3.1.6 Results: Empirical Findings

3.1.6.1 Results of the Hierarchical Bayes Model

In this section the detailed results of the CBC experiment will be presented.Table 3.3 presents the average utilities of each attribute level of the hierarchical Bayes model for televisions where the raw part-worth utilities were rescaled by a method called zero-centered Diffs. The Diffs method rescales utilities so that the total sum of the utility differences between the worst and best levels of each attribute across attributes is equal to the number of attributes times 100 (Sawtooth Software, 1999).

Table 3.3. Results of the discrete choice (hierarchical Bayes) model

Attribute level	**Sample 1 (“A-G closed” scale format)**		**Sample 2 (“A-x%” scale format)**	
	N=90		N=87	
	Average Utilities	(SD)	Average Utilities	(SD)
Brand				
Samsung	6.01	(24.36)	7.12	(21.04)
Sony	3.42	(15.30)	11.99	(17.56)
Philips	8.27	(21.47)	5.85	(27.45)
TCM of Tchibo	-17.70	(29.62)	-24.96	(21.92)
Equipment version				
Simple*	-28.46	(36.39)	-31.09	(30.57)
Medium**	-1.62	(18.39)	-1.73	(17.20)
High-Tech***	30.08	(36.74)	32.83	(38.89)
Energy label				
A/A-60%	61.82	(48.01)	20.69	(54.59)
B/A-40%	23.49	(24.27)	17.79	(18.26)
C/A-20%	-21.65	(27.53)	-14.87	(33.16)
D/A	-63.66	(34.89)	-23.60	(41.15)
Purchase price				
499€	61.18	(54.72)	75.70	(56.48)
649€	25.04	(26.75)	33.53	(22.97)
799€	-25.30	(23.68)	-20.50	(28.15)
949€	-60.92	(41.63)	-88.72	(47.59)

The average utilities show the influence of attribute level change on the likelihood of choosing a product.A positive value (e.g. a low price) increases the utility for a consumer, whereas a negative value (e.g. a high price) decreases the utility. Consistent with theories of utility maximisation, the preferred television in both samples (i.e. the one with the greatest overall utility) was the one that had attribute levels with the highest utility value for each attribute (high-tech equipment version, highest energy efficiency class and lowest price). Only with regard to brand preference did the samples show slight variance.

With regard to data quality, the average root likelihood (RLH) can be used as a measure of fit to assess convergence of HB estimates. RLH is the geometric mean of the predicted probabilities (Sawtooth Software, 2008). In this study, as each choice task presented 4 alternatives, the chance probability of any alternative's being chosen was 25 % (corresponding RLH of 0.25). RHL was 0.648 for the model of sample 1 ("A-G closed" scale), and 0.609 for the model of sample 2 ("A-x %" scale format). The relatively large values indicate good overall fit of the two models. The actual values of 0.648 for sample 1 and 0.609 for sample 2 indicate that these iterations were about 2.6 or 2.4 better than the chance level.

3.1.6.2 Importances of Attributes

In a second step, conjoint importances were computed. Importances describe how much influence each attribute has on a purchase decision. Conjoint importances are displayed in Table 3.4.

Table 3.4. Relative attribute importances derived from the hierarchical Bayes estimation of utilities

	Sample 1 *"A-G closed" scale format*	**Sample 2** *"A-x%" scale format*
Brand	13.4%	13.7%
Equipment version	18.6%	18.6%
Energy label	33.6%	23.5%
Purchase price	34.5%	44.3%

In both samples the most important product attribute of a TV was the purchase price, followed by the energy label, the equipment version and the brand. However, there were differences in conjoint importances of the attribute energy label between sample 1, with 33.5 %, and sample 2, with 23.5 %. This analysis shows that an energy label with a "A-G closed" scale format has over 10 % more influence on consumer decision than an energy label with an "A-x %" scale format.

3.1.6.3 Simulation of Market Response

A market simulator can be used to convert individual utilities from HB estimation into simulated market choices and to compute shares of preferences for competing product alternatives. Market simulation models are used to analyse consumer choices for a defined set of products and their specific product features. Share of preference can be defined as the percentage of respondents that would prefer one of the specified products. For our analysis, we applied a randomised first choice simulation method to estimate share of preference. We assumed a maximum utility rule, which predicts that respondents would choose the option with the highest composite utility. Randomised first choice simulations then estimate the choices of each participant, adding random error to the utility values for every 100,000 iterations and averaging those predictions across iterations and respondents. See Orme (2006) for more detailed discussions of the computation of randomised first choice simulations.

In the following scenario, a realistic market situation was demonstrated by calculating the share of preference for four hypothetical products. Reflecting the real market situation, the price of the appliance varied according to the energy efficiency class (i.e. the most expensive television came with the highest energy efficiency class, whereas the cheapest television was labelled with the lowest energy efficiency class). The attributes brand and equipment were set at a constant level to test the isolated effect of the combination of energy efficiency class and price.

The results in Table 3.5. show that respondents of sample 1 were about 2.7 times more likely to choose the television with the highest energy efficiency class in combination with the highest price than respondents from sample 2 (33.7 % vs. 12.5 %). Respondents in sample 1 were about 1.7 times less likely to choose the television with the lowest energy efficiency class in combination with the lowest price than respondents in sample 2 (30.7 % vs. 53.0 %). By changing the energy efficiency class from the lowest energy efficiency class in combination with the lowest price to a TV with the highest energy efficiency class in combination with the highest price, the preference share in sample 1 increased by almost 3 % whereas the preference share in sample 2 decreased by almost 40 %. We can therefore conclude that an increase from a D- to an A-labelled television produces enough utility for respondents in sample 1 so that the shares of preference are more than equalised as prices increase. In other words, respondents of sample 1 are willing to put up with a high price if the energy efficiency class is high. Our analysis therefore proves that respondents in sample 1 have a higher willingness-to-pay for energy-efficient appliances than respondents in sample 2.

Table 3.5. Share of preference (SoP) of four hypothetical products

Attributes	**Highest energy efficiency class & 949€**		**Second highest energy efficiency class & 799€**		**Second lowest energy efficiency class & 649€**		**Lowest energy efficiency class & 499€**	
Sample	1	2	1	2	1	2	1	2
Brand	Samsung		Samsung		Samsung		Samsung	
Equipment version	Medium		Medium		Medium		Medium	
Energy label	A	A-60%	B	A-40%	C	A-20%	D	A
Price	949€		799€		649€		499€	
Share of Preference (in %)	33.7	12.5	19.1	12.9	16.5	21.6	30.8	53.0
Standard error	4.03	2.97	2.63	2.31	2.75	3.14	4.05	4.22

3.1.7 Discussion and Conclusion

The purpose of this study was to analyse the influence of two different label formats on consumer decisions. As conjoint analysis results provide much richer results than simple direct inquiries into people's preferences, we were able to reduce social desirability bias by asking consumers to face realistic trade-offs between different product attributes. The survey shows that the well-known "A-G closed" scale format has a greater impact on consumer decisions than an "A-x %" scale format. That is, the new label categories encourage consumers to forget energy-efficient products and shop for the cheapest TV instead. The fact that the effectiveness of the European energy label decreases with the introduction of additional "A" categories illustrates that labels and brands that intend to reduce complexity for consumers operate under narrow constraints. Labels can reduce uncertainty and overcome information asymmetry, but in order to do so they need to present consumers with a meaningful reduction of complexity. Going from a closed scheme to an extended scheme by adding new categories reduces the effectiveness of the label. Policy makers can conclude from our study that responding to industry requests for "more flexibility" can result in more complexity for consumers and actually counteract their efforts to increase consumer awareness of appliance energy use.

The survey was conducted to provide evidence on the effect of the two labelling schemes. In spring 2009, the Parliament decided to reject the proposal to introduce the additional classes A-20 % etc. (European Parliament, 2009a) – a decision that our research study supported. Since then, negotiations have continued, with the European Parliament calling on the Commission to submit a new proposal by the end of September 2009 (European Parliament, 2009a). After several months of negotiations, a compromise proposal from the Swedish Presidency of the Council was finally submitted. Members of the European Parliament and representatives from the European Commission and the EU Swedish Presidency agreed on a system that would continue using letters A to G for classifications, but would expand the A categories into a maximum of three tiers (A+, A++ and A+++). However, a successive research study by Heinzle and Wüstenhagen (2012) showed that such a label would also have a weaker impact on consumer decisions than the well-known “A-G closed” scale format. The survey clearly showed that introducing additional categories weakens the effect of the label, resulting in less consumer awareness about energy efficiency.

Given that the new labelling scheme was the result of a political compromise strongly backed by industry associations, questions arise about the effectiveness of participatory decision making in environmental policy and the role of firms’ and industry associations’ non-market strategies. While it remains an interesting area for further research to explore why the European industry associations supported the “beyond A” scale, our findings suggest that their stance may not have been in the best interest of those manufacturers which show technological leadership and which, using a combination of the current labelling scheme and dynamic adjustments, could have maintained a competitive advantage. By reaping the benefit of the higher latent WTP, manufactures showing technological leadership might get a higher return on their investment in R&D with the “A-G scale” scheme.

3.2 Heating and Insulation[9]

Martin Achtnicht

3.2.1 Introduction

In the course of efforts to address climate change and its negative impacts, policymakers have turned their attention to the building sector. This sector is a major emitter of the greenhouse gas carbon dioxide (CO_2) due to the high energy demand for electricity and heating in OECD and non-OECD European countries (IEA, 2009). In Germany, for example, approximately 30 % of the total energy produced is consumed in residential buildings. Together, space heating (74 %) and water heating (11 %) in residential buildings account for approximately one fourth of the end energy consumption (BMVBS, 2007).

Given the European Union Greenhouse Gas Emission Trading System (EU ETS), decentralised heat generation is of particular relevance for future climate policy. Unlike electricity and district heating, emissions arising from decentralised heat generation are not covered by the EU ETS. Therefore, measures to save heat energy in residential buildings are likely to result in effective CO_2 abatement instead of just shifting emissions. For example, buying a more energy-efficient heating system, shifting from a fossil-fueled to a non-fossil-fueled heating system and improving the thermal insulation properties of exterior walls, roof, top ceiling, cellar ceiling or windows reduce the CO_2 emissions of a building, among other benefits.

In Germany, thermal insulation regulations for buildings have existed for more than five decades. The first was the 1952 DIN 4108 standard. Currently, the Energy Savings Ordinance (ESO/EnEV) and the Renewable Energies Heat Act (REHA/EEWärmeG) are in force. ESO basically regulates the annual primary energy requirement and energy efficiency for heating, warm water and ventilation systems, as well as the transmission loss of the building envelope (EnEV, 2007, 2009). It applies to new buildings and reconstruction, retrofits and refurbishments of existing buildings, provided the structure is regularly heated or cooled. For instance, the ESO stipulated that oil- and gas-fired furnaces installed prior to October 1978 had to be removed by the end of 2008. Beginning in January 2009, every owner who wants to sell or let his/her residential building must provide what is called an energy pass to prospective buyers and tenants. This energy pass contains

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9 A modified version of this paper with a higher emphasis on the methodology was published under the title "Do Environmental Benefits Matter? Evidence from a choice experiment among house owners in Germany" in Ecological Economics 10 (11), 2011, 2191-2200.

information about the energy performance of the building and is intended to help interested parties estimate heaing expenditures before the sale or lease contract is concluded. This regulation follows the EU Directive on the energy performance of buildings (EU, 2002). Buildings erected after 2009 have to partly cover their heat requirement by renewable energies as prescribed by REHA (EEWärmeG, 2009). REHA aims to raise the share of renewables in Germany's heating energy consumption to 14 % by 2020. A solar thermal system alone, for instance, would have to cover 15 % of a building's heating energy. Heat pumps and wood-burning heating systems would have to provide at least half of the heating energy. House owners can also comply with the required standards by using several renewable energy sources, local and district heating coming from cogeneration or waste heat recovery, overfulfilling the insulation standard defined by ESO, or a combination of these measures. In addition to these mandatory requirements, there exist several public funding programmes to promote homeowners' investments in energy efficiency and renewable energies.

Although household behaviour is also relevant for residential energy use (e.g., Poortinga et al., 2003; Lindén et al., 2006), this study focuses exclusively on technology. Heating equipment and insulation determine energy use in buildings for years and even decades. Between 1989 and 2006 less than 30 % of Germany's old buildings (i.e. residential buildings which were completed between 1900 and 1979) had been refurbished to improve energy efficiency (BMVBS, 2007). Given an annual refurbishment rate of approximately 1 to 2 %, much energy-saving potential remains. In order to design cost-effective policies that make an impact on residential energy use and related CO_2 emissions, it is important to understand homeowners preferences on heating and insulation technologies and learn more about the kinds of decisions they make.

In this section we present the results of a choice experiment concerning energy retrofits for existing houses in Germany. The sample consists of owner-occupiers of single-family detached houses, semidetached houses and row houses. It should be noted that the housing types under study comprise 60 % of Germany's total living space and almost 50 % of Germany's residential units (IWU, 2007). In the experiment, participating homeowners could choose either a modern heating system or an improved thermal insulation. Unlike previous studies (e.g., Sadler, 2003; Banfi et al., 2008; Kwak et al., 2010), we explicitly included both cost and environmental benefits of energy-saving measures.

The remaining section is structured as follows. Experiment design and data are described in sections 2 and 3, respectively. In section 4 some results of our analysis are presented and discussed. Using mainly contingency tables, we analyse the impact of the experimental attributes on choice. In order to confirm the findings based on the descriptive analysis, we estimate a standard logic model. In the final section we provide an experiment summary.

3.2.2 Choice Experiment

In order to investigate preferences on energy-saving measures and its attributes we conducted a choice experiment among homeowners in Germany. We were particularly interested in the role that environmental benefits play compared with other benefits. We also wanted to understand whether single attribute values differ between the heating system measure and the insulation measure. Though choice sets are hypothetical and choices are only stated, choice experiments seem to be the most appropriate method. The researcher has full information about non-chosen alternatives, can vary attribute levels independently, is able to elicit WTP measures for non-market goods and can therefore overcome possible drawbacks of revealed preference data (Louviere et al., 2000). Choice experiments have been employed in numerous empirical studies, some in an energy-saving context (e.g., Sadler, 2003; Banfi et al., 2008; Kwak et al., 2010).

In our choice experiment, interviewees were given the choice between two hypothentical modernisation measures – one for heating supply, the other for heating usage. Specifically, they could choose a modern heating system or an improved thermal insulation. We did not specify the concrete energy source (i.e. gas, oil, coal, wood, biomass, solar, air, water, geothermal heat) or the part of the house for the insulation measure (facade/exterior wall, roof, top ceiling, cellar ceiling, windows). Rather, we asked interviewees to imagine the respective technology they would like to have for their home.

The alternatives to choose from were described by the following seven attributes: acquisition costs, annual energy-saving potential, payback period, CO_2 savings, opinion of an independent energy adviser, public and/or private funding, and period of guarantee. Table 15 describes the attributes and the related levels in greater detail. It should be noted that the acquisition costs, the energy-saving potential and the payback period (i.e. the number of years it takes for the energy-saving measure to pay itself off) could not be added up in our experiment. While the energy-saving potential was calculated with current energy prices only, the payback period also factored in an estimated energy price development. Interviewees were informed about the procedure by the interviewer at the beginning of the experiment.

It should further be noted that the attribute levels of energy-saving potential had been customised to avoid unrealistic values. Interviewees were asked beforehand to state their annual heating costs. Then, the customised levels of the energy-saving attribute were set to 25, 50 and 75 % of the stated heating costs. If interviewees did not know or did not state their fuel bill, annual costs of 14 euros per square metre were assumed. This corresponds with an annual heating energy consumption of 200 kilowatt hours per square metre, at a price of 0.07 euros per kilowatt hour. Both values are reasonable assumptions for Germany, given the average heating energy consumption of single-family detached, semidetached and row houses (BMVBS, 2007) and the average prices for natural gas and domestic heating oil in 2008 (BMWi, 2010).

Recent surveys in Germany indicate that long payback periods are the main barrier to modernisation (BMVBS, 2007; Stieß et al., 2010). According to

BMVBS (2007), only 3 % of owners and tenants are willing to accept payback periods of 12 years or more. Stieß et al. (2010) identify a period of 15 years as the upper limit for most homeowners. As pointed out by Jakob (2007), the payback period of energy-saving measures is highly uncertain and depends on various factors. In particular, the assumed interest rate and time horizon determine the capital costs related to such measures, while energy prices and their development determine the marginal costs of heat generation. We explicitly included the payback period in our choice experiment to take these issues into account, but removed the related uncertainty.

By including both energy-saving potential and CO_2 savings, we made interviewees evaluate trade-offs among cost savings and environmental benefits. Though somewhat hypothetical, the results enable us to quantify the effect, if any, of environmental benefits on choices of energy-saving measures. Previous studies on energy-saving measures (e.g., Sadler, 2003; Banfi et al., 2008), however, had a slightly different focus and are lacking this feature.

Table 3.6. Attributes and related levels

Attributes	Heating	Insulation
Acquisition costs (including, if any, public and/or private funding)	€10,000 €20,000 €30,000	€10,000 €20,000 €30,000 €40,000
Annual energy-saving potential at current energy prices (including fuel and electricity costs related to heating)	25 % 50 % 75 % of current value, in €	25 % 50 % 75 % of current value, in €
Payback period (number of years after which the modernisation measure will pay off)	10 years 20 years 30 years	10 years 20 years 30 years
CO_2 savings	0 % 25 % 50 % 75 % 100 %	25 % 50 % 75 %
Opinion of an independent energy adviser	Recommendable *blank*	Recommendable *blank*
Public and/or private funding	Yes No	Yes No
Period of guarantee	2 years 5 years 10 years	2 years 5 years 10 years

In order to capture the impact of professional recommendations on choices, we included the opinion of an independent energy adviser as attribute. In Germany, various professionals have the right to provide on-site energy advice, in general, and energy passes, in particular, for existing buildings (EnEV, 2009). Architects, engineers, physicists, skilled craftsmen and others with experience in energy-saving construction can serve as energy advisers, though there is no official job description as such. Independent energy consultation is also available from the consumer advice centre and publicly sponsored by the Federal Ministry of Economics and Technology.

In Germany, there exist several public funding programmes to encourage investments in energy-saving measures. For example, the KfW (Germany's government-owned development bank) provides grants and loans at reduced rates of interest for refurbishment measures to reduce home energy consumption. Private companies might also offer discounts on their products and services. In the experiment we used funding as a qualitative attribute and subsumed any grants or subsidies under acquisition costs. We therefore avoided obtaining two different price elasticities, but were still able to study the effect of funding on choices per se.

Guarantee in this context means that for a given period of time the builder or contractor is obligated to remedy deficiencies free of charge. The German Construction Contract Procedures (GCCP/VOB) stipulates that contractors are liable for defects of heating and insulation systems for at least two years. If within that period of limitation any defect must be remedied, then another two-year period starts for this product or service. Some builders and contractors provide longer periods of guarantee, mostly coupled with maintenance contracts. In case of insolvency or bankruptcy, all contractor's rights and obligations, including guarantees, are undertaken by insolvency insurance if the contractor is a member of the Chamber of Crafts (mandatory in Germany).

Given two alternatives, each described by seven attributes, each with two to five levels, the total number of possible combinations was far too big for interviewees to choose from. We therefore employed an orthogonal fractional factorial design using Sawtooth software. In the end, each interviewee was presented with 12 choice sets and asked to state and choose which of the displayed alternatives seems more attractive. Hensher et al. (2001) and Carlsson and Martinsson (2008) provide empirical evidence that 12 choice sets is a reasonable number and does not significantly affect the results. Likewise, previous studies have used larger matrices than our 7x2 choice set without overtaxing interviewees (e.g., Brownstone et al., 1996; Goett et al., 2000).

3.2.3 Survey and Sample

The data used in this study is a subsample of a larger survey of German households carried out in June 2009. In order to guarantee the quality and the representativeness of the sample, we charged the market research company GfK Group with carrying out the survey. It was conducted in two stages. After recruiting individuals who matched the requested subsamples with telephone interviews, individuals were visited at their homes for face-to-face interviews using the computer (CAPI method).

Table 3.7. Summary of sample's demographics

Survey question - demographics	Per cent (N=408)
Gender	
Male	60.8
Female	39.2
Age	
24-35	5.4
36-45	21.8
46-55	28.7
56-65	22.3
66+	21.1
Not stated	0.7
Education	
Without school degree	0.3
Secondary modern school degree	34.1
High school degree	39.2
Academic high school degree	11.8
University or college degree	14.5
Not stated	0.3
Household's monthly net income	
Less than €1,000	4.7
€1,000-1,499	10.3
€1,500-1,999	15.0
€2,000-2,499	19.4
€2,500-3,499	18.9
€3,500+	15.0
Not stated	16.9
Children (18 or younger) in household	30.2
Region	
Western Germany	82.6
Eastern Germany	17.4
Number of inhabitants	
1-4,999	30.4
5,000-19,999	26.7
20,000-99,999	27.5
100,000-499,999	8.8
500,000+	6.6

The interviews took about 50 to 60 minutes on average. The questionnaire consisted of five parts and contained questions about attitudes towards the environment (part 1), the household's energy use (part 2), housing conditions (part 3), and socio-economic and demographic information (part 5). The choice experiment made up part 4 and is the main difference between the three gathered subsamples, each of which included more than 400 interviews.

As we were interested in individuals who make decisions on their heating supply and heating usage independently, only owner-occupiers of single-family detached houses, semidetached houses and row houses (in the following we will refer to them for short as homeowners) who do not use district heating took part in our choice experiment. Since in some German municipalities the use of district heating is mandatory, we excluded homeowners from the beginning who might be affected by this regulation. Moreover, individuals were explicitly asked during the telephone screening whether they are involved in household's energy-related decisions, such as choice of electricity supplier or heating technology. Only those who affirmed their involvement were recruited and interviewed. During the interview individuals were asked to state who makes energy-related decisions in their households. Approximately 51 % stated "myself", 36 % "me and my partner together", and 13 % "my partner". Though studying choices that are relevant to the household as a whole, the choice experiment relied on individual responses. Table 3.8 and 3.9 provide details about demographic profile and housing type (with N=408), respectively.

Table 3.8. Summary of sample's houses

Survey question - houses	Per cent (N=408)
House type	
Single-family detached house	74.0
Semidetached house	14.2
Row house	11.8
Year of completion	
Before 1948	22.6
1949-1978	32.8
1979-1986	13.7
1987-1990	7.1
1991-2000	14.2
2001-2009	9.6

3.2.4 Descriptive and Econometric Results

What choices did our interviews make and what impact did the different attributes have on homeowners' choices? In order to answer these questions we first use contingency tables showing frequency distributions of chosen attribute levels.

From those results we then derive and compare the relative importance of each attribute. Finally, we estimate a simple standard logit model to verify the descriptive findings econometrically.

Table 3.9 gives the absolute number of times alternatives, the specific attribute levels chosen by interviewees and the proportion relating to the total number of alternatives containing that level. Though the technology itself (i.e. heating and insulation) is a label and defines the alternatives, we treated it as a regular attribute. As both heating and insulation were included exactly once in each choice set, the proportions presented in Table 4 coincide with the total choice per centage. Heating alternatives were chosen more frequently in our experiment (relatively and absolutely). However, since the feasible attribute levels for acquisition costs and CO_2 savings vary between heating and insulation systems, this observation does not necessarily imply a general preference for heating systems. We will adress this issue for the econometric analysis below.

As expected, we found that the more expensive the hypothetical alternative is, the less likely it is to be chosen. Alternatives costing €10,000 were chosen in approximately 68 % of the times that level occurred, compared with less than 32 % for alternatives costing €40,000. This clearly indicates that the impact of acquisition costs on choices between energy-saving measures is negative. Likewise, the choice probability decreases with an increasing payback duration. While alternatives with a payback period of 10 years were selected in approximately 57 % of the times that level occurred, the related per centage drops to approximately 44 % for a payback period of 30 years. All remaining attributes (i.e. energy savings, CO_2 savings, energy adviser, funding, period of guarantee) seem to affect choices positively. Yet the impact of energy advisors and the funding and period of guarantee on choices is less likely because the observed differences between the related attribute levels are relatively small.

It should be noted that the attribute CO_2 savings is a special case: The picture that arises from the figures in Table 18 is ambiguous. While, as expected, the best level achieves the highest per centage (65 %), the worst one achieves the second highest (50 %). Basically, this is due to the fact that the levels 100 % and 0 % were only allowed for heating alternatives. Table 19 again presents figures on CO_2 savings for chosen and non-chosen alternatives, but this time separated into energy-saving measures. Now the positive impact of environmental benefits in terms of heating choices is evident, since the relative choice probabilities increase almost continuously with increasing saving levels. Yet figures for insulation systems suggest that CO_2 savings play no role there.

Table 3.9. Chosen alternatives and attribute levels

Attributes/Alternatives	Chosen		Not chosen		Total	
	Absolute	per cent	Absolute	per cent	Absolute	per cent
Technology						
Heating	2,861	58.4	2,035	41.6	4,896	100
Insulation	2,035	41.6	2,861	58.4	4,896	100
Acquisition costs						
€10,000	1,721	68.4	795	31.6	2,516	100
€20,000	1,356	54.5	1,132	45.5	2,488	100
€30,000	1,095	43.9	1,397	56.1	2,492	100
€40,000	724	31.5	1,572	68.5	2,296	100
Energy-saving potential						
25 %	1,401	42.9	1,863	57.1	3,264	100
50 %	1,683	51.6	1,581	48.4	3,264	100
75 %	1,812	55.5	1,452	44.5	3,264	100
of current value, in €						
Payback period						
10 years	1,867	57.2	1,397	42.8	3,264	100
20 years	1,595	48.9	1,669	51.1	3,264	100
30 years	1,434	43.9	1,830	56.1	3,264	100
CO_2 savings						
0 %	933	50.4	919	49.6	1,852	100
25 %	902	44.4	1,128	55.6	2,030	100
50 %	909	44.4	1,136	55.6	2,045	100
75 %	942	46.7	1,074	53.3	2,016	100
100 %	1,210	65.4	639	34.6	1,849	100
Energy adviser						
Recommendable	2,640	53.9	2,256	46.1	4,896	100
blank	2,256	46.1	2,640	53.9	4,896	100
Funding						
Yes	2,602	53.1	2,294	46.9	4,896	100
No	2,294	46.9	2,602	53.1	4,896	100
Period of guarantee						

2 years	1,505	46.1	1,759	53.9	3,264	100
5 years	1,673	51.3	1,591	48.7	3,264	100
10 years	1,718	52.6	1,546	47.4	3,264	100

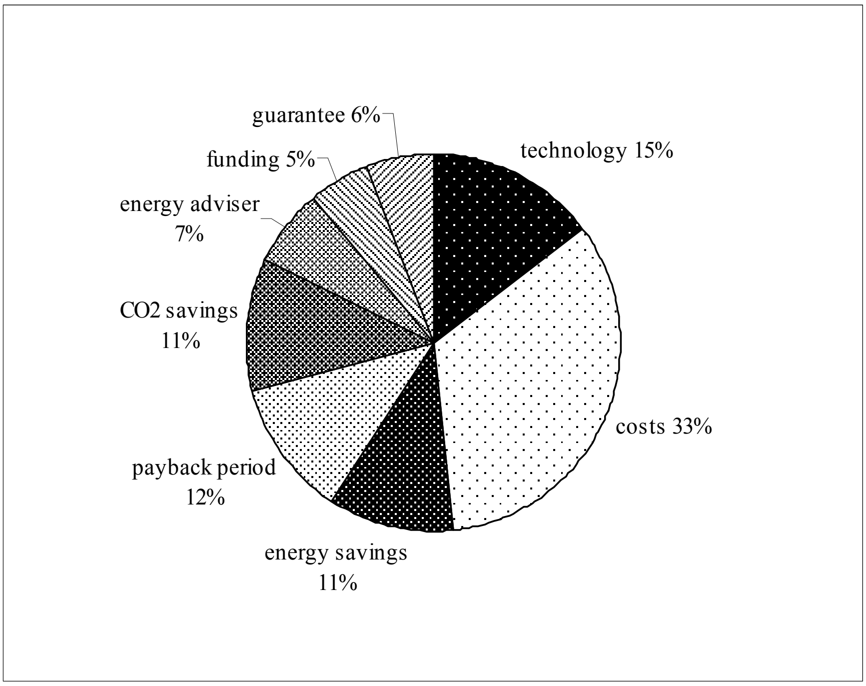
Table 3.10. Chosen CO_2 saving levels (separated into energy-saving measures)

Attributes/Alternatives	Chosen		Not chosen		Total	
	Absolute	per cent	Absolute	per cent	Absolute	per cent
CO_2 savings of heating						
0 %	933	50.4	919	49.6	1,852	100
25 %	241	56.7	184	43.3	425	100
50 %	249	62.1	152	37.9	401	100
75 %	228	61.8	141	38.2	369	100
100 %	1,210	65.4	639	34.6	1,849	100
CO_2 savings of insulation						
25 %	661	41.2	944	58.8	1,605	100
50 %	660	40.1	984	59.9	1,644	100
75 %	714	43.3	933	56.7	1,647	100

In order to further understand the impact of each attribute on choice, we derive the relative importance of each attribute. For each attribute we (1) scale the proportions for chosen attribute levels given in Table 18 to one, (2) compute the ratios between the scaled proportions of the maximum and the minimum level and (3) scale the logarithms of those ratios again to one. In doing so, we basically follow the approach described in Sawtooth (2008). It should be noted, however, that considering attributes which lack a predefined or accepted order of preference for the related levels (like technology in our case) may bias the derived attribute importance. Nonetheless, this approach allows further insights into observed choices and their underlying preferences. Figure 12 presents the results of this analysis. The evidence indicates that all attributes affecting the expense of energy-saving measures (i.e. acquisition costs, energy-saving potential, payback period and public and/or private funding) do the most to determine choice (making up over 60 % of the decision) in those cases when acquisition costs predominate (making up 33 % of expenses). However, other attributes still achieve a considerable per centage. Particularly environmental benefits, measured by CO_2 savings (11 %), seem to be important for choosing energy-saving measures, though we did not explicitly consider possible differences between heating and insulation systems here.

In order to overcome possible drawbacks of sole descriptive analysis, we also analyse the choice data econometrically, using a standard logit model. We let the seven attributes that specified the alternatives in the choice experiment enter the model. By including two CO_2-savings variables – one for each alternative[10] – we monitor for alternative-specific effects (i.e. whether the impact of CO_2 savings varies across alternatives). In addition, a constant for the heating system alternative is included to capture the average effect of all unobserved factors with the insulation alternative serving as reference. The model is fitted via maximum likelihood estimation using Stata's asclogit command. The estimation results are presented in Table 3.11.

Fig. 3.4. Relative importance of attributes



The econometric results basically confirm the findings from the descriptive analysis. As expected, energy-saving potential, recommendation of an independent energy adviser, funding, and period of guarantee enter the model positively signed, while the estimated coefficients of acquisition costs and payback period are negatively signed. All the coefficients differ significantly from zero at the 1 % significance level. There is further evidence for the varying impact of CO_2 savings: Though positively signed for both alternatives, CO_2 savings only enter sig-

10 The CO_2 savings variable thus interacts with the alternative-specific constants.

nificantly for heating systems. A Wald test rejects the hypothesis of equal coefficients (chi2=5.07). The alternative-specific constant itself enters the standard logit model significantly, and negatively signed. That is, factors that are not included in the model tend on average to increase the choice probability for the insulation alternative. Additional benefits of insulation, like maintaining a cool home during summer and increasing noise protection, may lead to this result. Curiously, this finding is somewhat at odds with the fact that heating systems were chosen more frequently than insulation systems. In any case, however, it emphasises the limitation of sole descriptive analysis. Interested readers are referred to Achtnicht (2010), where an in-depth econometric analysis was undertaken. By including demographic and other case-specific variables and using a more flexible mixed logit specification, the author allows for taste variation in observed and unobserved factors. For example, he finds that the current state of the building envelope and heating system in operation have an effect on homeowners' choices. Based on the estimated mixed logit model, Achtnicht (2010) further derives willingness-to-pay measures for saved CO_2 emissions.

Table 3.11. Estimated standard logit model

Variable	Coefficient	Std. Error	95 % Confidence Interval	
Acquisition costs	-0.0431**	0.00216	-0.0473	-0.0389
Energy-saving potential	0.000490**	0.0000577	0.000377	0.000603
Payback period	-0.0184**	0.00222	-0.0228	-0.0141
CO_2 savings × heating	0.00644**	0.000707	0.00506	0.00783
CO_2 savings × insulation	0.00261	0.00154	-0.000404	0.00562
Energy adviser	0.181**	0.0314	0.120	0.243
Funding	0.153**	0.0314	0.0917	0.215
Guarantee period	0.0221**	0.00550	0.0113	0.0329
Heating system	-0.205*	0.0921	-0.385	-0.0242
Observed choices	4896			
Persons	408			
Log likelihood	-2953.19			
Pseudo R2	0.1298			

** p<0.01, * p<0.05

3.2.5 Summary

Residential buildings strongly contribute to global CO_2 emissions due to the high energy demand for electricity and heating, particularly in industrialised countries. Within the EU, decentralised heat generation is of particular relevance for future climate policy because its emissions are not covered by the EU ETS. We conducted a choice experiment concerning energy retrofits for existing houses in Germany. In the experiment, approximately 400 sampled homeowners could choose either a modern heating system or an improved thermal insulation for their home.

For the most part, we used contingency tables for analysing the choice data. Heating systems were chosen more frequently than insulation systems by interviewed homeowners. It should be noted, however, that the used attribute levels for presented heating and insulation systems differ somewhat. We found that attributes affecting the expense of energy-saving measures do the most to determine choice in those cases when acquisition costs predominate. By estimating a standard logit model, we verified our descriptive findings. In particular, we provided empirical evidence that environmental benefits have a significant impact on choices of heating systems but played no role in insulation choices. In addition, we found that, on average, unobserved factors tend to increase the choice probability for the insulation alternative.

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4 Firm Strategies and Political Instruments

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4.1 Green Marketing Strategies to Influence Sustainable Energy Investments – What Can Be Learned from Segmentation and Behavioural Decision Models?

Stefanie Heinzle

4.1.1 Introduction

Our world has changed faster than anybody expected: global warming, an awareness of widespread environmental deterioration, fundamental political transformations (Kärnä et al., 2002). Social issues and corporate responsibility in general and environmental matters in particular have gone from the sidelines to the forefront of consumers' minds, academic research and management thinking (Chan and Lau, 2004).

As companies have realised that strategies focused on low-cost leadership or differentiation no longer provide sufficient competitive advantage, many firms have undertaken steps towards more sustainable business practices in an effort to reduce negative externalities. More and more firms have realized that corporate social responsibility is increasingly important if businesses want to compete in a global marketplace (Glorieux-Boutonnat, 2004). Developing a positive corporate image can help organisations remain competitive, increase marketing share, improve employee motivation and increase customer loyalty (Porter and Van der Linde, 1995; Forte and Lamont, 1998).

Although many consumers are interested in the environment, only a small share put their interest into purchasing practice. In other words, even when consumers have a positive attitude towards environmental issues, they are often passive in their purchase decisions. Understanding how consumers make decisions, therefore, is important for marketers concerned with the impact of human investment behaviour in the field of green marketing. Yet green marketing needs innovative approaches to better target and reach its potential customers. This article provides a review of literature in the field of green marketing, green consumer segmentation and behavioural decision models in the environmental sector in order to derive important lessons for effective green marketing strategies.

In section 2 we present an overview of the new green marketing philosophy. Section 3 discusses reasons for and barriers to environmental friendliness in consumer marketing. In the following section different segmentation models are presented. Section 5 discusses a set of behavioural models of decision making and implications for green marketing. Section 6 provides a summary of the results.

4.1.2 The New Green Marketing Philosophy

To enhance a firm's financial and environmental performance, businesses must adopt a new vision of marketing practice (Miles and Covin, 2000; Caves and Porter, 1977). Compared with the traditional marketing philosophy, which is dominated by material possession, individuality, newness, waste accumulation and visions of unlimited growth (Shrivastava, 1995; Van Dam and Apeldoorn, 1996), this new vision of marketing focuses on minimizing external impacts while satisfying the needs of the company and its customers (Fraj-Andres et al., 2009). This new strategic direction can provide competitive advantage resulting in a win-win-win situation for society, businesses and the environment (Hart, 1995; Porter and van der Linde, 1995).

