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Exploring policy space: Interactions between policy instruments on household energy efficiency

The case of domestic cold appliances in Germany

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Abstract

Household energy efficiency policy in Germany gets more and more differentiated since an increasing number of policy instruments targeting various fields of application are implemented and proposed by policymakers. Therefore, overlaps between such policy instruments become more likely. On the one hand, positive overlaps may allow realising synergies like an increased effectiveness or reduced costs stemming from a combination of policy instruments. However, the probability of negative overlaps and, thus, unintended outcomes like a lower effectiveness or additional costs related to a combination of policy instruments may grow on the other hand.

This thesis considers selected policy instruments on domestic cold appliance energy efficiency that have been implemented in Germany. In a first step, the functioning of individual policy instruments is investigated. Based on that, interactions within combinations of the selected policy instruments are explored. This is done by reviewing relevant literature and policy evaluation studies, conducting expert interviews as well as applying a framework for forming views on interactions as suggested by Boonekamp (2005).

The findings show that the EU energy label sets the framework for domestic cold appliance energy efficiency in Germany. Moreover, rebate programmes, information campaigns and minimum energy efficiency standards respective voluntary commitments are also found to be effective. Less successful policy instruments in improving domestic cold appliance energy efficiency are found to be cooperative procurement as a stand-alone instrument and a green tax. Furthermore, it is argued that most combinations of the investigated policy instruments have a reinforcing relationship.

Based on the findings it is concluded that interactions between policy instruments on household energy efficiency are still relatively unexplored. Further research in this area would facilitate considering the issue of interactions between policy instruments in evaluation studies.

Keywords: Policy evaluation, policy interaction, policy instruments, energy efficiency, households

Executive Summary

Background of the research

Energy efficiency policy in Germany and the European Union (EU) is becoming more and more differentiated. For the household sector, this means that policymakers are concentrating on segments such as buildings or electric domestic appliances. In the last years, a number of policy instruments on domestic appliance energy efficiency have been introduced and proposed at both the EU and national level. Furthermore, the proposed EU Directive on energy end-use efficiency and energy services which is setting general national targets of 1% cumulative savings annually will lead to an increased attention on energy end-use efficiency by policymakers and the introduction of additional policy instruments. In order to be able to prove the success and to identify the contribution of certain policy instruments for reaching this target, the energy savings have to be captured and evaluated.

The introduction of additional policy instruments might lead to a growing number of overlaps between different policy instruments. In other words, the steering effect and costs of one policy instrument on energy efficiency could be influenced by another instrument already in place. An opportunity of a growing number of overlaps could be seen in the fact that interactions between policy instruments could be positive, i.e. it would be possible to realise synergies between policy instruments in terms of reducing costs and increasing the effectiveness. However, coordination between policy instruments and the assessment of their effects gets more complicated with a growing number of overlaps. As a consequence, interactions could also be negative in terms of additional costs and a lower effectiveness if policy instruments are not well coordinated.

Research objective and focus

This research was performed in order to understand how individual policy instruments on energy end-use efficiency are functioning and interacting with each other. For this purpose, the case of policy instruments on domestic cold appliance energy efficiency in Germany was chosen. The following research question was considered for investigating the chosen case:

- *How do individual policy instruments on domestic cold appliance energy efficiency "function" and interact with each other?*

In order to address this question more in detail, it was divided into two sub-questions:

1. *What can be learnt from evaluation studies and expert assessments about the "functioning" of selected policy instruments on domestic cold appliance energy efficiency?*

2. *What can be learnt from theory and practice about interactions between selected policy instruments on domestic cold appliance energy efficiency?*

The research questions were approached by a literature review and the selection of key policy instruments on domestic cold appliance energy efficiency. The selected policy instruments have been implemented between 1995 and 2005 in Germany. In a next step, the research questions were investigated by reviewing policy evaluation studies on the selected policy instruments, conducting in-depth interviews with experts in the field of policy instruments on household energy efficiency, and applying a framework for forming views on interactions between policy instruments on household energy efficiency as suggested by Boonekamp (2005) and modified for the purpose of this thesis.

Main findings

The main findings of this thesis are structured as answers to the research questions.

Research question 1: What can be learnt from evaluation studies and expert assessments about the "functioning" of selected policy instruments on domestic cold appliance energy efficiency?

The findings show that the EU energy label is the most important policy instrument for domestic cold appliance energy efficiency in Germany. The label categorised the market for domestic cold appliances according to energy efficiency, made energy consumption of such appliances visible and enhanced the diffusion of energy efficient appliances. Furthermore, the label acts on consumers, retailers and manufacturers. Finally, the EU energy label can be seen as a simple and relatively inexpensive policy instrument on domestic cold appliance energy efficiency. Pitfalls can be found in the facts that compliance of the retailers in some distribution channels in terms of proper labelling is lacking and that the revision process failed to rebase the energy efficiency classes of the label.

Rebate programmes can be successful in supporting the market transformation towards a higher share of energy efficient domestic appliances as experience from Germany and other European countries shows. Rebates act on the consumers since they provide a financial incentive to invest in a certain energy saving option. This creates a higher demand for domestic cold appliances qualified for the rebate which influences retailers and manufacturers to supply eligible appliances. Marketing and information activities related to the rebate programme can ensure a high participation rate. However, rebate programmes are perceived to be a relatively costly policy instrument for improving domestic cold appliance energy efficiency. Additional critical issues can be uncertainties about the share of free-riders, the treatment of the replaced appliances and the fact that rebate programmes might create wrong associations among consumers towards very energy efficient domestic cold appliances. This means that rebates might send the signal to consumers that energy efficiency does not make sense from an economic point of view.

A minimum energy efficiency standard and a voluntary commitment are regarded to be substitutes. Both policy instruments aim at taking the least energy efficient appliances from the market, contribute in simplifying domestic cold appliance energy efficiency policy and reduce the information requirements for consumers. Country specific differences and the upper segment of the market can be taken into account with a European-wide voluntary commitment while a minimum energy efficiency standard is applied in the same manner all over Europe. However, the impact of both policy instruments depends on how ambitious the set threshold on minimum energy efficiency requirements is. For instance, the market in Germany already anticipated the minimum energy efficiency standard as it was implemented. The threat of regulation contributes in making a voluntary commitment more effective as the experience shows. Furthermore, both policy instruments need proper monitoring and enforcement in order to have a full impact.

Information campaigns can contribute in raising the consumers' awareness towards energy saving options and provide motivation to realise such options in the long term as the German experience shows. Furthermore, this policy instrument also allows targeting consumers indirectly via multipliers for information. Such multipliers could be retailers of domestic cold appliances that are motivated and educated to use energy efficiency as an additional sales argument. However, the effect of an information campaign depends much on the visibility, the design and chosen target groups. Furthermore, significant effects of an information campaign can only be observed after a longer period of time in most cases.

Cooperative procurement of very energy efficient domestic cold appliances as a stand-alone policy instrument is not possible in countries like Germany. There are difficulties in organising buyer groups for domestic cold appliances due to the decentralised structure of the demand side. Nevertheless, activities of a motivating characteristic targeting the supply side could contribute in bringing very energy efficient domestic cold appliances forward.

A green tax targeting the residential electricity consumption addresses both the investment decision and proper utilisation of an energy saving option. As the German example of a green tax shows, such a tax has the ability to make consumers to consider electricity costs by setting financial incentives and bringing the issue of energy efficiency on the public agenda. However, the green tax is not perceived to be an appropriate policy instrument for the case of domestic cold appliance energy efficiency since it is regarded to be too broad. This increases the difficulties for the consumers to link the tax with an investment decision in favour of an energy efficient domestic cold appliance.

Research question 2: What can be learnt from theory and practice about interactions between selected policy instruments on domestic cold appliance energy efficiency?

In general, the policy space for policy instruments on domestic cold appliance energy efficiency in Germany seems to be filled out in a way that eases realising synergies. Most investigated pairs of policy instruments show a reinforcing relationship. For a few combinations a neutral relationship was found while a mitigating relationship seems to be hardly ever the case.

The findings on interactions between the selected policy instruments in Germany show that the EU energy label sets the framework for policy instruments on domestic cold appliance energy efficiency by preparing the ground in terms of categorising the market according to energy consumption. This facilitates the adoption of further policy instruments and allows realising synergies. Information campaigns, rebate programmes and cooperative procurement are policy instruments for targeting the upper market segment with very energy efficient domestic cold appliances. Furthermore, the green tax can also have an impact on this segment of the market. In general, it was found for Germany that combinations of policy instruments targeting the upper segment of the market as well as the EU energy label are complementary policy instruments and reinforcing. Weakly reinforcing interactions are the case for pairs of policy instruments not belonging to the category economic means. Therefore, a strongly reinforcing interaction can be realised in combinations including a rebate programme. However, pairs of policy instruments consisting of a green tax are found to be weakly reinforcing respective neutral since the green tax is seen as a policy instrument which is difficult to link to the case of domestic cold appliances.

It was found that the right chronological order of policy instruments over time allows realising weakly reinforcing interactions. For instance, the EU energy label and policy instruments targeting the upper market segment prepare the ground for a minimum energy efficiency standard or a voluntary agreement. In turn, a voluntary commitment or a minimum energy efficiency standard makes the revision of such "preparatory" policy instruments necessary which enhances their effectiveness.

Neutral relationships were found for the German case in combinations of policy instruments addressing the implementation on the one side and the utilisation of domestic cold appliances on the other side. Furthermore, combinations consisting of a policy instrument with a relatively low relevance, of different energy efficiency classes or with non-overlaps in time are also seen as neutral.

Table of Contents

List of Figures

List of Tables

1. Introduction

"The tendency has been to evaluate instruments as individual entities and to consider their characteristics in relative isolation. This is marked in contrast to the political context within which they must operate … the policy world is very crowded and there are already multiple instruments in place … There is as yet very [little] research on how to co-ordinate instruments or on the ways in which instruments interact …There is a great deal of wishful thinking as a result." (Guy Peters and van Nispen, 1998 in Sorrell, 2003, p. 30)

1.1 Problem statement

Energy efficiency policy in the European Union (EU) is becoming more and more differentiated. Instead of addressing whole sectors, policymakers in the EU are increasingly focusing on sub-sectors, certain fields of application or technologies on the supply and demand side of energy. For the household sector, this means that policymakers are concentrating on segments such as buildings (e.g. insulation of new buildings, refurbishments or ventilation, heating and cooling systems) or electric domestic appliances (e.g. "white goods", stand-by power consumption of electric appliances or lightning). In the last years, a number of policy instruments on domestic appliance energy efficiency have been introduced at both the EU and national level (e.g. information campaigns on household energy efficiency, rebates for energy efficient domestic appliances, the EU energy label or minimum energy efficiency standards for domestic appliances). Furthermore, policy instruments on energy efficiency that also target the household sector have been proposed (e.g. Proposal for a Directive of the European Parliament and of the Council on energy end-use efficiency and energy services or the Directive on eco-design of Energy-using Products).

In general, policy instruments have to be coordinated, i.e. well adapted to markets, existing incentive structures, and barriers that need to be overcome. Therefore, a good understanding of policy instruments is crucial for solving this challenge. A further issue in this regard is to ensure that new policy instruments are integrated into the goals of current or other to be introduced policy instruments in order to achieve "optimal" policy outcomes. The underlying rationale behind the need for coordination is that the introduction of new policy instruments increases the probability of interactions between policy instruments. In any case, there will be a growing number of overlaps between different policy instruments since free "policy space"[1] becomes more limited. This means that the steering effect of one policy instrument could be influenced by another policy instrument already in place. An opportunity of a growing number of overlaps could be seen in the fact that interactions between policy instruments could be positive, i.e. it would be possible to realise synergies between policy instruments in terms of an increased effectiveness and reduced costs. However, coordination between policy instruments and the assessment of their effects (ex-post evaluation) gets more complicated with a growing number of overlaps. Furthermore, the difficulty of predicting the effects of proposed policy instruments (ex-ante evaluation) increases. As a consequence, interactions could also be negative ("policy congestion")[2] if policy instruments are not well coordinated. Due to an increasing number of uncoordinated overlaps between policy instruments, the

[1] Majone (1989, p. 11) defines policy space as "a set of policies that are so closely interrelated that it is not possible to make useful descriptions about one of them without taking the other elements of the set into account." Thus, the structure of policy space includes both the design of the individual policy instruments and the linkages between them (Sorrell, 2003).

[2] Majone (1989, p. 15) uses the term policy congestion to describe the negative consequences of interrelations between policy instruments: "… in an already crowded policy space, solutions beget new problems in the form of policy overlaps, jurisdictional conflicts and unanticipated consequences".

possibility of "ex-post surprises" in terms of unintended or unexpected outcomes like a lower effectiveness or increased costs grows. To put it in a nutshell, the uncoordinated introduction of new policy instruments may just consume more policy space and leaves out the opportunity of "optimising" synergies between policy instruments as well as avoiding negative interactions. Therefore, coordination is essential in order to realise and "optimise" synergies within policy packages. One way of facilitating coordination and avoiding "ex-post surprises" arising from policy instruments could consist in trying to understand how individual instruments have been "performing" in practice. Based on the practical understanding of individual policy instruments, the next step would be to investigate how policy instruments could be interacting with each other. If the answer shows evidence that there could be interactions, an interesting issue to investigate would be the probable outcome of such interactions.

The proposed EU Directive on energy end-use efficiency and energy services (Commission Proposal COM (2003) 739 final) which is setting general national targets of 1% cumulative savings annually (1.5% for the public sector) will lead to an increased attention on energy end-use efficiency by policymakers.[3] To accomplish such an energy saving target, policymakers will have to focus on enhancing energy end-use efficiency in all sectors of the economy and to introduce additional policy instruments on energy end-use efficiency. In order to be able to prove the success and to identify the contribution of certain policy instruments for reaching this target, the energy savings have to be captured and evaluated. For this purpose, an understanding of the functioning of individual policy instruments on energy end-use efficiency and how combinations of such policy instruments are interacting with each other is needed. The understanding of both the performance of policy instruments and interactions between individual policy instruments will facilitate the design of sound packages of policy instruments on energy end-use efficiency. Furthermore, these insights could be used for adjusting or refining ex-ante policy evaluation approaches (e.g. energy policy scenarios). By including the knowledge about the functioning of individual policy instruments and policy interaction into energy policy scenarios for forecasting the outcome of proposed policy instruments on energy end-use efficiency, it becomes possible to gather a better understanding of the likely effects of such policy instruments. Accurate forecasts of future energy and electricity demand are essential for governments and energy utilities in EU member states.[4]

1.2 Research questions

The main research problem that this thesis addresses is the interaction of policy instruments on domestic "cold appliance"[5] energy efficiency. For this purpose, an understanding of how individual instruments have been "performing" in practice and how they might be interacting with each other is essential. The following research question sets the framework for the thesis:

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[3] Energy end-use efficiency describes energy efficiency on the demand side of energy. See section 3.2.1 for a detailed discussion.

[4] As every EU member state, Germany has to fulfil greenhouse gas reduction targets under the Kyoto Protocol to combat climate change. In this regard, forecasts of future energy demand are crucial for designing climate policies. Further, they also facilitate policies aiming at securing the supply of energy. Likewise, the German energy utilities have to decide about investments in new power stations since most of the existing stations will have to be modernised or replaced by new ones within the next 10 to 15 years. Future energy (electricity) demand is one parameter, besides others, influencing investment decisions which have to be taken today by the German energy utilities.

[5] The term "cold appliance" is used as a collective phrase to refer to any type of domestic refrigerator, freezer and their combinations throughout this thesis.

- *How do individual policy instruments on domestic cold appliance energy efficiency "function" and interact with each other?*

This research question can be divided into two sub-questions:

1. *What can be learnt from evaluation studies and expert assessments about the "functioning" of selected policy instruments on domestic cold appliance energy efficiency?*

2. *What can be learnt from theory and practice about interactions between selected policy instruments on domestic cold appliance energy efficiency?*

The research will be focused on the evaluation of policy instruments on domestic cold appliance energy efficiency in Germany.

1.3 Objectives

Following from the research questions, the objectives of this thesis are threefold. The first objective is to give an introduction to the background of typical policy instruments on household energy efficiency.[6] Stemming from that, the second objective is to gain an understanding on how the selected key policy instruments on domestic cold appliance energy efficiency in Germany are "performing" in practice and, in particular, on how they interact with each other. Finally, the third objective of this thesis is to develop and examine a methodological approach on investigating interactions between policy instruments on energy end-use efficiency.

1.4 Scope, limitations and delimitations

The scope of this thesis includes policy instruments on domestic cold appliance energy efficiency being in place between 1995 and 2005 in Germany. For this purpose, seven key policy instruments have been selected for close evaluations that address domestic cold appliance energy efficiency in different ways. The selected policy instruments include a minimum energy efficiency standard, the EU energy label, rebate programmes for energy efficient domestic cold appliances, a procurement project for very energy efficient cold appliances (energy+), an information campaign ("Initiative EnergieEffizienz"), a green tax and a voluntary commitment on reducing energy consumption of domestic cold appliances by the European manufacturers.

Efficiency gains in this field of application could arise from technical energy saving options as well as changes in the consumers' lifestyle. However, energy savings, which could be realised due to changes in the lifestyle, are not considered in this thesis because of simplification reasons.

Energy demand of households does not primarily arise from cold appliances. Further areas of energy demand could for example be other electric domestic appliances like TV sets or computers, the heating system, appliances based on other energy carriers than electricity or transport demand arising from households. However, policy instruments addressing energy

[6] The terms household or domestic appliance energy efficiency describe energy efficiency on the demand side (energy end-use efficiency). This is due to the reason that households are situated on the demand side of energy (see section 3.2.1 of this thesis for a detailed discussion of the terminology).

end-use efficiency in such areas are excluded. This is done due to data availability and simplification reasons since the aim is to investigate methodological and practical questions related to the evaluation of interactions between policy instruments. The supply-side of energy (resource extraction, conversion, storage and distribution) is for the same reasons not part of the analysis.

Besides internal interactions (interactions between policy instruments on energy end-use efficiency) there could also be external interactions with environmental policy instruments (e.g. emissions trading system or environmental performance standards) and policy instruments on securing energy supply. However, such kinds of interactions are not considered. Again, this is done due to data availability and simplification reasons.

1.5 Justification for the research

Understanding the functioning of selected policy instruments on energy end-use efficiency and interactions between such policy instruments becomes increasingly important for policymakers in the EU. For instance, the proposed EU Directive on energy end-use efficiency and energy services calls for an evaluation of the different policy instruments on energy end-use efficiency and foresees that the contribution of each policy instrument towards reaching the saving target is captured and proven to the European Commission (Commission Proposal COM (2003) 739 final). The case of domestic cold appliances has been chosen due to the characteristics of this field of application and the significant improvements in energy efficiency over the last years. It is claimed that these improvements were mainly due to policy instruments on the EU and national level of the individual member states (ADEME et al., 2000; IEA, 2003). A broad range of policy instruments on domestic cold appliance energy efficiency are available and applied on both the European and national level in countries like Germany. This makes the case interesting for investigating questions related to the functioning of selected policy instruments and interactions between them. Germany has been chosen due to data accessibility and availability. Data availability in terms of market data, reports from research projects or evaluation studies makes exploring questions related to the functioning of selected policy instruments on energy efficiency of domestic cold appliances feasible. Furthermore, the broad data availability facilitates investigating interactions between policy instruments and testing a methodology for analysing interactions.

1.6 Outline of the thesis

The structure of this thesis is organised in seven chapters. The first chapter introduces the research objectives and questions as well as the scope, limitations and delimitations of the thesis. The second chapter presents the applied research methodology. In the third chapter, the background of energy efficiency, policy instruments and policy interaction is presented. The fourth chapter outlines the case of domestic cold appliance energy efficiency and presents selected policy instruments on domestic cold appliance energy efficiency in Germany. Chapter five explores the functioning of the selected policy instruments. Based on that, interactions between the selected policy instruments are analysed in chapter six. The final chapter presents conclusions and recommendations for further research.

2. Methodology

This chapter describes the research methodology used in this thesis. It first explains the methodological approach taken in the thesis, and then describes the different phases of the research. Finally, a justification for the chosen research methodology is given.

2.1 Methodological approach

This thesis takes a qualitative research approach to increase the understanding of the functioning and interactions between selected policy instruments on domestic cold appliance energy efficiency in Germany. Denzin and Lincoln (2000, p.3) describe qualitative research as "… an attempt to understand the world as it operates, studying phenomena as they exist in their own settings and as they relate to the phenomena around them". Moreover, the methodological approach taken is that of a case study. Yin (1994, p. 13) describes a case study as "… an empirical enquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used." For this thesis, the particular approach of an intrinsic case study is taken. This means that the focus is primarily on understanding the case of domestic cold appliances itself rather than be "theory-building" or enabling to draw generalisations also valid for other cases (Mayring, 1996). However, this does not mean that general conclusions will not be possible. Whenever possible, attempts are made to draw conclusions that have wider application in the field of household energy efficiency or energy end-use efficiency policy in general.

As a case study, the research is able to draw on multiple sources and methods to increase the understanding of the particular case. Hence, multiple sources as academic literature on policy instruments and policy interaction, relevant policy evaluation studies and qualitative in-depth expert interviews are used in this thesis in order to investigate the selected policy instruments on domestic cold appliance energy efficiency. This process of using a number of different sources is described as triangulation. Stake (2000, pp. 443-444) describes triangulation as "a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation". Therefore, the process of triangulation allows investigating the different ways in which the selected policy instruments on domestic cold appliance energy efficiency function and interact with each other.

The sources used for carrying out the research can be divided into two main fields. The first field includes a review of literature, databases and Internet searches while the second field includes qualitative in-depth expert interviews based on an interview guideline.

Review of literature and Internet searches

The data acquired in this field was secondary sources found in academic literature, the Internet, policy evaluation studies and literature provided by persons being active in this field of research. The literature search was based on several databases. These included the library and electronic journals database of Lund University (LOUVISA respective ELIN). Words searched for incorporated in different combinations: energy end-use efficiency, energy efficiency, policy instruments, policy interaction, policy evaluation, domestic cold appliances and household energy efficiency. Internet searches were mainly carried out to find additional sources and policy evaluation studies. Persons who are dealing with energy efficiency policy were contacted via email or in-person. This made it possible to gather material and informa-

tion related to policy instruments on domestic cold appliance energy efficiency not being publicly available.

A review of the literature on policy instruments and policy interaction in general as well as literature on household energy efficiency policy was carried out in order to set the background for the research. The identification and selection of key policy instruments on domestic cold appliance energy efficiency in Germany was based on a review of the literature, internet searches, a database on policy instruments on energy efficiency (MURE) and interaction with staff from the Wuppertal Institute in Germany. Ex-post policy evaluations of the selected policy instruments were reviewed in order to investigate the function of selected policy instruments on domestic cold appliance energy efficiency. Analytical frameworks for studying interactions between policy instruments in general and on household energy efficiency in particular were reviewed for developing an approach for analysing interactions between the selected policy instruments on domestic cold appliance energy efficiency. The approach suggested by Boonekamp (2005) was chosen and modified in some parts for the purpose of this thesis.