There exists no universally accepted term for marketing activities that take into account ecology: environmental marketing (Coddington, 1993; Miles and Covin, 2000), ecological marketing (Fisk, 1974; Hennion and Kinnear, 1976; Dyllick, 1989, Prakash 2002), green marketing (Peattie, 1995), sustainable marketing (Fuller, 1999; van Dam and Apeldoorn, 1996), sustainability marketing (Belz, 2005; Kirchgeorg and Winn, 2006), greener marketing (Charter, 1992; Charter and Polonsky, 1999) eco-marketing (Belz, 1999) and enviropreneurial marketing (Menon and Menon, 1997). Generally, these terms are regarded as all standing for the same activity: incorporating environmental considerations into corporate marketing (Chamorro et al., 2007). This article makes use of the term green marketing, since it is most frequently used in academic literature to refer to strategies incorporating ecologically responsible behaviour. According to Peattie (1995), green marketing compromises "the holistic management process responsible for identifying, anticipating and satisfying the requirements of customers and society, in a profitable and sustainable way".

Green marketing can be viewed as a whole new marketing philosophy that attempts both to satisfy customers and take into account a society's ecological interests (Jain and Kaur, 2003). According to the principle of green marketing, a firm must serve customers' long-term welfare, in addition to their short-term needs. The goal of green marketing is to maximise consumers' quality of life, advocating not only the quantity and quality of consumer goods and services but also the quality of the environment (Kotler and Armstrong, 2001). Green marketing is thus an ideal opportunity to raise customers' environmental awareness. According to Stuart Hall (1997, p. 69), "companies can and must change the way customers think by creating preferences for products and services consistent with sustainability. Companies must become educators rather than mere marketers of products".

4.1.3 Reasons for and Barriers to Environmental Friendliness in Consumer Marketing

Traditionally, companies have seen expenditures in environmental performance beyond minimum compliance as at odds with wealth maximisation (Miles and Covin, 2000). Since the advent of green marketing, however, an increasing number of articles have been published, identifying motives for corporate "greening" (Hamilton, 1995).

Companies may choose to adopt green marketing strategies for a variety of reasons. Economic reasons for choosing a green marketing approach are the cost savings from increased resource efficiency, the avoidance of rising waste disposal costs and the rising costs of environmental compliance. Frequently the savings associated with greening activities result in a competitive advantage in the marketplace (Porter and van der Linde, 1995). Non-economic reasons encompass mainly norms and pressures from different stakeholders. By choosing a green marketing approach firms might pre-empt control regulations and influence future regulations, giving them the possibility to reap first-mover advantages. Companies can gain strong public recognition on account of their environmental efforts and higher customer value (Arora and Cason, 1996). Also, as consumers become greener, demand for products with high environmental performances increases. Due to this demand, companies see new market opportunities that can be exploited (Polonsky, 1994). By generating a more positive public image, companies can establish an emotional connection between consumers and a brand (Ginsberg and Bloom, 2004). Fraj-Andrés et al. (2009) showed that environmental marketing positively affects firms' operational and commercial performance and this improvement has in turn an influence on their economic results. The authors showed that environmental marketing is an excellent strategy to obtain competitive advantages in costs and in product differentiation. Another reason for integrating environmental friendliness into the marketing approach is that competitors' environmental activities pressure firms to become more responsible (Polonsky, 1994). Additionally, many organisations now believe that they are members of the wider community and therefore have a moral obligation to be more socially responsible (Polonsky, 1994; Keller, 1987). Top managers (Lawrence and Morell, 1995) and company values (Buchholz, 1993) are also important factors in this development. Two management theories provide further reasons why some companies invest in enhancing environmental performance. (For a more detailed discussion, see Miles and Covin, 2000). The "slack resources" theory (Waddock and Graves, 1997) suggest that companies that have a better financial return might have more resources to invest in superior environmental performance, even when these investments do not meet the general capital budgeting criteria. The reason behind these projects is mainly to increase competitive advantage through enhanced reputation and image (Miles and Russell, 1997). The second theory to explain that trend is called "good management theory". It suggests that companies with an innovative management approach seek to enhance competitive advantage and follow an environmental marketing approach in order to satisfy not only customers but also stakeholders, thereby raising shareholder value (Waddock and Graves, 1997).

Despite these incentives to adopt environmental friendly marketing strategies, there are also many barriers. The most important risk often mentioned is high initial capital investments at company and customer levels. Business practice creating environmental benefits leads to non-excludable positive externalities but is often connected to high investments, which most of the time entails direct private costs to companies. Firms in return price green products at a premium by transforming environmental benefits from non-excludable externalities to excludable financial benefits and transfer company-level action dilemmas to their customers. But rational consumers would prefer the advantages of a non-excludable greener environment without having to bear its price. This is the reason why most markets for environmental friendly products stay small (Prakash, 2002).

Besides the magnitude and risk of capital investment (Ginsberg and Bloom, 2004), one of the main risks of green marketing is that by applying this approach a company must ensure that their business activities are entirely credible and truthful to customers in order to avoid consumer scepticism or even cynicism (Mohr et al., 1998). By making use of exaggerated or even wrong claims about products consumer backlash can occur (Carlson et al., 1993). In addition, companies have to conform to all regulations and laws dealing with green marketing. As regulatory compliance can be expensive, companies might want to circumvent compliance when possible (Lyon, 2003).

4.1.4 Green Consumer Segmentation

Many studies in green marketing attempt to define the characteristic of green consumers for segmentation purposes because recognizing customer differences is a key to successful marketing (McDonald and Dunbar, 1998). For market segmentation, a set of variables must be chosen that will set the segmentation criteria used to identify consumption patterns and assign individuals to homogeneous groups (Finisterra do Paco and Barata Raposo, 2008).

Since the very beginning of green marketing, academics have attempted to gain a deeper understanding of consumer purchasing intentions towards green products. Berkowitz and Luttermann (1968) and Anderson and Cunningham (1972) were early pioneers studying the profile of green consumers. Since then a number of studies have been conducted to identify the characteristics, attitudes and/or behaviour of consumers that may influence environmental conscious consumption and serve as an opportunity to identify and segment new markets (McDonald and Oates, 2006; Kilbourne and Beckmann, 1998). In marketing literature these factors are often classified into demographic and socio-economic characteristics, psychographic characteristics and behavioural variables (Kroeber-Riel and Weinberg, 1996; Kotler, 2001). Yet such studies on green consumer profiles have often resulted in mixed and frequently contradictory results (Wagner, 1997; McDonald and Oates, 2006).

4.1.4.1 Demographic and Socio-Economic Characteristics

In the early 1970s, Berkowitz and Lutterman (1968) and Anderson and Cunningham (1972) argued for a green consumer profile as being female, pre-middle aged, highly educated and with a high socioeconomic status. Yet these findings could be only marginally supported. Henion (1972), for instance, showed that environmentally friendly behaviour was consistent across ***income groups***. Samdahl and Robertson (1989) identified the environmentally conscious consumer to be less educated and with a lower income than the average American citizen. ***Age*** as a demographic characteristic has also been explored by many green marketing researchers (Anderson et al., 1974; Jain and Kaur, 2006). While early research found that younger consumers tend to be more environmentally conscious, more recent studies identified green consumers as being older than the average (Samdahl and Robertson, 1989; Vining and Ebreo, 1990; Roberts, 1996). Research on consumer behaviour and ***gender*** showed that women in general share more concern about the environment (Zelezny et al., 2000) and are more willing to contribute (Empacher et al. 2000, Preisendörfer 1999). As far as ***income*** is concerned, studies showed that there is either a positive relationship between income and environmentally friendly behaviour (e.g. Zimmer et al, 1994; Schwepker and Cornwell, 1991) or a negative relationship (Samdahl and Robertson, 1989; Roberts, 1996). The relationship between ***education*** and environmentally friendly attitudes and behaviour was confirmed by several other studies (Aaker and Bagozzi, 1982; Roberts, 1996; Zimmer et al, 1994; Straughan and Roberts, 1999). Yet Samdahl and Robertson (1989) found a negative correlation with environmental attitudes and Kinnear et al. (1974) found no correlation at all. Laroche et al. (2001) found a relationship neither between the level of education nor the household income nor the work status and the willingness to pay for more environmentally sound products.

Although these summarised findings are far from conclusive (a more comprehensive literature review can be found in, say, Schwepker and Cornwell, 1999 and Laroche et al, 2001), they show that demographic variables have an important influence on consumers, environmental attitudes and/or behaviour and offer an easy way to segment a market. Yet most authors agree that other variables – e.g. knowledge, values, attitudes – are more important in explaining ecologically friendly behaviour (Webster, 1975; Banerjee and McKeage, 1994; Straughan and Roberts, 1999).

4.1.4.2 Psychographic Characteristics

Psychographic characteristics have not been researched as extensively as demographics. Several studies show that environmental ***knowledge*** has an important influence on environmentally friendly behaviour (e.g. Vining and Ebreo, 1990), whereas other studies (e.g. Laroche et al., 2001) found that consumers' environmental knowledge, or ecoliteracy, did not have a significant influence. Consumers' ***values and beliefs*** are also important when examining influences that affect environmentally friendly behaviour. This is because values affect people's beliefs, which in turn influence personal norms that lead to environmentally friendly behaviour (Reser and Bentrupperbaumer, 2005). The work of Triandis (1993) and McCarty and Shrum (1994) argued that values such as individualism and collectivism influence the adoption of environmentally friendly behaviour, pointing out that collectivist people tend to be friendlier to the environment. McCarty and Shrum (1994) also investigated the impact of values such as fun/enjoyment and security on consumers' environmentally conscious behaviour. They showed that while fun/enjoyment values had a significant impact on attitudes about the importance of recycling and recycling behaviour, the security factor value did not. Several other studies have also pointed out that general values are related to specific values such as environmental concern and behaviour. The studies showed that respondents with weaker self-transcendent values are less likely to report environmental concern and behaviour (e.g. Stern et al., 1994). Stern et al. found empirical evidence for three value orientations that cause environmental concern: egoism, altruism and biospherism. De Groot and Steg (2007; 2008) created a rating scale to test the three value orientations and showed that biospherism, and to some extent altruism, is positively related to environmental concern and behaviour.

Another psychographic variable is ***political orientation.*** Straughan and Roberts (1999) found that pro-environmental arguments often go along with a more liberal or left-of-centre political agenda (Straughan and Roberts, 1999). ***Attitudes*** are also considered to be predictors of environmentally friendly behaviour. Importance and inconvenience are the two most studied attitudes influencing environmentally friendly behaviour. Amyx et al. (1994) describe importance as the level of environmental concern and inconvenience as the individual's perception about the inconvenience of environmentally friendly behaviour. In an empirical study McCarty and Shrum (1994) found that the more individuals thought that recycling was inconvenient, the less likely they decided to recycle. In contrast, the perception of importance of recycling had little influence on behaviour. Schlegelmilch et al. (1996) also analysed the relationship between environmental knowledge, attitudes and behaviour and environmentally friendly purchase behaviour. They found that attitudes are the most consistent predictor of such decisions. Another psychographic criterion is the experience of significant ***life events or life status changes*** such as divorce or relocation. Andreasen writes in his study that "measures of status change should be seriously considered as predictor variables in future consumer studies in marketing, particularly those concerned with developing market segments" (Andreasen, 1984, p. 794). Mathur et al. (2006) also support the use of life events for market segmentation. The authors developed a life-event-based segmentation model and suggested that when life events are included in such segmentation models, a significant improvement over age- or cohort-based segmentation models can be reached.

4.1.4.3 Behavioural Characteristics

In terms of behavioural variables, Laroche et al. (2001) conducted an exploratory study testing the hypothesis that consumers with a more ***environmentally friendly behaviour*** are willing to pay a premium price for environmentally friendly products. Surprisingly, the stated behaviour of "recycling" was not a statistically significant influence on consumers' willingness to pay a premium price for environmentally friendly products. Another factor is ***perceived behavioural control,*** i.e. the extent to which a consumer thinks his own behaviour might help preserve the environment. Straughan and Roberts (1999) already showed that consumers concerned about the environment will show more proactive behaviour when they think that their individual action can contribute to preserving the environment.

4.1.4.4 Selected Segmentation Studies

One of the most prominent segmentation studies was conducted by Roper Starch Worldwide. It analysed whether American consumers engaged in environmental friendly behaviours, such as recycling, reading product labels or paying more for ecological friendly products. It was a nationwide, long-term syndicated study of consumer attitudes and behaviours towards the environment. The study identified five distinct groups: the true-blue greens, who are true environmental activists and leaders (30 % of total American consumer population in 2007 vs. 10 % in 1996); the greenback greens, who express a high commitment towards the environment and are willing to pay a premium for green products but are not involved in pro-environment activities such as recycling due to restricted time (10 % in 2007 vs. 5 % in 1996); sprouts, who lack a high level of concern about the environment but do take part in some kind of environmentally responsible activities (26 % in 2007 vs. 33 % in 1996); grousers, who are relatively uninvolved in pro-environmental activities and think that environmental problems are not caused by them and are too big and complicated to address (19 % in 2007 vs. 15 % in 1996); and basic browns (renamed in 2007 in "apathetics"), who are convinced that they cannot make a difference and do not feel the need to rationalise their behaviour (18 % in 2007 vs. 37 % in 1996) (Roper Starch, 2005).

D'Souza classified consumers in a two-dimensional model in four segments (D'Souza, 2004): environmentally green consumers, emerging green consumers, price-sensitive green consumers and conventional consumers. Conventional consumers generally do not buy environmentally friendly products because they do not see any environmental risks in connection with the products they buy. Emerging green consumers see the benefits of green products but are not motivated to buy them. Environmentally green consumers are those with a high environmental concern and are willing to buy green products whenever they have the opportunity to do so. In contrast, price-sensitive green consumers are not willing to pay more for environmentally friendly products but see environmental risks when buying ecologically unfriendly products (D'Souza, 2004).

Consumer groups can also be distinguished into dark green consumers, light green consumers and ignorant consumers (Wuestenhagen 2000). The last segment is not interested in the environment. Dark greens put a greater value on a product's environmental benefits than on its other attributes. In addition, they are willing to pay more for environmentally friendly products. Light green consumers are less willing to pay for environmental attributes and often value convenience and comfort as more important. But they can be motivated to become environmentally active and to perceive the environmental friendliness of the product as an added value (Kaenzig and Wuestenhagen, 2010).

4.1.5 Behavioural Models of Decision Making and Implications of Green Marketing

Although many consumers are interested in the environment, only a small segment of consumers in the marketplace put their interest into purchasing practice. In other words, even when consumers have a positive attitude towards environmental issues they are largely passive in their purchase decisions. Researchers call this the **attitude-behaviour gap,** or the **value-action gap.** It describes the recognition of a disparity between stated attitudes and actual behaviour: Attitudes alone do not influence consumer decision making enough to become a sustainable consumer purchase (Chatziddakis et al., 2007; Kollmuss and Agyemann, 2002; Maiteny, 2002).

In addition there exists a long-standing debate on the **"energy efficiency gap",** which describes the absence of energy-efficient investments that appear to be cost-effective on an estimated lifecycle cost basis (Ruderman et al., 1987). Lack of information, imperfect markets, organisational barriers or limited access to capital are possible explanations why consumers underinvest in energy efficiency (Levine et al., 1995). Several of these market and nonmarket failures are in direct connection to individual decision making, including the existence of high "implicit discount rates" among consumers who decide between appliances with different costs and energy efficiencies (Hausman, 1979). Researchers have discussed implicit discount rates ranging from 25 % to over 100 % (Sanstad et al., 2006; Train, 1985).

Both the attitude-behaviour gap and the energy-efficiency gap can be regarded as non-rational and inconsistent behaviour. Behavioural decision models can help better explain human behaviour regarding energy use. These models provide amother look as to why consumers fail to adopt sustainability innovations, despite their positive attitudes towards the environment and the cost efficiency of the investment. Economics has traditionally assumed that decision makers have stable and coherent preferences that do not depend on the context. But since humans' cognitive capacity is limited (Simon, 1955), the rationality assumptions were shown to be violated in many studies (Slovic and Tverksy, 1974). Empirical evidence that consumer decisions are not always made rationally started with the work of Tversky and Kahnemann (1974), who showed that consumers consistently violate axioms of rational choice in particular situations. Since then a lot of academic work has been devoted to identifying the ways consumers violate the axioms of rational choice (Gillingham et al., 2009). Numerous experiments have shown that individuals make decisions different from standard rationality assumptions held by economists (Goldberg and von Nitzsch, 2001).

Systematic biases in consumer decision making have attracted the interest of academics, and especially those in the field of behavioural economics. The behavioural economics literature is influenced by psychology to understand how consumer decisions take place (Rabin, 1998; Gillingham et al., 2009). The field of behavioural economics tries to integrate a more robust psychological understanding of decision making into microeconomics. Traditionally, microeconomics assumes consumer choices are rational, given that consumers have ordered, known, invariant and consistent preferences. Behavioural economists replace this classic microeconomic assumption with those of bounded rationality or other heuristic decision-making methods (McFadden, 1999). Wilson and Dowlatabadi (2007), Shogren and Taylor (2008) and Gillingham et al. (2009) reviewed the topic of behavioural economics specifically in the context of environmental economics. These studies show that empirical literature, while unusually limited, claims that behavioural failures can put investments in energy efficiency below the optimal level (Gillingnahm et al., 2009). Behavioural economics can be used to explain why energy-efficient investments are not taken, although from a rational point of view it would be a smart choice. In other words, behavioural economics studies how the world is instead of how it assumed to be.

4.1.5.1 The Power of Framing

The presentation of different elements of a decision– e.g. alternatives, attributes, outcomes and probabilities– can yield different decision outcomes (Keeney, 1992). Rational choice, in contrast, would assume that preferences between different options stay the same (Tversky and Kahneman, 1981). As a result framing effects are often taken as explanations for irrational consumer decisions.

The Power of Loss Aversion

Prospect theory was developed by Daniel Kahneman and Amos Tversky in 1979 and is perceived as a “paradigm challenging the expected utility paradigm” (Levy and Levy, 2002). Prospect theory claims that decisions are not dependent on absolute wealth but with respect to a reference point that acts as a standard against which other stimuli are compared. Prospect theory argues that decision makers employ an S-shaped value function. One important concept within prospect theory is “loss aversion”. It states that gains and losses do not have symmetric impacts on decisions but that “the impact of a difference on a dimension is generally greater when the difference is evaluated as a loss than when the same difference is evaluated as a gain” (Tversky and Kahneman, 1991, p. 1040). Empirical estimates of Tversky and Kahneman (1991, 1992) have shown that decision makers weigh losses about twice as strongly as gains. In addition, prospect theory posits that the marginal impact of a change in outcome will decrease (or diminish) as one moves further away from a reference point (“diminishing sensitivity”) (Tversky and Kahneman, 1991). Examples of loss aversion include judging the effectiveness of a condom with a 95% success rate or a 5% failure rate (Linville et al., 1993), judging the quality of ground beef labelled as being 80% lean or 20% fat (Levin and Gaeth, 1988), or judging a cancer treatment with a 50% success or a 50% failure rate (Levin et al., 1998).

The loss aversion may have a major impact on the way individuals interpret information, thereby affecting green marketing. When providing information to consumers, energy information can be framed in different ways. Framing energy costs as a loss has a higher impact on consumer choice than framing them as gains. Thaler and Sunstein (2009) argued that energy conservation methods can be framed in two different ways. For instance, one can say that **using** energy conservation can **save** $350 per year, or one can say that **not using** energy conservation methods can **lose** $350 per year (Thaler and Sunstein, 2009). Thaler and Sunstein found that information campaigns framed as losses are far more successful. Thus, instead of highlighting possible gains through different kinds of investments into energy efficiency, this information could be framed as losses in case the investments are not taken, e.g. "due to insufficient thermal insulations you will spend x€ too much on energy costs per year" or "if you don´t invest in a combined heat and power plant, x€ per year on addititional income will slip through your fingers".

Another concept of loss aversion that has found an important application in prospect theory is the "endowment effect" by Thaler (1980). This effect states that people value something much more once they own it, so that the maximum amount they are willing to pay to acquire a good is less than the value they would demand when selling or giving up an item. The effect can be explained by the fact that we attach emotions about previous experiences to products. Knetsch (1989) conducted an experiment in which half of the respondents received a candy bar and the other half of the respondents was given a coffee mug. Both items had about the same price value. Then the respondents had the chance to trade the items. Confirming the endowment effect, preferences for the coffee mug over the candy bar ranged from 10 to 89 %, depending on which item was received first.

This insight has important implications for green marketers. Consumers might attach emotional value to their old products. This can present a challenge when trying to sell new products to consumers (e.g. replacing old household appliances with more efficient models). In light of this insight, retailers could offer their customers the chance to try out the products before they have to pay the final price. This allows customers to experience the product benefits beforehand, thereby establishing an emotional attachment to the product (Policies Studies Institute, 2006). Once the consumers have the product in their house, they are reluctant to give up the new ownership because they would view it as a loss.

The Power of Defaults

Another framing effect which shows that individual preferences are not fixed or invariant is that most consumers do not look for and process all the relevant information available on the market; instead they "anchor" on specific information (Tversky and Kahneman, 1974; Ariely, Loewenstein and Prelec, 2003). This is why preferences can be biased towards the initial anchor point, e.g. the status quo or the default option.

The power of defaults is well known for different fields (Goldstein et al., 2008; Polak et al., 2008) and is described as being the option that consumers receive if they do not explicitly ask for another option (Brown and Krishna, 2004). Anderson (2003) and Sunstein and Thaler (2003) have shown that, when applying defaults, consumers tend not to select another alternative (Anderson, 2003; Sunstein and Thaler, 2003). One prominent example is the power of default for organ donations. Countries within the European Union vary enormously regarding the percentage of donors among the population. In Denmark for example, only 4.25 % of the population are registered as donors, whereas in countries such as Austria, France and Hungary, almost 100 % of the population are donors (Johnson and Goldstein, 2003). The most important difference between the countries is their default policies. For instance, Denmark is an explicit-consent country: People have to register first in order to become a donor. Countries such as Austria follow a presumed-consent default policy: Everybody is an organ donor unless they opt out (Johnson and Goldstein, 2003). Johnson and Goldstein (2003) have explained the different ways in which defaults influence the decision-making process. On the one hand, defaults can be perceived as being government or manufacturer recommendations. On the other hand, making an active decision requires physical effort (Samuelson and Zeckhauser, 1988). One explanation for these phenomena is human inertia, which has been described by a number of behavioural economics studies. Thaler and Sunstein (2003) point out that any change from the status quo or present state requires the individual to invest time and effort. Many people are reluctant to do that, especially when they tend to procrastinate. When faced with a complex decision-making process, they either avoid decisions or delay them. The problem of inertia and procrastination is related to the theory of "bounded self-control" (Mullainathan and Thaler, 2000). Bounded self-control describes individuals who have the right intentions or beliefs but prove to be limited in their capacity or lack the willpower to execute their intentions to change behaviour. Although people would like to change their behaviour or buy a product today, they are often too busy. Although individuals comprehend the consequences and advantages of a specific behaviour and have the right intentions, they lack the energy to implement their intentions. The existence of inertia also explains the fact that default rules tend to be "sticky" (Thaler and Sunstein, 2003). In a fully rational world, setting the default differently should not impact consumer choice since consumers could simply go for the option that suits their needs best, regardless of the default (Thaler and Sunstein, 2003).

The power of defaults explains why individuals stay with defaults they know despite the better alternatives on the market. That is why Loewenstein and Ubel (2008) argue that "soft" paternalistic interventions are becoming more important as awareness spreads of people's tendency to act against their best interests. Guiding consumers towards choices that meet their preferences while preserving their autonomy has been described by Thaler and Sunstein (2003) as libertarian paternalism and by Camerer et al. (2003) as asymmetric paternalism.

One prominent example in the field of green electricity has been discussed by Pichert and Katsikopoulos (2008). The authors point out that many electricity consumers do not switch to a greener electricity mix even when willing to pay for it. The authors mention the example of German electricity providers who made green energy the default option: Most of the consumers kept the default green tariff. In other words, consumers stick with their default electricity provider or electricity mix although they have the possibility to choose otherwise according to their preferences.

There are various other domains in which the default option is usually not the environmentally-friendly one. When purchasing a plane ticket, for instance, the customer can choose to offset his carbon emissions by ticking a box. Setting the default differently could be done by pre-checking the box so that the consumer has to opt out if he wants something else (Allcott and Mullainathan, 2010). Another example would be to set a different default temperature for washing machines. McCalley (2006) investigated whether the default setting leads to significant differences in energy consumption. One experimental group used a washing machine whose washing temperature was set to 95° C for a normal wash programme. In case users wanted to wash their clothes at a lower temperature, they had to lower the temperature setting themselves. The other experimental group received a washing machine where the default temperature was set to cold and users had to increase the temperature. Setting the default differently led to a 24 % reduction in energy use (McCalley, 2006).

Another strategy is choice editing. It pre-selects products by eliminating inefficient products or environmentally unfriendly products to influence consumers' choice by increasing the standard for all (Sustainable Consumption Roundtable, 2006). Marks&Spencer, for instance, decided only to stock free range eggs or fair-trade coffee.

Businesses as well as governments have the power to nudge consumers towards energy-efficient shopping behaviour. Retailers and manufactures have an important responsibility in making the environmentally friendly consumption easy and inexpensive. Manufacturers can design the products to help consumers use the product in a more sustainable way, such as making an economy wash programme in washing machines the default option. Karsten and Reisch (2008) have emphasised the legitimacy of choice editing and claim it as a way for "making the sustainable choice the easy choice".

The Power of Choice Overload

Contrary to popular belief, behavioural economists have found that more choice options are not necessarily "better". The "choice overload" hypothesis (Iyengar and Lepper, 2000) suggests that too many choices can lead to information overload and ultimately prove to be demotivating. This can lead individuals becoming overwhelmed by all the options so that they become even more entrenched in the standard product model, or "default". Schwartz (2004) has called this "the tyranny (or 'paradox') of choice". Iyengar et al. (2003) showed that participation in pension plans in the U.S. decline as the number of fund options increases. Benartzi and Thaler (2002) showed that retirement plan participants might have difficulties dealing with many investment choices.

In newly deregulated markets, like electricity and other utilities, competition has increased, allowing customers to choose their preferred electricity provider and select among a variety of different electricity mixes. For many consumers the increases in competition give them choices that better match their preferences. But most consumers have little knowledge about electricity and as choices increase the decision-making process can become more difficult. More choices mean more sensitivity to regret and opportunity costs for selecting another option (Schwartz, 2004). When choice is particularly excessive, individuals might avoid making a choice altogether and stay with their default electricity provider and product.

The Power of Decoy Effect

A decoy is an alternative added to a consideration set that changes the relative attractiveness of other alternatives (Huber et al., 1982). Consumers rarely make decisions in absolute terms. Instead they have an "internal value meter that tells us how much things are worth" (Ariely, 2010, p.2), concentrating on the relative advantage of one alternative over the other. Huber et al. (1982) investigated the decoy effect with regards to restaurant options. In their study they asked the respondents to choose between two different restaurant options characterised by the amount of stars and the driving distance in minutes. The first option was a five-star restaurant that was about 25 minutes away by car. The second option was a three-star restaurant that was only 5 minutes away. Both options were designed to be equally attractive to the respondents. But when a decoy was introduced to the choice set (a four-star restaurant that was 35 minutes away) the attractiveness of the five-star restaurant increased significantly. In contrast, when another decoy was introduced, a two-star restaurant that was 15 minutes away, respondents tended to choose the three-star restaurant. In other words: The option that was consistently better than the decoy was preferred by the respondents (Huber et al., 1982).

In the context of investment choices, one might consider the following example. If consumers have the choice between a cheap, but inefficient appliance and an expensive, but efficient appliance, consumers might have difficulties choosing because they have to trade-off between two important attributes. If a third option were introduced, e.g. an efficient but even more expensive product, the comparison with the clearly inferior option (a very expensive efficient product) makes the moderate expensive efficient product seem even better.

The Power of a Pennies-A-Day Effect

The "pennies-a-day" effect, coined by Gourville (1998), describes a technique of temporally reframing a price. Reframing a transaction from an aggregate expense to a series of smaller, daily expenses makes prices seem lower and more attractive to consumers. He cites the prominent example of celebrity advertisements that ask donors to save a child's life for "only the cost of a cup of coffee a day". Gourville (1998; 1999) found that up to a certain point, a pennies-a-day framing can lower the perception of the monetary magnitude on an expense compared with aggregate framing. Gourville believes that the pennies-a-day framing fosters the retrieval of ongoing costs (e.g. a cup of coffee a day) and makes the price seem trivial. Yet, framing the price as an aggregate cost fosters the retrieval of bigger and infrequent costs (Gourville, 1998).

This finding has important implications for framing of costs. In the field of energy-efficient household appliances or heating appliances, showing how much energy is consumed over the product's lifetime as an aggregate cost might foster the retrieval of bigger and more infrequent costs. If the costs are shown in a smaller temporal frame (e.g. per year), consumers might compare the prices to smaller, ongoing costs. They might underestimate total expenditure and therefore be less willing to pay for a product with a lower level of energy consumption.

4.1.5.2 The Power of Time Inconsistency

One possible explanation behavioural economists give to explain why individuals do not always make consistently rational choices is time inconsistency. Compared with time consistency, where present consumption is traded off for future consumption at a constant discount rate (O'Donoghue and Rabin, 1999), there is much empirical and experimental evidence showing that often consumers don't make decisions based on a constant discount rate (Frederick et al., 2002) and that hyperbolic or proportional discount functions represent consumers value costs and benefits over time more accurately (Loewenstein and Prelec, 1992; Harvey, 1994). Hyperbolic discounting is when individuals are impatient and strive for immediate gratification (Ho et al., 2006). This mainly occurs when products are characterised by immediate costs but with delayed benefits as with, for instance, an energy-efficient heating system. Time inconsistency implies that people heavily discount future savings. This has an important impact on the way in which individuals attach value to the efficiency or lifetime operating costs of products.

Because of time inconsistency, consumers tend to overvalue the present and undervalue the future and ignore operating costs during their purchase decisions. This short-term thinking is an important barrier in the field of energy efficiency investments (e.g. energy-efficient heating systems or household appliances), since individuals often only see the initial investment costs and not the lifecycle costs when deciding for or against an energy-efficient investment. Frederick et al. (2002) give an overview of studies investigating individual preferences regarding different models of energy-consuming products when it comes to trade-offs between long-term operating costs and upfront investment costs. Most studies reveal that discount rates far exceed market interest rates, ranging up to 210 % for air conditioners, 138 % for freezers and up to 300 % for refrigerators (Frederick et al., 2002).

Green marketers must recognise the occurrence of time inconsistency and identify measures to overcome this by highlighting the importance of future operating costs. One way to overcome this barrier would be to show the long-term operating costs of products rather than just the purchasing price to consumers. Providing estimated monetary operating costs would allow the consumer to see at a glance how much money could be saved over the long-term. The discussion of providing operating and lifecycle costs is not new. Lund (1978) already suggested more than 30 years ago that operating costs and life-cycle costs are ways of surmounting this barrier (Kaenzig, 2009). Kaenzig and Wuestenhagen (2010) claim that providing information about operating costs can take the form of either providing explicit life-cycle cost information (e.g. operating costs in monetary units) or by providing implicit LCC information through ecolabels (e.g. the EU energy efficiency label), since a product with a higher efficiency class implies lower operating costs in the long run (Kaenzig and Wuestenhagen, 2010).

The other possibility to overcome the barrier of time inconsistency is to offer attractive payment schemes or financing mechanisms. For instance: offering consumers the possibility of installing energy-saving technologies at no upfront cost and spreading repayments over long periods so that these repayments are lower than their predicted energy bill savings (e.g. the "Pay-as-you save" scheme in the United Kingdom) (Barenergy, 2010).

4.1.5.3 The Power of Social Environment

The power of the social environment originates from the fact that generally consumers are heavily influenced by other people. Consumers' behaviour is deeply embedded in social context (Jackson, 2005). Most consumption choices are influenced by some kind of social influence. The influence will be described in the next section.

The Power of Status and Self-Image

Consumers not only buy products or services to satisfy a functional need; they also want to make a statement about themselves. Modern identities are created through the symbolism of consumption (Jackson, 1999). People care about what others think about their purchase behaviour; products symbolise concepts that are used to express one's identity and portray one's status. Veblen (1899) describes goods as proof of social status that creates respect from other people. Eastman et al. (1999) defines status as "the position or rank in a society or group awarded to an individual by others". Since Veblen's time, economists have observed that individuals "do good" because of their aspiration for "social approval". Social approval motivates people to behave "in the right way" (Glazer and Konrad, 1996). Though social approval is not a material good, people behave pro-socially to get an external reward.

These findings hold important implications for green marketing. Because individuals are highly motivated by "social approval", it is important that others see what they do. Possible strategies range from displaying a leaderboard – that is, a list of those households that have made major conservation efforts (Houde and Todd, 2010).

The Power of Social Norms

Social norms are described as the "rules" of how to behave in a particular situation. Bicchieri (2006) describes social norms as "the grammar of society". In the context of environmental behaviour, several studies have shown that awareness of social norms on electricity and gas consumption resulted in a 20-28 % consumption reduction (Nolan et al., 2008; Cialdini, 2003). Cialdini et al. (2008) tested which form of information about reusing towels in hotels has the highest impact. They tried out different messages: "Save the environment", "Preserve resources for the future", "Partner with the hotel to save the environment" and "Join your fellow citizens in helping to save the environment". The last message, which represented a social norm, generated recycling activity of about 48 %, whereas the other message only produced a reuse rate of about 36-38 %.

During one other study regarding energy consumption (Schultz et al., 2007), 300 households in California were informed about their energy consumption compared with the average energy consumption of their neighbours. The households were split in one of four experimental conditions. Those households that had a higher than average energy consumption level either received only standard information about their energy consumption or received both this information and a sad face – an injunctive normative message implying disapproval. Those households that had a higher than average energy consumption received either only the standard information or both this information together with a happy face, implying approval. The results showed that those households that consumed more energy than average reduced their level of energy consumption over the period of study, either by 6 % when a sad face was included or by 4.6 % when the sad face was not included. Interestingly, those households that had a lower than average energy consumption increased their energy consumption towards the average level by 10 % when the happy face was not included. Those that had received a happy face in addition to the standard information increased the usage by only 1 %. This result has important implications: For those households that have a lower than average energy consumption, the approval portrayed by a smiley had a high impact in convincing the households to maintain their low consumption and not to adapt to the average energy consumption in their neighbourhood.

Strengthening social norms towards energy-related topics (e.g. through individuals or groups setting positive examples and/or through governments or NGOs providing information focused on the societal or group-level benefits of individual behaviour change) is likely to have a positive effect on the adoption of these behaviours.

4.1.6 Conclusions

Understanding how consumers make decisions is important for marketers concerned with the impact of human investment behaviour in the energy sector. This article provides a review of literature in the field of green marketing, green consumer segmentation and behavioural decision models in the environmental field.

Studies in behavioural economics and psychology indicate that consumer behaviour in the real world often dramatically differs from that which is predicted by standard economics. Hence old assumptions must be abandoned and companies need to become more flexible in identifying creative ways of doing business. An improved understanding of consumer behaviour gives marketers the possibility to succeed in an increasingly sustainable world.

The literature on segmentation teaches us that consumers are heterogeneous and market instruments must be designed to take these differences into account since different segments respond differently. The review showed that demographic variables are an easy way to segment a market regarding the influence of consumer attitudes toward environmental attitudes and behaviour. Yet other variables are even more important. Though it is not that easy to segment a market, these other variables have to be taken into account. No single marketing strategy is likely to influence consumers the same way. Instead, a mix of different marketing strategies is necessary and effective in influencing different consumer segments. As a result, green marketers must develop strategies to address distinctive target groups individually. A closer investigation of segmentation criteria and its relevance in green marketing could lead to better knowledge about specific target groups, products and contexts. Marketing strategies hence need to allow for flexible approaches that recognise how different consumers are.

Findings from literature on behavioural economics reveal different insights into effective green marketing strategies. Examples of anomalous behaviour are numerous: the status quo bias, loss aversion, and time inconsistency, just to name a few. Based on the examples provided in the previous section, a key challenge in defining green marketing strategies is dealing with the enormous complexity of consumers' decision behaviour. Understanding consumers' decision-making processes better and accepting that consumers often don't behave rationally and occasionally even against their self-interest helps marketers to design more effective marketing campaigns.

4.2 Increasing Energy Efficiency in Private Households in Germany – An Overview of Existing and Proposed Policy Measures

Felix Groba and Thure Traber

4.2.1 Introduction

In 2007 the German government announced both the Integrated Energy and Climate Program (IEKP) and its climate target to reduce GHG emissions by 40 % over 1990 levels by the year 2020. The IEKP is Germany's framework designed to accompany and complement the national reductions caused by the European emission trading in order to put the country on a path to reaching this ambitious goal. While the German government sticks to the 40 % target, estimates of the emission reduction effect of the IEKP have gradually declined as more studies have been carried out. From the first IKEP-scenario calculations in 2007 (BMU, 2007) to the latest calculations conducted in Politikszenario V (hereafter UBA, 2009a) the projected reductions have declined from 41 % to less than 30 % measured against the base year 1990. Several factors gave rise to these estimate reductions. First, the announced policy measures have not been implemented in their full scope and some measures have yet to be implemented at all. Second, cross-impact evaluation of some measures was largely neglected in earlier assessments. Third, the implemented policies have not delivered their expected effects. Many additional measures and policies have been proposed over the last years promising to reach the climate target.

While the energy supply sector has been served rather well by the European Emission trading system (ETS), the Feed-in Tariff for renewable Energies (FiT) and, with less success, the CHP-Bonus for combined heat and power production, other sectors like transport or the energy demand side did not deliver significant reductions. A sector of particular interest is the household sector, where estimated carbon abatement costs are often low (MCKinsey, 2007; Kemfert et al., 2007). Yet several market failures and imperfections are suspected to prevent efficient technologies from gaining market shares (Gillingham et al., 2009). The objective of this section is twofold. First, we give an overview of the potential market and behavioural failures affecting household energy consumption. Second, focusing on the German level, we summarise current policies that specifically address the household sector and assign these policies to the market failures they may have caused. Furthermore, we give an overview of proposed additional measures and set them in theoretical perspective to make them available for subsequent evaluation.

4.2.2 Household Behaviour and Policy Intervention

In principle, the use of resources in market economies is determined by market forces. Under certain assumptions and conditions these market mechanisms allocate resources efficiently. The same is true for energy markets and efficient consumption of energy. In reality, however, the theoretical conditions for an efficient allocation of energy resources are often not met. Identifying the degree of market or behavioural failures that create inefficiencies provides an opportunity for beneficial policy intervention.

This section gives an overview of the theoretical aspects of potential market and behavioural failures in energy efficiency markets. In order to align the theoretical section with the section on households, we focus only on market failures that are of relevance for individual consumer decisions. In subsequent sections of this paper we identify which of the market and behavioural failures are addressed by current and hypothetical policy measures targeting an increase in energy efficiency (see also Annex III).

The general, neoclassical assumptions relevant in the context of energy consumption of private households are:

- consumers are rational and utility maximising by choosing the optimal bundle of goods given budget constraints and market prices;
- consumers have perfect and costless information about all goods and prices and are able to calculate optimal consumption bundles;
- there are no transaction costs involved in market trading; and
- there is perfect competition among market agents.

When identifying potential market and behavioural failures the literature commonly focuses on the energy efficiency gap. The energy efficiency gap is the difference between the observed level of energy efficiency and optimal energy use. Energy efficiency is defined as the energy service provided per unit of energy input (Jaffe, 2004). The efficiency gap is the underinvestment in energy efficiency relative to a description of the socially optimal level of energy efficiency (Gillingham et al., 2009). Along this line of argument Gillingham et al. (2009) have assembled a list of commonly cited market and behavioural failures in the context of energy efficiency.

- **Energy market failures:** *Environmental externalities and other external costs* of energy production and consumption are not fully reflected by market prices, which induces an overuse of energy relative to the social optimum. Additionally, actual consumer prices may not reflect marginal social cost, since utilities commonly employ *average cost pricing,* which could also lead to non-optimal energy consumption (Gillingham et al., 2009, p. 10).
- **Capital market failures:** *Liquidity constraints* were identified as a market barrier for energy-efficient investments quite early (Blumenstein et al.,

1980). Consumers may not choose energy-efficient products due to a lack of credit, which may lead to an underinvestment in energy efficiency.

- **Information problems:** Consumers often *lack information* about the availability and the savings potential from energy-efficient products. This can lead to a systematic underinvestment in energy efficiency (Howarth and Sanstad, 1995). The problem can be linked to behavioural failures such as an inappropriate accounting of future cost reduction when making investment decision with respect to energy-efficient acquirements.
  The *principal agent problem* is another informational market failure that may also lead to underinvestment relative to the social optimum. The principal may have incomplete information on the energy efficiency of a product or building, while the agent has no possibility to recoup the costs of investments in energy efficiency (Jaffe and Stavins, 1994).
  A further market failure may arise due to *asymmetric information,* which may lead to adverse selection. An information asymmetry occurs when information on the energy efficiency of goods cannot perfectly be transferred from the seller to the consumer and may be left out of decision making (Howarth and Sanstad, 1995). Clearly informational transaction costs for consumers are a central element in this context, since they might be the very source of market failure.
  Lastly, *positive externalities from learning-by-using* may provide free information gathered by an adopter of energy-efficient products to other consumers. Thus, the accumulation of knowledge about efficient investments may not be sufficient from a societal viewpoint.
- **Behavioural failures:** Psychological and sociological studies have shown that the assumption of perfect consumer rationality does not hold true in reality. Aversion to risk, uncertainty, the use of short term discount rates, heterogeneity of preferences, transactions costs of searching and processing information, limited sensitivity to changes of energy service attributes and the relative unimportance of energy costs as a proportion of total expenditure can lead to significant systematic biases in decision making (Wilson and Dowlatabadi, 2007). The most relevant explanations of the behavioural deviation from standard economic assumptions are given by prospect theory, by bounded rationality and by heuristic decision making.
  The *prospect theory* of decision making postulates that when outcome is uncertain individuals evaluate potential welfare changes with respect to a reference point, commonly the status quo. Furthermore, consumers are risk averse with respect to losses and risk seeking with respect to gains. Consequently, individual welfare changes are greater from expected losses than from gains of the same magnitude.
  The problem of individual *time inconsistency* can also be explained by prospect theory. In standard theory, time consistency is ensured by trading off present for future consumption at a constant discount rate. Yet as empirical and experimental evidence shows (Kahneman and Tversky, 1979), varying, product-specific individual discount rates well above market interest rates may cause underinvestment in energy efficiency.

Another explanation for non-rational behaviour is *bounded rationality.* This theory claims that individuals face cognitive constraints in processing information, which may lead to an overconsumption of electricity. A related problem is *heuristic decision making*. In order to reduce cognitive burden, individuals tend to follow sequential decision strategies that deviate substantially from conventional utility maximisation assumptions (Gillingham et al., 2009).[7] These problems can eventually lead to an underinvestment in energy efficiency because future increases in fuel and electricity prices are ignored (Kempton et al., 1982).

The economic literature has tried to identify market and behavioural failures that present an opportunity for net-beneficial interventions. A perusal of the literature shows that no single policy addresses all failures and imperfections. The degree of heterogeneity of agents and products in the energy efficiency market requires the implementation of a policy mix. Within this policy mix, each policy may address several of the identified market failures.

Against the backdrop of this theoretical scheme, the next section outlines policy measures in Germany and briefly explains the related market and behavioural failures.

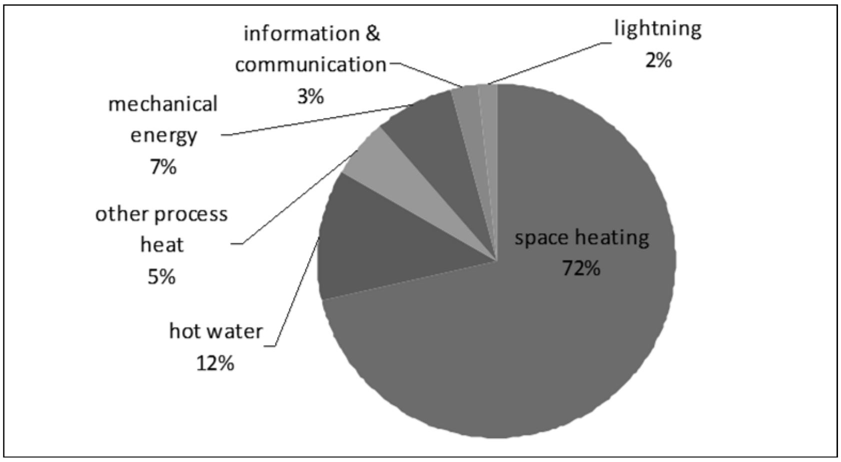
4.2.3 Existing Household Sector – Specific Measures

Energy consumption in residential and commercial buildings represents approximately 40 % of total final energy use and accounts for 36 % of the EU's total CO_2 emissions and for about half the CO_2 emissions not covered by the EU's Emission Trading System (European Commission, 2010). Several initiatives on European and national levels have been taken to address the potentials of emission and fuel expenditure reduction by increasing efficiency and reducing consumption of energy in private households.

The European Union has presented a variety of plans, directives and communications to set up the framework for energy efficiency policies. Naturally, EU-directives require member states to reach a particular result but do not dictate means of achieving the target. This leaves leeway for legislative and administrative implementation. The current overarching policy framework on the European Level was defined in 2005 with the EU Commission's Green Paper on Energy Efficiency (European Commission, 2005), which reemphasised existing energy-saving measures and spelled out additional options to achieve a sustainable, competitive and secure energy supply in Europe. Based on the consultations launched by the green paper, the Action Plan for Energy Efficiency 2007-2012 (European Commission, 2006), presented in 2006, emerged as another cornerstone. The plan's intention is to reduce energy consumption by 20 % by 2020. The stated objective is to provide the most energy-efficient buildings, appliances, processes, cars and energy systems to EU citizens. It aims at mobilizing the general public, policy-makers and market actors to support the dissemination of energy-efficient infrastructure and products. The 75 specific actions in 10 priority areas aspire to increase the yield of energy production and distribution, to facilitate financing and investments in the sector and to encourage rational energy consumption behaviour. A decisive criterion for choosing appropriate measures is cost-efficiency. Cost efficiency favours measures and products with the lowest lifecycle costs and the least environmental damages.

The largest share of final energy consumed by households is contributed by heating processes and end-use appliances such as information and communication technologies and lighting (Figure 1). The subsequent sections give an overview of existing policies on the European and especially on the German level and put them in theoretical perspective.

Fig. 4.1. Final energy consumption of households by application in %



Source: Bundesverband der Energie- und Wasserwirtschaft e. V. (BDEW), Endenergieverbrauch in Deutschland 2007, Teil A: BDEW-Projektgruppe “Nutzenergiebilanzen”, 12/2008

4.2.3.1 Space Heating and Domestic Hot Water

The insulation of buildings during construction or retrofitting measures is likely to be one of the main levers for increasing energy efficiency and reducing emissions from space heating and domestic hot-water consumption. Implementing different demand- and supply-side policies, such as raising consumer awareness, offering financial assistance and creating appropriate standards for insulation and heat production could be a significant contribution to European Union’s overall climate and energy objectives.

European Level

On the European level, the 2002 Directive on Energy Performance of Buildings (EC 2002), which addresses policies aiming at supply- and demand-side changes, is of main importance. Other directives, such as the Directive of Energy End-Use Efficiency and Energy Services (EC 2006) and the Ecodesign Directive (EC 2008) are of relevance as well, but are more important with regard to end-use appliances and electricity services efficiency:

- **Energy Performance of Buildings Directive – EPBD** (2002/91/EC)
  This directive and its revision in early 2010 constitute the current legal framework for energy efficiency on residential and tertiary sector buildings. The main objective is to prescribe an energy-saving target for member states and to establish a common ***methodology to calculate and rate the integrated energy performance of buildings***. It recommends the ***creation of minimum standards on the energy performance*** of new houses and existing buildings subject to major renovation. The directive aims to create a ***system of energy performance certification*** for buildings and ***requires regular inspection of boilers and central air-conditioning systems***. Accordingly, member states must ensure that ***information*** on energy efficiency measures and financial and legal frameworks is transparently available to all market actors and that ***market barrier reduction*** is promoted. Finally, the directive suggests that ***financial instruments*** must be strengthened and ***additional fund*s** made available. In order to assure that necessary actions are taken on all levels, the directive sets its scope to all market actors – energy distributors, system operators, retail energy sales companies and final customers.
  To establish a common methodology for the calculation of minimum standards in the member states, the directive lays out an integrated approach focusing on the building's insulation quality and relevant aspects of heating and cooling installations, lighting systems, the position and orientation of the building and heat recovery.
  These provisions and energy performance requirements have been clarified and strengthened in a revision of the directive adopted in May 2010. With regard to the integrated approach of defining standards, the directive specifies a benchmarking methodology for calculating cost-optimal levels of minimum requirements on the energy performance of buildings. Cost-optimality is defined as the minimum of lifecycle costs, which include investment, maintenance, operating, energy and disposal costs (European Commission, 2008). Member states shall also set minimum energy performance requirements for technical building systems such as ventilation, heating, lightning and hot water equipments as well as building elements, such as roofs and walls. While the Ecodesign directive regulates the energy efficiency of market products, the EPBD targets the energy efficiency of these products in technical systems.

- **Energy End-Use Efficiency and Energy Services Directive** (2006/32/EC)
  The scope of this directive is quite broad. It applies to retail sale, supply and distribution of energy, including electricity, natural gas, district heating, heating oil, coal and lignite, forestry and agricultural energy products. Thus, although more relevant for energy end-use appliances, this directive also applies to heating services and products. The directive promotes energy-saving targets of 9 % by each member state by 2016. Generally, it is an umbrella to complement and improve the implementation of existing EU energy efficiency legislation, such as the directives on energy performance of buildings, combined heat and power[11] and appliance energy labelling.[12] The purpose of the directive was to establish the institutional, legal and financial framework needed to reduce market barriers to efficient energy end use. It required member states to establish ***national energy efficiency action plans*** outlining intermediate targets for 2009 and measures to achieve the defined savings targets. It also created a framework for a uniform measurement system of energy savings to guarantee the comparability of national savings and actions. Furthermore, it encourages the development of a market for efficient energy services and of new energy-saving programmes and policy measures. Member states are required to provide transparent information on energy efficiency improving policies and programs. The ***supply side policy obligations*** require member states to prevent businesses from activities that obstruct the supply of services and programmes improving energy efficiency, to inform end consumers about programmes to increase energy efficiency and to cooperate in voluntary agreements or market-based measures aimed at increasing energy efficiency. Member states must repeal national legislation and regulation that might create market obstacles for reaching energy-saving targets. Also, disincentives in the national transmission and distribution systems that lead to unnecessarily high energy consumption must be eliminated. What is more, the text furthermore provides for the development of energy auditing systems for final consumers, whereby the certification following such energy audits is equivalent to the procedure obtained in the Energy Performance of Buildings Directive. The directive recommends that end-users be provided with individual meters and informative billing indicating current prices and consumption, comparing current consumption with previous consumption and including contact details for agencies that can provide information on how to improve energy efficiency.

National Level – Germany

Following the EU Directive on Energy End-Use Efficiency and Energy Services the German government adopted a National Energy Efficiency Action Plan in 2006 outlining the steps to achieve the directive goals. It listed existing measures contributing to a reduction in emissions and identified further measures deemed

[11] Directive 2004/8/EC
[12] Directive 92/75/EEC

necessary. In 2007, the German government introduced the **Integrated Energy and Climate Programme** (IEKP) to implement the decisions of the European Council on climate conservation, renewable energies and energy efficiency. The IEKP specified additional measures from the national action plan and presented a portfolio of 29 measures aiming to achieve an emission reduction of 40 % by 2020 compared with 1990 levels.

The paragraphs below outline measures that apply to energy efficiency in domestic space heating and hot water consumption. The policy measures will be discussed with a view towards rectifying suspected market and behavioural failures.

The main instrument for the reduction of building energy consumption in Germany is the energy-saving law and its ordinances. Other important instruments are the government's CO_2 modernisation programme, the respective energy-efficient rehabilitation and construction programmes of the Kreditanstalt für Wiederaufbau and the informational campaigns run by the German Energy Agency (DENA).

1. **Energy Saving Law (EnEG)**
   The enactment of the Energy Saving Law (EnEG) requires the avoidance of unnecessary energy losses and the installation and operation of energy-saving appliance systems when constructing new buildings. The law prescribes the dispersion of operation costs such that the energy consumption of the end-user can be appropriately measured and accounted for in energy bills. Thus, it establishes not only prescriptive standards but also incentive instruments targeting changes in consumption patterns.
   - ***Energy Saving Ordinance (Energie-Einspar-Verordnung ENEV)***
     The current EnEV, effective since October 2009, specifies ***standards*** that reduce the allowed annual primary energy consumption of new buildings by 30% and increase the benefits of insulation by 15 % on average. With regard to building modernisation either the increased ***retrofitting requirements*** for major components have to be met or the building energy consumption has to be 30 % below previous levels, with insulation performing 15 % better. Retrofitting ceiling insulation in old buildings is obligatory beginning in 2011. Furthermore, accumulator heaters older than 30 years have to be removed by 2020. However, homeowners are not required to renovate and measures must be economically acceptable, leaving leeway for interpretation. The most obvious achievement was the introduction of an energy pass for buildings to provide information about energy performance and to increase the enforceability of established requirements and standards. The enforcement of the ordinance was tightened by requiring certificates for realizing retrofitting measures and by penalizing infringements on construction and retrofitting requirements. The 2009 ordinance already constitutes a tightening of the previous 2007 energy-saving ordinance. The current requirements for new building will increase with a new ordinance planned in 2012 that is designed to guarantee an increase in dynamic efficiency.

While in principle the effect of the ordinance reduces externalities from energy production, the inclusion of parts of the energy market in the emission trading system may only partially lead to reductions of emissions. Requirements for metering and accounting may reduce problems caused by average cost pricing and excessive consumption. Furthermore, the energy pass provides information that may reduce inefficiencies due to asymmetric data, the principal agent problem and learning-by-using.

- ***Heat Cost Ordinance (HeizkostenV)***
  This ordinance regulates the billing of heating costs and warm water in tenancy and proprietary relationships and was last amended in 2009. The amendment allows landlords to increase the consumption-based share of the ancillary rental expenses to 70 % giving the tenant an incentive for energy-saving consumption. Yet, it also increases the information requirement on behalf of the owner and requires usage-bound accounting as well as the replacement of old heating cost and warm-water meters installed before 1981 with new equipment from 2013 onwards to allow for detailed consumption accounting. Additionally, the tenant has the right to rent reductions in case the landlord does not fulfil the retrofitting requirements. The lack of information for tenants is overcome by clear consumption-based accounting. The new approach also partially addresses the principal agent problem between landlords and tenants, since the landlord, in principle, now has an incentive to invest in efficient retrofitting.

2. **Financing Renovation, Retrofitting and Energy-Efficient Construction**
   Since 2001, grants and low-interest credits have been made available by four programmes, mainly. These programmes incentivise investments in energy-efficient construction and retrofitting measures of existent housing with federal funds provided mostly by the Kreditanstalt für Wiederaufbau (KfW). The following are the most prominent of these programmes:

- ***CO_2 Modernisation Programme***
  The CO_2 modernisation programme was introduced in 2001 to supplement existing financing programmes targeting CO_2 reduction and modernisation. The programme supports energy-efficient retrofitting of buildings that have been constructed before 1995 by giving investors additional incentive. The programme is not targeted solely at the residential sector, but addresses the public sector, services and industry as well. The government provides financial resources via the KfW for either full-scale renovation to newly built house levels or specific energy-efficient retrofitting measures such as heat insulation, modernisation of windows, and heating systems exchange. From 2001 until 2007 a total credit volume of €10bn was allocated. In 2006 and 2007 the programme had a volume of €3.4bn and €1.8bn, respectively. During this time, federal funds were reduced

from €1.1bn to €850m. For 2008, considerable reductions were planned. Yet, the first economic stimulus package increased federal funds to €1.4bn in 2008 and to €1.5bn in 2009. It also created a credit volume of €3.8bn in 2008 and €4.1bn in 2009 (UBA, 2009a).

- ***KfW Energy – Efficient Rehabilitation***
  This programme also supports financing emission reducing modernisation measures in residential houses with grants and low interest loans. It supports non-energetic modernisation and maintenance measures as well as the demolition of rental buildings. Since 2009 the eco-plus version of the programme has facilitated highly efficient single retrofitting measures such as insulation, window replacement and heater exchanges based on renewable energies, combined heat and power generation or district heating. In 2006 and 2007 the approved credit volume was €2.8bn and €3.3bn, respectively (Deutscher Bundestag, 2008). In 2009, the total approved credit line was €3bn, while the credit volume for eco-plus modernisation was €675m.
- ***KfW Energy-Efficient Construction***
  Introduced in 2005, the two lines of this programme provide financial support for the construction of new residential houses or the acquisition of existing ones. Most of the funding is to be used to reduce primary energy consumption to at least 30 % below the prescribed EnEV 2009 norms. The programme also encourages the installations of renewable energy heating equipment and cogeneration. The credit volume was €2.2bn and €2.1bn in 2006 and 2007, respectively.
- ***KfW Proprietary Programme***
  Introduced in 1996, this programme focuses on financing the construction of new or the acquisition and modernisation of existing private residential buildings and owner-occupied flats. The programme supports 30 % of total costs and offers loans up to €100,000. In 2007 and 2008 the total credit volume was, respectively, €5.2bn and €4.5bn, of which roughly 70 % went to acquisition and modernisation. The programme does not specifically target energy efficiency, but since a majority of its funds go for modernisation it is an important instrument for reducing emissions in the residential sector. This programme directly addresses problems arising from limited credit market access and liquidity constraints of investors. Moreover, the KfW gathers and provides knowledge to potential investor, thereby restricting information deficits. Furthermore, as long as externalities are not accounted for by the emission trading system – as in the case of domestic heat production – the policy reduces environmental externalities from CO_2 emissions.

3. **Renewable Energy Heat Law (EEWärmeG)**
   The German government aims to increase the renewable energy share in heat supply from today's 6 % to 14 % in 2020. The Renewable Energy Heat Law, passed 2009, requires 5 % of the heat consumption of new buildings to be supplied by renewable energies. However, the law does not set standards or prescribe measures for the existing house inventory. In order to help constructors to carry additional costs, the government linked the implementation of the law to the market incentive programme, which was created in 1999 to support the introduction of renewable energies. On the supply side the law stipulated that municipalities may introduce the obligatory connection and use of renewable energies in district-heating networks.
   - ***Market Incentive Programme***
     The programme supports the utilization of renewable energy appliances for heat supply and, as of 2008, the installation of heat pumps. The Federal Office of Economics and Export Control (BAFA) made €200m and €300m available in 2008 and 2009 respectively, triggering investments of approximately €3bn in 2009. The volume of the programme was reduced to €265m in 2010.
     The market incentive programme addresses two failures present in the energy market. On the one hand, it helps to overcome liquidity constrains for new and inexperienced renewable energy technologies in the capital market; on the other, it helps to reduce externalities from the use of fossil fuels in the domestic heating sector (externalities that the emission trading system only partly reduces). The increased use of renewable energy heat technologies may also trigger improved learning-by-using effects.
4. **Promotion and Support of Energy Consulting for Residential Buildings**
   The Federal Ministry of Economics runs an in-house counselling programme as an advisory service for efficient and rational energy usage in residential buildings. It is an instrument to identify potentials for energy investments and inform people about potential efficiency gains and existing support opportunities. House owners are supported financially to carry the cost of consultancy. Notably, the number of consultations has increased sharply since 1998, reaching its peak in 2006 when the programme's budget was €6m. The number of consultations decreased when the budget was reduced to €4.7m in 2008.
5. **Informational Campaigns**
   Informing consumers about energy efficiency opportunities and financial support schemes are strategies that can be put to use in a variety of ways. The German Energy Agency's (DENA) project on heat from renewable energies and the initiative Solar Heat Plus aims to inform consumers about the potentials and support schemes for residential heat from renewables. The DENA projects Energy Pass for Buildings and Quality Seal Efficiency House offer background information and working tools to ten-

ants and landlords about the mandatory energy pass. The DENA programme Future Building initiated the pilot project Low Energy House in the Housing Stock to establish ambitious efficiency standards using innovative technologies and prove best practices. DENA led to the renovation of 375 buildings – decreasing energy demand by 87 % on average – and established a network of regional expert centres for low-energy renovation.

The general purpose of informational campaigns is to decrease the lack of information on the side of potential consumers and investors. In particular, these programmes reduce principal agent problems between tenants and landlords. Moreover, they may also increase the benefits from learning-by-using as new technologies and construction techniques are established from which constructors, architects and investors can learn.

Effectiveness of Existing Measures in Germany

Table 4.1. CO_2 savings in existing policies aiming at efficiency improvement in space heating and domestic hot water supply

Measure/Instrument	Policy type	Direct emission reduction effect in €million. t CO_2-equiv.				
		2010	2015	2020	2025	2030
KfW – Energy-efficient rehabilitation	financial	3.4	5.5	7.7	9.9	12.1
KfW – Energy-efficient construction	financial	0.4	0.7	1.1	1.4	1.7
Energy counselling in residential buildings programme	financial	0.2	0.3	0.5	0.7	0.8
Market incentive programme	financial	1.6	3.1	4.8	6.4	8.0
KfW proprietary programme	financial	-0.3	-0.4	-0.5	-0.6	-0.6
Energy-saving ordinance	law	0.4	2.0	3.6	5.3	7.0
Heat cost ordinance	law	0.0	0.1	0.2	0.3	0.5
Renewable energy heat law	law	0.3	0.9	1.5	1.9	2.4
Deduction due to overlapping		0.7	2.9	5.1	7.2	9.4
Un-weighted effect of policy measures		6	12.5	19.1	25.7	32.2
Weighted effect of policy measures		5.3	9.6	14	18.5	22.9

Source: UBA (2009): Politikszenarien für den Klimaschutz V – auf dem Weg zum Strukturwandel, Treibhausgas-Emissionsszenarien bis zum Jahr 2030, Dessau-Roßlau, October 2009, p. 121.

The effectiveness of these measures with respect to their emission reduction contribution has been estimated by a study conducted for the Umweltbundesamt (UBA 2009a). Policy effects have been modelled based on the assumption that 2008 financing mechanisms are extended until 2030. The results suggest that from 2005 until 2020 roughly 14 MT of CO_2-equivalents and until 2030 additional 9 MT could be reduced (Table 4.1). Compared with 1990 levels this corresponds to a reduction of 22 % by 2020 and 34 % by 2030, respectively. The study revealed that a tightening of existing policies can achieve significant additional emission reductions. Section two of this report presents instruments already discussed in Germany alongside with best practice policy measures from other countries and some new policies ideas that might be worth further analysis.

4.2.3.2 Final Energy Using Appliances and Electricity

Electricity consumption in private households is responsible for a considerable share of total energy consumption. Lighting and the use of information and communication technologies is growing strongly and currently account for about 5 % of final energy consumption. Reducing individual electricity consumption with supply- and demand-side policies – such as requiring end-use appliances to be more efficient, providing households with information on the efficiency of appliances and consumption habits and setting appropriate incentives for behavioural changes – could be decisive in reducing consumption and CO_2 emissions.

European Level

Increasing electricity consumption efficiency in private households is a further lever for the European Union to achieve its emission reduction target and to increase supply security. The Directive of Energy End-Use Efficiency and Energy Services (EC 2006), already mentioned in the previous section, and the Ecodesign Directive (EC 2005) are the most important pieces of legislation. The Directive of Energy End-Use Efficiency and Energy Services introduced supply-side obligations that require member states to prevent industry and businesses from activities that obstruct the supply of services and programmes improving energy efficiency, to inform end consumers on programmes aiming at increasing energy efficiency and to cooperate in voluntary agreements or market-based measures aiming at electricity consumption reduction. As mentioned before, the directive provides for the development of energy auditing systems for the end consumer. According to the directive, end-users are to be provided with individual meters and informative billing indicating current prices and consumption, comparison of current consumption with previous consumption and institutional contacts providing details on how to improve energy efficiency. Each of these steps, indirectly, gives incentives to consumers to adopt efficient consumption levels. The most important directive setting standards and information criteria for energy appliances is the 2005 Ecodesign Directive and its respective commission regulations. Other European legislation includes the directive on labelling standard product information for energy-using products and the Ecolabel regulation.

1. **Ecodesign for Energy-Using Products Directive – EuP (2005/32/EC)**
This framework directive, revisited in November 2009, aims at an environmentally friendly, energy-saving design for all energy appliances that use, generate, transfer or measure energy and for all other energy related products with an impact on energy consumption. The text defines principles, conditions and criteria for setting environmental requirements for energy-using products. The directive's explicit scope is the EU's internal market. This makes member state implementation of the directive obsolete, since it applies directly to all products and parts produced and traded in the European market. This prevents separate national legislation on environmental product performance from becoming an obstacle to intra-EU trade. Manufacturers and importers have to ensure that products comply with the directives' standards that require consumer information about environmental performance.
The EU parliament and member states agreed that self-imposed measures by the industry can be given priority if they are more efficient and if certain criteria are fulfilled.[13] The directive makes no direct provision about mandatory requirements for specific products but prescribes conditions, criteria and a methodology for a ***framework of consultations with member state experts to derive implementing measures***. Currently, ***directly effective measures*** are taken on a product-by-product basis by the Commission and are supervised by a committee of member state experts. In this consultation process, standards for defined priority products, such as heating and boiler equipment, electric motors, lighting, domestic appliances, office equipment, consumer electronics, ventilation and air conditioning systems have been defined. It regards previous EU-regulations as implementing measures that have a direct effect on all member states. Relevant implementing measures for the private household sector are:

- ***Directives of efficiency requirements for:***

Hot-water boilers fired with liquid or gaseous fuels (92/42/EEC)
Household electric refrigerators, freezers and combinations thereof (96/57/EC)
Ballasts for fluorescent lighting (2000/55/EC)

- ***Commission regulation in regard to eco-design requirements for:***

Standalone circulators and product integrated circulators (EC No. 641/2009)
Electric motors (EC No. 640/2009)
Household refrigerating appliances (EC No. 643/2009)
Televisions (EC No. 642/2009)
No-load condition electric power consumption and average active efficiency of external power supplies (EC No. 278/2009)
Non-directional household lamps (EC No. 244/2009)
Fluorescent lamps without integrated ballast, high-intensity discharge lamps, and ballasts and luminaries able to operate such lamps (EC No. 245/2009)

Simple set-top boxes (EC No. 107/2009)
Standby and off mode electric power consumption of electrical and electronic household and office equipment (EC No. 1275/2008)
Additionally, the commission is conducting preparatory studies to implement standards for further product groups such as solid-fuel small combustion devices, laundry dryers and vacuum cleaners.

2. **Directive concerning the labelling of household appliances to indicate power consumption and other resources used (92/75/EC)**
The directive requires household appliances to display information on energy and other resource consumption. Suppliers must establish detailed technical design calculations and test reports. Member states have to take necessary measures guaranteeing that the obligations are met and that informational campaigns aimed at encouraging private consumers to efficient energy consumption are provided. Since the Directive was issued in 1992, several implementing rules on energy labelling for household appliances have been passed:
    - electric refrigerators , freezers (2003/66/EC)
    - electric ovens (2002/40/EC)
    - air-conditioners (2002/31/EC)
    - dishwashers (1999/9/EC)
    - lamps (98/11/EC)
    - combined washer-dryers (96/60/EC)
    - electric tumble dryers (95/13/EC)
    - washing machines(95/12/EC, 96/89/EC)
    - office equipment (No 2422/2001).
3. **Ecolabel Regulation**
Several different EU directives and regulations (92/75/CEE, 94/2/CE, 95/12/CE, 96/89/CE, 2003/66/CE, EEC No. 1980/2000) have set the framework for a European-wide ecolabel to promote products with a lower environmental impact than products in the same product group. The clearly displayed ecolabel provides consumers with environmental performance information. The label is awarded to products meeting certain environmental requirements and specific criteria defined within an assessment matrix. These criteria have been set and reviewed by the European Union Ecolabelling Board. Product suppliers apply to the national ecolabel office to have products awarded with the ecolabel. The terms of label use are determined contractually and label use is subject to an annual user fee. In order to qualify, products must be sold for end-use purposes, must represent significant volumes of sales and trade in the internal market and must have considerable potential to improve the environment. The regulation also requires the Commission and member states to promote the use of the ecolabel through information campaigns and coordination between the community's eco-label and existing national schemes. Several energy-using products are subject to the eco-label scheme:

- Electrically driven, gas driven or gas absorption heat pumps (2007/742/EC)
- Portable computers (2005/343/EC)
- Personal computers (2005/341/EC)
- Refrigerators (2004/669/EC)
- Washing machines (2003/240/EC)
- Light bulbs (2002/747/EC)
- Televisions (2002/255/EC)
- Dishwashers (2001/689/EC)

4. **Energy Star Label Programme**
   Based on a US initiative in 1992 the Energy Star label encourages manufacturers of office information and communication technology equipment to voluntarily apply energy performance specifications. As office equipment is responsible for a growing share of electricity consumption in the EU, the Commission adopted the label in 2005.

National Level – Germany

The National Energy Efficiency Action Plan and the Integrated Energy and Climate Program (IEKP) outlined earlier also set the framework for energy-saving measures targeting energy-using appliances. The extended part on European level policies indicates that major policies are made here.

The specific policies derived from this energy-saving framework are:

1. **Energy Appliances Law (EBPG)**
   Making the Eco-design directive into national law, the Energy Appliances Law, introduced in 2008, requires that the EU Commission's implementing measures be binding for the national market. The law states that products are only to be brought to the market if they conform to the requirements defined in the EU Commission's implementing measures. The law outlines informational duties of producers or importers and assigns market control to the Federal Institute for Material Research and Testing and its associated agencies. The law is further specified by the Energy Consumption Labelling Ordinance and the Energy Maximum Consumption Ordinance**.**
   - ***Energy Consumption Labelling Ordinance (ENVKH) and Energy Maximum Consumption Ordinance (ENVHV)***
     These ordinances, enacted in the 1990s, ratify the EU framework directive on standard product information as a national law. The European-wide ecolabel prescriptions must hence be visualised for products on the German market, indicating technical information and its consumption of energy and other resources.
   - ***Further energy labelling; voluntary industry commitments***
     The Blaue Engel introduced in 1978 is a well-known seal of environmental product quality and broad with respect to its product cov-

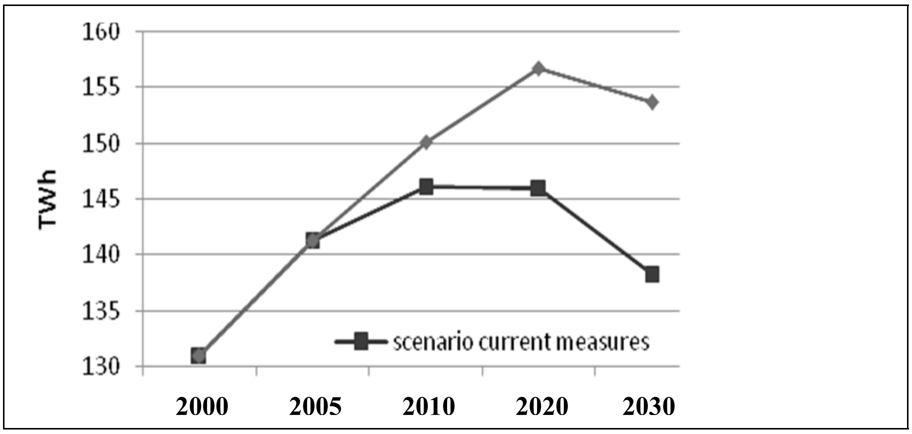
erage. Another widely used quality seal is the GEEA-label, assigned to TVs, computer, copy and fax machines, printer, power supplies, video recorder and battery chargers, though it has recently been replaced by the Energy Star label. Since 2002 the German Energy Agency (DENA) has coordinated the implementation of the Energy Consumption Labelling and the Energy Star programmes. DENA, therefore, is the national focal point for producers, dealers and informing consumers for European energy labels.