Qualitative in-depth interviews based on an interview guideline

In general, the methodology of expert interviews is used in order to gather knowledge in a relatively unexplored field of research. For instance, already existing research hypothesis can be tested and new hypothesises developed (Mayring, 1996). For the purpose of this thesis, in-depth expert interviews based on an interview guideline were conducted in order to acquire additional data on the functioning of the selected policy instruments on domestic cold appliance energy efficiency in Germany. Because of that it became possible to include additional view points on the selected policy instruments which were not captured in the reviewed policy evaluation studies. Furthermore, expert interviews were used in order to collect assessments by the experts on interactions between the selected policy instruments.

Applied methodology for the expert interviews

12 experts in the field of energy efficiency policy for the household sector and a background in policy instruments on energy efficiency of domestic cold appliances were interviewed for the purpose of this thesis.[7] 10 personal und two phone interviews based on an interview guideline were carried out. The character of the interview was qualitative, i.e. questions were constructed as open or semi-open questions.[8] An interview guideline set the framework for individual interviews.[9] The average duration of an expert interview was around 60 minutes. The interviews were taking place in the period of time from July 11 to 26 of the year 2005.

Experts were identified by reviewing relevant policy evaluation studies, research projects and reports, contacting organisations dealing with issues related to energy efficiency policy for households in Germany and Europe as well as by applying the "snowball technique" where the interviewees were asked to suggest further experts. The identified experts have been contacted by phone in a first step and, if not reachable, by email and asked if they would like to participate in an expert interview. A confirmation of the appointment as well as some background information on the interview and a short version of the interview guideline were sent

[7] A list of the interviewed experts can be found in appendix I.

[8] Semi-open questions are characterised by given answer categories and the possibility to elaborate on the answer (Mayring, 1996).

[9] See appendix II for the interview guideline.

by regular mail to the participating experts in advance to the interview.[10] It was tried to organise personal interviews. If this was not possible, phone interviews were arranged. Interviews with German-speaking interviewees were held in German while interviews with non-German speaking experts were held in English.

The interviewed experts can be divided into three main groups. The first group consists of five experts belonging to three research institutes (two German and one European institute). All of these experts have been actively dealing with issues related to domestic cold appliance energy efficiency. Such activities include conducting projects in this field of application or being responsible for carrying out evaluation studies of policy instruments on domestic cold appliance energy efficiency. The second group consists of five experts from governmental organisations like ministries, environmental or energy agencies on the German and international level. All of these experts are working in the field of energy efficiency policy with a focus on electricity consumption of households. The third group includes two experts representing two of the three main groupings of actors in the field of domestic cold appliances. One representative of the manufacturer respective consumer side was interviewed.[11]

The expert interviews were based on an interview guideline consisting of three parts. In the first part, questions related to the functioning of selected policy instruments were asked. This part was customised for each expert interview depending on the background of the interviewee. Furthermore, experts were asked to rank and discuss the relevance of the seven selected policy instruments. In a next step, the experts were asked to elaborate on their general understanding of interactions between policy instruments. Based on that, the experts were asked to assess and discuss selected interactions between the policy instruments chosen for the purpose of this thesis. The second part consisted of six hypothesises on interactions between policy instruments on energy efficiency of domestic cold appliances. Here, the experts were asked to what degree they agree or disagree with these hypothesises. In the third part, concluding questions were posed. Here, the experts had the chance to suggest an "optimal" mix of policy instruments from their point of view.

All interviews were recorded. Based on the records, a summary of each interview was written. The written summaries served as a foundation for the analysis of the interviews. In order to retain the anonymity of the interviewed persons the analysis of the interviews only delivers a general overview about the answers that were given by the interviewees.

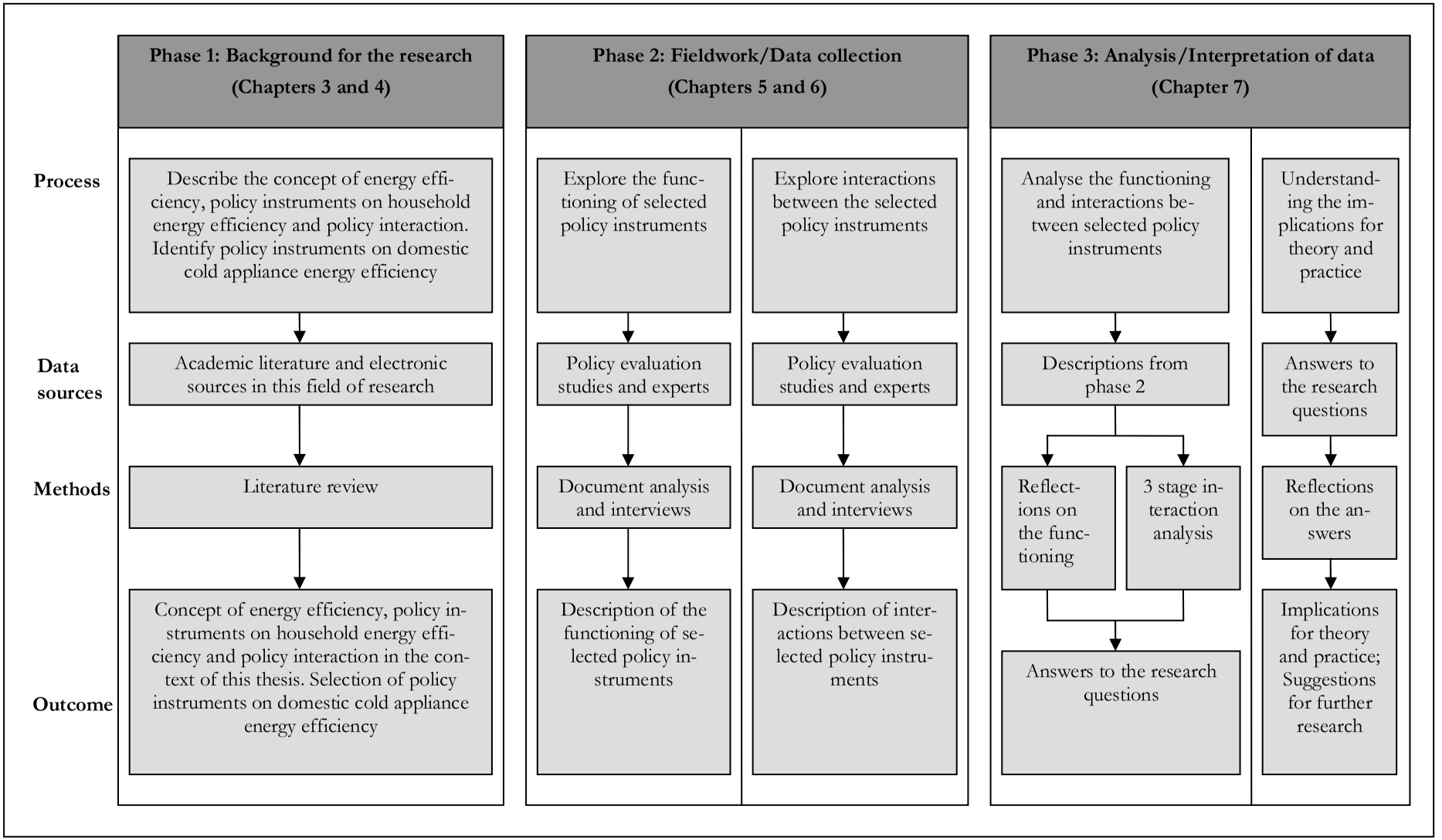
2.2 Thesis structure and research phases

Planning and research for this thesis occurred in three phases. The first phase included desktop research in order to set the background for the thesis and prepare the fieldwork phase (chapters three and four). The second phase included fieldwork which was aiming at gathering data related to the functioning and interactions between the selected policy instruments on domestic cold appliance energy efficiency (chapters five and six). The final phase was the analysis and interpretation of the gathered data during the fieldwork (chapters five, six and seven). Figure 2-1 gives an overview over the different research phases.

[10] For German speaking interviewees, this material was provided in German while for non-German speaking interviewees the material was provided in English. See appendix II for the material provided in English.

[11] Much effort was put into finding an expert representing the retailer side. However, all contacted retailers and retailer organisations refused to participate. As a main reason for non-participation, non-familiarity with the topic was named.

Figure 2-1: Research phases



2.3 Justification for the research methodology

For the purpose of this thesis, the case study approach is appropriate due to the complex nature of the issues being investigated and the impossibility to draw precise boundaries around the research focus on the functioning and interactions between policy instruments on energy end-use efficiency. The case study approach offers a holistic view of investigated phenomena since it is using a variety of support to draw a fuller picture (Mayring, 1996). Yin (1994, p.1) supports this by stating that such an approach is appropriate "… when "how" and "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real life context".

This statement describes the context of the thesis in a good manner. The functioning and interactions between policy instruments on domestic cold appliance energy efficiency are difficult to measure and evaluate due to the complexity of the individual policy instruments and interrelations between them. Furthermore, systematically investigating the functioning and interactions between policy instruments on energy end-use efficiency is an emerging field of research. Therefore, only a few written sources on these issues are available, so several sources of support are required to build up a full picture of the functioning and interactions between selected policy instruments on domestic cold appliance energy efficiency. The methods of reviewing policy evaluation studies and conducting expert interviews were chosen because other methods like a comparison of regions with different packages of policy instruments on domestic cold appliance energy efficiency or conducting consumer surveys investigating the buying decision are rather difficult to carry out.

3. Conceptual context

This chapter sets the theoretical background for this thesis. For this purpose, the concepts of energy end-use efficiency and policy instruments on household energy efficiency are described. Based on that, the idea of policy interaction is introduced.

3.1 Energy end-use efficiency

The understanding of the concept of energy end-use efficiency is essential when looking at the functioning and interactions between policy instruments on energy end-use efficiency. For this purpose, a definition of energy end-use efficiency is given, the rationales for promoting energy efficiency are outlined and conditions for realising energy efficiency potentials or energy saving options are described.

3.1.1 Energy conservation, energy efficiency and energy end-use efficiency

Energy conservation, energy efficiency and energy end-use efficiency are terms that are often used interchangeably but mean different things. In the following, these terms are defined and explained for the purpose of this thesis.

Energy conservation

Energy conservation means saving energy by reducing the energy consuming activity (Owen, 2000). In this case, a lower amount of energy consuming services is provided and, as a consequence, less energy consumed. Thus, the energy-intensity of carrying out the activity is not altered.[12] However, the environmental burden arising from energy consumption is reduced. On the other hand, energy conservation may not always produce economic benefits for consumers such as households or industries. This is due to the fact that reducing an activity could mean that less benefits arising from this particular activity are created. Energy conservation measurers were mainly taking place in industrialised countries in the 1970s as an immediate response to the first oil price shocks (Owen, 2000).

Energy efficiency

Energy efficiency means promoting behaviour, working methods and manufacturing techniques that are less energy-intensive. Thus, improved energy efficiency can be described as reducing the amount of energy required for a given level of certain energy services.[13] Furthermore, this means that the amount of services provided by each unit of energy can be increased. At the same time the need for expanding the existing energy generation capacity is avoided. Depending on the magnitude of increased energy consumption due to improvements in energy efficiency - also known as the rebound effect - energy conservation and, as a consequence, a reduction of the environmental burden arising from energy consumption is not always taking place. Some energy efficiency analysts and critics claim that the rebound

[12] An illustrative example for energy conservation could be switching of the light. Energy is saved by reducing the amount of light provided. However, the energy intensity of the activity is not changed.

[13] An illustrative example could be an improved insulation of a refrigerator. In turn, less energy is consumed for cooling the same amount of space. However, people might now decide to purchase an additional or even bigger refrigerator that takes up the energy savings due to the improved energy efficiency. In this example, the energy intensity of the activity is altered.

effect will erode most of the direct savings resulting from improvements in energy efficiency (see e.g. Khazzoom, 1980; Brooks, 1990; Inhaber, 1997). However, there are voices claiming that improved energy efficiency also leads to energy conservation, i.e. that the magnitude of the rebound effect is often very small (Greening, Greene, and Difiglio, 2000).[14] On the other side, improvements in energy efficiency should always result in economic benefits for consumers since the energy costs for maintaining certain activities or the standard of living are lowered (Owen, 2000). Thus, improved energy efficiency may provide a "double dividend" since both economic and environmental benefits are realised. The potential for energy efficiency can be described using different dimensions (Jochem, 2000; Neij and Öfverholm, 2001). Figure 3-1 illustrates the different dimensions of energy efficiency.

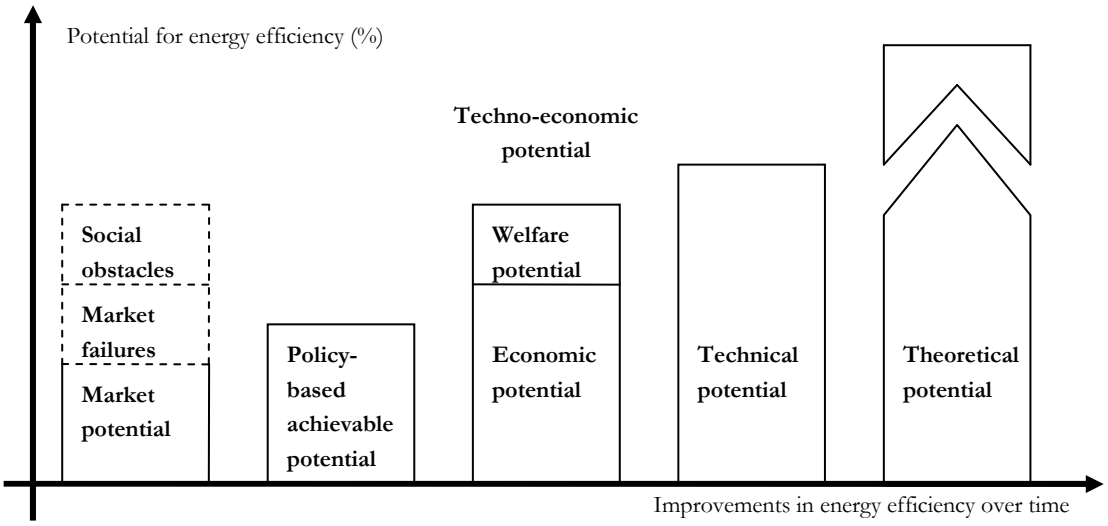


Figure 3-1: Potentials for energy efficiency [Source: Author, based on Jochem (2000)]

The absolute minimum amount of energy required to perform a certain service is called *theoretical potential* that is limited by theoretical considerations of thermodynamics.[15] The *technical potential* illustrates what could be achieved by applying the best available technology at a given point in time. These are merely non-commercial efficiency technologies, i.e. such technologies have only been demonstrated yet. The *techno-economic potential* describes the potential that could be reached by cost-effective technologies at a given point in time, i.e. the monetary savings due to these technologies exceed the costs. Finally, the *market potential* is defined as potential savings that can be expected in practice. The gap between market and techno-economic potential can be explained with market imperfections and social obstacles (Jochem, 2000).[16] Energy efficiency policy instruments such as minimum energy efficiency standards, subsidies for energy efficient technologies or information campaigns aim at closing this gap. Jochem (2000) introduces the *policy-based achievable potential* for describing this relationship. This potential depends on the implemented policy instruments and is situated be-

[14] Greening, Greene, and Difiglio (2000) find that the size of the rebound effect for household appliances is at 0%.

[15] This means that useful energy demand and energy losses can be minimised through process substitution, heat and material reuse, and avoided heat losses (Jochem, 2000).

[16] Market imperfections are e.g. barriers to energy efficiency, transaction costs or information asymmetries. In order to reach the economic potential these market imperfections have to be lifted. The economic potential represents the optimum from the individual point of view. Social obstacles are externalities arising from energy consumption which are not internalised in terms of e.g. higher energy prices. The welfare potential represents the optimum from the societal point of view (Jochem, 2000).

tween the market and techno-economic potential. Emerging technologies, changing energy prices and consumption patterns or new energy efficiency policy instruments influence the level of the technical, techno-economic, policy-based achievable potential and market potential over time (Neij and Öfverholm, 2001).

Energy end-use efficiency

The term energy efficiency functions as an umbrella for describing both energy efficiency on the demand and supply side of energy. For describing energy efficiency solely on the demand side, the term energy end-use efficiency is applied (Jochem, 2000).[17] On the demand side, end-use of energy is taking place while resource extraction, conversion into energy carriers as well as storage and distribution is occurring on the supply side (see figure 3.2).[18]

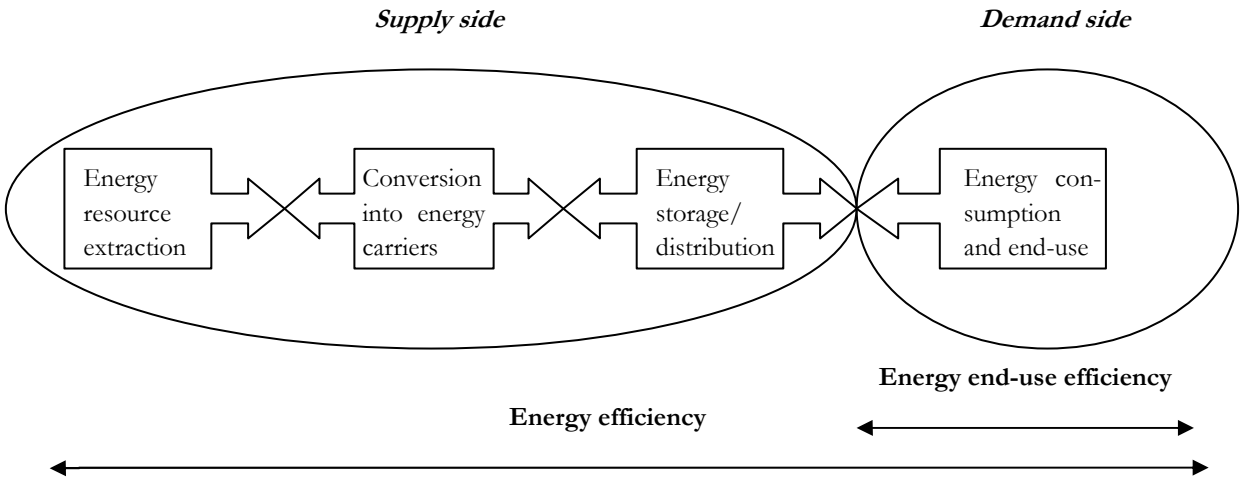


Figure 3-2: Demand and supply side of energy (Source: Jochem, 2000, modified by the author)

3.1.2 Rationales for energy efficiency

As outlined in the green paper on energy efficiency (Commission of the European Communities, 2005) there are three key reasons for promoting energy efficiency in the EU.

Security of energy supply

The first oil price shocks, also know as the oil crisis, in 1973 led countries in the EU to rethink their energy policy. Particularly, energy consumption and thus questions related to energy end-use efficiency became an issue with high priority on the political agenda (Commission of the European Communities, 2005). The main goal at that time was to improve the security of energy supply by becoming less dependent on energy imports (Owen, 2000). As a result, the strong relationship between growth in the gross domestic product (GDP) and in energy demand was already lifted in the mid 1970s. This was mainly due to short-term energy conservation measures such as rationing the energy supply in certain times or encouraging people to reduce unnecessary energy consumption (Owen, 2000). However, energy demand

[17] Sometimes the term demand side energy efficiency is used instead of energy end-use efficiency.

[18] For the purpose of this thesis, it is assumed that the household sector is situated on the demand side of energy. Therefore, household energy efficiency or energy efficiency of domestic cold appliances refers to the term energy end-use efficiency.

was not stabilised and still rising due to the absence of long-term structural measures. At the basis of current trends, projections show that the share of imported oil (gas) will be 90% (80%) of the total energy demand in 2030 (Commission of the European Communities, 2005). Furthermore, most energy imports come from political unstable regions and energy prices are expected to raise in the future, particular due to an increasing demand from the developing world (Commission of the European Communities, 2005). In this regard, a reduction of the energy demand in the EU is needed in order to be less dependent on imports and shifts in energy prices. Improved energy efficiency could significantly contribute in reaching this objective as stated in the green paper on energy efficiency (Commission of the European Communities, 2005).

Environmental reasons

Since the 1980s, environmental concerns have also been used as an argument for promoting energy conservation and energy efficiency. This was mainly due to an increased environmental awareness of the citizens in most European countries (Owen, 2000). The green paper on energy efficiency (Commission of the European Communities, 2005) names two environmental reasons for promoting energy efficiency. Firstly, energy saving is seen as the "quickest, most effective and most cost-effective manner for reducing greenhouse gas emissions, as well as improving air quality" (Commission of the European Communities, 2005). Therefore, increased energy efficiency would help to reach the emission reduction targets of the EU under the Kyoto Protocol. Secondly, increased energy efficiency would also contribute to the long-term efforts of the EU to deal with climate change. In this regard, the EU could be an example for developing countries to combat climate change by coming up with new policies and technologies. Such policies and technologies could assist the developing countries in decoupling their growth from energy consumption (Commission of the European Communities, 2005).

Competitiveness of the economy/Economic efficiency

In the 1980s, new supplies of oil and gas were developed. As a consequence, concerns about security of energy supply in many European countries decreased. At these times, the rhetoric shifted from the term energy conservation to the term energy efficiency. This was mainly due to the fact that interventions addressing the demand of energy were primarily based on the principle of economic efficiency (Owen, 2000). Globalisation of the world economy which took-off in the 1990s, also lead to an increased focus on economic efficiency in terms of costs per unit produced. Instead of promoting the use of less energy, measures aiming at stimulating the wise use of energy were implemented at these times. Such measures included for example energy efficiency standards for appliances or subsidies for better insulation of homes. Increased energy efficiency would reduce the costs per unit produced in the EU. There are estimations showing that about 20% of the current energy consumption in the EU could be saved in a cost-effective manner (Commission of the European Communities, 2005). Investments in energy efficiency could directly and indirectly create jobs in the EU in two regards. Firstly, the higher competitiveness or economic efficiency due to lower energy costs per unit produced creates additional employment. Secondly, the industry providing energy efficient equipment and energy services in the EU will expand which also creates new jobs (Commission of the European Communities, 2005).