The EBPG and voluntary industry commitments address problems arising from insufficient consumer information about energy consumption for specific products. This work may improve consumption decisions distorted by incomplete information. In case of underinvestment in energy efficiency, the law may reduce energy consumption and related externalities from energy production if not covered by the European emission trading system.

2. **Law of Opening the Metrology (2008):**
   This instrument has already been mentioned in the context of space heating and domestic hot water. It aims to achieve the clear and transparent accounting of electricity consumption. The law, introduced in 2008, provides for the introduction of smart-meter technology via the liberalisation of the metrology market. Relying on the private demand for technology, it gives consumers the right to choose metering point operators. On the one hand, the precise consumption-based billing enabled by smart metering permits averaged cost pricing to be reduced, giving consumers the opportunity to adjust consumption to off-peak times. On the other hand, the impact of this policy might be marginal, as electricity suppliers are not obliged to install the new technology for the benefit of all consumers.
3. **Informational Campaigns**
   In addition to the programmes in place, Germany is running several informational campaigns at the national, federal and municipal levels to inform consumers about energy efficiency. The most prominent in this respect is the ***Initiative for Energy Efficiency*** started in 2003. The aim of the initiative is to raise awareness and increase the profile and spread of energy-efficient equipment in households and industry. By implementing non-obligatory provisions, the initiative increases energy efficiency through changes in consumption, investment and usage behaviour. The campaign is organised by DENA, EnBW AG, E.ON AG, Vattenfall Europe AG and supported by the Federal Ministry of Economics and Technology.

Effectiveness of Existing Measures in Germany

Fig. 4.2. Development of electricity consumption in private households 2000-2030



Source: Figures are extracted from UBA (2009b): Politikszenarien für den Klimaschutz V – auf den Weg zum Strukturwandel, October 2009, Dessau, based on AGEB (2008) and calculations at ISI and IEF-STE.

The effectiveness of measures targeting final energy using appliances and electricity consumption in Germany has been assessed by the UBA study (UBA 2009b) mentioned above. The results suggest that without current measures the electricity consumption increase will continue until 2020 and decrease slightly thereafter. The policy measures adopted are expected to stabilise electricity consumption at 2005 levels as demand for end-using appliances continues to grow. In contrast to the aim of consumption reduction, the development in the current measures scenario would be equivalent to an increase of 17.9 % of consumption in 2020 over 1990 levels (Figure 2). This indicates that a substantial emission reduction cannot be expected if the government does not improve its policies. Strengthening existing instruments and introducing additional measures, therefore, is necessary for the fulfilment of the electricity consumption reduction target. As for the domain of space heating and domestic hot water supply, additional measures in the area of private household electricity consumption are discussed in section 4.

4.2.3.3 Green Electricity

The Renewable Energy Directive (2009/28/EG) prescribes the enactment of laws in the member states that increase the share of renewable energies in total primary energy supply to 20 %. In Germany the main instrument is the Renewable Energy Law and its feed-in tariff (FiT). The FiT establishes a fixed price for renewable energy sources and an annual digression of these tariffs for subsequent years to overcome market barriers and to adapt to cost developments of renewable energies.

Some measures also address the demand side for green electricity. The directive concerning common rules for the internal market in electricity (2003/54/EG), introduced in 2003, established an electricity identification requirement to increase consumer awareness about the environmental effects of their electricity consumption. The directive also increased the comparability and transparency of electricity contracts, enabling consumers to make more informed decisions when selecting electricity providers. In Germany the Energy Industry Act (Energiewirtschaftsgesetz), which was introduced in 2005, transformed the directive into national law. But these measures do not necessarily require suppliers to indicate electricity sources and additional environmental benefits of using renewable energies. Hence the electricity identification requirement is unable to replace the various green electricity labelling initiatives, but may increase the comparability of basic information required from electricity contractors.

Several initiatives to certify green electricity to increase market transparency and consumer information have already been introduced. The EUGENE Green Energy Standard was an international standard accredited by national green electricity labelling schemes. Initially financed by the European Union's CLEAN-E initiative, the project aimed at harmonizing green power labels. But it was abandoned in 2009 when it became clear that labelling green power had to be tailored to the needs of national electricity markets and consumer expectations. In Germany there is no government-sponsored initiative on green power labelling, but various quality seals of green electricity can be obtained. These include those of the Technical Supervisory Associations (*TÜV),* Green Peace Energy and Grünes Strom Label e. V. Unfortunately, the impact of these labels on consumer behaviour has yet to receive a thorough assessment.

4.2.4 Supplementary Measures

In the previous sections the energy and emission saving potentials of German policies were outlined mainly according to the study by the Federal Environmental Agency (UBA, 2009a). For *space heating and hot water supply* and for *end-use appliances and electricity consumption*, there is a gap between policy effectiveness and energy-saving targets. Because of this gap, we identified several adjusting points for existing policies and supplementary measures.

This section provides an overview of supplementary measures currently discussed.[13] In addition, it also identifies instruments that have been implemented in other countries or that seem feasible economically. We briefly discuss best practices and new measures and offer some theoretical observations about the link between market failure and policy intervention.

4.2.4.1 Space Heating and Domestic Hot Water

In section 3 we underlined the leeway for optimisation left by the implemented measures. Given the implementation of the following supplementary measures, significant additional savings could be achieved:

1. **Tightening retrofitting requirements for heating boilers and heat systems; strengthening certification enforcement:**
   Current requirements of the EnEV 2009 only apply to appliances taken into service before October 1978. The requirements do not apply to buildings that contain two flats and at least one is used by the owner. If these retrofitting requirements were tightened, significant energy efficiency gains and respective CO_2 reductions could be possible. With respect to the existing certification schemes on energy-efficient houses, owners and investors have to document improvements that are currently subject to random inspection. Strengthening the inspection would improve compliance and increase the visibility and impact of the energy pass.
2. **Applying renewable energy heat law to old buildings:**
   Renewable energies for heat services are mandatory only for the construction of new buildings. The installation of such devices on existing building stock is currently not mandatory but supported by the market incentive programme. Obligatory installation in the case of renovation could reduce CO_2 emissions more effectively and alleviate the common market failures connected with the diffusion of new technologies in the domestic heating sector. A specific example is the obligatory application of the Renewable Energy Heat Law to old buildings in Baden-Württemberg.
3. **Reduction of VAT for renewable energies:**
   The reduction of the value added tax can trigger additional energy-efficient retrofitting and renovation. The reduced revenue of the state might, at least partially, be offset by tax revenues induced by additional growth.
4. **Heat cost reduction rights for tenants and the inclusion of energy efficiency in rent indices:**
   Operating costs are becoming increasingly important for tenants. Yet landlords frequently disregard their rent share. Often, rent indices and brochures only indicate cold rents and neglect overhead costs. But this does not indicate the true price of living to potential tenants. Introducing a heat cost reduction right if EnEV requirements for building insulation and heating appliances are not met would give landlords the incentive to invest and to disclose true housing costs. Another instrument to unveil operating costs is to require landlords to inform tenants about the house's energy performance. The existing energy pass offers an adequate means for implementation.
5. **Heat contracting in residential housing market:**
   The main advantage of heat contracting is that landlords do not need to invest their own resources for the installation of new heating systems. Instead the landlord heat billing costs and payment shortfall risks are passed to the contractor. Additionally, contractors have an economic incentive to conduct their energy supply and service obligations with efficient technology since production, emission and distribution losses add to

their expenses. The user investor dilemma is reduced because contractors, unlike landlords, can amortise their investments into the heating system through higher heat prices creating higher auxiliary expenses for tenants. According to current legislation, landlords may only introduce contracting to tenants if explicitly stipulated in the rental agreement or if all parties agree to necessary changes. Furthermore, if heat contracting is not supplemented by landlord investments into building insulation, the largest share of energy saving-potential will remain untouched. Like the electricity market, consumers have the opportunity to choose contractors according to their "green" energy sources.

6. **Tightening standards for KfW support programmes:**
   The specific support of retrofitting measures that reduce energy consumption of renovated houses based on comparable energy efficiency standards. Supported new buildings could be an effective instrument parallel to the tightening of the ordinance in 2013.
7. **Obligation to connect renewable energies to the heat grid:**
   In order to reduce barriers for renewable energies in the heat sector, the renewable energy heat law currently gives municipalities the right to introduce a renewable energy requirement in district and local heat networks. Turning this optional policy into a general obligation would ease the access of renewable heat to the market.
8. **Feed-in-Tariff (FiT) for heat from renewable energies:**
   Currently, local and district heat networks are characterised by the absence of market prices, since heat is usually provided by regional monopolies where prices are administered. Hence, prices are not always transparent. The provision of renewable heat requires long-term investments in technology. Consequently, the introduction of a fixed guaranteed FiT, set on an appropriate jurisdictional level, could improve the basis for investment calculations in renewable heat.

4.2.4.2 Final Energy Using Appliances and Electricity

The overview of the effectiveness of the policy measures in section 2 reported that these instruments are only able to stabilise electricity consumption at 2005 levels but cannot contribute to a significant consumption and emission reduction measured against 1990 levels.[13] The following tightening or supplementary measures might help close the gap between policy outcome and policy goal:

1. **Introducing stricter minimum efficiency standards:**
   The Eco-Design directive can serve as the cornerstone for the introduction of binding and ambitious minimum efficiency standards for a broader set of energy products. The enactment of further product-specific measures could be put on the fast track. When it comes to implementing standards for a larger product group and dynamically adjusting existing standards, a top runner method is often proposed because it steers standards toward the best product in the market.

2. **Improving energy consumption labelling:**
   The revision process for the quality seal of energy appliances was enacted by the directive on the energy labeling of household appliances (92/75/EC). However, that process could be improved, and extended to further products.
   In early 2010 the European Commission issued a draft directive to keep up with the advances in energy efficiency technologies for televisions. This directive proposes additional energy classes to the existing label scheme. In May 2010 the European Parliament adopted a package of energy efficiency laws, including the proposed efficiency label scheme. It is now required that the energy consumption of household end-use appliances be clearly displayed in commercials to assist consumers in assessing expected running costs.
3. **Obligation to install smart meters:**
   Requesting and supporting the broad installation of smart meters by energy suppliers would set consumption reduction incentives for private consumers. As smart metering also allows for real-time electricity billing, consumers have an incentive to adjust their consumption patterns to the scarcities of the electricity system. This might also enhance the ability to integrate an increased share of fluctuating renewable energies.
4. **Financial support for highly efficient electrical appliances or introduction of an energy efficiency fund:**
   The establishment of a market programme for highly efficient electrical appliances is proposed by the German energy plan but has not yet to be implemented. A programme or a fund supporting highly efficient household appliances and efficiency technologies in business, service and industry would increase the market penetration of best available technologies.

With respect to end-use appliances and electricity consumption in private households, several best-practice policies from other countries have been identified:

1. **Offering free-of-charge counselling and information campaigns:**
   The increasing utilisation of existing counselling and information campaigns indicates great demand. Yet most programmes require a user charge, which reduces utilisation. The Danish Electricity Energy Fund introduced an interactive online portal with individualised and comparative consultation tools. The portal allows users to analyse individual electricity consumption based on a set of usage habits and appliance endowment. The tool is free of charge and gives individualised recommendations for action with respect to changes in consumption habits and an overview of existing support schemes for purchasing efficient appliances.
2. **Requiring that electricity suppliers provide individual feedback to consumers:**

Individual and comparative feedbacks from electricity suppliers to consumers should give information about specific household consumption. Moreover, the effectiveness of comparative electricity bill feedbacks can be increased by not only comparing to the abstract average household, but to the specific social context. Individual feedbacks are required in Norway and tested in some regions in Denmark and Germany. It has been shown, that such a feedback can lead to savings of 5-12 %.

3. **Introduction of electricity-saving requirements and demand-side management measures:**
   Energy reduction requirements for the electricity industry, as introduced in Denmark, Great Britain, Italy, France and Belgium, leave means of achieving policy goals to the industry. The systems in place differ tremendously in their design. However, they all target usage habits and the acquisition of energy-efficient appliances. Alternatively, or additionally, a system in which energy supply companies can purchase "white certificates", issued for each implemented energy-saving measure, would create a market for energy savings because companies that overachieve their energy-saving requirements can sell certificates.
4. **Progressive electricity tariffs:**
   Progressive electricity tariffs are mechanisms giving incentives for energy savings based on price differences. Examples include Japanese electricity tariffs to private household and the Vienna Public Utility Company (Wienstrom). In these cases the price per unit of consumed electricity increases progressively, creating incentive for consumption reduction.
5. **Commercial and informational campaigns for energy-efficient products:**
   These informational tools, which go beyond product labelling, are meant to make consumers purchase more efficient household appliances. Austria, for example, introduced an online tool promoting the top energy-efficient products for households. The tool also allows for in-depth comparison of prices and other product characteristics. Informational campaigns initiated under the Danish Electricity Efficiency Fund go even further, since they are tightly linked to the governments grant programmes for the purchase of energy-efficient appliances and related counselling programmes.
6. **Temporarily confined premium programmes:**
   The disbursement of a premium can reduce the price of highly efficient products to a level comparable with average products. An incentive is given to the consumer to purchase appliances with a high efficiency standard. In the Netherlands a temporally confined and subsidised programme supporting the purchase of energy-efficient household appliances, house insulation and the modernization of heating systems was introduced between 1999 and 2003 with great success. The system, run under the framework of the Regulatory Energy Tax, retrieved a share of the eco-tax paid if more energy-efficient technology was used.
7. **Dynamisation of efficiency standards (Top Runner):**

This instrument aims at a differentiation of the energy consumption label and a dynamic updating of energy efficiency standards for energy appliances. Currently, a comparable measure exists only in Japan, introduced as part of the framework of the Energy Conservation Law. But the frameworks of the Energy Consumption Labelling directive, Energy Star and the Eco-Design directive are suited to introduce the instrument in Europe as well.

4.2.4.3 Green Electricity

Increasing the share of renewable energies in private household electricity consumption could be an important lever to reduce GHG emissions. The decisive question is whether it is best to achieve this target by introducing appropriate supply or demand side policies. The following is an idea for a demand-side measure.

Setting green electricity contracts to default: Studies in behavioural economics unveiled that many people prefer an environmentally friendly source of electricity. But even when green electricity is available, people do not buy it because information presentation adversely affects choice.[13] Hence defining green electricity contracts as the standard option could be a way to increase the demand for green electricity from private households. There are two best practice examples. A private initiative in Schönau, Germany, took control of the local electricity grid in 1997. Purchasing energy mainly from renewables, the company supplies green electricity by default, but allows consumers to switch to alternative contractors. The second example is given by Energiedienst GmbH, which supplies a grid area in Baden-Württemberg. Here, the supplier offers a number of alternative contracts that set the standard contract to green by default. This allows consumers to switch to a cheaper "grey" alternative or to an even more expensive "greener" electricity contract, which offers energy from new facilities. In both examples the share of people using green electricity was drastically higher than on German average: Most people remained with the more expensive but environmentally friendly energy contract.

4.2.5 Conclusion

This report has given an overview of current measures targeting energy efficiency in the household sector. The focus has been on the two main energy consumption sources – space heating and hot water supply – and on final energy using appliances and electricity. The report outlines the effectiveness of these policies in energy saving and emission reduction. In view of current measures' failures to reach the overall target for energy efficiency and emission reduction, the report summarises potential supplementary policies.

The compilation of instruments and measures makes clear that there is a variety of policy action levels. The main objectives of supplementary policies are to improve consumer information, support financing conditions, introduce new technologies and improve market access. Without these supplementary measures, the standard policies may negate each other or be ineffective. Some policies might outperform other policies in the same field of action and use public funds more effectively. Generally, when giving policy recommendations about a specific proposal, the economic rationale should be laid out clearly. The underlying market imperfections and failures should be described thoroughly, therefore, and cost and effects should be estimated in future research.

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5 Impacts of the Instruments

5 Impacts of the Instruments

Lothar Rausch and Christof Timpe

5.1 Introduction

Household products consume natural resources in several ways. The manufacture of products, their use and sometimes even their form of disposal all contribute to overall resource consumption. Purchase decisions today influence how we use and replace products tomorrow.

The goal of sustainable development is to use nature in a manner that conserves natural resources. The present use of natural resources is largely unsustainable. It is hence desirable to make decisions that minimise resource use.

As part of the project Social, Environmental and Economic Dimensions of Sustainable Energy Consumption in Residential Buildings, we determined possible effects of suboptimal decisions on environment and economy. From observations and model experiments, we know that consumers do not always act perfectly. We examine the consequences of these decisions in detail for selected areas.

This paper discusses the results of the impact assessment of energy related decisions focused on heating, green power and the purchase of energy-labelled televisions.

5.1.1 Challenge

On the basis of results from model experiments, consumer surveys and stakeholder expert feedback, we evaluated three areas of private consumption. The decision to purchase television sets and the following use phase is highlighted in section 2. The focus is on the influence of the introduction of new energy consumption labels on the overall power consumption of TV sets. Section 3 examines the impact of electrical power supply type on consumption levels and compares different types of green power. In section 4, we evaluate the effectiveness of consumer choices in energy savings for one-and two-family houses.

5.1.2 Procedure

The data provided by the model experiments does not suffice to assess the effects of consumption choices. Hence, a different model was developed for each demand area. Each model reflects the factors determining resource use. All models describe the development of each demand area between 2010 and 2030. Because some of the influencing parameters are not yet available, we drew on the literature and trends to derive future assumptions. To determine the effectiveness of decision alternatives in a scenario analysis, the boundary conditions have been kept constant.

5.2 Evaluation of Consumer Choices: Televisions

5.2.1 Abstract

Based on EUP (2010), we assumed the introduction of energy labels for TV sets. The new labels reflect technological advancements to come in the near future. An initial scenario analysis using a stock exchange model shows that only strong purchasing recommendations for low energy consumption can compensate for the effects from larger screen size and longer usage time.

5.2.2 Introduction

The objective of the analysis is to estimate the effects of introducing new energy-saving labels for television sets. The EU has introduced new energy labels for televisions and has decided that the existing labels be adapted for higher standards.

During the processing of the seco@home project, the EU Commission finalised the introduction of energy labels for televisions (EUP 2010).

Based on this directive, we examined the impact of potential new energy-saving labels such as A + and A ++ on the electricity consumption of televisions in households – and, consequently, the resulting effects on the basis of selected sustainability indicators. This directive includes the design and the technical framework for labeling and calls for an efficiency requirement increase over the coming years.

5.2.3 Methodological Background

Many consumption decisions have an influence on television electricity usage. Screen size, television type, daily length of time in use, standby consumption and operation efficiency determine a television's electricity usage. The total number of televisions depends on demographic trends.

We modelled total television consumption using a design that mapped the given influence parameters onto model variables. The influence of individual parameters on the overall resultwas calculated on the basis of a scenario analysis. All other parameters were set to meaningful values.

To calculate the future electricity consumption of all installed television sets, a stock exchange model was developed. Old devices were replaced by new ones on a regular basis. A simplified algorithm with a constant replacement rate of 1/12th was determined. This is equivalent to an average lifetime of 12 years for each television set.

The power consumption of the devices is the main driver for determining environmental impact in the field of television usage. The power consumption of one television depends on energy label, screen size and usage time. The number of televisions in use is derived from statistical population data.

After the calculation of the total electricity consumption, GEMIS (Öko-Institut, 2010) was used to determine the environmental impact. The impact depends on the future energy mix for electricity production. This data was then entered into the GEMIS database.

The detailed steps and the assumptions for consumption patterns are explained below.

5.2.4 Definitions of Scenario Development Parameters

The key parameters for total power consumption result from the number of households, the equipment inventory[13] of the household, the average useful life of the units and the standby consumption of televisions. To keep the model manageable, different classifications were necessary. The variable parameters in the scenarios are device sizes and performance classes. Variations in the number of households, the average equipment inventory and the usage time were not assumed.

5.2.4.1 Technical Device Class

Currently (2010) there are three main technical device classes in use. Old devices consist mostly of cathode ray tube equipped televisions (CRT). These are no longer sold in most shops. New televisions have flat screens. Among the flat devices different technologies are used. The share of plasma screens is rapidly declining. Most new televisions are LCD devices. New technologies like OLED (organic LED) and niche applications such as rear projection televisions and projectors are not included. Add-ons like 3D-TVs have no significant impact on power consumption.

[13] Calculated as the number of devices per 100 households.

5.2.4.2 Categorization of Size

Television power consumption is determined by receiver electronics, signal processing and the reproduction unit. Since the display unit is the dominant factor and energy consumption is proportional to the illuminated area, there are a variety of size classes. In accordance with common international practice, the screen size information is given in inches. The area is defined with a fixed aspect ratio of 19 to 9.

For newly purchased television there are four different size classes:

Table 5.1. Definition of size classes

Class of size	Screen size [m²]
32" and smaller	0.28
37"	0.38
40"	0.44
Larger than 46"	0.58

From the conjoint analysis no preference for smaller devices could be derived. The same trends of increasing the size classes were thus expected for all scenarios. The increase in average unit size was derived from the survey; currently purchased equipment revealed a significant increase in screen size. A further increase of the size classes was expected for the next generation of devices.

Table 5.2. Assumed size changes of purchased TV sets

Class of size	2010	2030
32" and smaller	45 %	15 %
37"	40 %	15 %
40"	10 %	40 %
Larger than 46"	5 %	30 %

5.2.4.3 Efficiency Index

The new EU Directive on Energy Labelling of Televisions (EUP 2010) defines the following energy efficiency index:

Table 5.3. Efficiency index

Energy efficiency class	Energy Efficiency Index
A+++ (most efficient)	EEI < 0.10
A++	0.10 ≤ EEI < 0.16
A+	0.16 ≤ EEI < 0.23
A	0.23 ≤ EEI < 0.30
B	0.30 ≤ EEI < 0.42
C	0.42 ≤ EEI < 0.60
D	0.60 ≤ EEI < 0.80
E	0.80 ≤ EEI < 0.90
F	0.90 ≤ EEI < 1.00
G	1.00 ≤ EEI

The Energy Efficiency Index (EEI) is calculated as EEI = P/P_{ref} (A), where:

- P_{ref} (A) = P_{basic} + A · 4.3224 Watts/dm^2
- P_{basic} = 20 Watts
- A is the visible screen area expressed in dm^2

In the EU directive, it is assumed that the screen surface of the television leads to specific consumption levels taken into account by the technical specifications of the label. It starts from a base consumption per unit of 20 watts and then adds wattage based on screen size.

Because E and F represent obsolete technology and A+++ is not yet technically feasible, these labels were not included in the conjoint analysis.

Average values are used within the spectrum of the label's energy consumption. This produces the following power consumption table:

Table 5.4. Power consumption in watts for different screen sizes and labels

Watt	Label D	Label C	Label B	Label A	Label A+	Label A++
32" and smaller	108	90	75	63	51	38
37"	137	113	93	77	61	44
40"	157	129	106	87	68	49
Larger than 46"	202	164	133	108	83	58

5.2.4.4 Demographic Trends

The demographic trends are taken from Destatis (2010).

Table 5.5. Demographic trends

Year	2010	2020	2030	
German population	81,545,000	79,914,000	77,350,000	
Household size	2.05	1.98	1.93	Persons/household
No. of devices per household	1.6	1.7	1.8	Devices per household
Daily usage time	3.3	3.55	3.8	h/d

The daily usage time was recorded in the University St. Gallen questionnaire (Heinzle, 2010) and is similar to data from Destatis. It was assumed that usage time would increase by 0.5h/d during the scenario range.

5.2.4.5 Useful Life

Because we lacked data for new flat screen televisions, we assumed a useful life of 12 years for the present analysis. Empirical studies from Bitkom (BITKOM, 2010), however, show a rapid replacement of old televisions with new ones. The calculated results of new TV purchases in 2010 and 2030 – 5.6 million and 6.2 million sets, respectively – are lower than the 9.6 million purchases observed for 2010.

For the old equipment, the stock will sink to zero by the year 2022. An average power consumption of 100 watts was assumed.

5.2.4.6 Parameters not Included in the Study

Television standby consumption was not varied, since further savings were not expected. EU rules for new televisions are so strict that a significant change in levels is unlikely.

In addition to televisions, second-and third-party equipment is also available in the households. The number of these devices is covered by the equipment level. The usage of these devices is expressed in the average daily operating hours.

The different technical parameters of these devices are not taken into account. The use of computer monitors for television was not considered.

5.2.5 Scenario Definitions

To determine the influence of new energy-saving labels on expected future electricity consumption, a scenario analysis was carried out. Two scenarios are defined. They differ in whether televisions with the new energy labels A+ and A++ are purchased or not.

In the baseline scenario no additional purchase of these device classes were assumed. The scenario ‘new labels’ describes a gradual introduction to the market.

5.2.5.1 Scenario Assumptions

In the baseline scenario, all television labels from A to D were introduced. In the ‘new labels’ scenario for 2015 the additional labels A+ and A++ were introduced.

Table 5.6. Purchase assumptions for televisions with different labels

Label	2010	2015	2015	2030	2030
		Base	New labels	Base	New labels
A++			1.0 %		30.0 %
A+			1.0 %		30.0 %
A	40.0 %	47.5 %	45.5 %	70.0 %	30.0 %
B	40.0 %	37.5 %	37.5 %	30.0 %	10.0 %
C	10.0 %	7.5 %	7.5 %		
D	10.0 %	7.5 %	7.5 %		

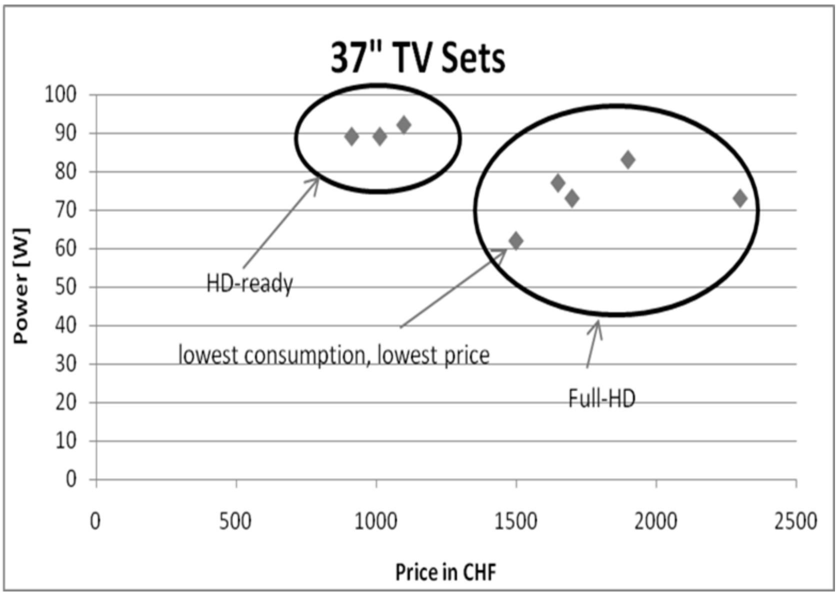
5.2.5.2 Analysis of the Purchase Price for Device Classes

There may be repercussions from high purchase prices for energy-saving televisions in terms of consumer behaviour. High prices of energy-saving devices could pose a barrier to adoption.

Using data at www.topten.ch (TopTest GmbH, 2010), an evaluation of the purchase price versus electrical power was performed.

The results of this analysis are shown in the following diagram:

Fig. 5.1. Prices and power consumption of 37” televisions

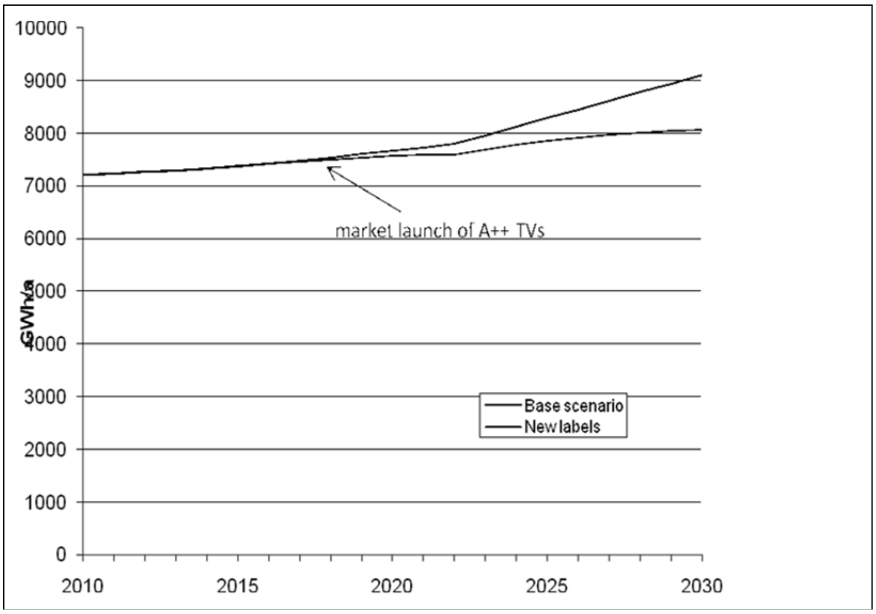


5.2.6 Findings

In the next step, the analysis of the impact of introducing new energy performance labels determined possible environmental impacts. An additional economic evaluation did not take place because no correlation between power consumption and television cost could be determined.

First, the power consumption of televisions for the years 2010 to 2030 was calculated using the stock model and the dynamics of specific consumption.

Fig. 5.2. Changes of total electricity consumption of television sets (authors' own calculations)

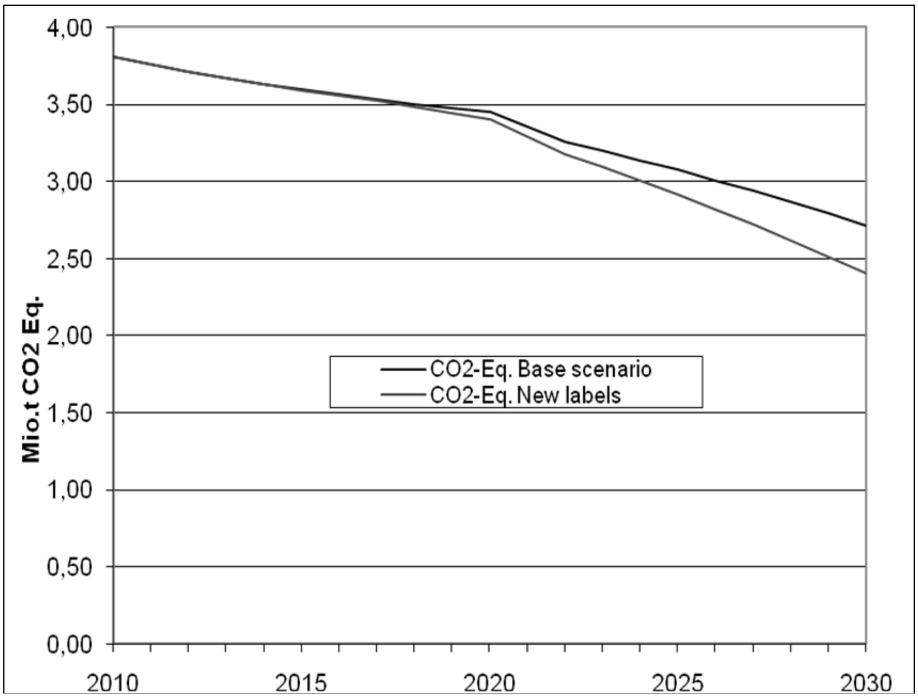


A higher number of televisions being purchased and larger screen sizes increase power consumption. Since the purchase of A+ and A++ appliances is assumed in the 'new labels' scenario for the years from 2015 onwards, there is a saturation of consumption growth in 2030.

The greenhouse gas (GHG) emission balance was calculated based on assumptions about power plant development in Germany. The increased use of renewable energy sources leads to reduced specific CO_2 emissions per unit of electricity generated. For the calculation of the CO_2eq balance, the development of electricity generation for the years 2010, 2020 and 2030 was included in the GEMIS 4.6 database (Öko-Institut, 2010).

The following diagram shows the CO_2eq balance based on the calculated results. By the year 2020, improvements in power plants will compensate for increased electricity consumption from televisions. In addition, new energy labels will bring about significant savings in greenhouse gases.

Fig. 5.3. Calculated GHG emissions from television use in Germany



5.3 Evaluation of Consumer Choices: Green Power

This section analyses the effects of private household purchasing decisions for green power. Due to the liberalisation of electricity markets in Europe, consumers not only have the opportunity to choose between differently priced electricity products. They can also choose between different energy suppliers and different products. One of the potential criteria for choosing one product over another is the environmental impact of the power source.

Since electricity markets were liberalised, green power has gained considerable market volume. A recent survey among green power suppliers assessed the market share of green energy in Germany (Köpke, 2010). According to this survey some 2.5 million households and some 100,000 commercial and public consumers in Germany drew green power in 2009. The total volume of green power purchased was estimated to be 12 TWh[14]. Although this figure is quite large in absolute

[14] Another 13 TWh are sold as green energy outside the scope of typical green energy products. For example, renewable energy might be blended with electricity from fos-

terms, it only represents some 2 % of the total final demand for electricity in Germany, which amounted to 540 TWh in 2009. Private households in Germany consumed some 7.3 TWh of green power, equivalent to around 5 % of the total power demand in this sector (Meinel, 2010; Köpke, 2010).

For the purpose of comparison: The total volume of energy supported under the feed-in mechanism of the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, hereafter EEG) is expected to be 90 TWh in 2010 (Amrion, EnBW Transportnetze, Transpower, Vattenfall, 2009). These figures illustrate the moderate significance of current green power demand in Germany as well as the significant potential for further growth in this market segment.

A green power product can be broken down into the following elements (Timpe, 2009):

- **matching power volumes** sold from "green" sources (these typically comprise renewable energy, but may under certain conditions also include high-efficient cogeneration based on fossil fuels);
- a proper tracking **of the origin of electricity**, which ensures that green energy volumes are not double-counted;[15]
- the application of certain **eligibility criteria** for electricity production (these criteria might exclude, for example, non-sustainable biomass or certain types of hydro power with high impacts on water systems); and
- measures to ensure a green power product's **environmental additionality,** i.e. the product's real contribution to a more sustainable energy system.

Not all green energy products contain all the elements mentioned above. There are several green power labels that aim to introduce more transparency in the green power market. Within the sector of domestic consumers, the label "ok power" has the highest market share, while the commercial and public sector is dominated by two labels, operated by TÜV Nord and TÜV Süd, whose criteria are generally less ambitious than "ok power" (Meinel, 2010).

5.3.1 Factors for Environmental Additionality

In order to assess the effects of consumer choices for green power on CO_2 emissions it is necessary to analyse the impact of such products on the energy system. Any reductions in CO_2 emissions can only be credited if, measured against a suitable baseline, the decision of consumers to use green energy actually leads to reduced carbon emissions. Incentivising investments in additional renewable energy power plants would be one example, provided that the power plants would not

sil or nuclear generation to create an electricity product from a variety of energy sources.

15 For more details on the issue of tracking systems, see the "A European Tracking System for Electricity" project (E-TRACK): http://www.e-track-project.org.

have been installed anyway and that they succeed in displacing fossil power plants.