3.1.3 Conditions for realising energy savings options

The realisation of technical energy efficiency potentials or energy saving options is dependent on certain conditions during the *implementation* as well as the *use phase* of the saving option

(see for example Boonekamp, 2005; Hennicke and Ramesohl, 1998). Boonekamp (2005) claims that four conditions during the implementation phase and one condition during the utilisation phase have to be fulfilled before the efficiency gains from the technical energy saving option are realised. The four conditions of the implementation phase include: (i.) availability of the saving option, (ii.) awareness of the saving option, (iii.) non-market barriers restricting the take-up of the saving option, and (iv.) motivation and incentives to invest in the saving option. The fifth condition addressing the utilisation phase includes that the implemented energy saving option has to be properly used in order to achieve the efficiency gains. Figure 3-3 illustrates the conditions that have to be fulfilled in order to realise an energy saving option.

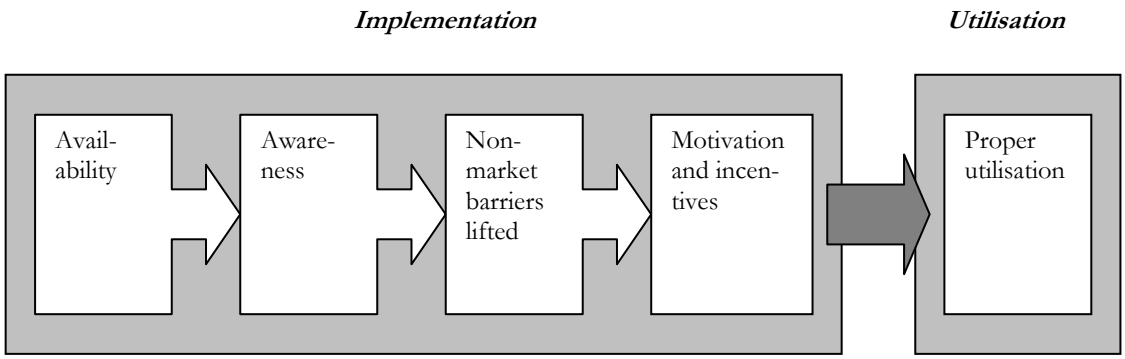


Figure 3-3: Conditions for realising an energy saving option (Source: Boonekamp, 2005; modified by author)

Implementation of the saving option

The first condition concerns the *availability* in terms of market readiness of the technical energy saving option. In other words, the saving option should be within the techno-economic potential before it can be implemented (Boonekamp, 2005). Based on the availability, the second condition addresses the *awareness and capacity* of the relevant actors regarding an energy saving option. The relevant actors have to know that an energy saving option is available and need to have the necessary capacity to implement the option (Boonekamp, 2005). Furthermore, the third condition says that existing *non-market barriers* for the take-up of the energy saving option have to be lifted. Such barriers include institutional barriers like a long decision process, social barriers like the acceptance and convenience of an energy saving option, as well as technical barriers including the moment of replacement of the old system or the compatibility with the existing system (Boonekamp, 2005). Finally, the fourth condition includes that *motivation and incentives* for investing in an energy saving option are necessary. Incentives can be of a financial or non-financial (social motivation) nature. Motivation can be created by addressing market barriers for an energy saving option like limited information, awareness and interest in energy costs and reducing energy expense, transaction costs, or limited capital and rapid payback requirements by the relevant actors (Boonekamp, 2005).

Utilisation of the energy saving option

Based on the above described conditions leading to the realisation of a technical energy saving option, the fifth condition aims at using the installed option in a proper way in order to finally realise the gains in energy efficiency. By ensuring continuous action after the implementation like maintenance or proper use, the energy savings are eventually realised (Boonekamp, 2005).

3.2 Policy instruments on household energy efficiency

Policy instruments belong to one or more policy spaces, i.e. areas where they are expected to have an outcome and lead to an effect. Policy space can be defined at different levels of generality (Sorrell, 2003). For example, the degree of generality of a policy space decreases from sustainability over environmental to energy efficiency policy. This section introduces the concept of policy instruments on household energy efficiency.

3.2.1 Typology of policy instruments

Policy instruments are intended to have an effect on the technical, techno-economic and market potential for energy efficiency and aim at closing the gap between the market and techno-economic potential. Various types of policy instruments for addressing different target groups and actors on the demand and supply side of an energy saving option are available.[19] For instance, policy instruments are used for addressing the technology of the energy saving option or the way in which the technology is used. Hence, each policy instrument on household energy efficiency will conform to one or more of the five conditions for realising an energy saving option as outlined in section 3.1.3 (Boonekamp, 2005). It is most likely that packages of different policy instruments are implemented to reach certain objectives of a country's energy efficiency policy.

Energy efficiency policy is a sub-part of energy policy. Furthermore, it contributes in reaching the objectives of environmental, economic or social policy (Owen, 2000). Environmental issues are addressed since energy efficiency policy helps to improve the environment by preventing harm and deterioration. Moreover, energy efficiency policy contributes in reaching the objectives of an economic policy by making an economy more resistant to shocks on the global energy market as well as increasing its competitiveness and efficiency. Finally, the objectives of a social policy are reached by providing energy services to affordable prices for all private consumers. To put it in a nutshell, promoting energy efficiency contributes to the transformation process of a country's energy system towards improved sustainability and, thus, is a cornerstone of sustainable development. Therefore, energy efficiency policy is defined as belonging to sustainability policy in the context of this thesis. The type of policy it is supposed to implement shapes a policy instrument's design. In the following, the example of how environmental policy determines the objectives of environmental policy instruments is given to illustrate this issue.

Environmental policy

According to Lundqvist (1996), the definition of environmental policy can be based on *function*, *institution* and *purpose*. A definition based on function would define policies that affect the environment as environmental policy, whereas an institutional definition would view policies undertaken by a certain set of institutions, an environmental ministry or certain agencies as environmental policy. Lundqvist advocates a purpose definition that defines environmental policy as "… courses of action which are intended to affect society – in terms of values and beliefs, action and organisation – in such way as to improve or to prevent the deterioration of, the quality of the natural environment" (Lundqvist, 1996, p. 16). In the following, the purpose definition is used to describe environmental policy.

[19] Several actors are relevant for household energy efficiency. Actors on the supply side of energy saving options include manufacturers, retailers or installers while support organisations (e.g. consumer counselling centres) and consumers are actors on the demand side. Policy instruments can directly or indirectly address their target group. The indirect influence happens through addressing actors not identical to the target group.

Environmental policy instruments

A general definition of policy instruments is given by Vedung (1998) where policy instruments are defined as follows: "Public policy instruments are the set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change" (Vedung, 1998, p. 21). By combining Lundqvist's purpose definition of environmental policy with Vedung's general definition of policy instruments, environmental policy instruments will be defined as follows: "Environmental policy instruments are the set of techniques by which governmental authorities wield their power in attempting to affect society – in terms of values and beliefs, action and organisation – in such a way as to improve, or to prevent the deterioration of, the quality of the natural environment" (Mickwitz, 2003).

Categories of policy instruments

In general, policy instruments like environmental policy instruments or policy instruments on household energy efficiency can be categorised in various ways. In this thesis, policy instruments are categorised according to the classification of Vedung (1998) who divides them into the categories *regulation*, *economic means* and *information*. This classification is based on the authoritative force involved. The degree of authoritative force is highest for regulation and lowest for information. Furthermore, there are policy instruments that cannot be classified according to these three categories. Such policy instruments contain features of instruments belonging to different categories. These instruments are classified as belonging to the category *other policy instruments* for the purpose of this thesis.

Regulation

Legislation or regulation aims at the modification of the set of options open to agents, i.e. they mandate the receivers to act in accordance with what is ordered in these rules and directives (Vedung, 1998). Such policy instruments include e.g. standards, bans, permits, zoning or use restrictions. For example, the use of regulations has been the most frequent public intervention approach in the environmental policies of most industrialised countries (Mickwitz, 2003). Minimum energy efficiency standards are the most common regulative instruments used in the field of energy efficiency policy. For the case of policy instruments on household energy efficiency, Boonekamp (2005) distinguishes between regulation on utilisation (e.g. mandatory maintenance and monitoring), regulation on implementation (e.g. standard) as well as regulation on information ("mandatory" information like energy labels).[20]

Economic means

Economic means are used for altering the benefits and/or costs of the agents. They make it cheaper respective more expensive in terms of money, time effort, and other valuables to follow certain actions (Vedung, 1998). Economic instruments include e.g. grants and subsidies, taxes and charges, and market creation through tradable emission quotas. Boonekamp (2005) differentiates between taxes (e.g. tax on electricity consumption) and financial support (e.g. subsidies for very energy efficient domestic appliances) as relevant policy instruments of the category economic means for the case of household energy efficiency. Taxes aim at both the implementation and utilisation of an energy saving option while subsides solely aim at the implementation.

[20] An energy label is perceived to be regulation for actors like manufacturers or retailers while it is information for consumers. For the purpose of this thesis, labels are classified as information.

Information
Information as a policy instrument aims at altering the priorities and behaviour of agents through the transfer of knowledge related to the objectives of a policy (Vedung, 1998). These instruments include different types of information campaigns, labelling or training. For the case of household energy efficiency, Boonekamp (2005) distinguishes between information on saving options and information on proper utilisation. Examples for both types of information are e.g. motivation and information campaigns or advice through counselling centres. Moreover, databases on energy saving options or energy labels are policy instruments of the type information solely targeting the implementation of a saving option.

Other policy instruments
The category other policy instruments consists of policy instruments which are difficult to classify according to the three categories presented above. For the case of household energy efficiency, such policy instruments could be voluntary commitments, procurement programmes for energy saving options or the promotion of research, development and demonstration (RD&D) of energy saving options (Boonekamp, 2005).

Table 3-1 gives an overview over the different categories of policy instruments and shows examples of policy instruments addressing the implementation and utilisation of an energy saving option.

Table 3-1: Examples of policy instruments on household energy efficiency (Source: Boonekamp, 2005; modified by the author)

Policy instrument category	**Implementation**	**Utilisation**
Regulation	-Minimum energy efficiency standard	-Mandatory maintenance and monitoring -Performance standard
Economic means	-Energy tax -Tax on appliance -Subsidy for energy saving option	-Energy tax
Information	-Information and motivation campaign -Database on energy saving options -Labelling of energy saving options -Advice through counselling centres -Audit for identifying energy saving options	-Information and motivation campaign -Advice through counselling centres
Other policy instruments	-Procurement of energy saving options -Voluntary commitment -RD&D promotion	

Each of the policy instruments being available for addressing household energy efficiency targets one or more conditions for realising an energy saving option. This could either be the implementation or utilisation of an energy saving option. However, the energy tax is an exemption to this since it is targeting both the implementation and utilisation of an energy saving option (Boonekamp, 2005). Table 3-2 shows the conditions addressed by selected policy instruments targeting household energy efficiency (grey coloured fields).

Table 3-2: Conditions addressed by selected policy instruments for household energy efficiency (Source: Boonekamp, 2005; modified by the author)

Category of the policy instrument	Policy instrument	Implementation				Utilisation
		Availability	Awareness	Non-market barriers	Motivation and incentives	Proper Utilisation
Regulation	Standard on option	■	■	■	■	
	Standard on use					■
Economic means	Energy tax				■	■
	Subsidy on option		■		■	
Information	Audit		■			
	On option		■		■	
	On use					■
	Labelling		■		■	
Other policy instruments	Procurement	■	■		■	
	Commitment	■	■	■	■	
	RD&D	■		■	■	

A more detailed explanation of policy instrument on household energy efficiency in terms of their design and conditions addressed can be found in Boonekamp (2005).

3.2.2 Characteristics of policy instruments

Policy instruments belonging to the same category can have different characteristics. Furthermore, the characteristics of a policy instrument may vary according to the view of the different actors and the target group. For instance, consumers perceive a label as information that is optional for them. Thus, a label has a "persuasive" characteristic for the consumers. On the other side, retailers and manufacturers see a label as a policy instrument belonging to the category regulation that is mandatory for them. This means that these actors recognize the label to be "coercive".

Van der Doelen (1998) proposes to characterise policy instruments according to their effectiveness and legitimacy. Legitimacy characterises to what degree a policy instrument is accepted by the relevant actors. On the other side, effectiveness describes the degree a policy instrument itself could contribute in achieving the goals of a policy.

Policy instruments with a "coercive" characteristic could have a high effectiveness in reaching the goals of a policy while their legitimacy is perceived to be low (Van der Doelen, 1998). A low legitimacy or acceptance means that the compliance with the policy instrument has to be monitored in order to enforce the policy instrument. The reason for a low legitimacy can be found in the fact that a "coercive" policy instrument is only "taking", i.e. does not provide any motivation or justification for its necessity to the relevant actors (Van der Doelen, 1998). For the case of household energy efficiency, all kinds of regulations or an energy tax have a "coercive" characteristic. Furthermore, information campaigns urging consumers to implement or properly use an energy saving option can also be characterised as "coercive". Such an information campaign could have a high effectiveness since the consumer is told "what to do" in order to act according to the desired behaviour. On the other side, the legitimacy is low since the policy instrument is providing no justification in terms of knowledge related to its necessity. This could arouse opposition among the actors towards the message of the in-

formation campaign and prevent them from acting according to the desired behaviour (Van der Doelen, 1998). Policy instruments with a "persuasive" characteristic have a high legitimacy but a low effectiveness in reaching the goals of a policy (Van der Doelen, 1998). A high legitimacy or acceptance means that the policy instrument is easy to enforce, i.e. the compliance does not have to be monitored. The reason for a high legitimacy can be found in the fact that a "persuasive" policy instrument is "giving", i.e. the actors are provided with motivation which stimulates to act according to the desired behaviour (Van der Doelen, 1998) However, the effectiveness of "persuasive" policy instruments is regarded as low since they are optional, i.e. the actors are not obliged to follow them. Furthermore, this means that such policy instruments are not leading to a long-term change in the behaviour of the actors (Van der Doelen, 1998). For the case of household energy efficiency, subsidies for energy saving options or information campaigns providing energy efficiency related knowledge can be characterised as "persuasive". Informative or knowledge-augmenting information campaigns are perceived as ineffective since they are too general and fail to provide clear instructions on the desired behaviour. However, they could have a high legitimacy since they promote the idea of energy efficiency (Van der Doelen, 1998).

Moreover, policy instruments for household energy efficiency could either have a "broad" or a "targeted" characteristic. "Broad" policy instruments address both the implementation and utilisation conditions of an energy saving option while "targeted" policy instruments only address one of the conditions (Boonekamp, 2005). For the case of household energy efficiency, a broad policy instrument could be an energy tax or an information campaign providing knowledge about energy efficiency in general. An example for a "targeted" policy instrument could be a rebate programme on an energy saving option which solely addresses implementation conditions.

3.3 Policy interaction

This section presents the concept of policy interaction which serves as a background for the analysis carried out in chapter six of this thesis. In this context, policy interaction is understood in terms of interactions between policy instruments. Policy interaction occurs if one policy instrument influences the operation and, as a consequence, the outcome of another policy instrument (Sorrell, 2003). Such interactions could either have a one-sided (e.g. policy instrument A influences the outcome of policy instrument B) or mutual (policy instrument A influences the outcome of policy instrument B and vice versa) nature.

On the one side, interactions between policy instruments could have negative impacts in terms of unintended outcomes such as a reduced cost-effectiveness, overlaps between policy instruments or jurisdictional conflicts (Simões et al., 2005; Sorrell, 2003). On the other side, interactions between policy instruments offer the potential to realise synergies between policy instruments (Sorrell, 2003). In this regard, policy integration is an active way for exploiting reinforcing interactions between policy instruments (Glachant, 2001, Simões et al., 2005). The concept of policy integration aims at integrating parallel measures into a broader policy mix by designing policy instruments in a way so that they operate together. Other possibilities for exploiting synergies could be a flexible design of policy instruments to react to external changes, coordination between different levels of government or learning from previous experience that is also described as policy learning (Glachant, 2001).

Interactions between energy policy instruments are still an emerging and relatively unexplored field of research (Sorrell, 2003). Some research on developing a methodological framework for analysing interactions between policy instruments has been undertaken (e.g.

Boonekamp, 2005; Simões et al., 2005; Sorrell, 2003). Furthermore, there are some examples of research projects where interactions between policy instruments have been investigated or taken into account (MURE-ODYSSEE, 2005; Sorrell, 2003). The following sections present the idea of interactions between policy instruments and briefly describe the underlying factors that could cause such interactions. Based on the gained understanding, it becomes possible to suggest "optimal" mixes of policy instruments. "Optimal" mixes of policy instruments in this context are defined as combinations that maximise synergies and avoid mitigations between policy instruments. Finally, available frameworks for analysing policy interaction are briefly described and discussed.

3.3.1 The idea of interactions between policy instruments

Interactions between policy instruments can be observed in combinations of policy instruments. The result of an interaction can either be that the effectiveness and/or costs of a combination of two policy instruments are higher, lower or equal to the sum of the effectiveness and/or costs of the separate policy instruments (Boonekamp, 2005; Sorrell, 2003).

1. ***Reinforcement:*** the combination of at least two policy instruments is more effective and/or less costly than the sum of the separate policy instruments,

2. ***Mitigation:*** the combination of at least two policy instruments is less effective and/or costly than the sum of the separate policy instruments,

3. ***Neutral:*** the combination of at least two policy instruments is as effective and/or costly as the sum of the separate policy instruments.

Depending on whether a combination of policy instruments has its origin in the same policy space or if the individual policy instruments are originating from different spaces, one can distinguish between *internal* and *external* interaction (Sorrell, 2003). Internal interaction is the case if there are interactions between policy instruments belonging to the same policy space, e.g. interactions between two or more energy efficiency policy instruments. The opposite is the case of external interaction where policy instruments belonging to different policy spaces are interacting, e.g. interactions between a policy instrument on energy efficiency and a policy instrument not addressing energy efficiency. Furthermore, interactions between policy instruments can occur at different levels of government. This means that they can either be *horizontal* or *vertical* (Sorrell, 2003). Horizontal interactions occur between two or more policy instruments from the same level of governance while vertical interaction is the case between two or more policy instruments from different levels of governance (Sorrell, 2003). Based on these classifications, Sorrell (2003) divides interactions between policy instruments into five different types. Four of them are relevant for the purpose of this thesis and described in the following.[21]

1. *Direct interaction* is the case where the target groups directly affected by two policies overlap in some way (Sorrell, 2003);

2. *Indirect interaction* is the case where either (i.) a target group directly affected by one policy instruments overlaps with the target group indirectly affected by a second (or

[21] A fifth type is trading interaction where two policy instruments are linked by the exchange of a trading commodity, such as a CO_2 emissions allowance (Sorrell, 2003).

vice versa); or (ii.) the target group indirectly affected by one policy instrument overlaps with the target group indirectly affected by a second (Sorrell, 2003);

3. *Operational interaction* can be observed where two policy instruments operate together in a way that the obligations and incentives imposed by one policy instrument are on purpose modified as a result of the coexistence of a second policy instrument (Sorrell, 2003);

4. *Sequencing interaction* is the case where one policy instrument that directly affects a target group is followed in time by a second policy that directly affects the same target group (Sorrell, 2003). Boonekamp (2005) defines this as a case of pre-implementation interaction, i.e. an earlier implemented policy instrument influences the design and, thus, the resulting effect of a later implemented policy instrument.

Boonekamp (2005) adds the case of *post-implementation interaction* where two policy instruments interact because of the resulting saving effect of one policy instrument and not due to the design, operation or sequencing of the two policy instruments.

3.3.2 Factors determining the quality and degree of an interaction

An understanding of the underlying mechanisms and factors determining the quality and degree of an interaction is necessary when investigating combinations of two or more policy instruments. A review of the literature on policy interaction identified a number of factors which are claimed to determine if a combination of two policy instruments can either be rated as reinforcing, mitigating or neutral. Five factors were identified which are relevant for the case of investigating interactions between policy instruments with the common objective to improve household energy efficiency. These factors are outlined in the following.

1. *Conditions addressed for realising an energy saving option by the policy instruments:* Boonekamp (2005) claims that the conditions addressed for realising an energy saving option determine the degree of interaction of a combination of two policy instruments.

2. *Categories, characteristics and size of the policy instruments:* The design of the combined policy instruments can have an influence on the degree of interaction between two policy instruments. Van der Doelen (2005) claims that the characteristics of two combined policy instruments determine the degree of synergies in a combination of two policy instruments. Stern (2000) shows that the categories of the combined policy instruments influence the degree of interaction, i.e. there are combinations of categories that suit for realising synergies. The size of the policy instruments is seen as a factor that could weaken the degree of interaction (Boonekamp, 2005). This means that combinations including at least one "broad" policy instruments are weakened in their degree of interaction.

3. *Actors addressed by the policy instruments:* The addressed actors for reaching a certain target group can influence the quality of interactions between two policy instruments (Boonekamp, 2005; Simões et al, 2005).

4. *Timing and chronological order of the policy instruments:* The timing and chronological sequence of policy instruments is a factor determining the degree of an interaction (Boonekamp, 2005; Sorrell, 2003).

5. *Scope:* Overlaps or non-overlaps in the scope (e.g. a certain energy saving option) of a combination of policy instruments implemented at the same point of time are claimed to determine the quality of an interaction (Boonekamp, 2005).

In the following, features of reinforcing, mitigating and neutral combinations relevant for the case of household energy efficiency are briefly discussed.

Reinforcing combinations

In general, complementary combinations of two policy instruments are regarded as reinforcing. Four types of combinations of complementary policy instruments were identified which suit for the purpose of this thesis.

Complementary conditions addressed

Boonekamp (2005) claims for the case of household energy efficiency that combinations of policy instruments with no overlaps in the conditions addressed for realising an energy saving option can be regarded as complementary. For example, this means that one policy instrument addresses the awareness towards an energy saving option while the other the financial or social motivation to invest in this option.

Complementary characteristics

Van der Doelen (1998) claims that combinations of two policy instruments with different characteristics ("persuasive"/"coercive") are complementary if they are aiming at the same objectives. This is due to the reason that a persuasive policy instrument increases the legitimacy of a coercive policy instrument. Thus, the effectiveness is enhanced since the persuasive policy instrument contributes to a higher acceptance and compliance with the coercive policy instrument. An example for the case of household energy efficiency could be if the revenues from a coercive policy instrument like a green tax are used for financing a persuasive policy instrument like a rebate programme for energy efficient domestic appliances.

Complementary actors addressed

Furthermore, combinations of policy instruments with the same objectives, design and target group but different actors addressed can be complementary (Boonekamp, 2005; Simões et al., 2005). An illustrative example for the case of household energy efficiency could be if one policy instrument (information campaign A) addresses actors on the demand side (consumers or support organisations) while another policy instrument (information campaign B) addresses actors on the supply side (manufacturers, retailers or installers) in order to influence the target group (consumers).

Complementary if sequenced

It is claimed that the right chronological order of policy instruments is another factor determining whether a combination of policy instruments can be regarded as complementary (Boonekamp, 2005; Sorrell, 2003). This means that the introduction of certain policy instruments at different points of time could lead to complementary combinations of policy instruments. An example for the case of household energy efficiency could be the introduction of a follow-up policy instrument like a minimum energy efficiency standard as a consequence of a preparatory policy instrument like an energy label. Complementary policy instruments of the categories information and economic means are seen as strongly reinforcing policy instruments in the literature. In general other combinations of complementary policy instruments are seen as less reinforcing than the combination economic means and information (Boonekamp, 2005; Stern, 2000).

Mitigating combinations

In general, a mitigating interaction is the case if non-complementary policy instruments in regard to the conditions addressed and sequencing are combined (Boonekamp, 2005).

Overlaps in conditions addressed

Overlaps in the conditions addressed by combinations of non-complementary policy instruments with the same scope could lead to a mitigating interaction (Boonekamp, 2005). For the case of household energy efficiency, this could be if both policy instruments address the financial motivation to invest in an energy saving option.

Non-complementary sequence

The improper sequencing of policy instruments could cause a mitigating relationship (Boonekamp, 2005). An example for the case of household energy efficiency could be if a minimum energy efficiency standard does not lead to the revision of an existing energy label.

Neutral combinations

Non-overlaps in conditions addressed

Non-overlaps in the conditions addressed could lead to a neutral relationship if the combination of policy instruments is non-complementary (Boonekamp, 2005). For the case of household energy efficiency this happens if one policy instrument is addressing the implementation conditions while the other the proper utilisation of an energy saving option.

Non-overlaps in the scope

Non-overlaps in scope are the case if two non-complementary policy instruments are aiming at different energy applications (Boonekamp, 2005). For the case of household energy efficiency this means that policy instruments targeting different energy applications or energy efficiency classes of the same energy application are neutral.

Non-overlaps in time

In general, non-overlaps in time mean that a combination of two non-complementary policy instruments in regard to the sequence is neutral (Boonekamp, 2005).

3.3.3 Packages of policy instruments

In general, packages of policy instruments are implemented in order realise an energy saving option. This is done due to the reason that not all conditions for realising an energy saving option can be covered by a single policy instrument. Therefore, packages consisting of certain policy instruments are needed to comply with all relevant conditions that have to be fulfilled (Boonekamp, 2005). Depending on the saving option, the package of policy instruments can differ. If a saving option is already available and there are almost no institutional restrictions for the take-up, a mix of policy instruments will differ from a package that is needed where restrictions in the take-up have to be overcome. Furthermore, certain types of policy instruments might not be acceptable or applicable to selected energy saving options or the political reality does not allow implementing certain policy instruments (Boonekamp, 2005). There will also be variations among countries in the content of packages of policy instruments for addressing the same energy saving option. For the case of household energy efficiency, Boonekamp (2005) suggests the following general criteria for an "optimal" mix of policy instruments:

1. All relevant conditions for realising a certain energy saving option should be covered by a set of policy instruments,

2. Policy instruments should be complementary, i.e. not overlapping in the conditions addressed for realising an energy saving option,

3. A policy instrument should influence more than one condition in order to limit the number of policy instruments needed,

4. Policy instruments should be introduced in the right chronological sequence,

5. All relevant actors for realising an energy saving option should be regarded.

As elaborated in section 3.4.2 of this thesis, van der Doelen (1998) regards packages of policy instruments with the same objectives and scope but different characteristics as "optimal". The "give and take" packaging of combinations of policy instruments with "persuasive" characteristics on the one side and "coercive" characteristics "allows harnessing for the strengths of individual policy instruments by compensating for their weaknesses" (Van der Doelen, 1998, p. 144).

3.3.4 Methodological approaches for analysing interactions between policy instruments

Analysing interactions between policy instruments is still an emerging and immature field of research. Most of the work in this field is focusing on identifying the occurrence of interactions between certain policy instruments and to what degree these interactions will affect the objectives of the respective policies. However, research on the understanding of the mechanisms of interactions and developing methodological approaches are very rare (Simões et al., 2005). There are only a few examples of methodological approaches for analysing interactions between policy instruments in a systematic way (Boonekamp, 2005; Simões, 2005; Sorrell, 2003). These approaches are all of a qualitative nature, i.e. a quantification of the effects of the interactions is not taking place.

For instance, Sorrell (2003) suggests a methodological approach for investigating interactions between climate policy instruments in the EU. Comparing the scope, objectives, operation, implementation and timing of each policy instrument identifies different types of interactions. Based on that, reasons for the co-existence for certain policy instruments with the emissions trading scheme of the EU are derived. Simões et al. (2005) suggest an approach for assessing overlaps between energy and environmental policy instruments targeting electricity systems. In order to identify interactions, the stakeholders addressed and the steering effects of the policy instrument are compared. A very relevant overlap between policy instruments is the case if they target the same stakeholders and have related steering effects. A relevant overlap is the case if there are non-overlaps in the stakeholders addressed but related steering effects. Based on that, the degree of interaction is determined. This is done by identifying overlaps in the objectives and analysing whether they are complementary or antagonistic, an analysis of the mechanisms in order to understand how well they are co-ordinated, and an assessment of divergences in behaviour steered of same stakeholders. A general methodological framework for analysing interactions between policy instruments on household energy efficiency is proposed by Boonekamp (2005) that is building on a comparison of the conditions addressed by a combination of policy instruments for realising an energy saving option. A modified and simplified version of this methodological approach is presented and applied in chapter six of this thesis.

4. The case of domestic cold appliances

This chapter gives a brief introduction to the case of domestic cold appliances. For this purpose, the characteristics of this field of application are briefly presented. Based on that, data on energy consumption as well as potentials and possibilities for improvements in energy efficiency of domestic cold appliances are outlined. Finally, selected policy instruments targeting energy efficiency of domestic cold appliances that have been implemented during the period of time from 1995 to 2005 in Germany are introduced.

4.1 Characteristics of the field of application

Domestic cold appliances belong to the everyday life of almost every private household in the EU. A typical household in the EU will either have a refrigerator-freezer with perhaps an additional freezer or pure refrigerator; or households will have a pure refrigerator and a separate freezer (IEA, 2003). Furthermore, the design in terms of size of freestanding domestic cold appliances is standardised in order to fit into an average kitchen in the EU. These dimensional limits place constraints on the available storage space and influence the degree of total volume available for insulation and refrigeration circuit that determine the energy consumption of cold appliances (IEA, 2003). Domestic cold appliances are constantly running and, thus, consuming electricity in order to keep food over a certain period of time fresh. Changing food habits towards the consumption of more ready-made and deep-frozen food underline the significance of domestic cold appliances in the everyday life of private households (DGE, 2004).[22] In most industrialised countries, there is a long tradition of ownership of domestic cold appliances and the stock has continued to rise (IEA, 2003). For instance, 99% of the German households owned at least one refrigerator in the year 2004 while it was 95% in 1980. Compared to that, 55% of the German households owned a freezer in 2004 compared to 49% in 1980. In total numbers for 2004, this means that the stock of refrigerators was 39 million and 21.5 million for freezers in Germany (GfK and ZVEI, 2004). Besides this, the capacity of individual domestic cold appliances has also been increasing. In contrast to these trends, the energy consumption of cold appliances has stabilised and is declining in the EU (IEA, 2003).

Characteristics of the technology applied

Heat naturally flows from areas of higher temperature to areas of lower temperature. Therefore, work is needed in order to cool a space (Kuehn et al., 1998). The leading technology for domestic cold appliances is the vapour compression refrigeration cycle that is applied in almost 100% of the available appliances (IEA, 2003). This technology functions like a phase change heat pump. A refrigerant with a low boiling point is used to transfer heat from cooler space to a warmer space (Kuehn et al., 1998).[23] Almost all domestic cold appliances in the EU use natural convective cooling to transfer heat to and from the heat exchangers while forced convection with electrically powered fans is common in more humid regions of the world (IEA, 2003). Furthermore, many appliances have a defrosting automatic in order to remove the accumulated frost. The energy consumption of domestic cold appliances is dependent on the technology used, i.e. the efficiency of the compressor (electrically driven mo-

[22] According to statistics from the year 2003, every German consumed about 30 kg of deep-frozen food. In general, private consumption of such products has almost doubled over the last decade (DGE, 2004).

[23] A more detailed description of the refrigeration cycle can be found in appendix IV.

tor) and the quality of the control system. Moreover, the efficiency of the heat exchangers (condenser and evaporator) and the quality of the insulation determine the energy consumption of a refrigerator since they contribute in reducing the work needed in order to maintain a low temperature (IEA, 2003).[24]

4.1.1 Energy consumption

Residential electricity consumption is one of the largest and fastest growing sectors of energy use and greenhouse gas emissions in OECD countries. In 2000, the household sector accounted for 30% of total electricity use, which corresponds to 12% of the primary energy use and 12% of the energy-related CO_2 emissions in the OECD countries (IEA, 2003). Residential electricity demand in the OECD countries grew with an annual growth rate of 2.4% on average between 1990 and 2000 (IEA, 2003).

Residential electricity demand in OECD countries arises from several individual end-users. The most important end-users are space heating, food refrigeration and storage, lightning, sanitary water heating, space cooling, consumer electronics, home laundry and cooking (IEA, 2003). Figure 4-1 shows the share of residential electricity consumption by major end-use in 22 IEA member countries in 1990 and 2000.

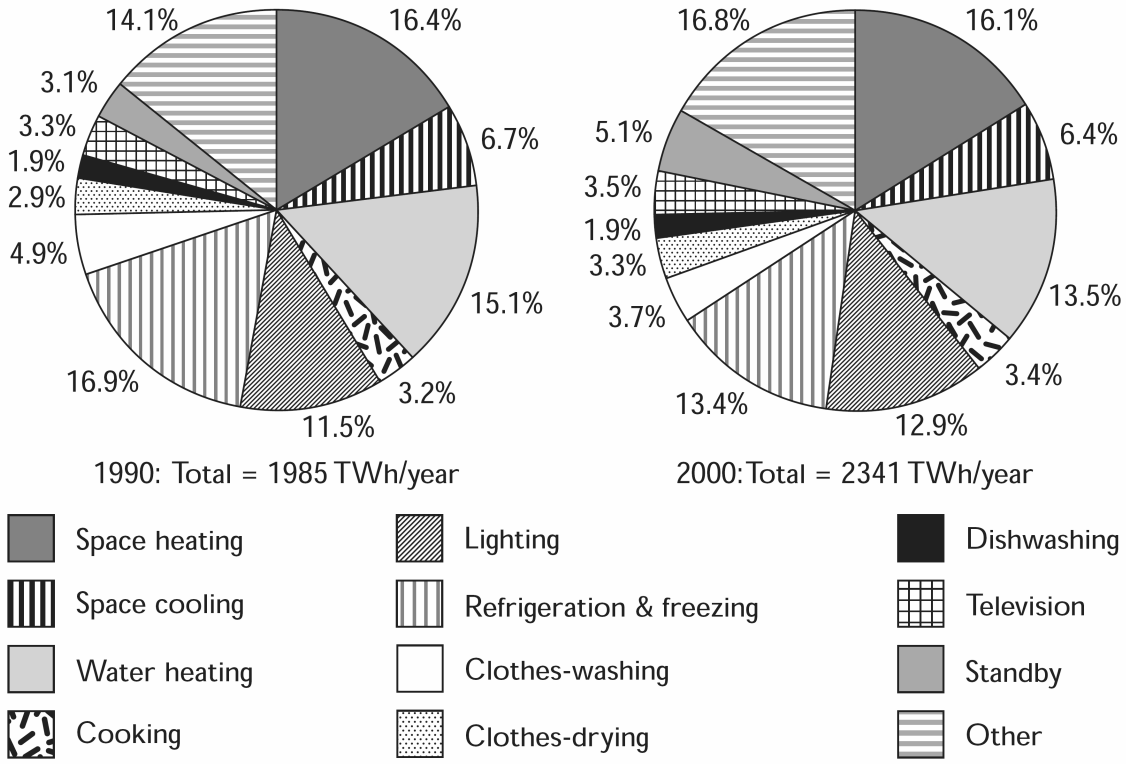


Figure 4-1: Share of residential electricity consumption by major end-use in 22 IEA member countries in 1990 and 2000 (Source: IEA, 2003, p. 30)

[24] Another factor influencing the energy consumption is the way how the appliance is used, e.g. the place where it is situated or how often the door is opened and closed by the users (see section 4.1.2).

Electricity consumption of domestic cold appliances of OECD countries in the year 2000 was at 314.6 TWh and had a share of 13.4%. This is a decline from 1990 levels where the share was at 16.9% and 335.3 TWh were consumed (IEA, 2003). The average household of European OECD countries consumed 700 kWh of electricity for food refrigeration in the year 2000 while the figure for households in North American countries or Japan was significantly higher (IEA, 2003). For the EU-15 member states, domestic cold appliances accounted for 17.4% of residential electricity consumption in 1999. This was equivalent to around 106.7 TWh/year and gave rise to 52 million tons of annual CO2 emissions that corresponded to 1.7% of the total emissions of the EU-15 in 1990 (ADEME et al., 2000).[25] The energy efficiency of the domestic cold appliance market in the EU has improved significantly between the years 1990 to 1999. The net efficiency improvement during this period of time is estimated to be at 27% (ADEME et al., 2000).

Figure 4-2 shows the distribution of produced domestic cold appliances according to energy efficiency classes between the years 1990 to 2002. The trend towards a higher share of energy efficient appliances becomes evident in this figure. For instance, the share of appliances in the class with the highest energy efficiency (A) reached almost 50% on average in the EU while it was below 5% in 1990.[26] The share of appliances in lower energy efficiency classes was declining during this period of time.

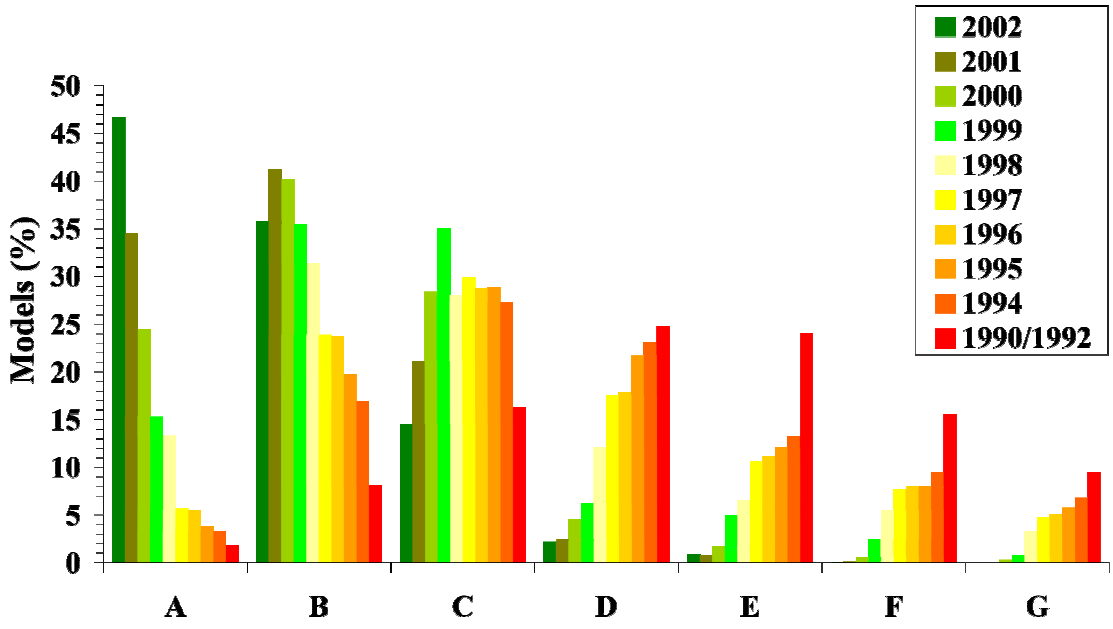


Figure 4-2: Share of produced domestic cold appliances according to energy efficiency classes in the EU between 1990 and 2002 in % (Source: CECED, 2005a)

Figure 4-3 shows the development of the shares of energy efficiency classes in total sales of domestic cold appliances in Germany from 1999 to 2000. A shift towards appliances belonging to the energy efficiency class "A" took place during these years.

[25] The differences to the IEA data above can be explained with the fact that electrical space heating and cooling is not such a major source of energy demand in the EU-15 countries as it is in other OECD countries (IEA, 2003).

[26] The division of the domestic cold appliances market into energy efficiency classes was undertaken as the introduction of the EU energy label was prepared. For this purpose, seven efficiency classes were introduced. "A" ("A++") represents the class of appliances with the highest while "G" the class with the lowest energy efficiency (see section 4.2.2).

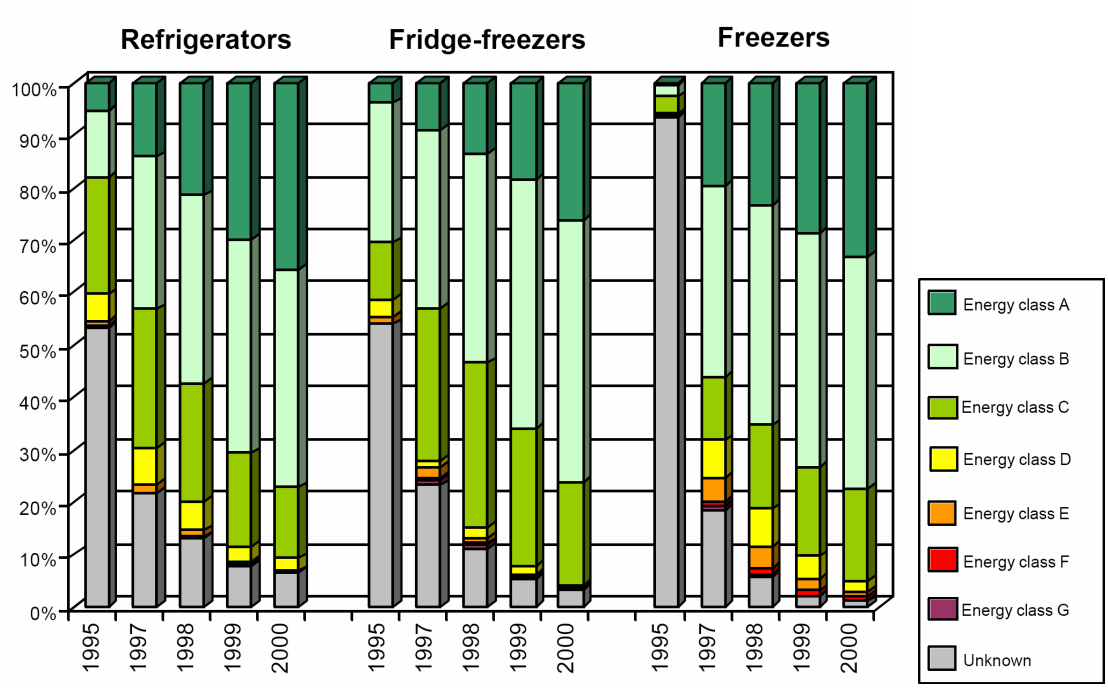


Figure 4-3: Development of the shares of energy efficiency classes in total sales of domestic cold appliances in Germany from 1995 to 2000 (Source: Schlomann et al., 2001, p. 72)

Figure 4-4 shows the distribution of sold refrigerator models according to energy efficiency classes in the 10 biggest EU countries in the year 2002.

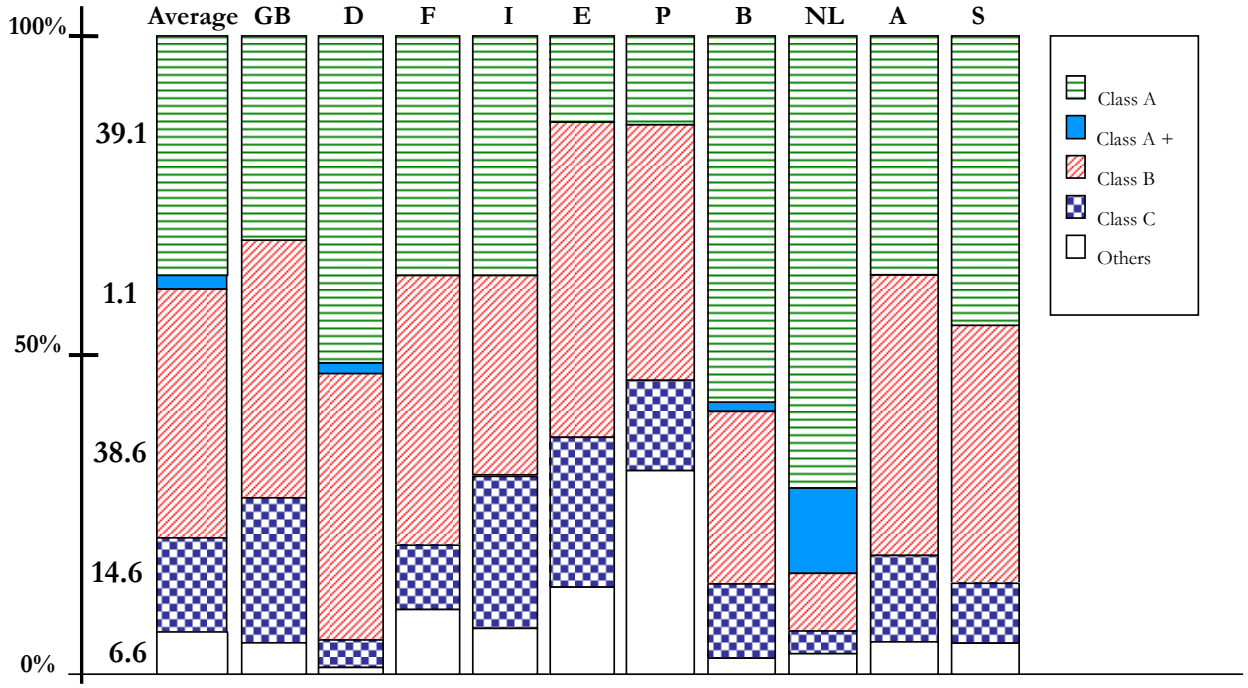


Figure 4-4: Distribution of sold refrigerator models according to energy efficiency classes in 10 selected EU countries in 2002 in % (Source: GFK Marketing Services, 2003)

Figure 4-4 clearly shows that there is a gap in the energy efficiency of sold refrigerators between Southern European countries on the one side and Northern European countries on the other side. The same holds for other categories of domestic cold appliances.

4.1.2 Options for raising energy efficiency

Despite the development towards higher energy efficiency, it is claimed that domestic cold appliances still have the largest cost-effective energy savings potential of any of the major residential electricity end-users (ADEME et al., 2000). Moreover, it is estimated that around 40-50% of the total cost-effective savings potentials in the field of residential electricity consumption can be accounted to domestic cold appliances (ADEME et al., 2000). Factors like age, type, specific energy efficiency or volume determine the energy consumption of a domestic cold appliance. The possibilities for improving energy efficiency of domestic cold appliances can be divided into technical- and use-related options.