For the purpose of environmental additionality, several factors need to be taken into account:

- The **EU Emissions Trading Scheme (EU ETS)** introduces a cap for the total emissions of large emitters in many sectors of the economy, including the power sector. Once the cap has been fixed for a certain allocation period, any expansion of renewable electricity or energy-saving measures might reduce emissions from fossil power plants, but because emission rights can be sold to other sectors these improvements do not lead to CO_2 emission reductions other than those stipulated by the EU ETS. Since the caps of the ETS are adjusted for each allocation period based on the development of renewable energy and energy demand, we do not take this effect in account.
- The **EU Renewable Energy Directive** 2009/28/EC has introduced ambitious mandatory national targets for the share of renewable energy in the overall final energy consumption of EU member states up to 2020. For Germany, the target is 18 %. (In 2009 renewable energy share in final energy consumption was 10.4 %). If a country exceeds its national target, it can transfer the surplus amount to other countries based on so-called “cooperation mechanisms”. Thus the national targets will most likely have the effect of caps for the renewable energy development. This means that any expansion of renewable energy production effectuated by green power demand will contribute to the realisation of the national targets, thus making other efforts in renewable energy obsolete. In order to enable environmental additionality of green power measured against the baseline defined by EU Renewable Energy Directive targets, national governments would have to make a pledge to aim at overshooting their national target at least by the renewable energy volume generated from voluntary green power demand and that this surplus will not be transferred to any other country. Without such pledges, the justification for green power to be sold at prices that are higher than those for “grey” power is reduced significantly. **European governments are hence strongly encouraged to take all necessary steps to issue such pledges.**[16]
- The **existing stock of renewable energy power plants** in the European electricity market is quite significant. In Germany, the law stipulates that the renewable energy supported through the feed-in tariff remain unavailable for the green power market. However, some 20 TWh/a is generated that is not supported by the feed-in tariff (mostly large hydro power). Furthermore, the

16 Such pledges are also necessary to ensure the additionality of any renewable energy used by electric vehicles.

net import of renewable electricity by German energy suppliers amounted to more than 21 TWh in 2009, with a rising tendency in recent years. With green energy demand only at 12 TWh, the oversupply renewable energy electricity in 2009 amounted to 41 TWh. So even if demand triples within a short period, no single new renewable power plant would have to be built in order to cover the demand.

This means that without further measures to ensure the additionality of green power products, the specific demand for green energy will be met by reallocating a certain share of renewable energy from the overall supply mix. No single new renewable energy power plant will have to be built to cover the green demand and thus the effects of green power demand on the share of renewable energy and carbon emissions will be zero.

To avoid this outcome, several green power quality labels require green products to incentivise investments in new renewable energy plants. Accordingly, the new renewable energy plants must refuse governmental support, even if they are entitled to it, so as to produce environmental benefits that go beyond those provided by, say, the German feed-in tariff.

For example, the “ok power” label (EnergieVision e.V., 2010) requires that

- at least 33.3 % of the energy sold to consumers under the label is supplied from power plants that are not older than six years;
- at least 66.7 % of the energy sold to consumers under the label is supplied from power plants that are not older than 12 years (this includes the share from plants less than six years old); and
- all the power plants that supply the energy accounted for under these shares do not receive public support for on-going production (such as a feed-in tariff).

In simplified terms, these criteria require a supplier of green power to build new renewable energy power plants every six years that cover at least one third of the volume of green power supplied to consumers. Of course the investment can also be made by other actors and the green power supplier can purchase the energy as defined by the criteria.

There are alternative regulations under the “ok power” label for some other types of green products, but these do not have a significant market volume. Some other green power labels have similar definitions of environmental additionality, yet others do not require any environmental additionality at all.

In the following, the “ok power” label is used as a reference for additionality criteria because it strikes a good balance between stimulating investments in new renewable plants and keeping costs of green power for consumers affordable. These are just several criteria that might be considered.

First, a slight reduction in the electricity consumption of high-priced televisions can be seen. A more detailed analysis of the results shows that the three devices priced at around 1,000 CHF are obsolete equipment with low resolution (HD-ready). For the group of five other devices, no clear relationship between price and consumption is observed.

An analysis of costs of purchasing energy-efficient equipment is not possible for the devices analysed so far. However the said effect will be considered in future strategy recommendation and analysis.

5.3.2 Methodology of the Assessment of CO_2 Reduction by Green Power

A suitable method is required for analysing the impact of green power demand scenarios on Germany's carbon emissions. The approach chosen here follows the proposal of Timpe (2009), which is based on the criteria for the "ok power" label as outlined above:

- If green power is supplied from power plants that are up to six years old and do not receive public support for on-going production, the emissions of the specific power plants are applied.
- If green power is supplied from power plants that are more than twelve years old, the average emission factor of the national electricity system is applied. The same applies for any generation that has received public support for on-going production, such as the German feed-in tariff.
- If supply is from power plants that are between six and twelve years old, the emission factor is calculated as the average between the national electricity system and the specific power plant.
  Like the "ok power" criteria, this third rule aims at incentivising suppliers to maintain renewable energy power plants as part of their product portfolio even after they reach an age of more than six years. The goal is to create a stable market for voluntary green power investments for at least 12 years of a plant's operation.

Applying this method to the minimum criteria defined by the "ok power" label leads to the following results:

- The 33.3 % of energy sold to consumers that is supplied from renewable power plants not older than six years is charged with the LCA emissions of the respective power plants. For the scenario calculations in the following section we use the emissions data of a wind park (~20 g/kWh, taken from the GEMIS model).
- For the 33.3 % of energy sold to consumers that is supplied from renewable power plants between six and 12 years old, the average of the emission factor of the national electricity system (648 g/kWh in 2010, 567 g/kWh in 2020 and 540 g/kWh in 2030, according to data used in the Blueprint Germany study), and the estimated emissions of the wind park are used.
- For the 33.3 % of energy sold to consumers that is supplied from renewable power plants older than 12 years, the emission factor of the national electricity system is applied as specified above.

Based on these calculations, the emission factor of a green power product meeting the minimum criteria of the “ok power” label is 327 g/kWh in 2010, 287 g/kWh in 2020 and 273 g/kWh in 2030. This gradual reduction is due to improvements in the national electricity emission factor as specified above.

For a general application of this method, the following points must be taken into account:

- Imports of electricity and domestic production are treated equally. All calculations in this approach are based on a lifecycle assessment of the power plants and their respective energy input. As a simplification for further analysis we assume that only renewable energy is sold as green power (without fossil fuelled cogeneration, etc.).
- For a precise calculation a residual mix emission factor would have to be taken into account instead of the average emission factor of the national electricity system. This residual mix would have to exclude double counting between the power plants that are considered a source of low-carbon for the additionality shares in the green power market and the emission factor applied to other parts of the electricity demand. Depending on the size of the green power market with additionality, the use of a residual mix emission factor can be quite important. We thus recommend that the relevant statistical data on the green power market be collected by the regulator or another suitable body and that the residual mix emissions be determined on an annual basis.

5.3.3 Evaluation of Scenarios for Measures Supporting Green Power Demand

In this section, four different scenarios are defined for measures that could be taken to support the demand for green power in the domestic sector. The scenarios cover the period between 2010 and 2030 and apply to Germany. The effects of the scenarios are assessed based on the methodology described in the previous section.

Two common factors for all scenarios were determined on the basis of the results of the reference case scenario in the study Blueprint Germany: A Strategy for a Climate Safe 2050 (Öko-Institut, Prognos, 2009). The scenario concerns the development of electricity demand in the German domestic sector, which is expected to decrease gradually from 140 TWh to 131 TWh in 2020 and to 118 TWh in 2030 due to energy efficiency gains. Furthermore, the structure of power plants in Germany is expected to change, which will reduce average emissions from electricity production from 648 g/kWh in 2010 to 567 g/kWh in 2020 and to 540 g/kWh in 2030.

5.3.3.1 Scenario 1: Business As Usual

In this scenario no specific measures are taken to incentivise green energy demand. Nevertheless we expect that the green energy market in the domestic sector will continue to grow steadily from 6 % in 2010 to 15 % in 2030. In absolute terms, the domestic demand for green power will increase from 9 TWh in 2010 to some 18 TWh in 2030. Based on this market share expansion and in the absence of specific measures by the government, we expect the share of products that contain an element of additionality will decrease from an estimated 33 % in 2010 to 25 % in 2030. In absolute terms, the volume of such products increases slightly from 3.0 TWh in 2010 and to 4.5 TWh in 2030. As for the minimum criteria of the "ok power" label (see above), the volume of additional renewable energy that can be attributed to voluntary private household demand increases gradually from 1.5 TWh in 2010 and to 2.2 TWh in 2030.

According to the method described in section 2.2, the reduction of emissions realised through green power demand compared with the national generation mix amounts to 1.0 Mt CO_2 in 2010 and to 1.2 Mt CO_2 in 2030. As can be seen from these figures, the growth rate of the emissions reduction is smaller than the volume of additional renewable energy. This is due to the assumed gradual reduction of specific CO_2 emissions in the average national generation mix, which serves as the reference case here.

Due to the limited volumes of the green power market, no residual mix calculation has been used in this assessment.

Table 5.7. Summary of scenario 1 (business as usual)

		2010	2020	2030
Green power demand (households)	TWh	9.0	14.4	18.0
Green power with additionality	TWh	3.0	4.0	4.5
Additional renewable energy	TWh	1.5	2.0	2.2
Emissions reduction (compared with national mix)	Mt CO_2	0.96	1.12	1.20

5.3.3.2 Scenario 2: Mandatory Use of Green Power Without Additionality Requirement

In this scenario no specific measures are taken to incentivise demand for green energy. Nevertheless, we expect that the market for green energy in the domestic sector will continue to grow steadily from 6 % in 2010 to 15 % in 2030. In absolute terms, the domestic demand for green power will increase from 9 TWh in 2010 to some 18 TWh in 2030. Based on this expansion of the market share and in the absence of specific government measures we also expect that the share of products containing an element of additionality will decrease from an estimated 33 % in 2010 to 25 % in 2030. In absolute terms, the volume of such products increases slightly from 3.0 TWh in 2010 to 4.5 TWh in 2030. Based on the minimum criteria of the "ok power" label (see above), the volume of additional renewable energy that can be attributed to the voluntary demand of private households increases gradually from 1.5 TWh in 2010 to 2.2 TWh in 2030.

In accordance with the methodology described in section 2.2, the reduction of emissions realised due to green power demand amounts to 1.0 Mt CO_2 in 2010 and 1.2 Mt CO_2 in 2030. As can be seen from these figures, the growth rate of the emissions reduction is smaller than those of the volume of additional renewable energy. This is due to the assumed gradual reduction of specific CO_2 emissions in the average national generation mix, which serves as the reference case here.

Because of the limited volumes assumed in the green power market, no residual mix calculation has been used in this assessment.

Table 5.8. Summary of scenario 2 (mandatory use of green power, without additionality requirement)

		2010	2020	2030
Green power demand (households)	TWh	9.0	131	118
Green power with additionality	TWh	3.0	4.0	4.5
Additional renewable energy	TWh	1.5	2.0	2.2
Emissions reduction (compared with scenario 1)	Mt CO_2	0	0	0

5.3.3.3 Scenario 3: Mandatory Use of Green Power with Additionality Requirement

In this scenario we also assume an obligation: Suppliers have to supply private households with electricity from renewable energy sources. However, unlike scenario 2, suppliers are required to provide 50 % of the green power demand from additional renewable energy generation by 2015; this requirement rises to 75 % by 2020 and 100 % by 2025.

This scenario creates a strong push for additional investments in renewable energy. The demand for green power with additionality (assumed here according to the minimum criteria of the “ok power” label) rises considerably from 3 TWh in 2010 to 98 TWh in 2020 and to 118 TWh in 2030. This translates to an additional renewable energy generation of 1.5 TWh in 2010, 49 TWh in 2020 and 58 TWh in 2030. In order to cover this demand, a significant number of renewable energy power plants will have to be built operating outside public support schemes. This leads to a significant CO_2 reduction on account of this green power obligation. Measured against the business as usual scenario, the reduction amounts to 26 Mt CO_2 in 2020 and 30 Mt CO_2 in 2030.

Part of the investments in additional renewable energy plants will be made in Germany, but given the internal market for electricity in Europe there will be imports from other European countries, too. As mentioned above, this renewable energy will only be additional relative to the baseline case if the governments of the countries involved make a pledge to overshoot their national target by the renewable energy volume and to refuse to transfer this surplus to any other country, as permitted by the EU Renewable Energy Directive. Furthermore the significant increase in renewable energy production must be considered when fixing new emissions caps and the caps for after 2020 must be set accordingly lower.

While this scenario leads to high CO_2 emission reductions, it must be recognised that the costs for the additional renewable energy generation will be passed on to the domestic consumers. Under the current framework conditions in Germany, private households bear a significant share of the additional costs from the feed-in mechanism. Under the scenario assumed here, the costs for supplying households with renewable energy generation would add to these costs and drive electricity prices for private households to high levels until renewable energy becomes competitive. One measure to avoid this would be to use the existing regulation in the EEG, according to which customers who are supplied 100 % from renewable energy can be exempted from the costs of the support mechanism.[17] However, such an exemption of private households from the costs of the EEG support system would in turn mean that other (non-domestic) consumers would have to bear the costs of the support mechanism alone.

This discussion shows that the allocation of the costs of an ambitious expansion of renewable energy to different consumer groups must be assessed carefully and that the additionality of the new renewable energy investments must also be ensured over national targets in the EU Renewable Energy Directive and emission caps in the EU ETS. Given these complexities, scenario 3 must be regarded as highly ambitious.

Table 5.9. Summary of scenario 3 (mandatory use of green power with additionality requirement)

		2010	2020	2030
Green power demand (households)	TWh	9.0	131	118
Green power with additionality	TWh	3.0	98	118
Additional renewable energy	TWh	1.5	49	59
Emissions reduction (compared with scenario 1)	Mt CO_2	0.96	26.3	30.2

5.3.3.4 Scenario 4: Voluntary Green Demand with a Minimum Additionality Requirement for Green Power

In this scenario no obligation is introduced, i.e. suppliers are not obliged to serve private households with electricity from specific sources. However, a regulation is introduced that all green energy supplied to domestic consumers must at least

[17] Currently, this regulation is only applicable for consumption of renewable energy that has been produced in Germany. In order to limit the additional costs for households, this regulation would have to be expanded to renewable energy produced in other countries as well.

meet additionality requirements comparable to those defined by the "ok power" label.[18]

In taking a conservative approach we assume that all green power sold to domestic consumers matches these minimum requirements.

In order to set up the scenario, we also need to estimate the share of domestic consumers who will purchase these green products between 2010 and 2030. This share has been estimated based on the following considerations:

- In Heinzle (February 2010), a willingness to pay for a 100 % green power product (compared to the current default supply – 15 % energy from renewable energy sources and 85 % from other sources) was found to be 5.3 ct/kWh. As the other cost elements of green power and "grey" power are more or less equal, we assume that the willingness to pay is equal to the accepted surplus for production costs in 2010.
- It is further assumed that the willingness to pay decreases over time according to the decrease in average additional costs for producing renewable energy. In order to assess these figures we used data from the German Lead Study for renewable energy (BMU, 2009). According to this study the average costs for producing renewable energy (excluding PV)[19] will decrease from 9.6 ct/kWh in 2010 and to 6.8 ct/kWh in 2030 due to learning effects. At the same time we expect the price for "grey" electricity (e.g. at the spot market) to increase from 4.5 ct/kWh in 2010 to 7.6 ct/kWh in 2030. From these figures additional renewable energy costs of 5.1 ct/kWh in 2010 and 2.4 ct/kWh in 2020 can be derived. In 2030 new renewable energy plants will be 0.8 ct/kWh lower than the expected market price for "grey" electricity. Accordingly, the willingness to pay is assumed to decrease from 5.3 ct/kWh in 2010 to 2.5 ct/kWh in 2020 and 0 ct/kWh in 2030.
- Comparing these figures we find that for all years of our scenario the willingness to pay is higher than the costs for additional renewable energy. This means that within the limitations of the concept of willingness to pay analysis, there seems to be no limitation for the purchase of additional renewable energy by domestic households.
- However, there are other restrictions that limit the development of a voluntary green market. The most important factor is the general reluctance of electricity consumers to switch supplier (or to switch between products of a supplier). According to the German regulator (Bundesnetzagentur), the switching rate

[18] As this paper focuses on households, we refrain from making predictions about other sectors of energy consumption. Of course, it might make sense to introduce such a regulation not only for domestic consumers but also for other consumer groups.

[19] PV has been excluded from this calculation because it was still relatively expensive in 2010. In the coming years, however, its generation costs are expected to decrease considerably, in which case PV will end up dominating the overall calculation.

was 4.8 % of domestic consumers in 2008 (Bundesnetzagentur, 2009). We assume that this rate has slowly increased to 5 % in 2010 and will further increase slowly to 10 % in 2030.

- Furthermore we assume that 20 % of households that switch supplier or product and have not yet used green energy will change to a green product. The factor of 20 % is an expert's guess reflecting the general discrepancy between the declared preferences (e.g. in the form of the willingness to pay) and the revealed preferences (the actual switching rate to green power). Accordingly, we also assume that 20 % of the households that are switching supplier or product and already use green energy will change to a non-green product.
- Based on these assumptions we can now estimate the share of green energy consumers in the domestic sector in Germany. This share starts out with the observed share of 6.4 % in 2010 and gradually rises to 18 % in 2020 and to 30 % in 2030.
- According to the general requirement, this energy must fulfil additionality requirements comparable to those of the "ok power" label. Applying the respective emission reductions mentioned above, this scenario results in CO_2 emission reductions beyond the business as usual scenario of 5.5 Mt CO_2 in 2020 and of 8.3 Mt CO_2 in 2030.

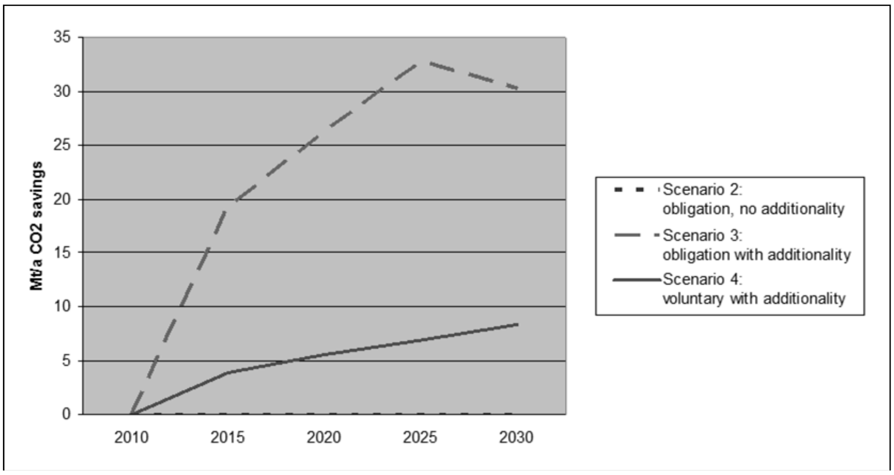
Table 5.10. Summary of scenario 4 (voluntary green demand with minimum additionality requirement for green power)

		2010	2020	2030
Green power demand (households)	TWh	9.0	23.7	35.7
Green power with additionality	TWh	3.0	23.7	35.7
Additional renewable energy	TWh	1.5	11.9	17.8
Emissions reduction (compared to scenario 1)	Mt CO_2	0	5.52	8.32

5.3.4 Conclusions

Figure 5.4 presents an overview of the CO_2 emission reductions based on additional renewable energy plants in the three scenarios compared with the business as usual scenario.

Fig. 5.4. CO_2 emission reductions compared with the business as usual scenario



As can be seen from the figure, the highest emission reductions can be expected from scenario 2, where all suppliers are obliged to serve domestic households with green power at an additionality comparable with the criteria of the “ok-power” label.[20] As discussed above, however, such a regulation could lead to a considerable increase in electricity prices for households for at least the next decade. This scenario should thus be regarded as very ambitious.

A more moderate development is described in scenario 4, which assumes a further moderate growth of a voluntary green power market, for which a minimum requirement is introduced that all green power sold (at least in the domestic sector) must fulfil the additionality criteria of the “ok power” label as a minimum. In this case a relevant CO_2 reduction can be achieved because all green power choices of domestic consumers will contribute to additional renewable energy generation. However, there will be additional costs for the green consumers compared with today’s products with no or little additionality. These costs are only borne by those consumers who have chosen to purchase green power. Thus, in order not to break the “polluter pays” principle in this scenario, the voluntary green power market should not be the only mechanism to support renewable energy. The voluntary green market should rather complement a general support mechanism paid for by all consumers, such as the feed-in support granted by the EEG in Germany.

Scenario 2, which introduces an obligation to supply domestic households with green power without a minimum level of additionality, does not lead to any reductions of CO_2 emissions compared with the business as usual scenario. This is

[20] The decrease in achievable CO_2 emission reduction after 2025 results from the overall reduction in domestic electricity consumption assumed in all scenarios. Due to decreasing energy consumption through 2030, the potential CO_2 reductions compared with the business as usual scenario are also smaller.

simply because we cannot expect a higher stimulation for investments in renewable energy plants compared to Scenario 1 if additionality is not required. It is clear from this analysis and the comparison with Scenario 4 that any green power supply obligation should focus on establishing additional renewable energy plants and should not be based simply on re-arranging the allocation of already existing renewable energy production in Europe to different consumer groups.

It must be emphasised that the numeric results shown in this section are driven to a large extent by the methodology used and the assumptions made for the scenarios. Most prominently, the proposed criteria for additionality of green power according to the "ok power" label could also be defined in a different way. However, the main conclusion still holds that CO_2 emission reductions can only be achieved on the basis of green power if this green energy demand stimulates additional investments in new renewable energy plants compared to the baseline case where this demand would not be there. Furthermore, it is necessary that this development is framed politically by adapting the emissions cap of the EU ETS to the emissions avoided by the additional renewable energy plants and by increasing the national targets for renewable energy under the RES Directive according to the contributions of the green power market to new renewable energy generation.

5.4 Evaluation of Consumer Choices: Heating

5.4.1 Introduction

Heating is the most influential factor in the ecological dimension of energy consumption in houses. The ecological impact depends on the thermal insulation and size of the building, the usage by the occupants and the efficiency of the heating system. A model was created that maps collective consumer decisions in ecological and economical dimensions. The model was limited to existing single- and double-family buildings because these are the main obstacles for sustainable development and are often self-owned. The question of money allocation for sustainable consumption thus has a broad basis.

Within the time range of the scenario analysis (2010-2030) the baseline was defined. An input from an expert interrogation was used to develop a second scenario. The analysis of the results proves that the modeling was appropriate.

5.4.2 Methodological Background

House typologies are often developed to model building stock. Two recent studies describe the housing at the EU level. The IMPRO building study (Françoise, et al., 2008) documents the physical properties of houses built in the EU. The number of houses and their types are listed therein. In the course of writing his PhD thesis at the University in Siegen, Hansen (2009) developed a similar model for Europe.

The modeling of the heating structure is based on assumptions from the Lead Study (BMU, 2009). This data is also available from PRIMES (Capros, P. et al., 2003ff) at the EU level.

For our analyses, we simplified these models even further. This made it possible to quickly calculate the impact of different consumption decisions. A further simplification limits the area analysed to one country – in this case, Germany.

5.4.3 Housing Typology

The housing typology is taken from the IMPRO building study (Françoise, et al., 2008) because its raw data is well documented. In the case of existing single- and double-family houses there are 10 types. The stock data is listed in Table 11. The whole list of house types covers 87 % of all houses in Germany. For other calculations, the missing 13 % are treated like known houses.

Table 5.11. Housing typology

Germany		Z2_SI_001	Z2_SI_002	Z2_SI_003	Z2_SI_005	Z2_SI_006_e	Z2_SI_006	Z2_SI_007_e	Z2_SI_007	Z2_SI_008_e	Z2_SI_008
Number of dwellings	1000	3890	1945	1167	3890	3890	72,8	1945	72,8	1945	72,8
Number of buildings	1000	2593,3	1296,7	778	2593,3	2593,3	48,5	1296,7	48,5	1296,7	48,5
Stock	Mio. m²	349	174	105	349	349	7	174	7	174	7
Occupants per building		3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3
Area roof	1000 m²	311196	155604	93360	311196	311196	5820	155604	5820	155604	5820
Area exterior wall	1000 m²	570526	285274	171160	570526	570526	10670	285274	10670	285274	10670
Area windows	1000 m²	85579	42791	25674	85579	85579	1601	42791	1601	42791	1601
Area Basement ground floor	1000 m²	233397	116703	70020	233397	233397	4365	116703	4365	116703	4365
Building typ		Single family	Single family	Single family	Single family	Single family	Single family	Single family	Single family	Single family	Single family
Year of construction		Until 1945	Until 1900	Until 1900	1945-1980	Since 1980	Since 2006	Since 1970	Since 2006	Since 1980	Since 2006

The main building components are described by their U-values and average size. The U-values are listed in Table 5.12.

Table 5.12. U-values in W/m²K for building units

House Type	Roof		Exterior wall		Window	
	historical	rehabilitated	historical	rehabilitated	historical	rehabilitated
Z2_SI_001	3.20	0.16	1.10	0.12	3.50	1.60
Z2_SI_002	3.20	0.16	2.70	0.12	3.50	1.60
Z2_SI_003	3.20	0.16	1.50	0.12	3.50	1.60
Z2_SI_005	3.20	0.16	1.16	0.12	2.80	1.60
Z2_SI_006_ex	0.36	0.16	0.37	0.12	1.60	1.60
Z2_SI_006	3.20	0.16	1.16	0.12	2.80	1.60
Z2_SI_007_ex	0.24	0.16	0.27	0.12	1.60	1.60
Z2_SI_007	0.24	0.16	0.27	0.12	1.60	1.60
Z2_SI_008_ex	3.20	0.16	1.16	0.12	2.80	1.60
Z2_SI_008	3.20	0.16	1.16	0.12	2.80	1.60

The thermal energy requirements for each type of house are determined in IMPRO depending on size and U-values. The components have lower U-values after rehabilitation.

The thermal energy requirements are reduced accordingly. The energy demand also depends on losses from aeration and gains from solar radiation and internal heating sources.

Poorly insulated houses are usually heated incompletely. Therefore the calculated heat requirements are reduced accordingly. The assumed heating degrees are listed in the following table.

Table 5.13. Degree of heating

Calculated demand [kWh/m².a]	Degree of Heating
0	100 %
100	100 %
200	90 %
300	75 %
400	60 %
500	50 %
600	45 %

Source: authors' estimates

5.4.4 Scenario Definitions

The scenario period is from 2010 to 2030. 14.5 million houses with 21.7 million dwellings were considered.

The baseline scenario follows the existing minimum energy requirements as currently laid out in the German Energy Saving Ordinance (EnEV-Online). These standards have to be applied in the case of modernization, renovation, enlargement or expansion of residential buildings. The 2009 updates of the EnEV include regulated minimum requirements on the technology installed in homes for heating and hot water supply and the current reporting requirements for owners and sellers of houses (energy pass for buildings). These will also be provided here. It is further assumed that KfW low-interest loans and grants for investments and measures to improve energy efficiency in residential buildings continue to be available, particularly for the CO_2 Building Rehabilitation Programme.

This ambitious scenario is based on an improvement of the EnEV 2009 according to EU directive 2010/31/EU on the energy efficiency of buildings. Such a revision is planned for 2012 and would tighten the minimum energy requirements by 30 %. Under the new EU directive, the rehabilitation of existing buildings must use an ever greater percentage of renewable energies; this is reflected in the ambitious scenario as well. In addition, the implementation of Germany's Energy Plan (BMWi and BMU, 2010) is considered. In particular this involves the expansion of the CO_2 Building Rehabilitation Programme and the introduction of further KfW support programmes, such as Energetic Urban Redevelopment. The renovation and retrofit requirements for homeowners will be expanded and the monitoring of their implementation will be improved. In addition to those property owners who meet or exceed the required building efficiency standards earlier than scheduled, additional incentives are offered in the form of tax breaks. In order to increase the attractiveness of investment in energy rehabilitation for the landlord, a tenancy law will be adapted so that the additional costs can be passed on easily to the basic rent. Finally, the energy taxes in the heating sector rise based on the CO_2 emissions of the used energy source.

The historical trends are updated in the baseline scenario. The disposal/demolition rate was taken from statistical data (Destatis, 2010). The reduction of ventilation losses in old houses and information to improve the heating systems were taken from Françoise et al. (2008).

Table 5.14. Assumptions for base scenario heating

Disposal/demolition of all houses built before 1970	0.2 %/a
Rehabilitation according to valid standards	Yes
Reduction of ventilation losses in old houses	30 %
Heating efficiency increased by	10 per centage points

Source: authors' estimates

The values for rehabilitation rates from Hansen (2009) were revised downward slightly.

Table 5.15. Rehabilitation rates for base scenario heating

Roof	0.64 %/a
Outer walls	0.5 %/a
Windows	2.0 %/a
Heating system	2.5 %/a

The second scenario is based on an expert interview (Weigl, 2009) and titled 'realistic and ambitious standards'. In principle, higher demolition rates, even for newer houses, are assumed. The expert differentiates between houses built before and after 1970.

Weigl (2009) sees higher efficiencies and better reduction of ventilation heat losses based on the same rates for the renewal of heating systems.

Table 5.16. Assumptions for the realistic and ambitious standards scenario

Disposal/demolition of houses built before 1970	0.5 %/a
Disposal/demolition of houses built after 1970	0.05 %/a
Reduction of ventilation losses in old houses	50 %
The efficiency of heating increases by	15 per centage points
Share of renewable heat in 2030	18 %

Source: Weigl (2009), adjusted[21]

The estimated rehabilitation rates for windows and outer walls are the same as in Hansen (2009). The rate for roofs is much higher because of the short payback period.

Table 5.17. Rehabilitation rate for the realistic and ambitious standards scenario

Roof	2.0 %/a
Outer walls	0.8 %/a
Windows	2.5 %/a
Heating system	2.5 %/a

5.4.5 Results

For the base scenario, the energy consumption is reduced from 1656 PJ/a to 1455 PJ/a. Using the heating mix from PRIMES (Capros, P. et al., 2003ff), the CO_2eq emissions are reduced from 145 Mt/a to 104 Mt/a by 2030.

The building stock affected by energy efficiency measures consists of

- 222 million m² of roof area,
- 318 million m² of exterior walls and

[21] The input given by the interviewed expert (Weigl, 2009) assumed that a renewable share of 15 % was **not** taken into account. This was because PRIMES baseline already assumes that renewables have a 2030 share of 18 %.

- 243 million m² of renovated windows.

For both the realistic and ambitious standards scenario, the energy consumption decreases from 1656 PJ/a to 1256 PJ/a. The CO_2eq emissions descrease from 145 Mt/a to 90 Mt/a by 2030.

The future building stock affected by energy efficiency measures consists of

- 695 million m² of roof area,
- 510 million m² of exterior walls and
- 243 million m² of renovated windows.

Additional costs due to higher efficiency amount to 30€/m² for roofs and 100€/m² for exterior walls. For heating systems with higher efficiency, additional costs of €2000 per system were assumed. The total additional costs for the higher efficiency in this scenario amount to €48bn over the baseline.

5.4.6 Conclusions

The analysis showed that a significant contribution to climate protection can be achieved only through comprehensive renovation of existing buildings. The rates achieved in rehabilitation of housing components do not suffice to renew the total stock within the scenario period, though. Even doubling the duration of the period or the assumed rate would not be sufficient to implement the total potential of energy savings from insulating exterior walls.

The possibilities of influencing consumer choices are limited and influenced by a variety of factors. One is the social structure of owners and tenants of single and multi-family buildings. This factor is assumed to remain constant in all the scenarios. The additional investment costs needed to rehabilitate the housing stock are high, but these investments contribute directly to domestic economic growth.

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6 Home Heating, Technology and Gender: A Qualitative Analysis

6 Home Heating, Technology and Gender: A Qualitative Analysis

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Abstract

Few empirical studies take gender into account when analysing sustainable consumption. Even those studies that consider gender are not without shortcomings in their theorizing on gender. Drawing on insights from gender theory, we use a multilevel approach to investigate the relevance of gender to domestic energy consumption in Germany. In our empirical study of home heating systems using renewable energy technologies, we analyse gender scripts of home heating devices, and we show how users' interactions with technology are intertwined with their performances of gender identities. Furthermore, we show how several symbolic binaries are inscribed with gendered meanings and become relevant in the diffusion stage of technology. Overall, our research contributes to a theoretically grounded understanding of gender's role in domestic energy consumption and takes an approach to gender that moves beyond the analysis of individual differences and "body counting".

6.1 Introduction

Many social science researchers study sustainable consumption, their main aim being to help encourage less resource-intensive ways of living. Although consumers' identities and lifestyles are regarded as central in understanding and changing consumption behaviour, research on gender and sustainable consumption (understood here as greener buying behaviour) has been infrequent and inconsistent. While the majority of studies show that women express greater ecological awareness (Devries, 1997; Preisendörfer, 1999; Empacher et al., 2000; Zelezny et al., 2000; Torgler et al., 2008), the correlation between gender and pro-environmental behaviour was found to be small (Zelezny et al., 2000: 444); although women seem to show stronger pro-environmental attitudes than men, for the most part they make similar purchase decisions. For instance, Mitani and Flores (2008) explored gender effects on real and hypothetical payments, i.e. payment decisions that are either binding or not binding. Their results are in line with those of previous studies on actual and stated behaviour (Cadsby and Maynes, 1998; Brown and

Taylor, 2000): They conclude that although gender influences hypothetical payments, it has no effect on real payments. In studies that focus on daily consumption routines, gender differences again seem to matter in some cases but not all: While women show a higher degree of environmentally sound behaviour in the areas of waste, food consumption and traffic, no significant differences could be found in their consumption of heat, electricity and water (Preisendörfer, 1999). Overall, such studies are few and their results inconsistent. Furthermore, no thorough theoretical understanding has been developed about how gender applies to consumption.

Research so far has mostly seen gender as constituted by differences between men and women. This approach has been heavily criticised as limited and simplistic (e.g., Wajcman, 1996; Hyde, 2005; Fournier and Smith, 2006; Degele and Winker, 2009; Lykke, 2010). First, suggesting that there are universal categories of men and women fundamentally opposed to each other ignores both their similarities and differences. With regard to consumption, the differences within the gender groups may be due to many factors, including ethnicity, parenthood, single parenthood and marital status (Preisendörfer, 1999; Empacher et al., 2000; Weller et al., 2001). Second, research that focuses on gender tends to disregard the fundamentally social nature of gender. That is, because gender and gender differences are produced within specific social contexts, research that disregards these contexts may fail to explain how differences originate and are stabilised (Gildemeister, 2004). Researchers should thus take into careful account the specific social context in question. Our research on gender and domestic energy consumption contributes to this endeavor theoretically, methodologically and empirically.

This shift in theoretical perspective follows broader discussions in social scientific research on sustainable consumption. Science and technology studies based on a social constructivist approach to consumption patterns can contribute to discourses about sustainable energy consumption in a much more comprehensive way than is usually assumed when social scientists are assigned the role of "people experts" (Guy and Shove, 2000). Rather than keeping the main focus on individual consumer choice, social science has begun to investigate how choice is structured and the roles that material and symbolic conditions play in shaping and stabilizing current energy regimes. This change of perspective expands our understanding of ordinary consumption and the role of energy in everyday life, paving the way to more sustainable patterns of consumption (Shove, 2003).

In this section we first provide a brief overview of theoretical approaches to gender as a social practice. Second, we describe the multi-level research design we used to investigate the gender dynamics of structural arrangements, symbolic representations and interactive identity constructions. Third, we present and discuss our empirical results on gender in the field of domestic heat energy consumption in Germany.

6.2 Moving Beyond Gender Differences: Gender as a Social Practice

When designers develop a technological artefact, they inscribe stereotypical assumptions about the future users, both female and male, into the design of the object. This inscription is de-inscribed later, say, when users are making sense of the object by using it (Akrich, 1992). The concept of "gender scripts", developed by Dutch and Norwegian feminists, captures both the practices of inscribing and of de-inscribing "representations of masculinities and femininities in technological artefacts. (...) Technologies are represented as objects of identity projects – objects that may stabilise or de-stabilise hegemonic representations of gender" (Oudshoorn and Pinch, 2003: 10). In this way, producing and using technologies can be interpreted as social practices that are deeply intertwined with practices of gender.