Options related to the technology

The Cold II study (ADEME et al., 2000) which was undertaken as a preparation of the revision of the EU energy label and the minimum energy efficiency standard for domestic cold appliances identified several technical design options in order to raise energy efficiency. The areas for improvements include the insulation, accessories and defrost system, heat exchangers, compressor, and the control system of the appliance. Furthermore, alternative technologies were suggested. For the identified technical options, a least life-cycle costs analysis (LLCC) was undertaken.[27] The results of this analysis show that the realisation of certain technical options would lead to improved energy efficiency and reduced costs occurring over the whole life cycle of the appliance for the consumers. A detailed discussion of selected technical options to raise energy efficiency can be found in ADEME et al. (2000).

Options related to the proper use

In order to realise the potentials for energy savings connected to the technical options for raising energy efficiency, domestic cold appliances have to be used in the right way. According to CECED (2005b) options related to the use include the proper location of the appliance (e.g. no placement close to radiators, heaters, stoves or in direct sunlight), regular maintenance (e.g. air vents should not be covered up, regularly defrosting in order to avoid frost layers or maintenance of the door seals), right selection of the temperature (e.g. 6 to 8°C for refrigerators and -18°C in a freezer is optimal) and the proper behaviour of the user (e.g. avoidance of unnecessary opening of the door or no placement of warm food in the appliance). Furthermore, the time of replacement of an old appliance influences the electricity demand arising from domestic cold appliances. For instance, 37% of all domestic cold appliances in Germany in the year 2003 were bought in 1992 or before, i.e. an accelerated replacement rate would lead to high energy savings (Öko-Institut, 2005).

4.2 Policy instruments

Policy instruments are applied for transforming the market for domestic cold appliances towards higher energy efficiency. For this purpose, a number of policy instruments stemming from different categories and of a different design are available. These policy instruments

[27] The LLCC calculates the costs of a domestic cold appliance over the whole life-cycle for the consumer. The result shows which improvements in energy efficiency would lead to the lowest costs over the life-cycle of a domestic cold appliance.

address various actors on the supply and demand side of domestic cold appliances. Actors on the supply side include manufacturers and retailers. Manufacturers decide about the design of the appliance and have the ability to bring forward new energy efficient technologies. Retailers decide about whether they should have energy efficient appliances in their product ranges and can give advice to the consumers on energy efficient appliances during the sales talk. Actors on the demand side include support organisations and consumers. Support organisations are e.g. electric utilities, consumer or environmental organisations which give advice on energy efficient appliances or help consumers in their purchasing decision. The most important group of actors on the demand side are the consumers. The consumers' investment decision in favour of an energy efficient domestic cold appliance finally contributes in transforming the market towards higher energy efficiency. Furthermore, the consumers influence with their behaviour during the use phase the actual energy consumption of domestic cold appliances.

4.2.1 Chronology of policy instruments on domestic cold appliance energy efficiency

Guidelines on labelling energy consumption of household appliances have been implemented in the EU and Germany since 1979. A directive of the European council (Council Directive 79/530/EEC) set the framework for a labelling of electric household appliances like cold appliances according to their energy consumption in the EU. This directive foresaw that the member states can force the manufacturers to label certain electric household appliances according to their energy consumption. However, the implementation of the directive was voluntary. In most of the member states the directive was not implemented. In Germany, the directive was implemented through a voluntary agreement between the manufacturers, retailers and the federal ministry of economy in the year 1980. Manufacturers were complying with this agreement while the compliance of retailers was low (DEnA, 2005). In the late 1980s and in the beginning of the 1990s, it became evident that a number of EU member states were starting to prepare the implementation of individual labelling schemes (DEnA, 2005). As a reaction to that, the European Council adopted in 1992 a framework directive on the labelling of household appliances according to their energy consumption in the EU (Council Directive 92/75/EEC). The directive foresaw a common energy label for the EU and it was compulsory for the member states to implement this directive into their national legislation. Among other electric domestic appliances, cold appliances had to be categorized according to the common EU energy label (Commission Directive 94/2/EC). In the 1990s, consumers and environmental organisations as well as energy agencies started to advice consumers on issues related to energy efficiency in Germany. Furthermore, electric utilities were also active in promoting energy efficient domestic cold appliances. Such actions on the demand side were undertaken as part of "least cost planning" (LCP) activities.[28] Such actions included rebate programmes and information activities like campaigns or counselling of consumers (Thomas, 1995). However, due to the liberalisation of the energy market in Germany most rebate programmes were phased out in the end of the 1990s.

4.2.2 Selected policy instruments in Germany

Seven policy instruments on domestic cold appliance energy efficiency have been selected for the purpose of this thesis. Four of them have a European context (minimum energy efficiency standard, EU energy label, energy+, voluntary commitment by the manufacturers of

[28] LCP describes activities of electric utilities on the demand and supply side of energy in order to minimise their production and investment costs (Wuppertal Institute, 1995).

domestic cold appliances in Europe) while the other three (rebate programmes, "Initiative EnergieEffizienz", green tax) have only been applied in Germany in this form. All policy instruments have been active for a certain period of time between the years 1995 and 2005 and applied for enhancing household energy efficiency.[29] Table 4-1 gives an overview over the selected policy instruments.

Table 4-1: Selected policy instruments on domestic cold appliance energy efficiency in Germany

Policy instrument	Category	Energy efficiency classes addressed	Period of time in place
Rebate Programmes	Economic means	A++, A+, A	Mainly in the 1990s
"(Revised) Old" EU energy label	Information	(A++, A+) A - G	1998-2004 (2004 onwards)
Minimum energy efficiency standard	Regulation	D - G	1998 onwards
Green tax	Economic means	A++ - G	1999 onwards
Energy+	Cooperative Procurement	A++, A+	1999-2004
"Initiative EnergieEffizienz"	Information	A++, A+, A	2002 onwards
Voluntary commitment	Voluntary commitment	A++ - C	2002-2010

In the following, the selected policy instruments are presented in the chronological order they have been implemented. A summary and an overview over the policy instruments' design (category, characteristics and size) as well as actors and conditions addressed for realising an energy saving option is given in the end of each section.

Rebate programmes

Climate protection achieved by reduced energy consumption on the one side and minimising the costs of energy production with the help of demand side activities (DSM)[30] on the other side were the objectives of typical rebate programmes carried out by the electric utilities in Germany in the 1990s. In order to achieve these objectives, the main goal on the demand side is to stimulate consumers with financial incentives to invest in an energy efficient domestic cold appliance (Wuppertal Institute, 1995).

The largest single rebate programme implemented so far by an electric utility in Germany was the KesS ("client energy saving service") programme. This rebate programme is also exemplary for other programmes implemented by electric utilities. The programme was carried out between October 1992 and February 1995 by the electric utility "RWE Energie AG" which is one of the biggest utilities in Germany (Thomas, 1995). It offered a 100 "Deutsche Mark" (DM) cash rebate to any consumer of RWE Energy who bought an energy efficient domestic cold appliance, dishwasher or clothes washer and was eligible for around 50% of

[29] The database MURE on energy efficiency policy measures in the EU as well as the results of internet searches and a review of relevant literature in the field of energy efficiency policy in Germany were used for identifying policy instruments on domestic cold appliance energy efficiency in Germany. Based on this search, the policy instruments included in this long list were sorted according to their relevance. This resulted in a short list containing the seven selected policy instruments.

[30] Demand side management activities (DSM) include efforts in increasing energy efficiency in order to avoid the construction of a new power station. Such efforts could be a rebate programme for household appliances or counselling of consumers. These activities are carried out as long as the marginal costs for reducing the energy consumption are below the marginal costs for producing additional energy (Wuppertal Institute, 1995).

the models on the market at that time.[31] The rebate was paid out through "RWE Energie". For this purpose, consumers had to visit one of the counselling centres of the electric utility. The programme's budget was limited to 100 million DM (Thomas, 1995). Furthermore, the programme was aiming at creating consumer loyalty (Wuppertal Institute, 1995). There are examples of similar programmes in Germany and the EU. A recent example is the electric utility of the city Aachen which offers a rebate programme for A+ and A++ labelled domestic cold appliances (STAWAG, 2005). The Energy Premium Regulation (EPR) in the Netherlands carried out between 2002 and 2003 is an example for a rebate programme on the national level (Kemna, 2002). Table 4-2 gives an overview over the policy instrument "rebate programmes".

Table 4-2: Rebate programmes

Short description of relevant section	Sub-parts	Category	Characteristic Size	Actors addressed	Conditions addressed
Rebates for energy efficient domestic cold appliances	No sub-parts	Economic means *(appliance)*	Persuasive *targeted*	Consumers	Awareness, Financial motivation

EU Energy label[32]

The objective of the EU energy label is climate protection achieved by reduced energy consumption of domestic cold appliances through mandatory labelling. The main goal on the demand side in order to achieve this objective is to raise the consumer's awareness towards energy efficient domestic cold appliances and to enable the consumer to take energy consumption into account when purchasing an appliance. Creating competition among manufacturers in order to stimulate innovation and providing retailers with additional sales arguments are the main goals on the supply side (Schlomann et al, 2001).

The EU directive on labelling of domestic cold appliances according to their energy consumption (Directive 96/57/EC) was translated into German law in January 1998 (Schlomann et al., 2001). The federal states in Germany are responsible for enforcing the EU energy label. The ordinance that is implementing the EU energy label in Germany obliges the retailers to provide all appliances displayed in the showroom with energy labels and to list the technical data in table form in the sales records. Necessary information for this purpose has to be provided by the manufacturers of cold appliances to the retailers. Special labelling regulations are valid for appliances that cannot be seen displayed by the consumer (e.g. internet or catalogue offers). The label consists of a generic coloured background and a data strip that is stuck on it. Size, form and colour design of the label are prescribed by the EU directive. The label contains information on the electricity consumption and the storage volume of the cold appliances. The most important part of the label is the categorisation according to one of the nine energy efficiency classes from "A++" to "G" of the cold appliance. The categorisation according to energy efficiency classes is based on the energy efficiency index (EEI) [33] of the appliance. "A++" stands for a very high energy efficiency (30% of the energy consumption of an average appliance in the years 1990-1992) while "G" for a low energy effi-

[31] 100 DM equals approximately 51 Euro.

[32] A figure of the EU energy label can be found in appendix III.

[33] For instance, an appliance of the energy efficiency class A++ has an EEI of less than 30%, i.e. it consumes below 30% of the energy of an average appliance in the years 1990-1992. For further information on the concept of the EEI see appendix III.

ciency (above 125% of the energy consumption of an average appliance in the years 1990-1992) of the appliance. In 2003, the existing EU directive on labelling of domestic cold appliances was revised by adding two additional classes (A+ and A++) to the already active energy efficiency classes from "A" to "G" (Commission Directive 2003/66/EC). The "revised" EU energy label became legislation in Germany in March 2004. The revision was necessary since energy efficient domestic cold appliances were not visible any longer. Most domestic cold appliances were already A and B labelled and the classes D-G cut-off by the minimum energy efficiency standard introduced in June 1998. Table 4.3 gives an overview over the policy instrument "EU energy label".

Table 4-3: Summary of the EU energy label

Short description of relevant section	Sub-parts	Category	Characteristic Size	Actors addressed	Conditions addressed
Mandatory labelling of domestic cold appliances according to their energy consumption	"Old" EU energy label (A-G)	Information *on appliance*	Persuasive *targeted*	Manufacturers Retailers Consumers	Awareness, Social motivation
	"Revised" EU energy label (A++ - G)	Information *on appliance*	Persuasive *targeted*	Manufacturers Retailers Consumers	Awareness, Social motivation

Minimum energy efficiency standard

The objective of the minimum energy efficiency standard is climate protection due to a reduced energy consumption occurring from domestic cold appliances. The main goal on the supply side is to drive manufacturers towards design change in favour of improved energy efficiency (MURE, 2005).

The EU directive on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof (Directive 96/57/EC) was translated into German legislation in June 1998. The minimum energy efficiency standard for domestic cold appliances obliges manufacturers to ensure that each domestic cold appliance offered for sale is fulfilling the minimum energy requirements laid down in the annex of the EU directive. In practice, the standard banned almost all domestic cold appliances within the energy efficiency classes D to G. This means that nearly all domestic cold appliances above the energy consumption of 90% of an average appliance in the years 1990-1992 were banned from the market. As a sign, manufacturers had to endow the appliances complying with the standard with a "CE" label.[34] Domestic cold appliances that were not fulfilling the requirements of the minimum energy efficiency standard were only allowed to be sold until September 1999 (MURE, 2005). Table 4-4 gives an overview over the policy instrument "minimum energy efficiency standard".

[34] CE stands for "Communauté Européenne" and is a label which shows that a product is complying with EU norms for products.

Table 4-4: Minimum energy efficiency standard

Short description of relevant section	Sub-parts	Category	Characteristic Size	Actors addressed	Conditions addressed
Ban of domestic cold appliances above a certain energy consumption	No subparts	Regulation *on appliance*	Coercive *targeted*	Manufacturers	Availability, Awareness, Institutional barriers, Motivation

Green tax

The objectives of the green tax or ecological tax reform in Germany are climate protection through reduced energy consumption from fossil fuels, the promotion of renewable energies and the creation of new jobs through reduced ancillary wage costs (MURE, 2005). In order to achieve these objectives, the green tax is setting financial incentives on the demand side for achieving more energy efficiency and energy conservation. Moreover, the revenues from the green tax are earmarked for promoting renewable energies and reducing the ancillary wage costs through contributions for statutory pensions insurance (MURE, 2005).

The ecological tax reform that was introduced in March 1999 is targeting all sectors of the economy in Germany. The green tax increased the costs of energy in several steps. Electricity is taxed besides motor fuels, fuel oil and gas. For private households, the rate of the green tax on electricity reached 20.5 Euro per consumed MWh in the year 2003. However, the revenues of the green tax are returned in full to the taxpayers through a reduction in pension insurance contributions and the promotion of renewable energies (MURE, 2005). Table 4-5 gives an overview over the policy instrument "green tax".

Table 4-5: Green tax

Short description of relevant section	Sub-parts	Category	Characteristic Size	Actors addressed	Conditions addressed
Taxation of electricity consumption of private households	No subparts	Economic means *(use / appliance)*	Coercive *broad*	Consumers	Financial motivation, Utilisation

Energy+

The overall objective of energy+ was climate protection through reduced electricity consumption of domestic cold appliances (SenterNovem, 2005). The intention behind this cooperative procurement project was to enlarge the existing market for energy+ appliances[35] in the EU. The goals on the demand side were to provide retailers, support organisations and buyers with information on energy+ appliances, to commit these actors to promote or purchase energy+ appliances as well as to give them the possibility to articulate their demands on the product design of such appliances. On the other hand, the goals on the supply side were to encourage innovation by manufacturers resulting in bringing forward energy efficient domestic cold appliances.

[35] Very energy efficient domestic cold appliances or energy+ appliances include appliances labeled as A+ and A++.

Energy+ was supposed to be a pilot project for testing the cooperative procurement[36] approach for very energy efficient household appliances on the European level. For this purpose, the case of very energy efficient domestic cold appliances was chosen (SenterNovem, 2005). A reason for choosing cold appliances was the fact that the EU energy label had to be revised. Therefore, the procurement project was intended to prepare the market for a stronger EU energy label and to bridge the gap until such a label enters into force (Thomas et al., 2003).[37] The pilot project was carried out in 9 EU member states and Norway during 1999-2002 (ADEME, 2001). A follow-up project with an expanded scope on almost all categories of cold appliances, 2E+, was carried out during 2002-2004 where 11 EU member states as well as Norway and Switzerland participated (SenterNovem, 2005). In this cooperative procurement project, coordinating units on the EU and national level worked together with major buyers (mainly retailers and housing associations) and bundled their demand for energy+ appliances as well as on improved characteristics of such appliances.[38] In turn, this sent a signal to manufacturers that there is a demand and thus a market for energy+ appliances. For this purpose, several activities on the supply and demand side were carried out (SenterNovem, 2005). Actions on the supply side included encouragement of manufacturers to design energy+ appliances by providing marketing channels (e.g. the energy+ list which contains participating organizations and all available A+ and A++ appliances) and an award competition (energy+ award) for the best energy+ appliance. On the demand side, actors have signed the energy+ declaration which states their intention to promote (supporters), purchase (consumers) energy+ appliances or have certain energy+ product ranges (retailers). Further actions to promote the energy+ project included a newsletter (Energy+ bulletin), meetings with representatives of the demand and supply side, participation on fairs and conferences, a website, a CD with information related to energy+ as well as media presence (SenterNovem, 2005; Thomas et al., 2003). Table 4-6 summarises the energy+ project.

Table 4-6: Energy+ project

Short description of relevant section	**Sub-parts**	**Category**	**Characteristic Size**	**Addressed actors**	**Conditions addressed**
Procurement of very energy efficient domestic cold appliances at the European level; Marketing channel for manufacturers: energy+ appliance list, energy+ award competition	Procurement of very energy efficient domestic cold appliances	Other policy instruments *(appliance)*	Persuasive *targeted*	Manufacturer Retailers Consumers Support Organisations	Availability, Awareness, Social Motivation
	Information on very energy efficient domestic cold appliances	Information *on appliance*	Persuasive *targeted*	Consumers	Awareness, Social Motivation

[36] One might distinguish between two types of procurement (STEM, 1998). Cooperative market procurement aims at increasing the market share of already on the market existing technologies [best available technologies (BAT)]. On the other hand, cooperative technology procurement aims at shifting the market share towards more energy efficient appliances by influencing the technical product characteristics and introducing more energy efficient appliances [future best technologies (FBT)].

[37] The revised EU energy label directive (Commission Directive 2003/66/EC) was published in 2003 and implemented by the EU member states until the end of 2004.

[38] Retailers were seen as actors on the demand side in the energy+ project.

"Initiative EnergieEffizienz"

The objective of the German information campaign „Initiative EnergieEffizienz" is climate protection through reducing CO_2 emissions due to electricity consumption of the private household sector. The main goals on the demand side in order to achieve this objective are raising the consumers' awareness towards the issues of energy efficiency, to inform on energy efficient electric domestic appliances and to give motivation to consider energy efficiency when using and buying such appliances. The goal on the supply side is to enable and motivate retailers to inform on energy efficient appliances (MURE, 2005).

This national information campaign on household energy efficiency was started in October 2002 by the German energy agency "DEnA" ("Deutsche-Energie-Agentur"). The campaign is organised as a public-private partnership project in cooperation with the three main associations of electric utilities in Germany.[39] Furthermore, the Federal Ministry of Economics and Labour and the Federal Environment Foundation are giving financial support. Three topics are in the focus of the "Initiative EnergieEffizienz". The first topic addresses stand-by losses of home entertainment and office equipment, the second topic aims at energy efficient lightning with high comfort, and the third topic targets energy efficiency of electric domestic appliances like cold appliances (MURE, 2005). The "Initiative EnergieEffizienz" targets both retailers and consumers. For raising the consumer's awareness towards energy efficiency, press releases about issues related to energy efficiency are published, leaflets containing information on energy efficiency in households distributed, exhibitions and road shows on energy efficiency organised, and a website supporting detailed background information as well as a 24 hours free of charge consumer hotline provided. When it comes to targeting retailers or point of sale activities, the campaign is cooperating with retailers by supporting them with information on how to include the issue of energy efficiency during the sales talk by providing arguments for purchasing energy efficient cold appliances. Retailers are personally contacted by regional project managers and encouraged to take part in the campaign. Further, they have the opportunity to get training by the regional managers and are equipped with point of sale information. Retailer involvement seems to be very important since around 73% of the German consumers are seeking information about the product at the point of sale (Agricola and Ahrens, 2005).

There are several examples of information campaigns on household energy efficiency with different design and scope on both the national and European level. Examples on the national level include an information campaign focusing on stand-by consumption carried out by the energy foundation of the federal state "Schleswig-Holstein" as well as information and counselling by consumer organizations and electric utilities (Agricola and Ahrens, 2005). Table 4-7 gives an overview over the "Initiative EnergieEffizienz".

[39] The participation and financial contribution of the electric utilities is part of their voluntary commitment agreed with the federal government to reduce their CO_2 emissions.

Table 4-7: Summary of the "Initiative EnergieEffizienz"

Short description of relevant section	Sub-parts	Category	Characteristic Size	Actors addressed	Conditions addressed
Motivation and information campaign related to energy efficiency of domestic cold appliances addressing consumers and retailers	(a) Motivation to consider energy efficiency	Information *on use and appliance*	Persuasive *broad*	Consumers	Motivation, Utilisation
	(b) Information on energy efficient use	Information *on use*	Coercive *targeted*	Consumers	Utilisation
	(c) Information and education of retailers	Information *on appliance*	Coercive *targeted*	Retailers	Awareness, Motivation

Voluntary commitment by the manufacturers of domestic cold appliances in Europe

The objectives of the voluntary commitment on reducing energy consumption of household refrigerators, freezers and their combinations are to reduce the total energy consumption of domestic cold appliances in the EU and to avoid a revision of the minimum energy efficiency standard. In order to achieve this objective, goals on the supply side include to phase-out "C" labelled appliances and to move the average energy consumption of the domestic cold appliances fleet towards a consumption level that corresponds to that of "A" labelled appliances. The goal on the demand side is to raise the consumers' awareness towards an energy efficient use of domestic cold appliances (CECED, 2002).

The voluntary commitment targets the period of time from 2002 to 2010 and was initiated by the European Committee of Manufacturers of Domestic Equipment (CECED) in the year 2002 (CECED, 2002).[40] It was offered to the European Commission in order to avoid the introduction of a new minimum energy efficiency standard. Three components characterise the voluntary commitment. Firstly, the "hard target" banned the production and import of all domestic cold appliances with an energy consumption of 75% and higher of an average appliance in the years 1990-1992 from December 2004 on. This has excluded almost all appliances below the energy efficiency classes "A" and "B". Secondly, the "fleet target" includes that the average energy consumption of domestic cold appliances in the year 2006 will be at 55% of an average appliance in the years 1990-1992. In the absence of market transformation tools developed by EU authorities and national governments, the fleet target will be at 57% (CECED, 2004a). Finally, the "soft target" includes a commitment to promote the consumer's awareness by providing them with information on the energy efficient use of domestic cold appliances. Table 4-8 summarises the voluntary commitment.