Ellen van Oost's (2003) striking study on shavers demonstrates how the design culture at Philips helps stabilise gender hegemony by means of gender scripts. The 'Philishave' device, intended for men, is characterised by its technical features, while the 'Ladyshave' design renders shaving an aspect of cosmetics and hides the technical character of the device – for instance, it has no screws and hence cannot be disassembled. The premise for the design philosophy draws on the well-known symbolic dichotomy of male instrumentality and female expressiveness (Parsons and Bales, 1955). The shavers are either associated with rational goal achievement through technology or with the sphere of emotions and bodily care. The assumption is that women, in contrast to men, dislike the association with technology and prefer the association with aesthetics. Thus, the design of the shaver constructs femininity as disinterest in technology and commitment to beauty. Both femininity and shaver are constructed: the one as technophobe and emotional, the other as technological artefact. Here, gender and technological artefact are both source and consequence of the same process (Faulkner, 2001: 81) and therefore co-construct each other. Or, as Judy Wajcman (2002: 358) puts it, "masculinities and femininities are constituted simultaneously with the production and consumption of technologies."

The shaver example also demonstrates how *symbolic* gender binaries are used to organise the gendered practices of everyday life, thereby turning men's shaving practices into something different from women's shaving practices. In the words of Sandra Harding (1986: 17), gendered social life is the consequence of "appealing to these gender dualisms to organise social activity, of dividing necessary social activities between different groups of humans."

In a study on the field of engineering, Scottish sociologist Wendy Faulkner (2000a) identified several highly gender dichotomies on the symbolic level, such as "machine focused" vs. "people focused", "hard" vs. "soft" or "objectivist rationality, emotional detachment and abstract theory" vs. "subjective rationality, emotional connectedness and concrete and holistic approaches". They all draw on the basic opposition between male instrumentality and female expressivity and are used to organise the social activities surrounding science and technology: While the popular images of science and technology are closely associated with the masculine sides of these polarities, the perceived feminine sides are downplayed considerably. As a consequence, the terms of the binary opposition stand in a hierarchy.

One of the most fundamental organising structures of modern societies is the separation of the public and the private sphere. Again, this separation is associated with gender: While the public is related to masculinity, the private is considered the feminine side (Hausen, 1976). Historically household work as a main aspect of the private sphere has been considered women's work. Household technologies for cleaning and cooking are thus associated with femininity and thereby concealed that which makes them technology to begin with (McKenzie and Wajcman, 1999). In contrast, "those [technologies] used in the non-routine tasks of home maintenance and gardening, plus the more 'high tech' music systems, are commonly used by men" (Faulkner, 2001: 83) and associated with masculinity and 'real' technology. Gender as a structural organizational principle is also mirrored by spatial arrangements that form the material environment for the technologies being used. For instance, Wajcman (1991: 106f.) points out that "domestic appliances 'belong' in the female space of the kitchen while communication technology such as the television is very likely to be found in the 'family room'".

Both the structural and the symbolic aspects of gender provide the framework for interpreting action and behaviour as either masculine or feminine when it comes to *gender identity performances*. These aspects not only contain concepts of how men and women should behave and differ from each other; they also serve as powerful normative resources for the performance of gender identity. For instance, the fact that the design of shavers is gendered makes it impossible to hold a gender-neutral perception about any user of shavers because the person and his or her action will appear as either gender-conforming or non-conforming. More broadly, the gender scripts provided through the structural and symbolic levels may "invite or inhibit specific performances of gender identities and relations" (Oudshoorn and Pinch, 2003: 10).

But research on gender has also been criticised for essentialising gender and taking the binary gender order for granted (Fournier and Smith, 2006; Nentwich and Kelan, 2007). As a result, scholars in the fields of gender and organisation (Bruni et al., 2005; Martin, 2006; Gherardi and Poggio, 2007) and gender and technology (Faulkner, 2001; Wajcman, 2002; Lohan and Faulkner, 2004; Mellström, 2004) developed a more nuanced concept of gender. On the one hand, notions of gender are "conceptualised as social and cultural constructions, shaped by historical circumstances and socio-political processes, and functioning as regulatory mechanisms or norms of discourse" (Henwood et al., 2008: 664, citing Wetherell and Potter, 1988). On the other hand, in everyday practices these institutionalised norms are not as clear-cut as the research would suggest (Faulkner, 2000a; 2000b). What counts as masculine or feminine shifts with the context (Johansson, 1998; Lohan, 2000; Kelan, 2010).

Faulkner (2000a), for instance, highlights the fluidity of masculinities in the field of engineering and technology. She finds that the "masculine culture" (see also Wajcman, 1991) depicted in engineering is a white, heterosexual, form of masculinity, one that is "successful" in terms of the capitalist marketplace. Suggesting that there is not just one, but many, ways of enacting masculinity, Faulkner (2000a: 786) concludes that "real women and men do not fit dichotomous assumptions any more readily than do real engineers or real engineering practice". She therefore proposes an analytical double perspective on (possible) binary constructions and multiple, fluid, and contradictory ways of performing gender identity in specific situations (see also Henwood et al., 2008: 669).

Based on these recent developments in gender theory, a multilevel approach is needed to investigate gendered social life. First, the socio-material context of action has to be taken into consideration as a potential site of gender inscriptions. Second, symbolic representations, serving as resources for sense-making, often reproduce gender in a binary way. Third, gender identity performances take place during everyday interactions. Here, structural conditions and symbolic representations of gender are made relevant for either reproducing or challenging this gendered order. Theorising gender as a social practice, and thus taking structures, symbols and interaction into account, helps us move beyond the essentialist understanding of gender criticised above. Although structure, symbols and identity may become conflated when gender is practiced in a specific situation (Martin, 2003), differentiating between them is a useful analytical heuristic for developing empirical research designs. This is why we shift our research focus away from a simple interest in gender differences in energy consumption behaviour and towards the ways that norms, material conditions and technology are turned into resources for gender identity performances.

6.3 Empirically Investigating Gender-Technology Relations in the Field of Domestic Energy Consumption

In analysing the social practices of gender within the field of domestic energy consumption, we concentrated on the technology and material conditions in this field that act as potentially gendered resources for users to perform different forms of masculinities and femininities. We analysed consumption and gender as intertwined practices that both produce and stabilise gender and certain modes of consumption. Our research focused on the three analytical levels introduced above:

1. In what specific ways is the field constructed according to gendered symbolic binaries?
2. How are these binaries made relevant in the structural and material context of domestic energy consumption?
3. How do both the structural and the symbolic conditions provide resources for the performance of gender identities?

The empirical setting for the investigation was the interface between the domestic use and the market distribution of home-heating technologies in Germany. Here future users and technologies meet for the first time, and multiple actors are involved as technologies enter private homes (Schwartz Cowan, 1987). When households decide on a specific system and begin to use it, they reflect on its pros and cons, and they develop new routines for using it. This shines light on sense-making processes revealing how different actors ascribe different meanings to domestic energy technologies (Eriksson-Zetterquist, 2007).

Having conceptualised gender as a multi-level phenomenon, we chose to collect data from multiple sources, as shown in Table 6.1.

1. Literature, participatory observation at trade fairs for building and household equipment, and expert interviews with various actors involved in technology diffusion provided contextual information on domestic energy consumption.
2. Marketing pamphlets for various home-heating technologies revealed symbolic meanings that are inscribed into the design and spatial arrangements of technologies.
3. Participatory observation at trade fairs also provided insights into interactions between future users and sales or marketing professionals. Finally, qualitative interviews with owner-occupier couples who had recently acquired a new home heating technology using renewable energy allowed us to reconstruct the intertwined processes of gender and consuming energy.

Table 6.1. Multilevel research design

Data sources	Analytical levels
Observations at 3 trade fairs, 15 expert interviews, literature Review	Structures
Marketing booklets	Symbolic binary
Observations at 3 trade fairs, 9 qualitative interviews with couples	Performance of gendered identity

We engaged in participatory observation at three trade fairs focused on building and home equipment, situations where home-heating technologies are presented to future users. We chose this kind of public place because it is easier to enter than a private home and because we hoped to be able to observe interactions between sellers and buyers. Interactions between future users and experts (craftspeople or salespeople) help buyers gather information without making commitments and help sellers make initial contacts. Our visits to trade fairs served several purposes: We made contacts with craftspeople and conducted ad hoc interviews with experts; we took photographs of booths to study how artefacts are presented to visitors; and we gathered a selection of technology marketing pamphlets. We observed that equipping private homes with energy-efficient technologies based on renewable resources has become a significant industry. Technologies that were once seen as alternative are now being marketed professionally as high-tech solutions for a more sustainable future.

We conducted 15 expert interviews with craftspeople (mainly heating contractors, but also tile stove experts), energy consultants, engineers and salespeople. The interviews informed us about historical and current developments in home heating, experiences interacting with users, the tools used to generate energy-related data and expert knowledge on the functions of home-heating technologies.

The marketing pamphlets we gathered at fairs and on the Websites of companies offering heating technologies allowed us to conduct document analysis. We looked for symbolic meanings, representations of the private sphere and the more or less tacit assumptions made by brochure writers about potential users. We discovered that wherever the technologies were depicted within their future location – the home – we could find either clear traces of gender in the form of direct displays of family members and their roles in the home or references to typically female and male activities in different realms of the home.

Finally, we conducted nine semi-structured interviews with heterosexual owner-occupier couples. We recruited these couples with the help of craftspeople at the trade fairs and through personal contacts. Our aim was to explore the gender practices of user-technology relations in the context of home heating. The couples were with and without children, aged between 30 and 60. Some lived in rural areas, others in towns of about 60,000 to 80,000 inhabitants. They had recently installed home-heating technologies based on solid biofuels (such as wood or wood pellets), solar thermal energy, geothermal energy or a combination thereof. In two cases, the systems consisted of living-room stoves, connected to the warm water central heating via a thermal storage unit. The interviews focused on the couples' everyday routines for using these home-heating technologies and on their decisions about buying central heating installations. By choosing households that had relatively new heating systems (no older than one year), we could also learn more about the interface between consumption and the market distribution of technologies, and how households interact with experts – marketing representatives, sales people, craftspeople and the like.

Our decision to interview couples turned the interviews into social situations in which the partners performed their relationships (Holstein and Gubrium, 1995; Behnke and Meuser, 2004). These interaction dynamics became an additional source of data. For example, we noted their response behaviour – who answered first when a question was posed – and how the partners reacted to each other and the topic. Our analysis revealed the practices of gender performed by these heterosexual couples.

Our process of gathering and analysing data was very much informed by the general principles of grounded theory methodology (Glaser and Strauss, 1967; Strauss and Corbin, 1990; Strübing, 2004). Three aspects of the research were crucial to our work. First, we constructed the research field following the principles of *theoretical sampling,* i.e. we based data gathering decisions on preliminary results from previous analysis. As a result, data collection, data analysis and theory building took place simultaneously rather than consecutively. Theoretical sampling implies conceptual representativeness (Strübing, 2004: 31) instead of statistical representativeness. Grounded theory seeks to reveal the conditions under which a phenomenon can be expected to occur, but not its quantity or its probability (Strübing, 2004: 33). Second, *constant comparison* was our primary principle of analysis. This method tracks both case-specific and general data trends and helps frame observed phenomena conceptually. Writing *analytical memos* helped us develop our ideas. Third, we *coded* the material so as to develop theoretical concepts textual and visual details. *Theoretical sensitivity* became an important source of inspiration, and we drew on findings from different studies on “the gender-technology relation” (Grint and Gill, 1995) as we investigated the sense-making process.

6.4 Results: Home Heating, Technology and Gender

Although dividing the social practice of gender into three elements serves important analytical purposes and helped us develop a straightforward research design, the distinction is not as clear-cut when it comes to empirical phenomena. Symbolic and materialised gender orders are reproduced through interaction and turned into resources for performing gender identity, thereby reaffirming and reproducing symbolic and material conditions. Hence, symbolic resources, structural conditions and identity performances both presuppose and constitute each other.

In presenting the results of our study, we first focus on gender’s relevance on the structural level. We contextualise home heating in Germany historically and highlight the development of its modern standards, thereby showing how the standards are intertwined with general principles of the gender division of labor. Second, we focus on symbolic binaries and how they are inscribed into the spatial arrangements of the home as well as the design of the technologies under question. Then, in our third and main focus of this analysis, we describe the user-technology interactions in the interviews with home-owning couples. During the interviews, we found that the symbolic gender binaries inscribed into material structures of home heating, as well as a gender division of labor, became relevant for the performance of gender identities. In particular, the notion of “technical competence” was a major resource for the performance of masculinity and hence a major resource for the gendering of buying decisions throughout the interviews.

6.4.1 Structural Conditions: Established Standards of Home Heating

In the decades since World War II, central heating has developed as the standard for supplying domestic heat energy in Germany, replacing single-room stoves fired with coal or oil. In 2008, 77 % of all private households used central heating or self-contained central heating (Statistisches Bundesamt, 2009). This development led to at least two important consequences. First, heating units like boilers disappeared from living areas into basement areas devoted to furnaces and other equipment. Second, as oil and gas became the standard sources for heat energy – in 2008, 86 % of German household used one or the other (Statistisches Bundesamt, 2009) – the daily practices of home heating have become thoroughly automated. The once complicated everyday routines have now been reduced to a minimum. Today, most people merely have to turn the thermostat valve on their radiators up or down, and possibly set the electronic control on the heating unit or have their fuel tanks filled once a year. These standards of automation and control also apply to most modern home-heating technologies using renewables such as geothermal, solar or biomass energy.

Regardless of the energy source, two things have changed since the introduction of fully automated central heating: The spatial arrangements of the technology in the domestic sphere and the work involved in using heating technologies. What used to be a housewife's responsibility – keeping the hearth or stove fire burning during the day – has turned into an abstract and relatively invisible process taking place in a room detached from the living area. Modern home heating has become a matter of abstract technical rationality – a more 'high-tech' and non-routine form of home maintenance that may have changed the way that responsibilities are distributed between the sexes (see Faulkner, 2001: 83).

As these forms of home heating have become centralised and automated, the single-room heating units placed in the living areas of private homes have not disappeared. But they no longer represent the standard form of heating; instead, they mostly serve as an additional source of warmth. Such stoves have become popular, well-designed objects displayed in the living area of homes. They are either used as single-room heating units or are connected to a central heating system via, say, a thermal storage unit. As we argued in an earlier study (Offenberger and Nentwich, 2009), these objects embody the emotional aspects of consuming heat energy, associated as they are with nostalgia and traditional forms of heating and allowing as they do for the multi-sensual experiences of fire (smell, sound, light and warmth). Moreover, because many single-room stoves must be fuelled by hand, the heating process is attached to bodily practices. Heating with single-room heating units, therefore, is associated with home decoration and emotional aspects like well-being and care for oneself and others.

6.4.2 Symbolic Binaries: The Gender Scripts of Home-Heating Technologies

As we compared the ways people visualised these two different forms of home heating (Offenberger and Nentwich, 2009), we found that they also capture different gender scripts. Depending on where the heating unit is located within the home, the symbolic gender binary is inscribed into the technological objects and also communicated through the marketing material. Figures 6.1 and 6.2 show how home heating is presented as either an issue of "facility management" or an aspect of "homemaking".

When home heating is a matter of "facility management", it is reduced to technology-related objects (e.g. boilers) and associated with symbolically masculine values (e.g. technical rationality, control and abstract understanding of heat energy). When it is seen as "homemaking", it is related to the use of stoves and associated with symbolically feminine values (aesthetics, care, well-being as well as the emotional, concrete and holistic experience of heat energy). Furthermore, we found that the gendered spatial order of family homes (Wajcman, 1991: 106f), which differentiates between symbolically feminine areas for living and symbolically masculine areas for technology, is reproduced in object design and marketing material, which highlights either the technical or the aesthetic aspects of heating technology. In other words, home heating is made into an issue of either instrumentality or expressivity insofar as designers and marketers highlight either the objects' rational and functional aspects or their emotional and aesthetic ones.

Many elements contributed to a gendered connotation of the home heating devices: the complex interplay of spatial ordering, the historical development of technological standards, the premises of object design and a gender division of labour. Hence, gender differences are inscribed into the socio-material arrangements that simultaneously facilitate domestic energy consumption and the performance of gender identities. Inviting some scripts of home heating and inhibiting others, these differences set up two separate stages for the performances of gender identities. To better understand the role of gender scripts in the use of these technologies, we explore in the next section how the couples we interviewed accounted for their acquisition of new home-heating technologies.

Fig. 6.1. Home heating and facility management

Fig. 6.2. Home heating and homemaking

Source: www.windhager.de

6.4.3 Performing Gender Identity

The Relevance of Technical Competence: The Binary of Expressivity and Instrumentality

As pointed out above, the gender script of home heating as facility management leads to a dominant perception of heat energy consumption as centred on masculine symbols: knowledge of infrastructure, an understanding of heating systems and technical expertise. Similarly, the interviewees saw technical competence not only as highly relevant for their purchasing decision, but also as a masculine attribute, and most female interviewees considered their male partners to be more technically competent than they are. In fact, females generally admitted that they assign their male partners the main responsibility for gathering decision-related information.

Mirroring this clear attribution of technical competence to masculinity and men, the majority of male partners talked more about the heating system and used technical vocabulary more often than their female partners. Some of the men even volunteered detailed technological explanations. In other cases, women created a stage for their partners' performances of technical knowledge by, say, asking them specific questions about the boiler's size or the central heating installation. Overall, both partners cooperated actively in constructing the male partner as the technical expert while positioning the female partner as less interested or less competent. Their efforts portrayed technical competence as masculine and in binary opposition to femininity.

We also found that the couples used the symbolic binary of technology and aesthetics to organise their internal division of labour. For instance, when the interviewer asked one of the women about her role in the decision-making process, she initially reported that her husband was responsible for everything, including dealing with craftspeople and learning about technical devices. Yet she also emphasised that they had agreed on the basic features of the new heating system beforehand, thereby expressing her commitment to equality. Elaborating on her role in the decision-making process, the interviewee then highlighted the expressive and aesthetic functions of the technology (Interview 3, paragraph 40):

Interviewer: Mhm. Well, would you still say that you fulfilled a specific role or task in this process?
She: No. (2sec) Choosing the stove and things like that.
Interviewer: Ah, ok.
She: More about the visual appearance [LAUGHS].

While technical features and competences are associated with masculinity, the aesthetic aspects of decision making, in this case its visual appearance, are clearly linked to femininity throughout the interviews. The gender scripts of (feminine) homemaking and (masculine) facility management serve the same two purposes. They both serve to explain the acquisition decision and they both serve to perform heterosexual gender identities. These gender scripts thus become materialised resources for producing difference. The partner dynamics of heterosexual couples serve to amplify displays of technical competence as a genuinely masculine attribute and displays of homemaking as a genuinely feminine attribute.

Male homosociality as a resource for masculinity

Another gender resource revealed in the data is male domination in energy-related professions. Engineers, craftspeople, energy consultants and other professionals have become key actors for facilitating modern home heating and for developing, selling, installing, setting up and repairing heat energy technologies. Without exception, the professions that diffuse energy technologies are numerically male-dominated. For instance, the per centage of women working in the German building industry was around 3,4 % in 2009 (Institut für Arbeitsmarkt- und Berufsforschung, 2010). The percentage of women working in the power supply industry is also low. (For descriptions of different segments and levels, see Röhr and Ruggieri, 2008.) Private households acquiring a new home heating technology are hence very likely to come in contact with a male expert. Here, masculinity and professional expertise on technology are inseparably intertwined, re-establishing once again the cultural equation of masculinity and technology (Wajcman, 1991; Oldenziel, 1999; Faulkner, 2001; Mellström, 2004).

In talking about technology experts and heterosexual couples create opportunities to perform male gender identity. Since both gender status and interest in technology are often congruent, the homosocial relationship established between male household members and technology experts serves to tighten the link between masculinity and technology.

As a consequence of this homosociality, those *perceived* as not technically competent are excluded: "Within these informal relationships men are often concerned to identify with other men within the, 'in-group', while simultaneously differentiating themselves from other groups of men and from women" (Collinson and Hearn, 1994: 14). These mechanisms of male homosociality can hence distance women from technology. We observed an example of this at a trade fair as we watched a couple talking to a craftsman at a booth. While the two men quickly engaged in a discussion about the possibilities of central heating units with renewable energy, the woman stood beside them, more or less passively, and eventually began looking around the booth. While the men talked – the conversation lasted for several minutes – they stood very close to each other and continuously engaged in direct eye contact.

While we could not tell from our observation whether or not the woman was initially interested in joining the conversation, it was obvious that the longer the men's conversation lasted, the more difficult it became to enter it. The men had established a separate relational space, made up of many more aspects than a simple functional exchange of information. Instead, the interaction between the male partner and the craftsman consisted of various signs – words, body language, facial expressions – that excluded the woman and established closeness between the men. Whether or not the woman was interested in joining the conversation, she became a spectator witnessing the men's demonstration of technical interest and competence. This gender stage performs both male homosociality and female exclusion.

Another example of male homosociality is chopping wood for furnaces. This activity provides men with the opportunity to enact traditional images of male heroism, physical power and specialised skill. Two of the men we interviewed noted the special tools – protective clothing, trailers, power saws – and special skills required to use these tools (see Int. 2, para. 240; Int. 3, para. 194). They spoke about these skills being passed on from fathers to sons – homosocial groups in which the use of physical power becomes central. When talking about this traditionally masculine domain, these men not only described the skills they use to provide the family with a fuel supply, but also drew on the narrative of chopping wood as a resource for performing their male gender identity.

As we stated earlier though, the practices of gender are not as clear-cut as one might assume from the strong and obvious link between masculinity and technology. In fact, the practices surrounding the gathering and use of firewood are not scenes only opportunities of performing masculinity. As soon as the wood enters the home and is turned into a resource for heat energy, women enter the scene again. For instance, one couple with two children described the firing of their tile stove as "feeding the stove", a task all of the family members enjoy (Int. 3, para. 242). In this case, the stove serves as the centre of family life on cold winter days. Both partners seem to have put considerable effort into choosing a stove design that perfectly expresses their individuality. The look, acquisition and everyday use of the stove contribute to forming the family's identity and home-making activities. This intense involvement turns the tile stove into an object of pleasure and satisfaction for both partners.

Our analysis shows that the binary opposition between technology and aesthetics, and its association with masculinity and femininity, are major resources for making sense of acquisition decisions in the interviews and in the performances of gender identities. Furthermore, the powerful equation of masculinity and technology is stabilised in situations of male homosociality where both the use of machines and the demonstration of technical expert knowledge gain central status. The interviewees' narratives seem to reproduce the gender scripts "female home-making" and "masculine facility management" in a distinctive and untroubled way. Yet the way the gender identities are performed depends greatly on dynamics such as the establishment and maintenance of homosocial groups. As with the firewood example, certain practices can invite the performance of both heroic masculinity and family care. Gender is always fluid and shifting and depends on context and symbolic resources (wood or a stove, stay) when performing gendered identities.

Defining and Demonstrating Technical Competence

We propose an even closer reading of the interview narratives – one that questions the simple logic of binary opposition and male-dominated technical competence. A simple yet complex question may help change our perspective on the interrelation between gender and technology: What counts as technical competence? Is it the ability to explain how a solar thermal panel or a geothermal heat pump works? Or is it the knowledge of how to arrange kitchen appliances for an easy workflow (an example one couple provided, though they did not regard it as an example of technical competence)? Does having experience in programming the electronic controls of boilers count as a higher degree of technical competence than knowing the exact amount of wood needed at a certain moment to fuel the furnace so it reaches the desired temperature?

A critical investigation of the gender-technology relations displayed in the interviews reveals that *defining* technical competence and *deciding* what counts as such become central features in users' accounts of distinguishing masculine and feminine gender identities. Male and female users actually *produced* gender differences through specific acts; they made different claims about what counts as technical competence. Clearly the gender scripts of home-heating technology favour the claim of technical competence as a masculine domain and dissociate femininity from technical competence. Given this symbolic and structural gender order, the process of ascribing or not ascribing technical competence to oneself becomes a matter of gender authenticity or inauthenticity. The latter notion has been used in research on women in science (Fox Keller, 1985) and engineering (Cockburn, 1999; Faulkner, 2000a) in order to "capture the sense that a woman who chooses to go into a male-dominated occupation is in some way putting aside or undermining her feminine gender identity" (Faulkner, 2000a: 787). A woman demonstrating technical competence equal to her male's partner or greater may run the risk of violating the norms that apply to heterosexual couples, according to which men have to be more masculine than women and women have to be more feminine than men. Consequently, men can also appear to be gender inauthentic if they admit to a lack of technical competence. *Defining* and *demonstrating* technical competence are, therefore, two functions of performing gender identity; they are not neutral accounts of people's activities.

6.5 Conclusions

The gender perspective has revealed several new dimensions to heat energy consumption. We have shown how the division of labour and the spatial arrangements within the home gender technological artefacts used for home heating. Analysis of the gender scripts of home-heating technologies – "facility management" and "homemaking" – has identified the different meanings users attach to home heating.

These meanings can provide important insights for sustainability promotion. Expectations about heat energy supply relate not only to comfort, convenience and efficiency but also to making the private home a cosy and pleasant place. Where different technologies (such as central heating and additional stoves) are used to meet these purposes, people might use more energy than necessary from the perspective of energy efficiency. Hence, technology design should aim at integrating the meanings of "facility management" and "homemaking" into home-heating technologies that fulfil both purposes at once.

Future research on the diffusion of sustainable technology must take into account the fact that technology is widely perceived as a masculine culture and embedded in a professional field that is numerically dominated by men (Röhr and Ruggieri, 2008). In both professional contexts and the domestic life, technology is an integral part of many men's gender identities. This identification can be helpful if it promotes the diffusion of new technologies that are more energy-efficient and based on renewable resources. However, it can also lead to a naive belief in technological fixes, based on the assumption that by itself technology diffusion will automatically lead to sustainable development. Hence, research on sustainable consumption should focus more on the tacit assumptions underpinning sustainability interventions.

Finally, our investigation has demonstrated that the dominant approach in consumption research – approaching gender as a static and given variable of male or female gender identity – throws insufficient light on the gendering of domestic energy consumption since it cannot capture the multilayered and reflexive processes that produce the "effects made by gender" (Henwood et al., 2008). The different accounts of men's and women's technical competence become mere methodological artefacts unless we attend to the interaction dynamics that produce these differences. The ways in which people identify with and subscribe to these norms are more about compliance with norms of masculine or feminine gender identity than about providing "true" accounts of (gender-different) behaviour.

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Annex I: Methodology Report of the SECO@Home Study

Contents

SHORT OVERVIEW OF THE SURVEY APPROACH

Target group:	Sample heating: owner-occupiers (detached house, semi-detached house, terraced house) Sample electricity and TV: German private households
Target persons:	(Co-) decision makers in energy concerns
Sample size:	n = 1,257 Subsample heating n = 433 Subsample electricity n= 414 Subsample TV n = 410
Interview method:	CAPI, 50-60 min
Project duration:	March – July 2009
Field phase:	week 22-26
GfK services:	

- Project management
- (Co-) Design of the questionnaire
- Methodical consulting with the conjoint design
- Implementation of the questionnaire
- 3 pre-tests of the questionnaire with video broadcast
- Revision of the questionnaire
- Realisation of 3 CBC-conjoints in the interview programme
- Recruitment and screening of the test persons
- Implementation of the interviews n = 1,257
- Development of the code frame and coding of open questions
- Data control (consistency check)
- Transmission of a weighted SPSS data record to the client, not including the conjoint data
- Submission of 3 conjoint data records in SPSS format

- Submission of 3 Sawtooth-compatible conjoint data records to the client
- Preparation of the present methodology report

1. Goals of the survey

A major obstacle for the distribution of energy-efficient products and services is the lack of information about consumer preferences for sustainable energy consumption. Having knowledge about the connections of decision-making behaviour and the subjacent influencing factors forms a basis for the development of strategies supporting sustainable energy supply and usage.

This research project contributes substantially to the clarification of consumer energy behaviour in three sectors: heating, electricity and household appliances. We collected, among other data, stated household preferences about purchasing innovative and sustainable products. We then estimated decision-making behaviour econometrically.

2. Description of the applied methods

Target groups and target persons

Target groups of the survey were:

a) owner-occupiers of detached houses, semi-detached house or terraced houses (for the heating sector)
b) private households in Germany (for the electricity and TV sector)

Energy (co-) decision makers in private households were questioned as *target persons*. Energy (co-) decision makers are people with major influence on the choice of electricity supply and consumption for the household (e.g. choice of electricity supplier or applied technologies).

Sample

For the CAPI survey GfK interviewers researched suitable interviewees based on the previous quota. 1,257 private households were interviewed. This was deemed representative sample for statistically accurate assessments of age, income and geography (regions north, south, etc.).

Design of the survey and questionnaire contents

Three questionnaires were created for the survey, one for each of the three sectors (heating, electricity and TV). All of them contained the same basic questions and a conjoint survey.

The content of the questionnaires was determined by ZEW based on the planned research project. The questionnaire draft was revised and adapted to fit common market research standards (e.g. regarding the wording of the questions, optional answers and filtering) by GfK in collaboration with ZEW.

The **basic survey** contained these topics:

- Target person determination
- Attitude and behaviour towards the environment
- Electricity and TV only: rating of different sources of energy
- Usage of electricity and heating
- Housing conditions and attitude towards energy efficiency
- Socio-demographic characteristics of the energy (co-) decision makers (age, income, etc.) or households (number of people, etc.)

The **second** part of the questionnaire was the conjoint survey. The conjoint design was created by GfK, with input and coordination from ZEW. The conjoint method was based on Choice Based Conjoint (CBC) and designed as a Dual Response None. This means that after choosing alternative preferences the interviewees were additionally asked if they would actually buy the chosen alternative.

The goal of the conjoints is to describe offers completely by using 8 attributes (product features) with 5 levels (feature characteristics), and to display the current market reality or the potential future market.

The conjoint designs were structured as follows:

Electricity

- Attribute 1: electricity mix, 5 characteristics
- Attribute 2: electricity supplier, 4 characteristics
- Attribute 3: location of electricity production, 4 characteristics
- Attribute 4: monthly costs of electricity, 5 characteristics
- Attribute 5: certification, 4 characteristics
- Attribute 6: period of notice, 4 characteristics

For the conjoint design in the electricity sector, 100 versions with 12 tasks and 3 alternatives for each task were created.

TV

- Attribute 1: brand, 4 characteristics
- Attribute 2: equipment, 3 characteristics
- Attribute 3: electricity consumption, 4 characteristics
- Attribute 4: price, 4 characteristics

This design contained 40 versions with 12 tasks each, and 4 alternatives per screen. For the TV conjoint, five sub groups with n= ca. 80 were created, which differ with regard to attribute 3 (electricity consumption).

The GfK methodology department provided the following detailed description:

From a technological viewpoint, the set of attributes and levels for every split group is identical:

Attribute brand:	4 characteristics
Attribute equipment:	3 characteristics
Variable attribute:	4 characteristics
Attribute price:	4 characteristics

The specified number of attributes and levels determines the need for information to be covered by the experimental design – independent of the specific texts used for the variable attribute.

The experimental design (i.e. the information about which configurations are used for the alternate choices) can be identical for all split groups. The algorithm for the design tries to arrange the screens such that partial utility values can be estimated precisely. Generally speaking, this occurs when all levels of one attribute are displayed with the same frequency and when the appearance of pair characteristics (e.g. brand A, equipment 2) within product concepts is "balanced" as much as possible. This task depends only on the number of attributes and levels, not on the texts used for characteristics.

In sum, for each split group the factors remain identical, except for the texts of the variable attribute. This means that all differences in the preference structures can be traced back to the wording of the variable attribute, which includes the willingness to pay.

Heating

- Attribute 1: specification of the measure, 2 characteristics
- Attribute 2: acquisition costs (including public or private support, if applicable), 4 characteristics
- Attribute 3: reduction of energy costs per year considering the current energy prices (this includes the fuel or electricity costs), 3 characteristics

- Attribute 4: amortisation period (time for measure to pay off), 3 characteristics
- Attribute 5: CO_2 reduction, 5 characteristics
- Attribute 6: opinion of independent energy consultant, 1 characteristic
- Attribute 7: support by state or private investors, 2 characteristics
- Attribute 8: duration of the warranty, 3 characteristics

For the conjoint design in the heating sector, 100 versions with 12 tasks and 2 alternatives for each task were created.

The conjoint analysis was executed by ZEW.

Quality assurance

Within the scope of consistency checks, numeric details stated openly (e.g. energy consumption) were reviewed with regard to plausibility and then adjusted.

The consistency checks were already integrated into the questioning process to give the interviewee or interviewer the chance to review answers when very high or very low values were entered.

Errors in filtering are excluded on account of computer-aided questioning.

Data supply

The results were transferred to ZEW as labelled SPSS data records. The three conjoint data records from heating, electricity and TV were transmitted in a Sawtooth-compatible format. The open questions were encoded by code frame and thus prepared for descriptive evaluation.

The total data record of n = 1,257 was weighted in a population representative manner. The weighting was necessary because in the heating sector only owner-occupiers of detached houses, semi-detached houses, or terraced house were questioned. The weighting compensates the over-representation of homeowners. The conjoint data was submitted in three separate SPSS partial data records with ca. n=400 for the single interviews in heating, electricity and TV. In addition three Sawtooth-compatible partial data records of the conjoint information were transferred to ZEW. Last, a SPSS questionnaire was created whose structure and number reflected the total SPSS data record.

Annex II: Questionnaires

1.1 Fragebogen Wärme

1.1.1 Fragebogen gesamt

1. Einleitung

Guten Morgen / Guten Tag, Herr / Frau …, mein Name ist … von der GfK Marktforschung in Nürnberg. Wir führen eine Befragung im Auftrag des Zentrums für Europäische Wirtschaftsforschung (ZEW) durch. Gegenstand der Untersuchung ist das Verbraucherverhalten im Bereich Energie, d.h. Heizen, Stromversorgung und die Nutzung von Haushaltsgeräten.

Ihre Meinung ist uns sehr wichtig, da die Ergebnisse einen Forschungsbetrag zur Politikgestaltung der Zukunft leisten sollen.

Screening siehe separate Fragebögen

Sind sie bereit, uns jetzt zu einem ca. 60-minütigen Gespräch zur Verfügung zu stehen?
Alle Angaben, die Sie hier machen, unterliegen selbstverständlich dem Datenschutz und werden nie in Verbindung mit Ihrem Namen ausgewertet.

Interviewerhinweis: Falls **keine** oder **geringe** Bereitschaft besteht:

Wir können auch gerne einen späteren Gesprächtermin vereinbaren, der Ihnen besser passt
( ) späterer Zeitpunkt passt besser ⇨ Tag und Uhrzeit vereinbaren
Tag: ______
Uhrzeit: ______

( ) Interview verweigert ⇨ Interviewerhinweis:
Dankeschön und Beendigung des Interviews

Arbeiten Sie selbst oder Angehörige Ihres Haushalts in einer der folgenden Berufsgruppen:

Werbung	☐ 1	⇨	Interview-Abbruch
Presse, Rundfunk, Fernsehen	☐ 2	⇨	Interview-Abbruch
Energieversorgung	☐ 3	⇨	Interview-Abbruch
Marktforschung	☐ 4	⇨	Interview-Abbruch
Nichts davon, andere Berufsgruppe	☐ 5	⇨	**Weiter im Interview**

1. Einleitende Fragen

R 1.1. Wer entscheidet in Ihrem Haushalt über Angelegenheiten in Zusammenhang mit Energie (Strom, Gas/Öl, Heizung) bzw. Energieverbrauch (z.B. Energie verbrauchende Geräte) <u>in erster Linie</u>?

☐ 1 Das entscheide ich
☐ 2 Das entscheidet mein Partner/meine Partnerin
☐ 3 Das wird bei uns partnerschaftlich entschieden
☐ 4a Bei uns läuft das ganz anders, nämlich 4b…
☐ 99 keine Angabe

R 1.2. Möchten Sie bei technischen Dingen im Allgemeinen genau Bescheid wissen, wie sie funktionieren, oder reicht es Ihnen, dass sie funktionieren?

☐ 1 Ich möchte genau Bescheid wissen
☐ 2 Hauptsache es funktioniert
☐ 99 keine Angabe Interviewerhinweis: keine Angabe/weiß nicht bitte **nie vorlesen**

2. Umwelteinstellungen und –verhalten

R 2.1. Was, glauben Sie, sind die zwei wichtigsten Probleme, dem sich unser Land heute gegenübersieht (zwei Nennungen möglich)?