[40] CECED represents manufacturers supplying about 95% of domestic cold appliances sold on the European market (CECED, 2004)

Table 4-8: Voluntary commitment by the manufacturers of domestic cold appliances in Europe

Short description of relevant section	**Sub-parts**	**Category**	**Characteristic Size**	**Actors addressed**	**Conditions addressed**
Phase-out of "C" labelled appliances (hard target); fleet average on "A"; Information on use	Voluntary commitment	Other policy instruments *(appliance)*	Coercive *targeted*	Manufacturers	Availability, Awareness, Institutional barriers, Motivation
	Information on energy efficient use	Information *on use*	Coercive *targeted*	Consumers	Utilisation

5. The functioning of selected policy instruments

After having implemented policy instruments on household energy efficiency, the simple and straightforward question of how they are "functioning" and "performing" arises (Bennear and Coglianese, 2005). Thus, besides monitoring the development in terms of changes in certain parameters, the applied policy instruments have to be evaluated. Policy instruments are evaluated in order to assess their effectiveness (goal-achievement) and efficiency (costs of goal-achievement) in a systematic way (retrospective or ex-post evaluation).[41] An understanding of how policy instruments are actually "functioning" in practice rather than a theoretical understanding about how they "should be functioning" is also crucial when investigating interactions between policy instruments (Sorrell, 2003).

5.1 Analysis of individual policy instruments

This section explores the "functioning" and "performance" of the seven selected policy instruments on energy efficiency of domestic cold appliances. For this purpose, relevant policy evaluation studies were reviewed and expert interviews carried out.[42]

5.1.1 The minimum energy efficiency standard

Review of policy evaluation studies

Experience in Germany

No specific evaluation for the minimum energy efficiency standard was found during the literature review. However, in the evaluation of the EU energy label in Germany, the impacts of the shift of appliance sales towards higher energy efficiency classes on energy savings and CO_2 emissions up to the year 2000 were calculated for domestic cold appliances (Schlomann et al., 2001). Part of this development can be credited to the minimum energy efficiency standard. However, the share attributable to the standard was not determined.

Experience in the EU

There are estimates by CECED (2002) claiming that the minimum energy efficiency standard contributed to 8-14 % of the energy savings stemming from improved domestic cold appliance energy efficiency in the period between 1992 and 1999 in the EU.

Interview results

The interviewed experts disagree about the relevance of the minimum energy efficiency standard (table 5-1).

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[41] Further, policy evaluation enables decisionmakers to apply a more "optimal" mix of policy instruments for achieving the objectives of a country's policy in a certain field (prospective or ex-ante evaluation). Policy evaluation also contributes to the learning process of policymakers since it provides them with insights about the functioning of certain policy instruments gained from ex-post evaluation (evidence-based policy making) (Bennear and Coglianese, 2005).

[42] The expert interviews included open questions on the functioning of the selected policy instruments. Moreover, the experts were asked to rank the policy instruments according to their achievements in promoting energy efficiency of domestic cold appliances in Germany until now. Calculating the average of the experts' assessments, the relevance of each policy instrument was determined. The relevance was rated by the experts on a scale between 1 (very low relevance) to 5 (very high relevance). Ratings from 1 to 2.3 correspond to a low relevance, from 2.4 to 3.6 to a medium relevance and from 3.7 to 5 to a high relevance.

Table 5-1: Relevance of the minimum energy efficiency standard as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
Minimum energy efficiency standard	2.8	2	7	1	4
	Medium-Low				

In general, the minimum energy efficiency standard is seen as an appropriate policy instrument for taking the least energy efficient appliances from the market and addressing segments of the market where other policy instruments are not perceived to be successful. A standard contributes in simplifying the policy process and reduces information asymmetries for consumers. However, the experts agree that a standard has to be made dynamic in order to retain its effectiveness. A dynamic standard would be adjusted according to the market development and introduction of new policy instruments periodically. Most experts agree that the minimum energy efficiency standard in Germany was just following the market development. Thus, the shift towards more energy efficient cold appliances had already been completed when the standard was introduced in Germany. However, the experts state that the minimum energy efficiency standard had a considerable effect on the European level. Especially, this was the case for Southern European countries. A number of experts stated that monitoring the compliance with the minimum energy efficiency standard is not very common in most EU countries.

5.1.2 EU energy label

In the following, the functioning of the "old" and "revised" EU energy label is investigated. Due to a lack of evaluation studies for the "revised" EU energy label, solely expert assessments were used to examine the functioning of the "revised" EU energy label.

Review of policy evaluation studies

Experience in Germany

The implementation of the "old" EU energy label was evaluated by Schlomann et al. (2001). The impact evaluation was focusing on assessing empirical sales data and collecting facts on the implementation of the EU energy label by observing the market and interviewing retailers. Furthermore, consumption and sales data were used to estimate the energy savings and CO_2 reductions due to the EU energy label.

The evaluation study shows a high degree of compliance with the EU energy label among manufacturers. Almost all manufacturers are labelling the appliances according to the energy efficiency classes (Schlomann et al., 2001). However, the degree of compliance in terms of correct labelling of the appliances by the retailers depends on the distribution channel. While the labelling behaviour of e.g. wholesale markets showed a high compliance, the degree of compliance of e.g. furniture stores or kitchen specialists was considerably lower. A reason for that could be that energy efficiency is not a sales argument for such groups of retailers. The degree of total compliance among all retailers was estimated to be 47% respective 66% if partly correct labelling is also considered (Schlomann et al., 2001). Furthermore, data on the sales of appliances in the different energy efficiency classes until the year 2000 was evaluated. The share of sold appliances belonging to the energy efficiency classes A and B was rising while the share of appliances falling into lower classes was declining since the introduction of the EU energy label (Schlomann et al., 2001). Based on that, energy savings and reductions in CO_2 emissions are estimated. For domestic cold appliances, energy savings of about 13-19%

were realised since the year 1995. 398,000 tons of CO_2 were avoided in the same period of time (Schlomann et al., 2001).

Experience in the EU

Waide et al. (2005) claim that the EU energy label "has been an undeniable success in terms of market transformation impacts" for the case of domestic cold appliances on the EU level. Estimations show that the average energy efficiency of domestic cold appliances increased by 37% at an average rate of 4% annually since the introduction of the EU energy label. This success becomes even clearer when comparing with the pre-labelling efficiency trend which was declining (Waide and Egan, 2005). Furthermore, Waide et al. (2005) claim that the design of the EU energy label did not only stimulate a higher demand for energy efficient domestic cold appliances by consumers but did also stimulate manufacturers to develop and supply appliances which reach a certain energy efficiency threshold in order to meet current and anticipated demand by consumers. Due to the categorical scale of the EU energy label with higher energy efficiency thresholds, manufacturers were challenged to develop higher efficient products. Before the introduction of the EU energy label, the "distribution by product sales by efficiency was entirely random" according to Waide et al. (2005). The improvements in energy efficiency were not followed by a rise in the price for domestic cold appliances. During the same period of time where the improvements in energy efficiency occurred, the real average price of domestic cold appliances in the EU was declining by 18% (Waide et al., 2005). CECED claims that the EU energy label contributed to 13-18% of the energy savings stemming from an improved energy efficiency of domestic cold appliances achieved during the period between the years 1992 and 1999 in the EU (CECED, 2002).

Issues related to the "revised" EU energy label

The market development made a revision of the existing ("old") EU energy label necessary since the class "A" had become the prevailing energy efficiency class making the EU energy label less effective (Waide and Egan, 2005). However, only a technical study was undertaken showing that a rapid revision was necessary (ADEME et al., 2000). No study on how to change the design of the EU energy label was carried out. Finally, two new energy efficiency classes A+ and A++ were added to the "old" EU energy label (Waide and Egan, 2005). Waide and Egan (2005) argue that the design of the "revised" EU energy label can be seen as not optimal since it creates confusion among the consumers. Conducted consumer research studies show that consumers would have preferred a simple rebasing of the EU energy label instead of adding two additional classes. This would have made it easier for consumers to comprehend the EU energy label (Waide et al., 2005).

Interview results

The experts agree about the high relevance of the EU energy label (table 5-2).

Table 5-2: Relevance of the EU energy label as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
EU energy label	4.3	4	0	2	10
	High				

All experts agree that the EU energy label is a "cornerstone", the "framework" or "prepared the ground" for improving domestic cold appliance energy efficiency. Before the introduc-

tion, it was neither possible to find out the energy consumption of a cold appliance nor was energy consumption relevant for the marketing. In this regard, the EU energy label induced a considerable change since it made energy consumption visible in an understandable way. This led to both a consumer pull for more energy efficient cold appliances and reactions by the manufacturers since they became something to compete for. The introduction of the EU energy label contributed to the fact that the appliances are distributed around the thresholds of the energy efficiency classes. Especially in the Southern European countries the energy label contributed to an increased awareness towards energy consumption of domestic cold appliances. Several factors contributed to the success of the EU energy label as stated by the experts. A factor can be seen in the fact that it was not difficult for manufacturers to develop new energy efficient appliances and that consumers were willing to pay a higher price for such appliances. Another success factors is that there is a high awareness of the consumers towards the EU energy label which is often also perceived to be a general label for quality. Finally, the experts regard the label as a relatively „inexpensive" policy instrument.

The experts regard compliance of the retailers with the EU energy label as a problematic issue. Nevertheless, the degree of compliance with the EU energy label has been improved during the last years on the EU level as most experts state. A reason for that could be found in the fact that retailers increasingly see the EU energy label as a marketing tool and an argument during the sales talk. In Germany, the degree of monitoring varies among the federal states. Therefore, other ways to control the compliance are consumer organisations and competitors that can detect non-compliance in a much more effective and quicker way than the federal authorities as stated by one expert. The experts agree that efforts in increasing the awareness of retailers towards the usefulness of the EU energy label would make controlling compliance unnecessary.

There is consensus among the experts that the revision of the "old" EU energy label was necessary in order to keep the label's effectiveness. However, there is also consensus among the interviewed experts that the revision of the EU energy label should have been done in another way because part of the information provided by the "revised" EU energy label is not used. This is due to the reason that the classes C-G are empty. Most of the experts would have favoured a rebasing of the EU energy label by keeping the energy efficiency classes from A-G but changing the thresholds. However, some experts stated that such a complete revision of the EU energy label would have been difficult and taken a long time to carry out. This is due to the reason that there would have existed two parallel systems making it difficult to communicate the change to the consumers. Furthermore, the need for a revision was very urgent. By adding two additional energy efficiency classes, the difficulties above were avoided and new incentives for manufacturers to develop energy efficient appliances created in a quick way. A further pitfall is seen in the fact that no consumer research was undertaken. This caused the motivation effect and comprehension level of the "revised" EU energy label to fall down. For instance, the bar of the "revised" energy label was not redesigned, i.e. the classes A++ and A+ are marked at the same point as the A class.

5.1.3 Rebate programmes

Review of policy evaluation studies

Experience in Germany

A rebate programme carried out by an electric utility in the early 1990s has been selected as an example for the purpose of this thesis. The reason for choosing the RWE KesS rebate programme was that it served as a model for other rebate programmes carried out by electric

utilities in the 1990s. The impact of the rebate programme carried out by the electric utility "RWE" [KundenenergiesparService (KesS)] has been evaluated in detail (Wuppertal Institute, 1995). For the evaluation, empirical surveys of programme participants, retailers and advisory staff of the electric utility, market analysis data on retail prices and sales data of individual appliance models, as well as technical data on energy consumption of appliances were used (Thomas, 1995). In the following, the main findings of the evaluation study are presented.

Firstly, the rebate served as a kind of label, i.e. consumers were asking for cold appliances eligible for the rebate rather than basing their purchasing decision on information about energy consumption of different cold appliances. Therefore, the rebate was perceived as a sign for quality (Thomas, 1995). Secondly, retailers began to adjust their product ranges according to the demand of the consumers, i.e. they started to change their stocks towards appliances being eligible for the rebate only a few months after the implementation of the programme. However, it seems to take between two to three years until retailers perceive the market signals to be secure enough and change their product range completely (Thomas, 1995). Thirdly, a rebound effect linked to the rebate programme was not detected. This means that consumers did not start to buy bigger appliances than planned or were using their appliances less consciously than before. However, some consumers were buying more expensive appliances with additional functions and features (Thomas, 1995). Finally, it was found that the rebate programme contributed in changing the behaviour of the participants towards more energy efficient manners than compared with the situation before the rebate programme. A reason for that could be found in the information activities connected to the rebate programme (Thomas, 1995).

Critical issues when it comes to estimating the energy savings and CO_2 reductions due to a rebate programme are to determine the share of free-riders (participant would have bought the appliance even without the rebate programme) and free-drivers (participant buys an energy efficient appliance due to the programme but does not apply for the rebate) among the participants as well as behavioural effects (rebound effect). The share of free-riders in the KesS rebate programme was rather high for domestic cold appliances, 47% for freezers and 60% for refrigerators (Thomas, 1995). This is mainly due to the fact that that a share of around 50% of the appliances available on the market was covered by the rebate programme.

Experience from other rebate programmes in Germany like the programme by the "Stadtwerke Hannover" or the "Stadtwerke Soest" shows that the participation rate is much lower if the marketing of the programme is less extensive, the duration of the programme rather short or retailers are not involved. Furthermore, a smaller share of eligible appliances for the rebate can reduce the number of free-riders within a programme and further enhance its effectiveness (Thomas, 1995). Thomas (1995) and Wuppertal Institut (1995) claim that a successful rebate programme should (i) continue for several years to achieve full participation, (ii) be orientated at the EU energy label in order to make it more comprehensive, (iii) only cover very energy efficient appliances, and (vi) provide information about energy costs saved when purchasing an eligible appliance instead of a non-eligible appliance.

Experience in other EU countries

Experience from other European countries like the Netherlands or Denmark shows that rebate programmes for energy efficient domestic cold appliances on the national level can be very successful and have effects that extend even beyond the campaign period.

The Danish experience from the year 1999 shows that it is possible to influence during a rather short period of time (11 weeks) the market transformation towards more energy efficient domestic cold appliances substantially. While the market share of "A" labelled appliances was between 9-10% before the programme, it rose to approximately 15-20% after the programme (Karbo, 2000). Furthermore, the number of "A" labelled appliances offered on the market had almost tripled and the average price of such appliances decreased by 15%. The focus on "A" labelled appliances that was created during the programme has subsequently been maintained (Karbo, 2000). Crucial for the success were the related information activities for consumers and the involvement, commitment and information of retailers that were also responsible for paying out the subsidy. To put it in a nutshell, the rebate programme made consumers to demand more "A" labelled appliances and encouraged manufacturers as well as retailers to supply such appliances.

The Dutch experience shows that a national rebate programme for energy efficient appliances can have a large impact on the total market share of "A" labelled cold appliances (Kemna, 2002). During the period of time between the years 1999 to 2001, the share of "A" labelled refrigerators (freezers) rose from 26% (29%) to 67% (69%). Especially in the first year (2000), sales of "A" labelled refrigerators (freezers) rose by 116% (95%) while the increase in the second year was about 22% (35%). In comparison, the average share of "A" labelled refrigerators in the EU rose from 12% in 1999 to 27% in 2001. Due the rebate programme, the Netherlands became a global leader in energy efficiency of domestic cold appliances. Furthermore, the average price of "A" labelled domestic cold appliances decreased by 25%. This also contributed in encouraging consumers to an early replacement of their appliances which resulted in sales increases in value of about 10%. In contrast to the Danish case, the rebates were paid out through the electric utilities.

Interview results

The experts disagree when it comes to the relevance of rebate programmes carried out in Germany until now (table 5-3).

Table 5-3: Relevance of rebate programmes as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
Rebate programmes	2.9	2.5	5	2	5
	Medium				

Proponents of rebate programmes claim that such programmes can have a significant effect on the market transformation process towards more energy efficient appliances. A reason for that can be found in the fact that people have a strongly positive reaction towards financial incentives. Furthermore, there is consensus among the proponents that such programmes should only target at the most energy efficient appliances such as "A++" labelled appliances. Almost all proponents were pointing at the experience in the Netherlands that made the Dutch market from a medium to a high efficient one in a short period of time.[43] Furthermore, the proponents agree that such programmes have to be designed in the right way, dy-

[43] As one expert stated, rebate programmes can even have an impact beyond the region and time they are implemented. For instance, the Dutch rebate programme had a significant influence on the market for domestic cold appliances in Belgium and regions of Germany neighbouring to the Netherlands. Reasons for that could be the information activities related to such a programme or same distribution channels for domestic cold appliances.

namic, very ambitious and be specific in terms of the targeted appliances. Rebate programmes are also seen as an effective policy instrument for targeting retailers since they get an additional marketing tool to advice consumers on energy efficiency.

Opponents argue there could be rebound effects and a high share of free-riders as well as substantial costs related to rebate programmes which make the implementation on the national level impossible. Another crucial issue is the treatment of replaced appliances, i.e. if such appliances are scraped or further used besides the new appliance. Opponents claim that rebate programmes are perceived not to have the ability to change attitudes or awareness towards energy efficiency in the long run since they are only having an effect as long as they are implemented.[44] It is argued that consumers might perceive rebates as a sign for a still immature and non-marketable appliance that could have a lower quality. Furthermore, consumers may not see the fact that energy efficiency could make sense from an economic point of view. Based on the wrong associations stemming from rebates, such programmes could even be a barrier for bringing the issue of energy efficiency into the everyday life of consumers.

5.1.4 Green tax

Review of policy evaluation studies

Experience in Germany

The effect of the green tax on private households was evaluated in the year 2004 in order to investigate the question if and how private households showed any reaction to the green tax (Knigge and Görlach, 2004). Besides the effect of higher petrol prices, the effect of the tax on electricity consumption was investigated. For exploring how private households in Germany were reacting to higher electricity prices due to the green tax, a survey was carried out. Altogether, the study shows that increased electricity prices and the green tax can lead to changes in the awareness and behaviour of private households related to energy efficiency. In the following, the findings of the evaluation study related to electricity costs are reviewed.

There is a high interest and awareness of the households towards their electricity consumption and energy costs. This interest and awareness is a major reason explaining the households' motivation for carrying out electricity saving activities. Electricity saving activities carried out on a regularly basis include switching off the lights in not used rooms (93% of the households), avoiding stand-by electricity consumption (75% of the households) or replacing regular light bulbs by energy saving light bulbs (51% of the households). 46% of the households have always or predominately changed a low energy efficient appliance against a more energy efficient one. This figure turns to 61% if households sometimes carrying out this activity are also counted. Thus, switching to energy efficient appliances is the at least carried out activity when it comes to saving electricity. However, when it comes to energy efficient electrical appliances with relatively higher investment costs, 86% of the households are willing to pay a higher price in exchange for lower electricity costs. The degree of willingness increases with the households' income (Knigge and Görlach, 2004).

Motivating reasons for saving electricity include (i) reducing the electricity bill (86% of the households), (ii) protecting the environment (74% of the households), and (iii) the extra costs arising from the green tax on electricity (43% of the households). 51% of the households

[44] One expert stated that during the rebate programme in the Netherlands only "A", "A+" or "A++" labelled domestic cold appliances were available on the market. However, after the phase out of the rebate programme, "B" labelled appliances became available on the market again.

who have more or less always carried out electricity saving activities during the last three years were strongly motivated by the additional costs arising from the green tax (Knigge and Görlach, 2004). When asked about the influence of the green tax, 78% of the households carrying out energy saving activities always, on a regular basis or sometimes answered that the green tax had an effect on them. 18% of the households were very strongly affected, 25% strongly and 35% less strongly affected by the green tax. Only for 21% of the households, the green tax did not have any effect (Knigge and Görlach, 2004).

Experience in other EU countries

Jänicke et al (1998) found for Denmark that a green tax is a necessary policy instrument for the diffusion of energy efficient cold appliances as well as innovations in this field of application. However, the green tax alone is not perceived to be a sufficient policy instrument for enhancing energy efficiency of domestic cold appliances (see section 6.3.1).

Interview results

Most experts argue that the green tax is the policy instrument with the least impact on enhancing energy efficiency of domestic cold appliances (table 5-4).

Table 5-4: Relevance of the green tax as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
Green tax	1.8	1	9	2	1
	Low				

The green tax's direct effects on the investment decision of consumers or on the behaviour during the use phase is not significant according to most of the experts. This is due to the fact that the green tax is perceived to be "a too broad" or "too mild" policy instrument. For instance, it is claimed that normal households do not draw a causal relationship between an increase in the green tax and a buying decision towards a more energy efficient appliance. Furthermore, the demand for electricity is perceived to be rather inelastic by most of the experts. A green tax is perceived to be acting more on the behaviour rather than the investment decision of the consumers. However, a majority of the experts says that the green tax helps in bringing the issue of energy costs on the agenda and makes people start thinking about how to reduce such costs. Therefore, some experts see at least an indirect and small effect of the green tax on the attitudes and behaviour of the consumers.

5.1.5 "Initiative EnergieEffizienz"

Review of policy evaluation studies

First results of an evaluation of the "Initiative EnergieEffizienz" have been published by Agricola and Ahrens (2005). During the first two years of the campaign (2002-2004), 3000 articles in nationwide newspapers and magazines were published respective broadcasted on radio or television, 5.5 million leaflets distributed through the participating retailers, and more than 3000 consumers got personally advised during exhibitions and road shows. Until the end of 2004, around 7200 retailers were taking part in the campaign (Agricola and Ahrens, 2005). These figures raise the question if and to what extend the campaign had an impact on the public awareness, behaviour and sold energy efficient appliances. For this purpose, a quantitative analysis based on interviews with consumers and retailers was carried out. The

preliminary main findings show that "public awareness and some attitudes towards energy efficiency in private households have changed slowly but continuously as a result of the activities" of the information campaign (Agricola and Ahrens, 2005). Related to that, it is claimed that an information campaign relying on a limited budget needs a functioning network of multipliers like retailers. In order to show results, such a campaign has to be run over a longer period of time (Agricola and Ahrens, 2005). The preliminary findings linked to domestic cold appliances show that the consumers' knowledge about energy labels for white goods has increased by 8% between the beginning of 2003 and end of 2004. For retailers, the importance of the EU energy label has increased by 10% and the number of energy efficient white goods sold increased by 2% (Agricola and Ahrens, 2005).

Interview results

The experts disagree about the relevance of the "Initiative EnergieEffizienz" (table 5-5).

Table 5-5: Relevance of the "Initiative EnergieEffizienz" as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
"Initiative EnergieEffizienz"	2.4	1.5	6	4	2
	Medium-Low				

Opponents of the "Initiative EnergieEffizienz" claim that the message of the campaign is too broad and general which decreases the visibility for the consumers. Even for some experts in the field of energy policy who should be more open towards such a campaign, the "Initiative EnergieEffizienz" is not perceived to be visible. Furthermore, it is claimed that the "Initiative EnergieEffizienz" is focusing on the wrong target group and missing to give concrete suggestions on what to do. There is consensus among the opponents that an information campaign is "in general a good policy instrument". As stated by some opponents, such campaigns have effects beyond the narrow scope they are aimed for since they are bringing the issue of energy efficiency on the agenda and increase public awareness. It is claimed that a focus on solely cold appliances or lightning could be an entry point to the public consciousness that in turn has an effect on other fields of application.