Interviewerhinweis: Bitte nur zwei Nennungen zulassen.
Programmierhinweis: Statements randomisiert abfragen

☐ 1 Arbeitsmarkt
☐ 2 Familienpolitik
☐ 3 Wirtschafts- und Finanzpolitik
☐ 4 Umwelt- und Klimaschutz
☐ 5 Rentenpolitik
☐ 6 Innere Sicherheit (z.B. Terrorismus)
☐ 7 Gesundheitspolitik
☐ 8 Integration von Ausländern und Migranten
☐ 9 Bildungspolitik
☐ 10 Energiepolitik
☐ 11a Sonstiges, bitte nennen 11 b__________________
☐ 99 keine Angabe

R 2.2. Was sind Ihrer Meinung nach die wichtigsten Ursachen für den Klimawandel? Mehrfachnennungen erlaubt. Intervieweranweisung: Wort Ursachen betonen

☐ 1 Veränderte Sonnenaktivität.
☐ 2 Erhöhter Ausstoß von Treibhausgasen.
☐ 3 Abholzung der Regenwälder.
☐ 4 Ozonloch.
☐ 5 Andere Ursache
☐ 98 Weiß nicht.
☐ 99 keine Angabe

R 2.3. Bitte kreuzen Sie für jede der folgenden Aussagen an, ob Sie eher zustimmen, neutral sind oder eher nicht zustimmen.

		Stimme eher zu	Eher Neutral	Stimme eher nicht zu	Keine Angabe
A	Für den Klimawandel ist vor allem der Mensch verantwortlich	☐	☐	☐	☐
B	Im Zuge des Klimawandels verschlechtert sich die Lebensqualität der Bevölkerung hierzulande	☐	☐	☐	☐
C	Der Klimawandel bedroht die Lebensgrundlagen der Menschheit	☐	☐	☐	☐
D	Es gibt keine ernsthaften negativen Folgen des Klimawandels	☐	☐	☐	☐

R 2.4. Bitte kreuzen Sie für jede der folgenden Aussagen an, ob Sie eher zustimmen, neutral sind oder eher nicht zustimmen.

		Stimme eher zu	Neutral	Stimme eher nicht zu	Keine Angabe
a	Wir Bürger und Bürgerinnen können durch unser Kaufverhalten wesentlich zum Schutz der Umwelt beitragen	☐	☐	☐	☐
b	Ich bin bereit, etwas für den Schutz der Umwelt zu tun, solange ich keine Abstriche bei meinem Lebensstandard machen muss	☐	☐	☐	☐
c	Umweltschutz sollte durch verbindliche staatliche Regeln für alle gestaltet werden, z.B. Öko-Steuern und Verbote	☐	☐	☐	☐
d	Wissenschaft und Technik werden viele Umweltprobleme lösen, ohne dass wir unsere Lebensweise ändern müssen	☐	☐	☐	☐

R 2.5. Auf der folgenden Liste haben wir verschiedene Aussagen zum Kauf von Produkten bereitgestellt. Bitte kreuzen Sie für jede dieser Aussagen an, ob Sie eher zustimmen, neutral sind oder eher nicht zustimmen.

		Stimme eher zu	Stimme eher nicht zu	Keine Angabe
A	Ich achte beim Kauf von Haushaltsgeräten auf einen niedrigen Energieverbrauch	☐	☐	☐
B	Ich achte darauf, dass Geräte und Produkte, die ich kaufe, möglichst langlebig sind	☐	☐	☐
C	Ich kaufe gezielt Produkte (z.B. Wein, Obst und Gemüse) aus meiner Region	☐	☐	☐
D	Ich kaufe gezielt Produkte, die bei ihrer Herstellung und Nutzung die Umwelt nur gering belasten	☐	☐	☐
E	Ich boykottiere Produkte von Firmen, die sich nachweislich Umwelt schädigend verhalten	☐	☐	☐
F	Ich bevorzuge Produkte aus fairem Handel	☐	☐	☐
G	Ich lasse häufiger das Auto stehen und fahre mit öffentlichen Verkehrmitteln oder mit dem Fahrrad	☐	☐	☐
H	Ich verzichte aus Umweltgründen auf Flugreisen	☐	☐	☐

R 2.6. Wären Sie bereit, für Produkte des täglichen Bedarfs, die bei vergleichbarer Leistung nachweislich umwelt- bzw. klimaverträglicher sind als Konkurrenzprodukte, einen Aufpreis zu zahlen?

☐ 1 Ja, ich würde einen Aufpreis akzeptieren
☐ 2 Nein, ich würde keinen Aufpreis akzeptieren
☐ 99 keine Angabe

R 2.7. Für wie umweltbewusst halten Sie sich:

☐ 1 Sehr umweltbewusst
☐ 2 Umweltbewusst
☐ 3 Wenig umweltbewusst
☐ 4 Nicht umweltbewusst
☐ 99 keine Angabe

3. Bewertung einzelner Energieträger

R/S 3.1. Im Zusammenhang mit der aktuellen Diskussion um den Bau von neuen Kern- oder Kohlekraftwerken interessiert uns Ihre Meinung. Wie Sie bestimmt wissen, haben sowohl die Stromproduktion in Kohlekraftwerken

als auch in Kernkraftwerken ihre Vor- und Nachteile. Halten Sie persönlich Kohlekraftwerke oder Kernkraftwerke für das geringere Übel?

☐ 1 Kohlekraftwerke
☐ 2 Eher Kohlekraftwerke
☐ 3 Beide gleich schlimm
☐ 4 Eher Kernkraftwerke
☐ 5 Kernkraftwerke
☐ 99 keine Angabe

R/S 3.2. In der letzten Zeit wurde in Deutschland viel über den Ausstieg aus der Atomkraft diskutiert. Was ist Ihre persönliche Meinung zum Atomausstieg?

☐ 1 Deutschland sollte an dem beschlossenen Atomausstieg bis zum Jahr 2023 festhalten.
☐ 2 Deutschland sollte sofort aus der Atomenergie aussteigen.
☐ 3 Deutschland sollte den Beschluss rückgängig machen und bestehende AKWs länger laufen lassen.
☐ 4 Deutschland sollte den Beschluss rückgängig machen und neue AKWs bauen.
☐ 98 weiß nicht
☐ 99 Dazu möchte ich nichts sagen.

R/S 3.3. Wie wichtig ist Ihnen, dass Ihr Strommix atomstromfrei ist?

1	2	3	4	5	6
Sehr wichtig					Unwichtig

☐ 99 keine Angabe

R/S 3.4 Ebenso wurde in Deutschland viel über die Förderung von erneuerbaren Energien diskutiert. Sollten Ihrer Meinung nach erneuerbare Energien staatlich gefördert werden?

☐ 1 Ja
☐ 2 Eher ja
☐ 3 Eher nein
☐ 4 Nein
☐ 98 Weiß nicht
☐ 99 keine Angabe

R/S 3.5. Aussagen zum Thema Energie: Stimmen Sie diesen Aussagen zu? (Bewertung 1 stimme voll und ganz zu bis 6 stimme überhaupt nicht zu)

Der Anteil der fossilen Energieträger (Kohle/Gas/Öl) an der Stromversorgung in D sollte ausgebaut werden.

1	2	3	4	5	6
Stimme voll und ganz zu					Stimme überhaupt nicht zu

☐ 99 keine Angabe

Der Anteil der Atomenergie an der Stromversorgung in D sollte ausgebaut werden.
1 2 3 4 5 6
Stimme voll und ganz zu Stimme überhaupt nicht zu
☐ 99 keine Angabe

Der Anteil der Windenergie an der Stromversorgung in D sollte ausgebaut werden
1 2 3 4 5 6
Stimme voll und ganz zu Stimme überhaupt nicht zu
☐ 99 keine Angabe

Der Anteil der Sonnenenergie an der Stromversorgung in D sollte ausgebaut werden.
1 2 3 4 5 6
Stimme voll und ganz zu Stimme überhaupt nicht zu
☐ 99 keine Angabe

Der Anteil der Biomasse an der Stromversorgung in D sollte ausgebaut werden.
1 2 3 4 5 6
Stimme voll und ganz zu Stimme überhaupt nicht zu
☐ 99 keine Angabe

Der Anteil der Wasserkraft an der Stromversorgung in D sollte ausgebaut werden.

1 2 3 4 5 6
Stimme voll und ganz zu Stimme überhaupt nicht zu
☐ 99 keine Angabe

R/S 3.6 Die Forschung arbeitet gerade daran, zukünftig CO2 mit sogenannten Carbon-Capture-Storage-Technologien (CCS) im Kraftwerk abzutrennen und geologisch zu lagern. Haben Sie schon einmal etwas von CCS (Carbon Capture and Storage, englisch für Auffangen und Einlagerung von Kohlenstoff) gehört?
☐ 1 ja
☐ 2 neinProgrammierhinweis: weiter mit Frage R/S 3.10.
☐ 99 keine Angabe Programmierhinweis: weiter mit Frage R/S 3.10.

R/S 3.7. Wie sinnvoll auf *einer Skala 1 bis 6* finden Sie das Vorhaben, das bei der Energieerzeugung anfallende Kohlendioxid (CO2) abzufangen und zu speichern? *1 bedeutet hierbei sehr sinnvoll, 6 nicht sinnvoll. Dazwischen können Sie abstufen.*
1 2 3 4 5 6

Sehr sinnvoll Nicht sinnvoll

☐ 99 Dazu kann ich keine Aussage machen

Programmierhinweis: weiter mit Frage R/S 3.10.

R/S 3.8. Wie beurteilen Sie die langfristige Sicherheit der CO2-Speicherung?

1 2 3 4 5 6

Langfristig sehr sicher Langfristig sehr unsicher

☐ 99 Dazu kann ich keine Aussage machen

Programmierhinweis: weiter mit Frage R/S 3.10.

R/S 3.9. Verglichen mit den Risiken der Endlagerung von radioaktiven Abfällen, ist die CO2-Speicherung

1 2 3 4 5 6

Viel sicherer als Atomkraftwerke Viel unsicherer als Atomkraftwerke

☐ 99 Dazu kann ich keine Aussage machen

Programmierhinweis: Fragen R/S 3.9. bis R/S 3.19. randomisiert abfragen

R/S 3.10. Welche Energieträger verbinden Sie mit folgendem Begriff: Umweltschutz

Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):

Interviewerhinweis: Bitte alle Items vorlesen.

☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.11. Welche Energieträger verbinden Sie mit folgendem Begriff: Klimaschutz

Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):

Interviewerhinweis: Bitte alle Items vorlesen.

☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft

☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.12. Welche Energieträger verbinden Sie mit folgendem Begriff: Akzeptanz in der Bevölkerung
Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.13. Welche Energieträger verbinden Sie mit folgendem Begriff: Versorgungssicherheit
Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.14. Welche Energieträger verbinden Sie mit folgendem Begriff: Unabhängigkeit vom Ausland
Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl

☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.15. Welche Energieträger verbinden Sie mit folgendem Begriff: Zerstörung des Landschaftsbildes
Bitte nennen Sie drei Energieträger, welche Sie negativ in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.16. Welche Energieträger verbinden Sie mit folgendem Begriff: Sicherheitsrisiko
Bitte nennen Sie drei Energieträger, welche Sie negativ in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.17. Welche Energieträger verbinden Sie mit folgendem Begriff: Schaffung von Arbeitsplätzen
Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.

☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.18. Welche Energieträger verbinden Sie mit folgendem Begriff: Übermäßige Subventionen
Bitte nennen Sie drei Energieträger, welche Sie negativ in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

R/S 3.19. Welche Energieträger verbinden Sie mit folgendem Begriff: Ausgereifte Technik
Bitte nennen Sie drei Energieträger, welche Sie positiv in Verbindung mit diesem Begriff bringen, gereiht nach dem Grad der Assoziation mit dem Begriff (1.,2. und 3. Priorität):
Interviewerhinweis: Bitte alle Items vorlesen.
☐ 1 Kohle
☐ 2 Gas
☐ 3 Öl
☐ 4 Atom (nuklear)
☐ 5 Windkraft
☐ 6 Wasserkraft
☐ 7 Biomasse (inkl. Holz. Biogas)
☐ 8 Solarenergie
☐ 99 keine Angabe

4. Strom- und Wärmenutzung

R 4.1. Wissen Sie, wie viele Kilowatt-Stunden (kWh) Strom Ihr Haushalt im vergangenen Jahr verbraucht hat?

ca ____ kWh
☐ 99 weiß ich nicht, kann ich keine Aussage dazu machen.

R 4.2. Wissen Sie, wie viele Cents Sie im vergangenen Jahr für 1 Kilowatt-Stunde Strom bezahlt haben?
ca.____Cent pro Kilowatt-Stunde
☐ 99 weiß ich nicht, kann ich keine Aussage dazu machen.

R 4.3. Wie hoch waren Ihre Kosten des Strombezugs für den Gesamthaushalt im vergangenen Jahr:
___EUR
☐ 99 weiß ich nicht, kann ich keine Aussage dazu machen.

R 4.4. Glauben Sie, dass Ihr Haushalt … Strom konsumiert als ein Durchschnittshaushalt der gleichen Größe in Deutschland?
☐ 1 viel mehr
☐ 2 mehr
☐ 3 gleich viel
☐ 4 weniger
☐ 5 viel weniger
☐ 99 keine Angabe

R 4.5. G Wie schätzen Sie den Preis von Ökostrom gegenüber konventionellem Strom ein?
(Glauben Sie, dass Ökostrom….. als konventioneller Strom ist?)
☐ 1 viel teurer (mehr als 10 %)
☐ 2 etwas teurer (bis zu 10 %)
☐ 3 gleich teuer
☐ 4 etwas billiger (bis zu 10 %)
☐ 5 viel billiger (mehr als 10 %)
☐ 99 keine Angabe

R 4.6. Welche Preisentwicklung erwarten Sie für Strom in den nächsten 10 Jahren?
☐ 1 Preis steigt stark an
☐ 2 Preis steigt leicht an
☐ 3 Preis bleibt in etwa auf dem aktuellen Niveau
☐ 4 Preis sinkt leicht ab
☐ 5 Preis sinkt stark ab
☐ 98 Weiß nicht
☐ 99 keine Angabe

R/Hz 4.7. Welche Art von Heizsystem nutzen Sie hauptsächlich zur Beheizung Ihrer Wohnung?
Interviewhinweis: Nur eine Nennung möglich
☐ 1 konventionelle Zentralheizung, und zwar betrieben mit…

☐ 1a Öl ☐ 1b Gas ☐ 1cHolz(pellet) ☐ 1d Kohle
☐ 2 Zentralheizung mit Niedertemperaturkessel, und zwar betrieben mit…
☐ 2a Öl ☐ 2b Gas
☐ 3 Zentralheizung mit Brennwertkessel, und zwar betrieben mit…
☐ 3a Öl ☐ 3b Gas ☐ 3c Holz(Pellets)
☐ 4 Wärmepumpen-Heizung, und zwar folgenden Typ…
☐ 4a Erdwärme ☐ 4b Wasser ☐ 4c Luft
☐ 5 Fernwärme/Nahwärme
☐ 6 Elektroheizung, und zwar folgenden Typ…
☐ 6a Direktheizung ☐ 6b mit Teilzeitspeicher ☐ 6c mit Vollzeit- oder Pufferspeicher
☐ 7 Einzelöfen, und zwar betrieben mit…
☐ 7a Öl ☐ 7b Gas ☐ 7c Holz(pellet) ☐ 7d Kohle
☐ 8 Mikro-Blockheizkraftwerk (Mikro-BHKW) , und zwar betrieben mit…
☐ 8a Öl ☐ 8b Gas ☐ 8c Erneuerbare Energieträger (z.B. Rapsöl, Biodiesel)
☐ 9 keine Beheizung.
☐ 98 Weiß nicht
☐ 99 keine Angabe

R/Hz 4.8. Wann wurde dieses Heizsystem eingebaut?
Programmierhinweis: Frage nur stellen wenn R6 = 2a,b oder c, sonst weiter mit R/Hz 4.9

___
☐ 99 keine Angabe

R/Hz 4.9. Wie hoch sind die jährlichen Brennstoffkosten/Stromkosten bezogen auf dieses Heizsystem?
Interviewerhinweis: Nach den Stromkosten nur fragen, wenn mit einer Elektroheizung geheizt wird und zusätzlich nennen wenn mit einer Wärmepumpe geheizt wird
Ca. ____€/Jahr
☐ 98 Weiß nicht.
☐ 99 Keine Angabe.

R/Hz 4.10. Welche Preisentwicklung erwarten Sie für den Energieträger dieses Heizsystems in den nächsten 10 Jahren?
☐ 1 Preis steigt stark an.
☐ 2 Preis steigt leicht an.
☐ 3 Preis bleibt in etwa auf dem aktuellen Niveau.
☐ 4 Preis sinkt leicht ab.
☐ 5 Preis sinkt stark ab.
☐ 98 Weiß nicht.
☐ 99 Keine Angabe.

R/Hz 4.11. Welches weitere Heizsystem gibt es in Ihrer Wohnung?
☐ 1 Elektroheizung.
☐ 2 Einzelofen, und zwar betrieben mit…
☐ 2a Öl ☐ 2b Gas ☐ 2c Holz(pellets) ☐ 2d Kohle
☐ 3 Solarthermische Anlage.
☐ 4 Keines
☐ 99 Keine Angabe

R/Hz 4.12. Wie hoch sind die jährlichen Brennstoffkosten/Stromkosten bezogen auf dieses Heizsystem?
Interviewerhinweis: Nach den Stromkosten nur fragen, wenn mit einer Elektroheizung geheizt wird
Ca. ____€/Jahr
☐ 98 Weiß nicht.
☐ 99 Keine Angabe.

R/Hz 4.13. Wie erfolgt bei Ihnen die Bereitstellung von Warmwasser?
☐ 1 ausschließlich gekoppelt mit primärem Heizsystem Programmierhinweis: weiter mit Frage R 5.1.
☐ 2 durch elektrische Warmwasserbereitstellung (Durchlauferhitzer, Boiler) Programmierhinweis: weiter mit Frage R 5.1.
☐ 3 mithilfe einer solarthermische Anlage
☐ 98 Weiß nicht. Programmierhinweis: weiter mit Frage R 5.1.
☐ 99 Keine Angabe. Programmierhinweis: weiter mit Frage R 5.1.
R/Hz 4.14. Ist ihre solarthermische Anlage mit ihrem Primären Heizsystem oder mit der Warmwasserbereitstellung gekoppelt?
☐ 1 gekoppelt mit primärem Heizsystem
☐ 2 gekoppelt mit elektrischer Warmwasserbereitstellung
☐ 98 Weiß nicht.
☐ 99 Keine Angabe.

5. Wohnverhältnisse und Einstellung zur Energieeffizienz

R 5.1 Wählen Sie bitte aus den im Folgenden genannten Kriterien diejenigen aus, die für Sie persönlich bei der Wahl einer Wohnung/eines Hauses maßgeblich sind.
Intervieweranweisung: Mehrfachnennungen erlaubt
Programmieranweisung: Statements randomisiert abfragen
☐ 1 Lage, Infrastruktur.
☐ 2 Anzahl der Zimmer, Raumanordnung.
☐ 3 Größe der Wohnfläche.
☐ 4 Höhe der Kaltmiete / Kaufpreis.
☐ 5 Energieverbrauch / energetischer Zustand des Hauses.
☐ 6 Sicherheit des Wohnumfelds.
☐ 7 Klima- und Umweltfreundlichkeit.
☐ 8 Ausstattung der Wohnung / des Hauses.

☐ 9 Verhältnis zu den Nachbarn.
☐ 10 Freiflächen wie Balkon, Terrasse oder Garten.
☐ 11 Gesamteindruck des Hauses, Image
☐ 12 Art der Wärmeversorgung/Energieversorgung
☐ 13 Andere.
☐ 99 keine Angabe

R 5.2 Wählen Sie bitte aus den von Ihnen genannten Kriterien die drei Wichtigsten aus.
Programmieranweisung: Nur die gewählten Kriterien anzeigen und zur Wahl stellen.

R 5.3. Bitte beschreiben Sie im Folgenden Ihre aktuelle Wohnsituation.
a. Wie groß ist die Wohnfläche?
Ca. ____qm.
☐ 99 keine Angabe

b. Anzahl der Zimmer __.
☐ 99 keine Angabe

R 5.4. Wie groß ist Ihre beheizte Wohnfläche?
Ca. ____qm.
☐ 99 keine Angabe

R 5.5. Wie groß ist die Anzahl der beheizten Zimmer?

__
☐ 99 keine Angabe

R 5.6. Wohnen Sie…?
☐ 1 zur Miete, und zwar in einem… Programmieranweisung: Weiter mit Frage R 5.8.
- ☐ 1a Einzelhaus. Programmieranweisung: Weiter mit Frage R 5.8.
- ☐ 1b Doppelhaushälfte. Programmieranweisung: Weiter mit Frage R 5.8.
- ☐ 1c Reihenhaus. Programmieranweisung: Weiter mit Frage R 5.8.
- ☐ 1d Mehrfamilienhaus. Programmieranweisung: Weiter mit Frage R 5.8.
- ☐ 1e Hochhaus. Programmieranweisung: Weiter mit Frage R 5.8.
- ☐ 1f Sonstiges Programmieranweisung: Weiter mit Frage R 5.8.

☐ 2 in Eigentum, und zwar in einem/einer…
- ☐ 2a Einzelhaus
- ☐ 2b Doppelhaushälfte.
- ☐ 2c Reihenhaus.
- ☐ 2d Mehrfamilienhaus. Programmieranweisung: Weiter mit Frage R

5.8.

☐ 2e Hochhaus. Programmieranweisung: Weiter mit Frage R 5.8.
☐ 2f Sonstiges Programmieranweisung: Weiter mit Frage R 5.8.
☐ 99 keine Angabe Programmieranweisung: Weiter mit Frage R 5.8.

R 5.7. Wann wurde das Gebäude erbaut?
☐ 1 vor 1948
☐ 2 1949-1978
☐ 3 1979 bis 1986
☐ 4 1987 bis 1990
☐ 5 1991 bis 2000
☐ 6 2000 bis 2009.
☐ 99 keine Angabe

R 5.8. Laut der Energieeinsparungsverordnung (EnEV) sind seit dem 1. Januar 2009 alle Hauseigentümer und Hauseigentümerinnen in Deutschland verpflichtet, bei Vermietung oder Verkauf ihres Gebäudes den so genannten Energieausweis vorzulegen. Dieser Energieausweis enthält Informationen über die Energieeffizienz eines Wohngebäudes. Er soll insbesondere Mietern und Käufern helfen, den Energieverbrauch eines Gebäudes vor einem möglichen Vertragsabschluss einzuschätzen.

Haben Sie von diesem Energieausweis für Gebäude bereits gehört?
☐ 1 Ja.
☐ 2 Nein.
☐ 99 keine Angabe

R 5.9. Was halten Sie von diesem Energieausweis?
☐ 1 Ich halte ihn für sinnvoll. Ein Energieausweis erhöht die Transparenz für Mieter und Käufer.
☐ 2 Ich halte ihn nicht für sinnvoll. Ein Energieausweis erhöht den bürokratischen Aufwand und somit die Kosten für Vermieter und Verkäufer.
☐ 3 Mir ist dieser Energieausweis eigentlich egal.
☐ 99 keine Angabe

R 5.10. Planen Sie bzw. können Sie sich vorstellen innerhalb der nächsten 5 Jahre umzuziehen?
☐ 1 Ja.
☐ 2 Nein. Programmieranweisung: Weiter mit Frage R 6.1.
☐ 99 keine Angabe Programmieranweisung: Weiter mit Frage R 6.1.

R 5.11. Wie wird Ihr nächstes Wohnverhältnis vermutlich aussehen?
☐ 1 Zur Miete in einer Wohnung.
☐ 2 Zur Miete in einem Haus.
☐ 3 Kauf einer Wohnung.
☐ 4 Kauf eines Hauses.

☐ 5 Bau eines Hauses. Programmieranweisung: Weiter mit Frage R 5.14.
☐ 99 keine Angabe

R 5.12. Werden Sie sich bei Ihrer nächsten Wohnungssuche/Haussuche den oben genannten Energieausweis vom Vermieter/Verkäufer zeigen lassen?
☐ 1 Ja.
☐ 2 Nein.
☐ 98 Weiß noch nicht.
☐ 99 keine Angabe

R 5.13. Wären Sie bereit für eine Wohnung/ein Haus mit einer höheren Energieeffizienz (und damit niedrigeren Energiekosten) auch eine höhere monatliche Kaltmiete/einen höheren Kaufpreis zu zahlen?Programmieranweisung:Formulierung abhängig von Antwort in R 5.11.
☐ 1a Ja, solange ich mir die Wohnung/das Haus noch leisten kann.
☐ 1b Ja, aber nur solange die Warmmiete insgesamt nicht steigt / wenn die innerhalb der Nutzungsdauer des Hauses insgesamt gesparten Energiekosten auch die Kaufpreiserhöhung decken.
☐ 2 Nein, eine Mieterhöhung/einen erhöhten Kaufpreis aufgrund einer verbesserten Energieeffizienz würde ich nicht akzeptieren.
☐ 99 keine Angabe

Programmieranweisung: Weiter mit Frage R 6.1.
R 5.14. Werden Sie sich bei Ihrem Bauvorhaben von einem Energieberater beraten lassen?
☐ 1 Ja, wahrscheinlich.
☐ 2 Nein, wahrscheinlich nicht.
☐ 98 Weiß noch nicht.
☐ 99 keine Angabe

6. Allgemeine demographische Informationen

Abschließend benötigen wir noch einige Angaben zu Ihrer Person und zu Ihrem Haushalt, damit wir die Angaben für verschiedene Alters- und Personengruppen auswerten können.
R 6.1. In welchem Jahr sind Sie geboren?

____
☐ 99 keine Angabe

R 6.2. Wie ist Ihr Familienstand?
☐1 ledig
☐2 verheiratet
☐3 verwitwet
☐4 geschieden
☐ 99 keine Angabe

R 6.3. Welchen Bildungsabschluss haben Sie? Nennen Sie bitte den höchsten.
☐ 1 (Noch) keinen
☐ 2 Haupt- (Volks-)schulabschluss
☐ 3 Realschulabschluss (Mittlere Reife)
☐ 4 Abschluss der polytechnischen Oberschule
☐ 5 Fachhochschulreife
☐ 6 Abitur (Gymnasium oder EOS)
☐ 7 Hochschulabschluss (Fach-/Hochschule, Universität)
☐ 99 keine Angabe

R 6.4. Wie ist Ihr aktuelles Beschäftigungsverhältnis?
☐ 1 Vollzeit-erwerbstätig (35h/Woche und mehr)
☐ 2 Teilzeit-erwerbstätig (weniger als 35h/Woche
☐ 3 Zurzeit arbeitslos Programmieranweisung: Weiter mit Frage R 6.6., Frage R 6.5 = 0 setzen
☐ 4 Auszubildende(r), Lehrling, Umschüler(in)
☐ 5 Wehr-, Zivildienstleistender
☐ 6 Schüler(in), Student(in)
☐ 7 Hausfrau/-mann Programmieranweisung: Weiter mit Frage R 6.6., Frage R 6.5 = 0 setzen
☐ 8 Rentner(in), Pensionär(in), im Vorruhestand Programmieranweisung: Weiter mit Frage R 6.6., Frage R 6.5. = 0 setzen
☐ 99 Keine Angabe

R 6.5. Wie viele Stunden pro Woche arbeiten Sie in bezahlter Arbeit?
Interviewerhinweis: Gemeint ist die tatsächliche Arbeitszeit, nicht die Regelarbeitszeit
_______Std.
☐ 99 keine Angabe

R 6.6. Wie viele Stunden pro Woche verwenden Sie für unbezahlte Arbeit (Haus- und Familien-Arbeit)?
_______Std.
☐ 99 keine Angabe

R 6.7. Leben Sie mit einem Partner/einer Partnerin zusammen?
☐ 1 Ja
☐ 2 Nein Programmierhinweis: weiter mit Frage R 6.10.
☐ 99 keine Angabe Programmierhinweis: weiter mit Frage R 6.10.

R 6.8. Wie viele Stunden pro Woche verwendet Ihr Partner/Ihre Partnerin für bezahlte Arbeit? _______Std.
☐ 99 keine Angabe

R 6.9. Wie viele Stunden pro Woche verwendet Ihr Partner/Ihre Partnerin für unbezahlte Arbeit (Haus- und Familien-Arbeit)?

_______Std.
☐ 99 keine Angabe

R. 6.10. Wie alt ist die haushaltsführende Person?
Interviewerhinweis: Haushaltsvorstand/ haushaltsführende Person ist nach allgemeiner Definition der- oder diejenige, die den größten finanziellen Beitrag zum Haushalts- bzw. Familieneinkommen leistet al.leinstehende gelten stets als Haushaltsvorstand. Wenn beide Partner das gleiche Einkommen beisteuern, wird der Befragten zum Haushaltsvorstand ernannt.
____ Jahre
☐ 99 keine Angabe

R. 6.11. Wie viele Personen leben in Ihrem Haushalt, sie selbst eingeschlossen?
_______ Personen
☐ 99 keine Angabe

R 6.12. Wie viele Personen in Ihrem Haushalt sind…
…unter 6 Jahre? __
…6 bis 14 Jahre? __
…15 bis 18 Jahre? __
☐ 99 keine Angabe

R. 6.13. Wie hoch ist ungefähr das monatliche Nettoeinkommen Ihres Haushalts? Alle Ihre Angaben werden streng vertraulich behandelt.

☐ 1 Unter 1.000 Euro
☐ 2 Zwischen 1.000 und 1.499
☐ 3 Zwischen 1.500 und 1.999
☐ 4 Zwischen 2.000 und 2.499
☐ 5 Zwischen 2.500 und 3.499
☐ 6 Über 3.500 Euro
☐ 99 keine Angabe

R 6.14. Welcher dieser folgenden Lebensereignisse haben Sie in den letzten 1-12 Monaten selbst erlebt bzw. vor mehr als 1 Jahr aber nicht mehr als 5 Jahren selbst erlebt?

	In den letzten 12 Monaten	**In den letzten 5 Jahren**	Keine Angabe
Umzug in eine neue Wohnung / in ein neues Haus			☐
Beginn des Ruhestandes / Pensionierung			☐
Geburt des 1. Kindes			☐
Geburt eines weiteren Kindes			☐

Geburt des 1. Enkelkindes			☐
Auszug des letzten Kindes aus der Wohnung / Haus			☐
Hochzeit			☐
Scheidung / Trennung			☐

R. 6.15. Interviewerhinweis: Feststellung des Bundeslandes

☐ 1 Baden-Württemberg
☐ 2 Bayern
☐ 3 Berlin
☐ 4 Bremen
☐ 5 Brandenburg
☐ 6 Hamburg
☐ 7 Hessen
☐ 8 Mecklenburg-Vorpommern
☐ 9 Niedersachsen
☐ 10 Nordrhein-Westfalen
☐ 11 Rheinland-Pfalz
☐ 12 Sachsen
☐ 13 Sachsen-Anhalt
☐ 14 Saarland
☐ 15 Schleswig-Holstein
☐ 16 Thüringen

R. 6.16. Interviewerhinweis: Feststellung Anzahl der Einwohner des Ortes

☐1 bis 4.999
☐2 5.000 – 19.999
☐3 20.000-99.999
☐4 100.000-499.000
☐5 500.000 Einwohner und mehr

R 6.17. Interviewhinweis: Feststellung Geschlecht des befragten Teilnehmers

☐1 männlich
☐2 weiblich

Conjoint Analyse Wärme

Im Folgenden werden Ihnen jeweils zwei hypothetische Modernisierungsmaßnahmen zur Auswahl gestellt, die Ihre Wärmeversorgung bzw. Wärmenutzung verändern. Ganz konkret haben Sie die Wahl zwischen einer moderneren Heizungsanlage und einer besseren Wärmedämmung. Dabei wird weder der konkrete Energieträger der Heizung (also Gas, Öl, Kohle, Holz, sonstige Biomasse, Solar-, Luft-, Wasser- oder Erdwärme) noch der Gebäudeteil der Dämmmaßnahme (also Fassade/Außenwand, Dach, oberste Geschossdecke, Kellerdecke oder Fenster) genauer spezifiziert. Das überlassen wir Ihnen: Stellen Sie sich bitte einfach die jeweilige Alternative/Technologie vor, die Sie sich für Ihr Haus wünschen würden.

Die zur Auswahl gestellten Alternativen werden durch sieben Eigenschaften beschrieben. Unter diesen Eigenschaften befinden sich u.a. die Anschaffungskosten, die Energiekostenersparnis und die Amortisationsdauer (d.h. die Anzahl der Jahre nachdem sich eine Modernisierungsmaßnahme rechnet). Bitte beachten Sie, dass sich diese drei Eigenschaften nicht miteinander verrechnen lassen! Während die Energiekostenersparnis sich auf aktuelle Energiepreise bezieht, berücksichtigt die Amortisationsdauer darüber hinaus wahrscheinliche Energiepreisentwicklungen.

Es kann im Einzelfall durchaus sein, dass es Heizungen oder Dämmungen mit den angegebenen Eigenschaften momentan noch nicht gibt. Das sollte Sie nicht stören; stellen Sie sich einfach vor, es gäbe sie.

Sagen Sie uns bitte jeweils, welche der gezeigten Alternativen Ihnen attraktiver erscheint und wählen Sie diese aus. Im Anschluss an jede Wahl werden Sie gefragt, ob Sie die gewählte Modernisierungsmaßnahme – wenn es sie denn gäbe – auch in der Realität an ihrem Haus durchführen würden oder nicht.

	Heizsystem	Wärmedämmung
Anschaffungskosten (ggf. inkl. Förderung aus öffentlicher und/oder privater	10.000 20.000 30.000	10.000 20.000 30.000 40.000
Energiekostenersparnis pro Jahr bei aktuellen Energiepreisen (umfasst ggf. zur Beheizung anfallende	25% 50% 75% des aktuellen Werts	25% 50% 75% des aktuellen Werts
Amortisationsdauer (Maßnahme rechnet sich in)	10 Jahre 20 Jahre 30 Jahre	10 Jahre 20 Jahre 30 Jahre
CO_2-Verminderung	0% 25% 50% 75% 100%	25% 50% 75%
Meinung eines unabhängigen	Empfehlenswert	Empfehlenswert
Förderung durch die öffentliche und/oder	Ja Nein	Ja Nein
Garantiedauer	2 Jahre 5 Jahre 10 Jahre	2 Jahre 5 Jahre 10 Jahre

1.2 Fragenbogen TV

1. Aktuelle Situation (Erstkauf vs. Ersatzkauf)

TV 1. Haben Sie innerhalb der letzten 12 Monate ein TV-Gerät gekauft oder planen Sie, sich eines innerhalb der nächsten 12 Monate anzuschaffen?
☐ 1a Ja, ich habe mir in letzter Zeit ein TV-Gerät gekauft
☐ 1b Ja, ich habe vor, in naher Zukunft ein TV-Gerät zu kaufen
☐ 2 Nein
☐ 99 keine Angabe

TV 2. Wer hat diese Entscheidung getroffen bzw. wer wäre für diese Entscheidung zuständig?
☐ 1 Ich selbst
☐ 2 Mein(e) Partner(in) / meine Familie / meine WG-Kollege(n) bzw. mein(e) WG-Kollegin(nen)
☐ 3 Ich gemeinsam mit meinem/r Partner(in)/ meiner Familie / meinen WG-Kollege(n) bzw. mein(e)n WG-Kollegin(nen)
☐ 99 keine Angabe

TV 3. Handelte es sich bei diesem Kauf bzw. würde es sich bei diesem Kauf um einen …
☐ 1 Erstkauf Programmierhinweis: weiter mit Frage TV 6
☐ 2 Ersatzkauf Programmierhinweis: weiter mit Frage TV 4
☐ 3 Kauf eines zweiten (oder zusätzlichen) Gerätes handeln Programmierhinweis: weiter mit Frage TV 4
☐ 99 keine Angabe

TV 4. Bei Ersatzkauf/Kauf eines zusätzlichen Gerätes: Handelt es sich bei diesem alten Fernsehers um einen
☐ 1 Röhren-
☐ 2 LCD-
☐ 3 Plasma – Fernseher?
☐ 4 Weiß ich nicht
☐ 99 keine Angabe

TV 5. Bei Ersatzkauf/Kauf eines zusätzlichen Gerätes: Wie groß war/ ist dieser alte Fernseher:
☐ 1 Bis 50 cm Bildschirmdiagonale
☐ 2 Bis 80 cm Bildschirmdiagonale
☐ 3 Bis 100 cm Bildschirmdiagonale
☐ 4 Über 100 cm Bildschirmdiagonale

☐ 5 Weiß ich nicht
☐ 99 keine Angabe

2. Verwendung des Neukaufs

TV 5. Bei Ersatzkauf/Kauf eines zusätzlichen Gerätes: Wie groß soll der neue Fernseher sein?
☐ 1 Bis 50 cm Bildschirmdiagonale
☐ 2 Bis 80 cm Bildschirmdiagonale
☐ 3 Bis 100 cm Bildschirmdiagonale
☐ 4 Über 100 cm Bildschirmdiagonale
☐ 5 Weiß ich nicht
☐ 99 keine Angabe

TV 6. Wo haben Sie das neu gekaufte Gerät platziert bzw. wo haben Sie vor, das neu gekaufte Gerät zu platzieren?
☐ 1 Im Wohnzimmer
☐ 2 Im Schlafzimmer
☐ 3 Im Kinderzimmer
☐ 4 In einem anderen Raum
☐ 99 keine Angabe

TV 7. Welche TV-Programme planen Sie hauptsächlich auf diesem neu gekauften Fernseher zu sehen? (Mehrfachantworten möglich)
☐ 1 Nachrichten
☐ 2 Sportbeiträge
☐ 3 Filme
☐ 4 Serien
☐ 5 Dokumentarbeiträge
☐ 6 Kindersendungen
☐ 7 Pay TV
☐ 99 keine Angabe

3. Fernsehverhalten

TV 8. Wie viele TV Geräte gibt es in Ihrem Haushalt insgesamt?
___ Stück

TV 9. Wie viel Stunden am Tag wird in ihrem Haushalt insgesamt fern gesehen?
1. Gerät: ___ h
2. Gerät: ___ h
3. Gerät: ___ h

Weitere Geräte zusammen: ___h
☐ 99 keine Angabe

TV 10. Wie viel Stunden am Tag schauen Sie persönlich fern?
Programmierhinweis: Frage bei 1-Personen-Haushalt filtern
___ h
☐ 99 keine Angabe

TV 11. Schalten Sie (bzw. Ihr Haushalt) Ihren Fernsehapparat bei Nicht-Gebrauch üblicherweise auf
☐ 1 Stand-by (mittels Fernbedienung)
☐ 2 Aus (Powerknopf direkt am Fernsehapparat)
☐ 99 keine Angabe

4. Wichtigste Kaufkriterien

TV 12. Welche Eigenschaften sind für Sie beim Kauf eines TV-Gerätes wichtig? Bitte nennen Sie die drei wichtigsten Kaufentscheidungskriterien bei der Wahl eines Fernsehers, gereiht nach ihrer Wichtigkeit:
Programmierhinweis: bitte Statements rotierend abfragen
☐ 1 Marke
☐ 2 Preis (Anschaffungskosten)
☐ 3 Design
☐ 4 Einfache Bedienung
☐ 5 Technologie
☐ 6 Bildschirmdiagonale (in cm)
☐ 7 Reaktionszeit
☐ 8 Stromverbrauch
☐ 9 Kontrastverhältnis
☐ 10 Bildhelligkeit
☐ 11 HD Ready
☐ 12 Full HD
☐ 13 Anschlüsse (USB, HDMI)
☐ 14 Garantie
☐ 15 Möglichkeit zur Ratenzahlung
☐ 16 Service (Wartung & Reparatur)
☐ 17 Finanzierungsmöglichkeiten
☐ 18 Sonstiges
☐ 99 keine Angabe

TV 13. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Fernsehgerätes folgende Eigenschaft ist: Marke

1	2	3	4	5	6
Sehr wichtig					Nicht wichtig

☐ 99 keine Angabe

TV 15. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Fernsehgerätes folgende Eigenschaft ist: Ausstattung
Interviewerhinweis: Die Ausstattung beinhaltet, ob der Fernseher z.B. HD-Ready ist, über welche Anschlüsse er verfügt (z.B. USB) oder wie hoch das Kontrastverhältnis ist.

1 2 3 4 5 6
Sehr wichtig Nicht wichtig
☐ 99 keine Angabe

TV 16. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Fernsehgerätes folgende Eigenschaft ist (je nach Sample): Stromverbrauch / Energielabel / CO2 - Ausstoß / Stromkosten

1 2 3 4 5 6
Sehr wichtig Nicht wichtig
☐ 99 keine Angabe

TV 17. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Fernsehgerätes folgende Eigenschaft ist: Anschaffungskosten

1 2 3 4 5 6
Sehr wichtig Nicht wichtig
☐ 99 keine Angabe

5. Fünf Untersamples

Programmierhinweis: zufällige Aufteilung des Samples auf 5 Untersamples
Programmierhinweis: Gestaltung des Conjoint als Dual-Response-None
Stellen Sie sich vor, Sie möchten einen neuen Flachbildschirm-Fernseher kaufen. Wenn Sie die folgenden Fernseher zur Auswahl hätten, die sich in nur 4 Punkten unterscheiden, welchen würden Sie kaufen?
Programmierhinweis: Nur für Sample 1
Choice Task für Sample 1: Angabe des Stromverbrauchs
Stellen Sie sich vor, Sie möchten einen neuen Flachbildschirm-Fernseher kaufen. Wenn Sie die folgenden Fernseher zur Auswahl hätten, die sich in nur 4 Punkten unterscheiden, welchen würden Sie kaufen?

Marke	Samsung	Sony	Philips	TCM von Tchibo
Ausstattung	Einfach 1	Mittel 2	High-Tech 3	
Stromverbrauch Betrieb in Watt	60 W	115 W	170 W	225 W
Preis	499€	649€	799€	949€

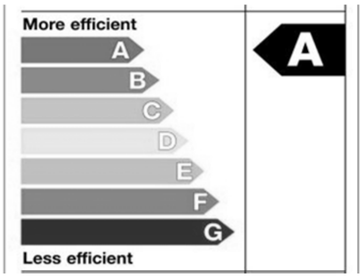
Programmierhinweis: Definition einblenden:
Ausstattung:
1 Einfach: HD-Ready, 1x HDMI, Reaktionszeit 8, Kontrastverhältnis 5000:1
2 Mittel: HD-Ready, 2x HDMI, USB-Anschluss, Reaktionszeit 6, Kontrastverhältnis 10000:1.
3 High-Tech: Full-HD, 4x HDMI, PC-Anschluss, USB-Anschluss, Reaktionszeit 4, Kontrastverhältnis 50000:1.

Bedeutung Energieverbrauch (für Sample 1)

TV 18. Aufgrund welcher der folgenden Gründe würden Sie auf den Energieverbrauch beim Kauf eines Fernseher schauen:
☐ 1 Primär aufgrund von Energiekosten
☐ 2 Primär aufgrund von Umweltaspekten
☐ 3 Ich würde keinesfalls auf den Energieverbrauch achten
☐ 99 keine Angabe

TV 19. Für einen Fernseher mit niedrigem Energieverbrauch im Vergleich zu einem Fernseher mit einem hohen Energieverbrauch würde ich folgenden Aufpreis akzeptieren:
☐ 1 Ich würde keinen Aufpreis akzeptieren
☐ 2 Ich würde einen Aufpreis von bis zu 10% akzeptieren
☐ 3 Ich würde einen Aufpreis von bis zu 20% akzeptieren
☐ 4 Ich würde einen Aufpreis von bis zu 30% akzeptieren
☐ 5 Ich würde einen Aufpreis von bis zu 40% akzeptieren
☐ 6 Ich würde einen Aufpreis von mehr als 40% akzeptieren
☐ 99 keine Angabe

Programmierhinweis: Nur für Sample 2
Choice Task für Sample 2: Angabe des Energielabels A-C
Vor der Präsentation der Choice Tasks: Die EU plant ein neues Label für Fernseher einzuführen, das wie folgt aussehen wird:



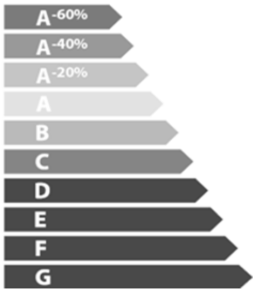
Die Farbe "Grün" steht für besonders geringen Energieverbrauch, die Farbe "Rot" für energiefressende Geräte.

Marke	Samsung	Sony	Philips	TCM von Tchibo
Ausstattung	Einfach 1	Mittel 2	High-Tech 3	
Energielabel	A	B	C	D
Anschaffungspreis	499€	649€	799€	949€

Programmierhinweis: Definition einblenden:

Ausstattung:
1 Einfach: HD-Ready, 1x HDMI, Reaktionszeit 8, Kontrastverhältnis 5000:1
2 Mittel: HD-Ready, 2x HDMI, USB-Anschluss, Reaktionszeit 6, Kontrastverhältnis 10000:1.
3 High-Tech: Full-HD, 4x HDMI, PC-Anschluss, USB-Anschluss, Reaktionszeit 4, Kontrastverhältnis 50000:1.
Programmierhinweis: weiter mit Frage TV 20.-23., dann Interviewende

Programmierhinweis: Nur für Sample 3
Choice Task für Sample 3: Angabe des Energielabels A - A-60%
Vor der Präsentation der Choice Tasks:
Die EU plant ein neues Label für Fernseher einzuführen, das wie folgt aussehen wird:



Die Farbe "Grün" steht für besonders geringen Energieverbrauch, die Farbe "Rot" für energiefressende Geräte. Die Kennzeichnungen A -20%, A -40%, A -60% bedeuten, dass das jeweilige Gerät 20, 40 oder 60 Prozent weniger Energie verbraucht als ein vergleichbares in der Energieeffizienzklasse A.

Marke	Samsung	Sony	Philips	TCM von Tchibo
Ausstattung	Einfach 1	Mittel 2	High-Tech 3	
Energielabel	A-60%	A-40%	A-20%	A
Anschaffungspreis	499€	649€	799€	949€

Programmierhinweis: Definition einblenden:
Ausstattung:
1 Einfach: HD-Ready, 1x HDMI, Reaktionszeit 8, Kontrastverhältnis 5000:1
2 Mittel: HD-Ready, 2x HDMI, USB-Anschluss, Reaktionszeit 6, Kontrastverhältnis 10000:1.
3 High-Tech: Full-HD, 4x HDMI, PC-Anschluss, USB-Anschluss, Reaktionszeit 4, Kontrastverhältnis 50000:1.

Bedeutung Energieeffizienzlabel (für Samples 2&3)

TV 20. Kennen Sie das europäische Energieeffizienzlabel: (Abbildung einfügen, 1x mit Label A-G; 1x mit Label A-60% -G)
☐ 1 Ja
☐ 2 Nein
☐ 99 keine Angabe

TV 21. Wofür steht dieses Label Ihrer Meinung nach? (Mehrfachantworten möglich)
☐ 1 Hohe Qualität
☐ 2 Umweltfreundlichkeit
☐ 3 Hoher Preis

☐ 4 Niedriger Preis
☐ 5 Energieverbrauch
☐ 6 Niedrige CO2-Emissionen
☐ 7 Made in Germany
☐ 8 Fair Trade
☐ 9 Ich weiß es nicht
☐ 99 keine Angabe

TV 22. Aufgrund welcher folgender Gründe würden Sie auf das Energieeffizienzlabel beim Kauf eines Fernseher schauen:
☐ 1 Primär aufgrund von Energiekosten
☐ 2 Primär aufgrund von Umweltaspekten
☐ 3 Ich würde keinesfalls auf die Energieetikette achten
☐ 99 keine Angabe

TV 23. Für einen Fernseher mit der Energieeffizienzklasse A (A-60%) im Vergleich zu einem Fernseher mit der Energieeffizienzklasse C (A-20%) würde ich folgenden Aufpreis akzeptieren:
☐ 1 Ich würde keinen Aufpreis akzeptieren
☐ 2 Ich würde einen Aufpreis von bis zu 10% akzeptieren
☐ 3 Ich würde einen Aufpreis von bis zu 20% akzeptieren
☐ 4 Ich würde einen Aufpreis von bis zu 30% akzeptieren
☐ 5 Ich würde einen Aufpreis von bis zu 40% akzeptieren
☐ 6 Ich würde einen Aufpreis von mehr als 40% akzeptieren
☐ 99 keine Angabe

Programmierhinweis: Nur für Sample 4
Choice Task für Sample 4: Angabe der Lebenszykluskosten über 10 Jahre

Marke	Samsung	Sony	Philips	TCM von Tchibo
Ausstattung	Einfach 1	Mittel 2	High-Tech 3	
Stromkosten (EUR in 10 Jahren) für Betrieb	180€	340€	500€	660€
Anschaffungspreis	499€	649€	799€	949€

Programmierhinweis: Definition einblenden:
Ausstattung:
1 Einfach: HD-Ready, 1x HDMI, Reaktionszeit 8, Kontrastverhältnis 5000:1
2 Mittel: HD-Ready, 2x HDMI, USB-Anschluss, Reaktionszeit 6, Kontrastverhältnis 10000:1.

3 High-Tech: Full-HD, 4x HDMI, PC-Anschluss, USB-Anschluss, Reaktionszeit 4, Kontrastverhältnis 50000:1.
Stromkosten (EUR in 10 Jahren) für Betrieb : TV 4h Betrieb/Tag, Preis/kWh: 20 Cent
Programmierhinweis: weiter mit Frage TV 24.-25., dann Interviewende
Programmierhinweis: Nur für Sample 5
Choice Task für Sample 5: Angabe des Stromkosten pro Jahr

Marke	Samsung	Sony	Philips	TCM von Tchibo
Ausstattung	Einfach 1	Mittel 2	High-Tech 3	
Stromkosten (EUR in 10 Jahren) für Betrieb	18€	34€	50€	66€
Anschaffungspreis	499€	649€	799€	949€

Programmierhinweis: Definition einblenden:
Ausstattung:
1 Einfach: HD-Ready, 1x HDMI, Reaktionszeit 8, Kontrastverhältnis 5000:1
2 Mittel: HD-Ready, 2x HDMI, USB-Anschluss, Reaktionszeit 6, Kontrastverhältnis 10000:1.
3 High-Tech: Full-HD, 4x HDMI, PC-Anschluss, USB-Anschluss, Reaktionszeit 4, Kontrastverhältnis 50000:1.
Stromkosten (EUR pro Jahr) für Betrieb : TV 4h Betrieb/Tag, Preis/kWh: 20 Cent

Bedeutung Stromkosten (für Sample 4&5)

TV 24. Aufgrund welcher der folgenden Gründe würden Sie auf die Stromkosten beim Fernseher schauen:
☐1 Primär aufgrund von Energiekosten
☐ 2 Primär aufgrund von Umweltaspekten
☐ 3 Ich würde keinesfalls auf die Stromkosten achten
☐ 99 keine Angabe

TV 25. Für einen Fernseher mit niedrigen Stromkosten im Vergleich zu einem Fernseher mit hohen Stromkosten würde ich folgenden Aufpreis akzeptieren:
☐ 1 Ich würde keinen Aufpreis akzeptieren
☐ 2 Ich würde einen Aufpreis von bis zu 10% akzeptieren
☐ 3 Ich würde einen Aufpreis von bis zu 20% akzeptieren
☐ 4 Ich würde einen Aufpreis von bis zu 30% akzeptieren
☐ 5 Ich würde einen Aufpreis von bis zu 40% akzeptieren
☐ 6 Ich würde einen Aufpreis von mehr als 40% akzeptieren
☐ 99 keine Angabe

1.3 Fragebogen Elektrizität

1. Aktuelle Situation

S 1a. Haben Sie in den letzten 5 Jahren Ihren Stromanbieter gewechselt?

☐ 1 Ja Programmierhinweis: Weiter mit Frage S 1c
☐ 2 Nein
☐ 99 Keine Angabe

S 1b. Haben Sie in naher Zukunft vor, Ihren Stromanbieter zu wechseln?

☐ 1a Ja, sehr sicher
☐ 1b Eher ja
☐ 2a Eher nein Programmierhinweis: Weiter mit Frage S 2a
☐ 2b Nein, sicher nicht Programmierhinweis: Weiter mit Frage S 2a
☐ 99 Keine Angabe Programmierhinweis: Weiter mit Frage S 2a

S 1c. Weshalb haben Sie Ihren Stromanbieter gewechselt bzw. weshalb haben Sie vor Ihren Stromanbieter zu wechseln? (Mehrfachantworten möglich)

☐ 1 Unzufriedenheit mit Stromanbieter
☐ 2 Wechsel zu Ökostromanbieter
☐ 3 Umzug in neue Wohnung/Haus
☐ 4 der neue Tarif ist günstiger
☐ 5 Sonstiges:____
☐ 99 Keine Angabe

S 2a. Haben Sie in den letzten 5 Jahren Ihren Stromvertrag gewechselt?

☐ 1 Ja Programmierhinweis: Weiter mit Frage S 2c
☐ 2 Nein
☐ 99 Keine Angabe

S 2b. Haben Sie in naher Zukunft vor, Ihren Stromvertrag zu wechseln?

☐ 1a Ja, sehr sicher
☐ 1b Eher ja
☐ 2a Eher nein Programmierhinweis: Weiter mit Frage S 4
☐ 2b Nein, sicher nicht Programmierhinweis: Weiter mit Frage S 4
☐ 99 Keine Angabe Programmierhinweis: Weiter mit Frage S 4

S 2c. Weshalb haben Sie Ihren Stromvertrag gewechselt bzw. weshalb haben Sie vor Ihren Stromvertrag zu wechseln? (Mehrfachantworten möglich)

☐ 1 Unzufriedenheit mit Stromanbieter

- ☐ 2 Wechsel zu Ökostromanbieter
- ☐ 3 Umzug in neue Wohnung/Haus
- ☐ 4 der neue Tarif ist günstiger
- ☐ 5 Sonstiges:____
- ☐ 99 Keine Angabe

S 3. Wer hat diese Entscheidung getroffen bzw. wer wäre für diese Entscheidung zuständig?

- ☐ 1 Ich selbst
- ☐ 2 Mein(e) Partner(in) / meine Familie / meine WG-Kollege(n) bzw. mein(e) WG-Kollegin(nen)
- ☐ 3 Ich gemeinsam mit meinem/r Partner(in) / meiner Familie / meinen WG-Kollege(n) bzw. mein(e)n WG-Kollegin(nen)
- ☐ 99 Keine Angabe

S 4. Wie hoch schätzen Sie die Schwierigkeit des Wechsels zu einem anderen Stromanbieter ein?
Antworten Sie bitte anhand der folgenden Skala:
„sehr hoch / hoch / eher hoch / eher niedrig / niedrig / sehr niedrig"

1	2	3	4	5	6
Sehr hoch					Sehr niedrig

- ☐ 99 Keine Angabe

S 5. Bitte bewerten Sie die Leistungen Ihres aktuellen Energieversorgers.
Antworten Sie bitte anhand der folgenden Skala:
„sehr zufrieden / zufrieden / eher zufrieden / eher unzufrieden / unzufrieden / sehr unzufrieden"

Interviewerhinweis: Bitte Skala immer pro Statement vorlesen.

	Wie zufrieden sind Sie mit …	Sehr zufrieden (1)	(2)	(3)	(4)	(5)	Sehr unzufrieden (6)	keine Bewertung möglich
A	**den Leistungen Ihres derzeitigen Energieversorgers insgesamt?**							
B	**dem Preis-Leistungs-Verhältnis Ihres derzeitigen Energieversorgers?**							

S 6. Bitte beurteilen Sie Ihr Vertrauen in Ihren aktuellen Energieversorger.
Antworten Sie bitte anhand der folgenden Skala:

„sehr hoch / hoch / eher hoch / eher niedrig / niedrig / sehr niedrig"

	Wie hoch ist Ihr Vertrauen in Ihren derzeitigen Energieversorger, …	Sehr hoch (1)	(2)	(3)	(4)	(5)	Sehr niedrig (6)	keine Bewertung möglich
a	**dass er angemessene Preise für die Produkte erhebt, die er anbietet?**							
b	**dass er den Strommix (dies bedeutet die prozentuelle Aufteilung der Energieträger, aus denen der Strom erzeugt wurde) liefert, für den Sie bezahlen?**							

Interviewerhinweis: Bitte Skala immer pro Statement vorlesen.

2. Kaufkriterien

S 7. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Stromtarifs folgende Eigenschaft ist: Kündigungsfrist

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

S 8. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Strompaketes folgende Eigenschaft ist: Strommix (= die prozentuelle Aufteilung der Energieträger, aus denen der Strom erzeugt wurde)

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

S 9. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Strompaketes folgende Eigenschaft ist: Art des Stromlieferanten (überregionaler Verbundunternehmen; regionaler Stromversorger; Stadtwerk; kleiner/privater/lokaler Stromversorger)

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

S 10. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Strompaketes folgende Eigenschaft ist: Ort der Stromproduktion

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

S 11. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Strompaketes folgende Eigenschaft ist: Monatliche Stromkosten

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

S 12. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Strompaketes folgende Eigenschaft ist: Zertifizierung (z.B. Grüner Strom Label)

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

S 13. Bitte geben Sie an, wie wichtig Ihnen bei der Wahl eines Strompaketes folgende Eigenschaft ist: Preisgarantie(d.h. dieser Tarif gewährt eine Preisgarantie für eine bestimmte Laufzeit, innerhalb dieser Zeit werden die Preise garantiert nicht erhöht).

1 2 3 4 5 6

Sehr wichtig Nicht wichtig

☐ 99 Keine Angabe

3. Anforderungen an Ökostromprodukt und Motive für Wechsel zu Ökostrom

S 14. Was bedeutet für Sie Ökostrom? Bitte wählen Sie alle Aussagen aus, die Sie mit Ökostrom in Verbindung bringen.

	Statements	Ja	Nein	Keine Angabe/ weiß nicht
a	Physikalische Lieferung von Ökostrom, d.h. aus der Steckdose kommt rein grüner Strom			
b	Bezug von Strom aus 100 % Anteil regenerativen Energiequellen			
c	Bezug von Strom aus mind. 50 % Anteil regenerativen Energiequellen, max. aus 50			

	% Anteil Kraft-Wärme-Kopplung			
d	Bezug von Strom mit einem höheren Anteil an regenerativen Energiequellen als der durchschnittliche deutsche Strommix aufweist (15%)			
e	Bezug von Strom ohne Atomstrom-Anteil			
f	Verpflichtung der Stromanbieter zur Verwendung der Gewinne aus Verkauf von Ökostrom ausschließlich zum Bau von Neuanlagen zur Produktion erneuerbarer Energien			
g	Sicherung einer zeitgleichen Einspeisung, d.h. es wird immer so viel Strom aus ökologischen Quellen zeitgleich eingespeist, wie ich als Kunde /Kundin zu dem Zeitpunkt gerade verbrauche			
h	Bezug von Ökostrom eines Energieversorgungsunternehmen, welcher keinen fossilen Strom im Produktportfolio hat			
i	Bezug von Ökostrom eines Energieversorgungsunternehmen, welcher keinen nuklearen Strom im Produktportfolio hat			
k	Bezug von Strom, der in der Region erzeugt wird			

S 15. Würden Sie einen Aufpreis für ein Ökostromprodukt gegenüber einem konventionellen Produkt akzeptieren?

☐ 1 Nein, ich würde keinen Aufpreis akzeptieren.
☐ 2 Ja, ich würde einen Aufpreis (in %) akzeptieren, und zwar von ____% (in ganzen Zahlen)
☐ 99 Keine Angabe

S 16. Beziehen Sie derzeit Ökostrom?

☐ 1 Ja Programmierhinweis: Weiter mit Frage S 19, Formulierung 1 bei Frage S27
☐ 2 Nein Programmierhinweis: Weiter mit Frage S 18 Formulierung 2 bei Frage S27
☐ 99 Keine Angabe Programmierhinweis: Weiter mit Frage S 21, Formulierung 2 bei Frage S27

S 18. Aus welchen Gründen beziehen Sie bisher keinen Ökostrom?
Bitte nennen Sie mir die drei wichtigsten Gründe geordnet nach ihrer Wichtigkeit.

☐ 1 Persönliche Trägheit
☐ 2 Hoher zeitlicher Aufwand
☐ 3 Schwierige Wechselmöglichkeit zu anderen Stromanbietern
☐ 4 Höhere Kosten von Ökostrom
☐ 5 Wenig Transparenz über Anbieter und Produkte
☐ 6 Niedriger Informationsstand über Ökostrom
☐ 7 Kein Vertrauen in Zertifizierung (Öko-Label)
☐ 8 Mangelndes Vertrauen in tatsächlichen Umweltnutzen
☐ 9 Hinderung durch Vermieter oder Mitbewohner
☐ 10 Negative Folgen eines Wechsels (z.B. Anbietergebundenheit oder Stromausfall)
☐ 11 Skepsis, ob Strom tatsächlich aus erneuerbaren Energiequellen erzeugt wird
☐ 12 Über staatliche Auflagen (EEG, KWK Bonus,...) zahle ich bereits mit meinem normalen Tarif für die Erzeugung von Ökostrom
☐ 13 Sonstiges: ____
☐ 99 Keine Angabe

S 17. Wenn andere in Ihrem Umfeld Ökostrom beziehen würden, würden Sie es auch ernsthaft in Erwägung ziehen:

☐ 1a Ja, sehr sicher Programmierhinweis: Weiter mit Frage S 19
☐ 1b Eher ja Programmierhinweis: Weiter mit Frage S 19
☐ 2a Eher nein Programmierhinweis: Weiter mit Frage S 20
☐ 2b Nein, sicher nicht Programmierhinweis: Weiter mit Frage S 20
☐ 99 Keine Angabe Programmierhinweis: Weiter mit Frage S 20

S 19. Welche der folgenden Motive haben Sie zum Wechsel zu Ökostrom angeregt bzw. welche Motive könnten Sie anregen?
Bitte nennen Sie mir die drei wichtigsten Gründe geordnet nach ihrer Wichtigkeit.

☐ 1 Umweltaspekte
☐ 2 Klimawandel
☐ 3 Keine Ressourcenabhängigkeit von fossilen Energieträgern
☐ 4 Verantwortung gegenüber zukünftiger Generationen
☐ 5 Interesse in neue Technologien
☐ 6 Vergleichbare Kosten gegenüber konventionellem Strom
☐ 7 Kosteneinsparung
☐ 8 Setzung eines politischen und Lebensstil-thematischen Signals
☐ 9 Setzung eines Signales gegenüber großen Energiekonzernen
☐ 10 Anerkennung im Bekanntenkreis
☐ 11 Förderung von Stromerzeugung in der Region
☐ 12 Sonstiges: ____

☐ 99 Keine Angabe

S 20. Wie wichtig wäre Ihnen beim Bezug von Ökostrom, dass Ihr Anbieter ausschließlich Ökostrom verkauft, d.h. keinen fossilen oder Atomstrom an andere Kunden anbietet?
Antworten Sie bitte anhand der folgenden Skala:
„sehr wichtig / wichtig / eher wichtig / eher unwichtig / unwichtig / sehr unwichtig“
1 2 3 4 5 6
Sehr wichtig Sehr unwichtig
☐ 99 Keine Angabe

4. Basisprodukt und Default-Setzung

S 21. Verschiedene Stromversorgungsunternehmen bieten ihren Kundinnen und Kunden Möglichkeiten an, um ihr Stromproduktindividuell zusammen zu stellen. Wie möchten Sie Ihren Strom am liebsten auswählen?
☐ 1 Ich wähle völlig individuell, zu welchen Anteilen (in %) einzelne Stromerzeugungsarten in meinen Mix einfliessen Programmierhinweis: Weiter mit Frage S 23 a oder b (zufällige Aufteilung)
☐ 2 Es gibt nur ein einheitliches Basisangebot – Ich muss gar nicht individuell zusammen stellen
☐ 99 Keine Angabe Programmierhinweis: Weiter mit Frage S 23 a oder b (zufällige Aufteilung)

S 22. Wodurch sollte sich das einheitliche Basisangebot Ihrer Meinung nach auszeichnen? (Nur eine Antwort möglich)
☐ 1 Mir ist ausschließlich ein niedriger Preis wichtig
☐ 2 Mir ist ein günstiger Preis etwas wichtiger als ein hoher Anteil erneuerbarer Energien
☐ 3 Mir ist ein hoher Anteil erneuerbarer Energien etwas wichtiger als ein günstiger Preis
☐ 4 Mir ist ausschließlich ein hoher Anteil an erneuerbarer Energien wichtig
☐ 99 Keine Angabe
Programmierhinweis: Zufallsaufteilung des Samples auf Frage S 23a und S 23b

S 23. a) Sie sind bisher Kunde/Kundin eines Stromanbieters, der Ihnen für 25€ / Monat den durchschnittlichen deutschen Strommix liefert (15% erneuerbare Energien). Mit Ihrer aktuellen Monatsrechnung erhalten Sie das Angebot, für 30€ im Monat künftig einen Ökostrom-Mix (100% erneuerbare Energien) geliefert zu bekommen. Wie wahrscheinlich ist es, dass Sie zum Ökostrom-Mix wechseln?
Antworten Sie bitte anhand der folgenden Skala:
„sehr hoch / hoch / eher hoch / eher niedrig / niedrig / sehr niedrig“

1 2 3 4 5 6
Sehr hoch Sehr niedrig
☐ 99 Keine Angabe

S 23. b) Sie sind bisher Kunde/Kundin eines Stromanbieters, der Ihnen für 30€/Monat einen Strommix liefert, der 100% aus erneuerbaren Energien besteht. Mit Ihrer aktuellen Monatsrechnung erhalten Sie das Angebot, für 25€ im Monat künftig einen Strommix zu beziehen, der aus 15% erneuerbaren Energien besteht. Wie wahrscheinlich ist es, dass Sie zu diesem Strommix wechseln?
Antworten Sie bitte anhand der folgenden Skala:
„sehr hoch / hoch / eher hoch / eher niedrig / niedrig / sehr niedrig“
1 2 3 4 5 6
Sehr hoch Sehr niedrig
☐ 99 Keine Angabe

5. Ökolabels

S 24. Welche der folgenden Ökolabels sind Ihnen im Zusammenhang mit Strom bekannt?
☐ 1 TÜV
☐ 2 Grüner Strom Label
☐ 3 OK Power
☐ 4 Naturemade
☐ 5 EU Energielabel
☐ 6 Recs Zertifikate
☐ 7 Blauer Engel
☐ 8 EU Margerite
☐ 9 Keines dieser genannten Labels Programmierhinweis: Weiter mit Frage S 28
☐ 99 Keine Angabe Programmierhinweis: Weiter mit Frage S 28

S 25. Welche der folgenden Ökolabels zeichnet sich für Sie durch eine hohe Glaubwürdigkeit aus?
Bitte nennen Sie die drei wichtigsten Labels, gereiht nach Ihrer Glaubwürdigkeit:
☐ 1 TÜV
☐ 2 Grüner Strom Label
☐ 3 OK Power
☐ 4 Naturemade
☐ 5 EU Energielabel
☐ 6 Recs Zertifikate
☐ 7 Blauer Engel
☐ 8 EU Margerite
☐ 9 Keines der Labels ist glaubwürdig

☐ 99 Keine Angabe

S 26. Worüber informieren diese Ökostromlabel?
☐ 1 Niedrige Umweltbelastung der Stromproduktion
☐ 2 Physische Belieferung der Kunden mit Ökostrom
☐ 3 Förderung neuer Stromerzeugungsanlagen auf Basis erneuerbarer Energien
☐ 4 Inländische Stromproduktion
☐ 5 Höherer Preis
☐ 6 Garantie der bestmöglichen Transparenz im Hinblick auf Einsatz der Kundengelder
☐ 99 Keine Angabe

S 27. Programmierhinweis: Formulierung 1 (bei S16 = 1): **Haben Sie beim Bezug von Strom auf Ökostromlabels geachtet?**
Programmierhinweis: Formulierung 2 (bei S16 = 2, 99) **Würden Sie beim Bezug von Strom auf Ökostromlabels?**
☐ 1 Ja, ich achte darauf.
☐ 2 Nein, ich achte nicht darauf.
☐ 3 Ökostromlabel sind mir nicht bekannt.
☐ 4 Keine Angabe
☐ 99 Keine Angabe

S 28. Welche Arten von erneuerbaren Energien würden Sie via Förderfonds eines zertifizierten Öko-Produktes am liebsten unterstützen?
Programmierhinweis: Erklärung „Förderfonds eines zertifizierten Ökoproduktes“: Aus dem Erlös des verkauften Ökostroms fließt pro verkaufter Kilowattstunde ein gewisser Anteil in den Förderfonds für Maßnahmen zur ökologischen Aufwertung.
Bitte bringen Sie die verschiedenen erneuerbaren Energien in eine Ihren Präferenzen entsprechende Rangreihenfolge von 1 (am liebsten) bis 6 (am wenigsten).
☐ 1 Kleinwasserkraftwerke
☐ 2 Sonnenenergie
☐ 3 Windenergie
☐ 4 Geothermie
☐ 5 Biomasse
☐ 6 Biogas
☐ 99 Keine Angabe

Conjoint Analyse Elektrizität

Programmierhinweis: Gestaltung als Dual-Response-None

Stellen Sie sich vor, sie möchten ein neues Stromprodukt auswählen. Wenn Sie die folgenden Möglichkeiten zur Auswahl hätten, die sich in 7 Punkten unterscheiden, welchen würden Sie kaufen?

Strom-mix	60% Kohle 25% Kern-kraft 15% un-bekannter Herkunft	60% Kohle 25% Kern-kraft 5% Wasser 5% Wind 5% Biomasse	60% Kohle 25% Gas 5% Wasser 5% Wind 5% Bio-masse	50% Wind 30% Wasser 15% Bio-masse 5% Solar	100% Wind
Strom-lieferant	Grosser, überre-gionaler Stromver-sorger	Mittlerer, regionaler Stromver-sorger	Stadtwerke	Spezi-alisierter Anbieter*	
Ort der Strompr oduktion	In der Re-gion	In Deutsch-land	In der Schweiz	In Osteuropa	
Monat-liche Strom-kosten*	50 Euro	55 Euro	60 Euro	65 Euro	70 Euro
Zer-tifizier-ung	ok power	TÜV	Grüner Strom Label	keine Zer-tifizierung	
Preisgar-gar-antie**	Keine	6 Monate	12 Monate	24 Monate	
Kün-digungs-frist	Monatliche	Vierteljährli-che	Halbjährli-che	Jährliche	

*** Programmierhinweis: Definition einblenden Spezialisierter Anbieter:** Anbieter führt nur Strom aus denjenigen Stromquellen im Sortiment, welche im Attribut Strommix aufgelistet sind.

*** Monatliche Stromkosten:** Annahme Kosten pro Haushalt (3500 kWh/Jahr)

**** Programmierhinweis: Definition einblenden Preisgarantie:** Dieser Tarif gewährt eine Preisgarantie für eine bestimmte Laufzeit oder bis zu einem bestimmten Datum. Innerhalb dieser Zeit werden die Preise garantiert nicht erhöht.

Annex III: Market and Behavioural Failures Adressed by Current & Proposed Measures

			Market Failures							Behavioural Failures		
			Energy Market		Capital Market	Information Problems						
		Policy Measure:	Exter- nalities	age cost pricing	strains	mation	metric in- formation	agent problems	n-by- using	spect theory	ed ration- ality	cision making
Existing Policy Measurs	Space Heating and Domestic Hot Water	Energy saving law and ordinance	*	*		*	*	*	*			
		Heat cost ordinance	*	*								
		CO_2-Modernisation Programme	*		*							
		KFW-programmes	*		*							
		Renewable energy heating act	*						*			
		Market incentive programme	*		*				*			
		information campaigns				*	*		*			
	Appliances	Energy appliance law	*			*						
		Law of opening the metrology		*		*						
		initiative for energy efficiency				*						

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