Proponents of the "Initiative EnergieEffizienz" state that it takes some time until such a campaign has a significant impact. However, the campaign contributed to an increased public awareness towards energy efficiency within only two years as claimed by the proponents. Furthermore, the campaign contributed in telling the consumers the meaning and usefulness of other policy instruments like the EU energy label as stated by the proponents. Another success is seen in the fact that much more retailers than initially planned agreed to participate in the campaign.

Energy+

Review of policy evaluation studies

Experience in Germany

The evaluation of the first energy+ project carried out for Germany shows that a market transformation towards energy+ appliances took place. Likewise, the EEI of best appliances was continuously lowered during the project. In the year 2000, the EEI of the most energy

efficient refrigerator was at 38% and reached 35% of the energy consumption of an average appliance in the years 1990-1992 in 2002 (Thomas et al., 2003).

Manufacturers were actively participating. They stated that they perceived the energy+ project as an additional tool in their strategy for promoting cold appliances and their environmental work. Furthermore, the project made it possible to commercialise already developed energy+ appliances and to strive for a new market niche. However, manufacturers stressed that they would have been able to position themselves on the market even without the energy+ project (Thomas et al., 2003). Retailers became aware of the energy+ project however they did not actively participate in the beginning. A reason for that could be that manufacturers were not actively promoting very energy efficient appliances (Thomas et al., 2003). A problem of the energy+ project in countries like Germany could be seen in the fact that it was not possible to organise groups of private buyers. Private buyers or consumers are normally not organised and, thus, more difficult to reach.[45] In order to organise buyer groups, retailers were addressed. They were offered the possibility to declare that they would buy certain ranges of A+ and A++ appliances. However, the manufacturers perceived such declarations as of a low relevance. All actors saw the energy+ appliance lists as positive. However, problems with this list were that it was difficult to keep them updated in terms of e.g. available appliances on the market (Thomas et al., 2003). When it comes to the energy+ label, problems were seen in the fact that there had already been own labels by the manufacturers in place. Thus, the energy+ label could have contributed in making the labelling of very energy efficient appliances more difficult to understand for the consumers. However, consumers seemed to confuse the EU energy label and energy+ sign with a label for quality. Therefore, retailers and manufacturers were hesitant to actively promote the label since it might keep the sales of more expansive appliances low. Another problem leading to confusion of the consumers was that not all appliances being eligible for energy+ were labelled as such (Thomas et al., 2003). The energy+ award competition was seen as the main driver for manufactures to develop very energy efficient appliances. However, confusion was created by the fact that the energy+ award winner and the cold appliance on the first position of the energy+ list were not necessarily identical due to different criteria of the competition (Thomas et al., 2003).

Experience in other EU countries

Several evaluations of the energy+ project in the different participating countries and on the EU level have been carried out (ADEME, 2001; SenterNovem, 2005; Thomas et al., 2003). In general, the energy+ project is seen as a successful policy instrument for accelerating the market transformation towards energy+ appliances and for preparing the market for a more demanding energy label. It is perceived to be a very effective, not too expensive and time consuming policy instrument for speeding up the market transformation for the case of very energy efficient cold appliances. The fact that several European countries were participating could have even influenced the market in non-participating countries (ADEME, 2001; SenterNovem, 2005; Thomas et al., 2003). A report by SenterNovem (2005) on the EU experience shows that the availability of energy+ appliances increased between the years 1999 to 2004 in the EU. In 1999, there were only 2 energy+ appliances while in 2001 the number reached 16 (end of first energy+ project) and in 2004 (end of the second energy+ project) already 866 different models were available. Figures for 2003 show that 50% of the domestic cold appliances on the EU market were "A" labelled and around 7% were "A+" and "A++"

[45] In contrast, this was possible in the Nordic countries or Switzerland. In these countries, the housing organisations are responsible for equipping apartments with refrigerators while in Germany it is up to the tenant to equip the kitchen.

labelled. Sales statistics followed the development on the supply side of cold appliances. The estimated savings in terms of lower energy consumption due to a higher energy+ appliances penetration are around 100 GWh/year. On average, energy+ appliances in 2004 had a 25-45% better energy efficiency than basic "A" class cold appliances (SenterNovem, 2005). However, the question arises to what extend this is due to the energy+ project. The literature on the energy+ project (ADEME, 2001; SenterNovem, 2005; Thomas, 2003) does not give any estimates on what the influence of the project on this process could have been. It is stressed that there could have been an indirect effect, which means that the energy+ project could have prepared the ground for a revised EU energy label by introducing new energy efficiency classes as well as interacted with other policy instruments and prevailing conditions in the participating countries. According to SenterNovem (2005), such conditions could be: (i.) existence of local manufacturers, (ii.) enthusiasm of representatives of international industries, (iii.) interest of retailers, (iv.) local energy policy and governmental activities, (v.) additional measures like energy+ activities, (vi.) the penetration of the EU energy label on white goods and a controlling body, and, (vii.) enough willing consumers.

Interview results

In general, the experts see energy+ as of a low relevance for Germany (table 5-6).

Table 5-6: Relevance of energy+ as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
Energy+	2.2	2	6	5	1
	Low				

Energy+ is regarded to be of a low relevance because there were difficulties in bundling the demand side as stated by the experts. Thus, energy+ was not very visible and known on the demand side and the procurement did not result in enormous sales.

Activities carried out by the energy+ project on the supply side are seen as more effective and relevant. In general, energy+ is perceived to have motivated and helped manufacturers to introduce very energy efficient domestic cold appliances on the market. Especially the energy+ award competition and the energy+ appliance lists contributed to the success on the supply side as claimed by the experts. The reason for manufacturers to declare that they are not dependent on energy+ could be explained with the fact that they wanted to avoid participating in financing such a policy instrument in later stages. According to the view of the experts, energy+ can be summarised as a successful project in motivating manufacturers, demonstrating very energy efficient cold appliances and preparing the market for a revision of the EU energy label.

5.1.6 Voluntary commitment by the manufacturers

Review of policy evaluation studies

CECED made the commitment to report on the compliance with the voluntary commitment. For this purpose, a notary is commissioned and data on the weighted EEI of each manufacturer as well as technical data on all models of cold appliances available on the EU market collected. Annually, a report showing the result of the voluntary commitment is pub-

lished. In 2004, the first annual report for the year 2003 was published (CECED, 2004b). The results presented in this report are summarised in the following.

In 2003, participating manufacturers represented 95% of the European market. The notary data collection shows that the weighted average EEI was at 64.38 in 2003 compared to 67.26 in 2002. For the new EU member states, the EEI was around 70%. Furthermore, the trend towards the energy efficiency class "A" continued meaning that the shares of "B" labelled appliances started to decline. Additional A+ and A++ appliances became available for some categories of domestic cold appliances (CECED, 2004b). The fleet target has to be achieved individually by each participant during the year 2006. For this purpose, the position of each of the 14 participating manufacturers was monitored. Two participants had already reached the fleet target in 2003, nine were close to the average in the year 2003 (64.38%) and three manufacturers were still above the average from the year 2002 (67.26%). Two out of these three manufacturers were even above the average in the year 2001 (74.11%) which means that they have to overcome a gap of two years (CECED, 2004b).

Interview results

The experts disagree about the relevance of the voluntary commitment (table 5-7).

Table 5-7: Relevance of the voluntary commitment as rated by the experts

Name of the policy instrument	Relevance		Distribution of the experts' ratings		
	Average	Median	low	medium	high
Voluntary Commitment	2.8	3	5	3	4
	Medium				

Proponents of the commitment claim that it helped to further develop energy efficient domestic cold appliances and to bring the market forward. If the commitment is ambitious, properly monitored and there are sanctions in the case of non-compliance then it could be an equivalent policy instrument to minimum energy efficiency standards. The only difference between both policy instruments is seen in the fact that the voluntary commitment achieves a certain level of energy efficiency on average. In turn, this gives more freedom to the manufacturers and allows addressing other segments of the market than the lower part. Furthermore, it is claimed that the commitment allows to better address the specifics of different countries than a common standard for Europe that might put a high burden on certain countries or manufacturers. Finally, the commitment is better monitored than the minimum energy efficiency standard as claimed by the proponents.

Opponents of the commitment say that it could have been much more ambitious in terms of the targets. For the case of Germany, it does not have any influence on the situation since it was already fulfilled when it was implemented. Moreover, the opponents claim that the voluntary commitment is only following the general trend of the market development. In order to make such a commitment effective, there has to be a stick such as the threat of a standard in the background as stated by the opponents.

5.2 Main findings

In the following, the main findings on the functioning and relevance of the selected policy instruments on domestic cold appliance energy efficiency are briefly summarised and reflected.

According to the interviewed experts and reviewed literature, the most relevant policy instrument for improving domestic cold appliance energy efficiency until now is the EU energy label. By setting the framework for energy efficiency in this field of application, the label contributed significantly to a higher share of energy efficient domestic cold appliances in Germany. Such a categorical label makes the energy consumption of domestic cold appliances visible and acts on consumers, retailers and manufacturers. Furthermore, it is perceived to be a simple and relatively inexpensive policy instrument. The revision of the EU energy label was crucial for keeping the label successful. However, by adding two additional energy efficiency classes during the revision process the label became less comprehensive for the consumers. Furthermore, the energy efficiency classes C-G are left empty. Additional problems can be found when it comes to the compliance of retailers. Due to the high number of retailers the labelling of individual retailers is difficult to monitor. In order to make the existing EU energy label more effective, compliance by retailers has to be increased by showing the advantages of the label. Furthermore, the energy efficiency classes need to be simplified again, and the label designed in a way that allows adapting to the development of the market.

Rebate programmes, the minimum energy efficiency standard and the voluntary commitment are seen as of the second most relevant policy instruments.

If properly designed, rebate programmes can be very effective in transforming the market towards more energy efficient appliances. A reason for that could be found in the fact that an increased demand by consumers makes retailers to adapt their product ranges and manufacturers to supply more energy efficient appliances. Crucial for the success of rebate programmes are the related information and marketing activities. However, rebate programmes are seen as very costly policy instruments. Furthermore, the rate of free-riders could be very high, the treatment of the replaced appliances is often unclear in such programmes and there are doubts about the effectiveness in the long-term. It is also claimed that rebate programmes could be "counterproductive" in terms of creating wrong associations of consumers towards energy efficiency. Therefore, only very energy efficient appliances should be eligible for a rebate, and a rebate programme has to be adapted to the development of the market as well as linked to information and marketing activities in order to be effective.

In general, a minimum energy efficiency standard and a voluntary commitment are regarded as substitutes. They reduce the information requirements for consumers and simplify the policy process. The impact of such policy instruments depends on how ambitious they are, i.e. where the threshold for minimum energy efficiency requirements is set. For instance, the relevance of the minimum energy efficiency standard in Germany can be regarded as low since it had already been anticipated by the market development. For the case of a voluntary commitment, this is determined by the fact of how serious the threat of regulation instead of the commitment is perceived to be by the participating manufacturers. Furthermore, standards only aim at the lower energy efficiency classes while a voluntary commitment can also be used for targeting higher energy efficiency classes. Furthermore, the voluntary commitment allows taking country specific differences in the EU into account. Proper monitoring of the commitment is also crucial for its effectiveness. As the experience shows, a voluntary commitment is usually better monitored than a standard since it is up to the manufacturers to report on compliance.

The relevance of an information campaign is more difficult to assess in general. The experience with the "Initiative EnergieEffizienz" shows that information campaigns have to be carried out over a longer period of time in order to bring the issue of energy efficiency on the public agenda and have an influence on the attitudes and behaviour of the consumers. Fur-

thermore, the effectiveness of an information campaign depends much on its design and the way how it is implemented. Visibility, comprehensiveness for the consumers and a well defined focus are seen as crucial for the success of such a campaign. The experience of the "Initiative EnergieEffizienz" shows that retailers or the point of sale have also to be targeted by an information campaign since they are multipliers for information on energy efficient domestic cold appliances and have direct influence on the consumer's investment decision.

Finally, the energy+ project (cooperative procurement as a stand alone policy instrument) and the green tax are seen as the least relevant policy instruments for the achievements in enhancing energy efficiency of domestic cold appliances in Germany until now.

The energy+ project contributed in preparing the market for the "revised" EU energy label. Furthermore, the experience showed that activities carried out on the supply side – incentives for manufactures in terms of appliance lists and an award competition – can be relevant for bringing very energy efficient domestic appliances forward. Nevertheless, the energy+ project showed that the procurement approach for domestic cold appliances does not work in Germany. This is due to the reason that it is difficult to bundle the demand side since private buyers of cold appliances are not organised. A lesson from the energy+ project is that activities targeting manufacturers could ease a revision of the EU energy label.

The green tax contributes in bringing the issue of electricity costs on the agenda. Thus, it might have an indirect impact on domestic cold appliance energy efficiency as the German experience shows. Nevertheless, the green tax is perceived to be a too broad policy instrument for targeting domestic cold appliance energy efficiency since it is difficult for the consumers to link the policy instrument to domestic cold appliances. Therefore, the influence of the green tax on the investment decision in favour of an energy efficient domestic cold appliance is regarded as rather low. The green tax is the only policy instrument of the category economic means that is also targeting the use of domestic cold appliances. However, the influence on the behaviour is much dependent on the elasticity of the demand for electricity. This shows that the rate of the green tax has to be significant for the consumers and be continuously increased in order to have an impact.

6. Interactions between selected policy instruments

Energy efficiency policy aiming at domestic cold appliances is dominated by the in section 4.2.2 described policy instruments in Germany. As shown in chapter five of this thesis, the impact of individual policy instruments in terms of improving energy efficiency of domestic cold appliances can be significant. Based on these insights, the question of how combinations of such policy instruments are interacting with each other arises. In order to explore this question, a three-stage evaluation of interactions between the selected policy instruments is undertaken in this chapter (figure 6-1).

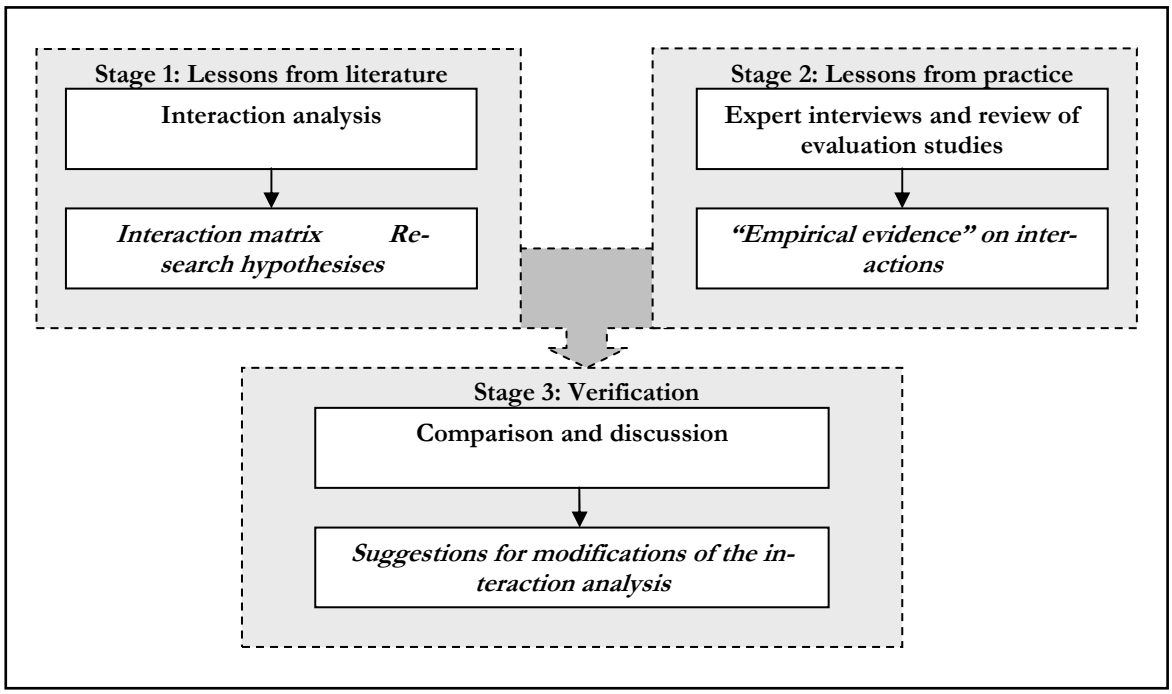

Figure 6-1: Summary of applied methodology for evaluating interactions between policy instruments

The first stage of the evaluation consists of an interaction analysis resulting in a matrix mapping interactions between policy instruments.[46] A general framework for investigating possible interactions in sets of energy policy measures as suggested by Boonekamp (2005) and modified for the purpose of this thesis was applied for this analysis.[47] Based on the findings, research hypothesises on interactions between policy instruments are developed. Building on that, the *second stage* consists of collecting "empirical evidence" on selected interactions between policy instruments and the developed research hypothesises by reviewing relevant policy evaluation studies and conducting expert interviews. In the *third stage*, the conclusions of the second stage are used for verifying the findings from the interaction analysis. Finally, suggestions on how to modify the interaction analysis from stage 1 are given.

[46] The first stage is called lessons from literature because it is building on an analysis of combinations of policy instruments according to the factors determining the quality and degree of an interaction as discussed in the relevant academic literature (see section 3.3.2 of this thesis).

[47] For example, this approach is applied in the MURE-ODYSSEE project of the European Union. Combing energy efficiency indicators and a database on energy efficiency policy measures set up an energy efficiency profile of each EU country. For further information see: http://www.odyssee-indicators.org/ and http://www.mure2.com.

6.1 Stage 1: Lessons from literature

6.1.1 Applied methodology for the interaction analysis

The underlying framework of this analysis is the method for mapping interactions between policy measures on household energy efficiency as suggested by Boonekamp (2005). This approach can be described as a framework for forming views on interactions between selected policy instruments. The approach suggested by Boonekamp (2005) has been simplified and modified in some parts for the purpose of this thesis.[48] The applied analytical framework allows investigating interactions in a systematic way and is of a qualitative nature. A matrix mapping interactions between policy instruments is the result of this analysis. Constructing the interaction matrix is based on the following seven steps:

1. Selection of policy instruments on domestic cold appliance energy efficiency being implemented between 1995 to 2005 and relevant for Germany,

2. Extraction of the part being relevant for domestic cold appliances from policy instruments also addressing other fields of application,

3. Division of generally defined policy instruments into different subparts,

4. Description, categorisation and characterisation of the policy instruments,

5. Rating the degree of basic interaction of the different cells,

6. Adjustment for non-overlaps in time,

7. Adjustment for post- and pre-implementation interaction.

Information needed for the rating of the different cells of the interaction matrix is obtained from a screening of the policy instruments that is carried out in steps 1 to 4. The obtained information from the screening allows determining the degree of interaction of the different cells of the matrix. This is done with the help of steps 5 to 7. While steps 1 to 4 speak for themselves, a more comprehensive description of steps 5 to 7 is given in the following.

Step 5 investigates whether the degree of "basic" interaction of a combination of two policy instruments on domestic cold appliance energy efficiency is reinforcing, mitigating or neutral. For analysing the degree of "basic" interaction, information on each policy instrument gathered from steps 1 to 4 is needed. This information is then used for rating the interaction as reinforcing, mitigating or neutral. The rating will be done as follows:

Reinforcing combinations include combinations of two complementary policy instruments. The combination can either be strongly ("2") or weakly ("1") reinforcing. Strongly reinforcing pairs of policy instruments include combinations with complementary conditions addressed and of the categories economic means and information. Weakly reinforcing pairs of policy instruments include combinations of policy instruments with complementary characteristics or actors addressed. *Mitigating combinations* can either be strongly ("-2") or weakly ("-1") mitigating. Strongly mitigating combinations of policy instruments include policy instruments with overlaps in the conditions addressed. In general, a policy instrument of the size "broad"

[48] The analytical approach suggested by Boonekamp (2005) includes additional steps being relevant for the case of different fields of application. These steps are left out since this thesis only investigates one field of application.

weakens the degree of a strong to a weak interaction. *Neutral combinations* ("0") have either a non-overlap in energy efficiency classes or in the conditions addressed.

The rating of each interaction is entered into the matrix and adjusted in steps 6-7. In step 6 adjustments for non-overlaps in time will be made. A non-overlap in time means that a combination of policy instruments is neutral. In such a case, the interaction resulting from step 5 is changed to a neutral. In step 7, adjustments for post- or pre-implementation interaction will be undertaken. Both types of interactions can either be weakly reinforcing or weakly mitigating. If there is such an interaction, the rating of the cell in the interaction matrix is changed accordingly. Positive pre-implementation is the case if the policy instruments are sequenced in the right order while a negative pre-implementation interaction is the case if this order is not followed.

6.1.2 Interaction analysis

This section presents the results of the interaction analysis of the policy instruments that have been applied in Germany to improve domestic cold appliance energy efficiency. All possible pairs of policy instruments respective sub-parts of policy instruments were analysed.[49] Table 6-1 presents the selected policy instruments and their sub-parts.[50]

Table 6-1: Selected policy instruments and their sub-parts

No.	Policy instrument	No.	Sub-parts
1	Minimum energy efficiency standard	**1**	No subparts
2	EU energy label	**2a**	"Old" EU energy label
		2b	"Revised" EU energy label
3	Rebate programmes	**3**	No subparts
4	Green tax	**4**	No subparts
5	"Initiative EnergieEffizienz"	**5a**	Motivation to consider energy efficiency related to domestic cold appliances
		5b	Information on energy efficient use
		5c	Information and education of retailers
6	Energy+	**6a**	Procurement of very energy efficient appliances
		6b	Information on very energy efficient appliances
7	Voluntary commitment on reducing energy consumption of domestic cold appliances	**7a**	Voluntary commitment
		7b	Information on energy efficient use

The matrix shows the final result of the interaction analysis. The interaction analysis was based on the general descriptions of the policy instruments in section 4.2.2 and the suggested approach by Boonekamp (2005) outlined in section 6.1.1 of this thesis. All interactions between possible pairs of policy instruments respective sub-parts of policy instruments are presented in the matrix (table 6-2).

[49] A more detailed overview over the different steps of the analysis and information used can be found in appendix IV.

[50] A more detailed description of the selected policy instruments can be found in section 4.2.2 of this thesis.

Table 6-2: Matrix resulting from the interaction analysis [Numbers in brackets: hypothetical rebate programme on the national level; Policy instrument no. 1: minimum energy efficiency standard]

Policy instrument		***1***									
Label (2)	(2a)	1	***2a***								
	(2b)	1	1	***2b***							
Rebate (3)[51]		0 (0)	0 (2)	0 (2)	***3***						
Green tax (4)		-1	1	1	0 (-1)	***4***					
DEnA (5)	(5a)	0	1	1	0 (1)	1	***5a***				
	(5b)	0	0	0	0 (0)	1	1	***5b***			
	(5c)	0	1	1	0 (2)	1	1	0	***5c***		
Energy+ (6)	(6a)	1	1	1	0 (2)	1	1	0	1	***6a***	
	(6b)	1	1	1	0 (2)	1	1	0	1	1	***6b***
Voluntary (7)	(7a)	0	0	1	0 (2)	1	1	0	1	1	1
	(7b)	0	0	0	0 (0)	1	1	-2	0	0	0

The ratings in the matrix stemming from the carried out interaction analysis can be split into four different groups. The features of these four groups are outlined in the following.

The first group includes mutually reinforcing pairs of complementary policy instruments (yellow coloured cells). These cells consist either of combinations of policy instruments of the categories "information" and "economic means" (3&2a, 3&2b, 3&5a, 3&5c, 3&6b, 4&2a, 4&2b, 4&5a, 4&5b, 4&5c, 4&6b, 4&7b) or of pairs of the same category (5a&2a, 5a&2b, 5a&5b, 5a&5c, 5a&6b, 5a&7b, 5c&2a, 5c&2b, 5c&6b). Furthermore, certain pairs of policy instruments of the categories "other policy instruments" and "information" respective "economic means" are also mutually reinforcing (3&6a, 4&6a, 5a&6a, 5c&6a, 6a&6b, 7a&3, 7a&4, 7a&5a, 7a&5c).

The second group includes one-sided reinforcing pairs where pre-implementation interaction is the case (light grey coloured cells). Pre-implementation interaction is the case where policy instruments have been introduced in the right chronological order, i.e. one policy instrument was preparing the ground for another policy instrument (1&2a, 1&2b, 1&6a, 1&6b, 2a&2b, 2a&6a, 2a&6b, 2b&6a, 2b&6b, 7a&2b, 7a&6a, 7a&6b).

The third group consists of neutral pairs of policy instruments (non-coloured cells). In such combinations one policy instrument is addressing the implementation while the other the utilisation of an energy saving option (5b&1, 5b&2a, 5b&2b, 5b&3, 5b&5c, 5b&6a, 5b&6b, 5b&7a, 7b&1, 7b&2a, 7b&2b, 7b&3, 7b&5c, 7b&6a, 7b&6b, 7b&7a). There are also non-overlaps in the energy efficiency classes addressed (1&3, 1&5a, 1&5c, 1&7a). Moreover, non-overlaps in time also lead to a neutral relationship (2a&7a).

Finally, the fourth group includes mutually mitigating combinations of policy instruments (dark grey coloured cells) with overlaps in the conditions addressed (1&4, 3&4, 7b&5b).

[51] For the case of rebate programmes, a national programme has never been implemented in Germany during the relevant period of time. Therefore, most of the combinations including a rebate programme are rated as neutral. The numbers in brackets represent the case of a regional respective a hypothetical national rebate programme.

6.1.3 Research hypothesises

The results of the interaction analysis carried out in section 6.1.2 are used for deriving research hypothesises on interactions between policy instruments on domestic cold appliance energy efficiency. Six general research hypothesises have been derived.

1. Combinations consisting of two complementary policy instruments including a rebate programme are strongly reinforcing.

2. Combinations consisting of two complementary policy instruments including a green tax are weakly reinforcing.

3. Combinations of two complementary policy instruments of the category information are weakly reinforcing.

4. Combinations of policy instruments that have been introduced in the right chronological order are weakly reinforcing.

5. Combinations of policy instruments addressing the implementation on the one side and the utilisation on the other side are neutral.

6. Combinations of policy instruments with overlaps in the conditions addressed and same characteristics are mitigating.

6.1.4 Pros and cons of the interaction analysis

In the following, the pros and cons associated with the suggested approach for analysing interactions between policy instruments on household energy efficiency are raised and briefly discussed.

The interaction matrix consists of seven steps that are relatively easy to carry out. Thus, the costs in terms of time and financial resources are relatively low when analysing interactions between policy instruments. The results provided by the analysis are more of a qualitative nature since they tell if there is either a strong, weak or no interaction within a combination of two policy instruments. However, the rating is relative, i.e. it says nothing about the absolute degree of interaction. Furthermore, the results of the analysis are a "snapshot" of the current situation. The suggested approach of an interaction analysis should not be considered as a methodology creating "pure" objective results since the analysis is relying on personal judgement in some of the steps. This could be the case when it comes to e.g. the characterisation of policy instruments and identification of conditions addressed. Due to this reason, the analysis should be carried out in a transparent way where the results stemming from the different steps can be followed. External experts could back up the underlying assumptions of the analysis with assessments. This would contribute in making the analysis more objective. Therefore, the suggested interaction analysis should be seen as an approach only giving a broad picture and idea about possible interactions in combinations of two policy instruments. However, the accuracy of the analysis improves with knowledge about the functioning of policy instruments and the underlying factors determining the quality and degree of interactions.

6.2 Stage 2: Lessons from practice

In this stage, "empirical evidence" stemming from a review of evaluation studies and expert interviews on interactions between the in section 4.2.2 selected and described policy instruments is collected and analysed. For this analysis, the selected policy instruments were considered as whole entities, i.e. they were not split-up into sub-parts as done for the interaction analysis in section 6.1 of this thesis. The results of the expert interviews on interactions between policy instruments are summarised in an interaction matrix (table 6.3) similar to that in section 6.1.2 of this thesis. Furthermore, experts were ask to assess and discuss hypothesises on interactions between policy instruments. Finally, the pros and cons of the "empirical" approach are discussed.

6.2.1 Review of policy evaluation studies

The review carried out in section 5.2 of this thesis was repeated and focused on finding support on interactions between policy instruments on domestic cold appliance energy efficiency. This was done in order to gain an understanding to what degree interactions between policy instruments are an issue in policy evaluation studies. In general, interactions between policy instruments were not a main subject in the reviewed policy evaluation studies. Interaction related statements in policy evaluation studies are relatively rare and in all cases of a qualitative nature. None of the evaluation studies made an attempt to quantify the degree of interaction between policy instruments.

EU energy label

The evaluation of the EU energy label in Germany carried out by Schlomann et al. (2001) sees a reinforcing relationship between the label and information campaigns targeting retailers as well as consumers. Firstly, information campaigns contribute in motivating retailers to properly label the appliances and to use the EU energy label as a marketing tool. This could increase the effectiveness of the EU energy label due to a higher compliance by retailers. Secondly, broad information campaigns providing consumers with knowledge on the meaning of the EU energy label and motivation to consider energy efficiency could also contribute to a higher compliance of retailers. This would be due to the increased demand for energy efficient appliances. Schlomann et al. (2001) recommend implementing such information campaigns simultaneously in order to optimise synergies between the different types of information campaigns. Moreover, rebate programmes for very energy efficient appliances are proposed. However, they are perceived to be too expensive in terms of costs per reduced ton CO_2. Instead, a special label for very energy efficient appliances as an information and motivation measure for consumers and retailers is suggested. This would also stimulate innovation by the manufacturers.

Rebate programmes

Thomas (1995) regards information activities related to a rebate programme as crucial for enhancing its effectiveness in terms of a higher participation rate. The Danish experience shows that a rebate programme combined with information measures could be very effective in raising the market share of very energy efficient appliances (Karbo, 2000).[52] Wuppertal Institute (1995) claims that rebate programmes could contribute in making a minimum energy

[52] Success factors were that several activities including a large information campaign on the national level (including TV-spots) supported by retailers, manufacturers and utilities was carried out, a website containing a list with "A" labelled appliances was made available as well as involvement of retailers in advance to the campaign was taking place.

efficiency standard more effective. This is due to the reason that rebate programmes accelerate the transformation of the market towards more energy efficient appliances. In turn, this allows an earlier revision of the minimum energy efficiency standard.

Green tax

Jänicke et al. (1998) investigate the Danish case and state that a green tax alone is not sufficient for improving energy efficiency of domestic cold appliances. Manufacturers see the tax as a necessary but not sufficient condition for the diffusion of energy efficient appliances and innovation. Other policy instruments like the EU energy label, information campaigns targeting consumers and retailers or a minimum energy efficiency standard were also necessary for enhancing the effect of the green tax (Jänicke et al., 1998).

"Initiative EnergieEffizienz"

Agricola and Ahrens (2005) show that the "Initiative EnergieEffizienz" contributed in raising the awareness towards the EU energy label. Moreover, the campaign contributed in convincing retailers of the label's importance. Thus, a reinforcing interaction is seen between the label and the "Initiative EnergieEffizienz" targeting both consumers and retailers. Furthermore, Agricola and Ahrens (2005) state that the design of the "Initiative EnergieEffizienz" was based on experience gained from previous activities in the field of household energy efficiency. Such activities include rebate programmes of the electric utilities in the 1990s or carried out information campaigns. Thus, there is the case of pre-implementation interaction between the "Initiative EnergieEffizienz" and earlier activities.

Energy+

The literature on energy+ claims that there might be interactions with other policy instruments (ADEME, 2001; SenterNovem, 2005; Thomas et al., 2003). A possible interaction could be synergies with rebate programmes for energy+ appliances. The price for most energy+ appliances is higher than the average price for domestic cold appliances. Brand, design, price, size, convenience or other features are often higher valued in the purchasing decision by consumers than energy consumption (SenterNovem, 2005). In this regard, a rebate programme would reinforce the effect of energy+ since potential buyers would now have an additional stimulus (financial incentive) to consider energy efficiency and to purchase energy+ appliances. This would attract manufacturers and retailers to offer more energy+ appliances. Dutch experience shows that a rebate programme could lead to a faster market transformation process and a higher penetration of energy+ appliances. The share of A+ and A++ appliances already reached 14% in 2003 and 21% in 2004 that is much higher than the EU average (SenterNovem, 2005). When it comes to possible interactions with the "revised" EU energy label, it is not clear what the effect of the upcoming revision respective that of energy+ was (SenterNovem, 2005). It is claimed that energy+ provided a neutral platform to collect and disseminate data on very energy efficient cold appliances. Therefore, the standard setting process for the "revised" EU energy label was indirectly influenced by energy+ and facilitated the adoption (SenterNovem, 2005). This could be regarded as positive pre-implementation interaction.

Voluntary Commitment by the manufacturers

In CECED (2004a), it is stated that the fulfilment of the fleet target of the voluntary commitment is also dependent on the investment decision taken by the consumers. Therefore, CECED calls for implementing supporting policy instruments that aim at influencing the investment decision of consumers.

6.2.2 Expert interviews

Expert interviews were conducted in order to analyse interactions between the selected policy instruments.[53] This section presents the results from the expert interviews. Based on the general findings from the interviews, an interaction matrix was developed. The analysis of the interviews only delivers a general overview on the answers that were given by majority of the interviewees. If there were significant differences in the assessments of the interviewed experts, the different points of view are presented.

Interactions between selected policy instruments

Experts were asked to assess selected interactions between pairs of policy instruments and to briefly motivate their answer.[54] In the following, a general overview over the results of the interviews is presented and discussed.

Reinforcing combinations

In general, a reinforcing relationship is seen between complementary policy instruments. The combination of policy instruments raising the consumers' awareness and/or providing social motivation on the one hand with policy instruments offering financial motivation to invest in the energy saving option on the other hand is regarded as stimulative. Complementary combinations of policy instruments strongly encourage consumers to make a decision in favour of an energy efficient appliance or to use such an appliance properly. When it came to rebate programmes, experts were asked to assume the existence of a rebate programme such as they were carried out by the German electric utilities in the 1990s or in the Netherlands. Most experts rated the combinations of the EU energy label and a hypothetical rebate programme, as well as energy+ and a hypothetical rebate programme as strongly reinforcing. This was justified with the fact that a rebate programme would enhance the relevance of the classification of the EU energy label. Most experts named the Dutch experience with a rebate programme on the national level as an example. The combination of a hypothetical rebate programme and the "Initiative EnergieEffizienz" is seen as weakly reinforcing by most experts. Reasons for such a rating are that the "Initiative EnergieEffizienz" is perceived to have only a low impact and to give too broad information that is difficult to connect to a rebate programme. However, when looking at the recent situation with (almost) no rebate programmes in Germany, experts were rating the interaction with other policy instruments as neutral in general.

Combinations of complementary policy instruments including the green tax are perceived to be weakly reinforcing. The experts agree that the link between the green tax and another policy instrument like the EU energy label is not evident for many consumers.

There are also combinations of policy instruments of the same category that are seen as reinforcing. Especially the combination of the "Initiative EnergieEffizienz" and the EU energy label is regarded as strongly reinforcing by some experts. This is due to the fact that the EU energy label helps to apply the energy efficiency related knowledge provided by the "Initiative EnergieEffizienz" when making an investment decision. Furthermore, combinations including the voluntary commitment are seen as weakly reinforcing. This is explained with the fact that other policy instruments solely targeting the investment decision like the EU

[53] The methodology applied for carrying out the expert interviews is described in section 2.2 of this thesis. A template of the interview guideline can be found in appendix II.

[54] Experts had the opportunity to rate selected pairs of policy instruments similar to the approach chosen in section 6.1. See the interview guideline in appendix II for details.

energy label, the minimum energy efficiency standard or rebate programmes prepared the ground for the voluntary commitment. The same is seen for the EU energy label and the minimum energy efficiency standard. Another weakly reinforcing relationship is seen between the green tax and a hypothetical rebate programme. According to this view, a green tax brings the issue of electricity costs on the agenda and raises the consumers' motivation towards considering energy efficiency by making them calculating their energy costs. Based on that, rebates give direct financial motivation for an investment in a certain energy saving option.

Mitigating combinations

In general, the experts see no mitigating combinations of policy instruments. However, it is stated that a non-dynamic design of policy instruments like an energy label or a rebate programme could lead to mitigating combinations of policy instruments. This could be the case if an energy label is not revised as a consequence of the implementation of a minimum energy efficiency standard or voluntary agreement.

Neutral combinations

In general, neutral combinations were seen between policy instruments targeting the implementation on the one side and policy instruments aiming at the proper use on the other side. Furthermore, combinations were rated as neutral if the impact of a policy instrument was perceived to be weak. Some experts stated that a weak policy instruments makes the assessment of interactions with other policy instruments difficult. Neutral combinations were mostly seen between the minimum energy efficiency standard and policy instruments like the "Initiative EnergieEffizienz" or energy+. This was explained with the fact that these policy instruments target different energy efficiency classes. Furthermore, some combinations including the green tax were regarded as neutral because the experts were not able to identify any relationship between the two policy instruments.

Simplified interaction matrix

The generalised findings from the expert interviews are summarised with the help of a simplified interaction matrix (table 6-3).

Table 6-3: Simplified interaction matrix (numbers in brackets: hypothetical rebate programme; Source: expert interviews carried out by the author)

Policy instrument		***Standard 1***						
Label (2)	(2a) "old"	1	***2a***					
	(2b) "revised"	1	1	***2b***				
Rebate (3)		0 (0)	0 (2)	0 (2)	***3***			
Green tax (4)		0	1	1	0 (1)	***4***		
DEnA (5)		0	1-2	1-2	0 (1)	1	***5***	
Energy+ (6)		0	1	1-2	0 (2)	1	0	***6***
Voluntary (7)		1	1	1	1 (0)	0	1	1

6.2.3 Hypothesises on policy interaction

The experts were asked to consider and assess six selected hypothesises on interactions between policy instruments which were derived from a literature review of relevant evaluation studies and reports on policy instruments. The findings are presented and discussed in this section.

Firstly, the experts were confronted with the hypothesis that "labels and information campaigns on energy efficient appliances are mitigating each other". The intention behind this hypothesis was to test if the experts regard one channel for distributing information on energy efficient appliances as sufficient. There is consensus among the experts that a combination of an energy label and information campaigns on energy efficient domestic cold appliances is not mitigating. The experts agree that there are positive synergies between both types of information instead. Furthermore, an information campaign is needed in order to promote the label and to raise the consumers' awareness towards energy efficiency as stated by the experts. Therefore, the hypothesis is reformulated:

1. *An energy label and information campaigns on energy efficient appliances are reinforcing.*

Secondly, the experts were asked to assess the hypothesis "the effect of procurement programmes such as energy+ can be enhanced with a rebate programme and information on energy efficient appliances". The intention behind this hypothesis was to find out if the effectiveness of a policy instrument like energy+ could be improved with the help of additional policy instruments. In general the experts agree with this hypothesis. However, most experts state that such a mix of policy instruments is unrealistic for the case of Germany. One group of experts says that it is unlike to implement a national rebate programme due to financing issues. Another group of experts sees energy+ as not a suitable policy instrument for domestic cold appliance energy efficiency. However, policy instruments like energy+ could be suitable for other fields of application like office equipment as stated by one expert. Therefore, the hypothesis is kept unchanged:

2. *The effect of procurement programmes such as energy+ can be enhanced through a rebate programme and information on energy efficient appliances.*

Thirdly, the hypothesis "the effect of an energy label, information and education of retailers can be enhanced through a rebate programme" was tested. This hypothesis was used to examine if the experts agree that economic means and information are complementary policy instruments. There is consensus among the experts that the combination of a rebate programme and information is reinforcing in general. Information and financial incentives are perceived to be complementary policy instruments by most experts. However, some experts stated that the degree of interaction depends much on the design of both policy instruments. For instance, failures in the design of an information campaign (e.g. chosen distribution channels or target group) could reduce the degree of interaction as several experts claim. Therefore, the hypothesis is formulated as follows:

3. *Complementary policy instruments of the categories information and economic means are reinforcing.*

Furthermore, the experts were asked to assess the hypothesis "rebate programmes are the best information programmes". The intention behind this hypothesis was to test if rebate programmes are perceived to be able to deliver information on energy efficient domestic cold appliances. All experts disagree with this hypothesis. Information is regarded as a necessary framework for a rebate programme. This means that information is needed for e.g.

promoting a rebate programme, raising the consumers' awareness and motivating them to consider energy efficiency. Therefore, the hypothesis is reformulated as follows:

4. *Rebate programmes are dependent on information campaigns for reaching their full effect.*

Fifthly, the experts were confronted with the hypothesis "the effect of information, labels or education of retailers can be enhanced with the help of a green tax". The experts' attitude towards the green tax and information as complementary policy instruments was tested with the help of this hypothesis. The experts are disagreeing in their assessment. Some experts see a reinforcing relationship while others see no relationship at all. In general, experts motivate their disapproval with the fact that the green tax is to too broad and only of a low relevance. Experts who approve this hypothesis state that additional policy instruments could communicate the effect of the green tax that raises the effectiveness of the tax. Due to the disagreement among the experts, this hypothesis is dropped.

Finally, the hypothesis "the effect of voluntary commitments by manufacturers can be enhanced if they are combined with other policy instruments such as rebate programmes or information campaigns" was posed to the experts. This hypothesis was used to test if the experts see possibilities for a reinforcing relationship between a voluntary commitment and policy instruments of the categories information or economic means. Most experts agree with this hypothesis but state that it depends much on the design of the voluntary commitment. The reinforcing relationship gets stronger if there is a fleet target according to the view of some experts. On the other hand, there is no relationship at all if the voluntary commitment is not very ambitious in terms of the threshold for phasing out appliances or the fleet target. Therefore, the hypothesis is reformulated as follows:

5. *Realising an ambitious fleet target becomes possible if there are additional policy instruments aiming at transforming the market towards more energy efficient appliances.*

Additional to the six hypothesises discussed above; the following hypothesises on the proper timing or sequencing of policy instruments were emerging during the expert interviews.

6. *An energy label, information campaigns and rebate programmes prepare the ground for an effective minimum energy efficiency standard or voluntary commitment.*

7. *A minimum energy efficiency standard or voluntary commitment makes the revision of policy instruments like an energy label, information campaigns or rebate programmes necessary and, thus, enhances the effectiveness of such policy instruments.*

6.2.4 Pros and cons of the "empirical" approach

This section briefly discusses the pros and cons of the empirical approach chosen for investigating interactions between policy instruments on energy efficiency of domestic cold appliances in Germany. Furthermore, the "empirical" approach is compared with the approach applied for analysing interactions in section 6.1 of this thesis.

In general, in-depth expert interviews based on an interview guideline could be used for exploring areas of research which have not been much investigated yet or where a general theory is missing (Mayring, 1996). By applying such an "empirical" approach it becomes possible to verify existing hypothesises and to develop new hypothesises for the relevant field of research. In this thesis, expert interviews have been used to explore the case of interactions between selected policy instruments on domestic cold appliance energy efficiency. Further-

more, the approach was chosen in order to verify the findings from the interaction analysis carried out in stage 1. Compared to the interaction analysis, expert interviews provide results which are more objective. This means that the results are based on assessments from different point of views. Moreover, the "empirical" approach allows exploring issues which are outside the framework of the interaction analysis.

However, there are also some critical issues connected to expert interviews (Mayring, 1996). Experts might only give general and broad answers during the interview. In turn, this hinders a deeper analysis of the topic. Furthermore, experts might also disagree in their answers. This could make the analysis difficult to carry out and sometimes impossible to derive general conclusion. Another critical issue could be that the experts might explain things how they should be from their point of view instead of describing how they actually are. Therefore, the findings and conclusions derived from the expert interviews should always be seen with a critical mindset. Compared to the interaction analysis, the costs of carrying out expert interviews are significantly higher. This makes applying the methodology of expert interviews difficult in policy evaluation studies with a limited budget.

6.3 Stage 3: Verification of the interaction analysis

This section compares the results of the interaction analysis with the general findings stemming from the expert interviews and the review of relevant evaluation studies. For this purpose, similarities and differences are identified and discussed. Finally, suggestions for modifying the interaction analysis are given.

6.3.1 Comparison of the results from stage 1 and stage 2

In order to identify similarities and differences between the two stages, the research hypothesises from stage 1 and hypothesises stemming from stage 2 are compared. Furthermore, the interaction matrix from stage 1 (table 6-1) and the interaction matrix from stage 2 (table 6-3) are considered for this comparison.

Similarities

In general, the findings of the "empirical approach" confirm the results of the interaction analysis. Due to this reason, none of the research hypothesises which were developed during stage 1 was dropped. Furthermore, most of the experts were using a similar reasoning for explaining the ratings of the different interactions as it was used for the interaction analysis.

Differences

The results are differing when it comes to mitigating combinations in the interaction matrix. The combination of a rebate programme and a green tax is rated as mitigating by the interaction analysis since both policy instruments address the condition financial motivation. However, the experts see a reinforcing relationship since the green tax primarily contributes in raising the motivation to consider energy efficiency by bringing the issue of energy costs on the agenda while the rebate programme mainly addresses the awareness towards and the motivation to invest in certain energy saving options. The reinforcing interaction can be made even stronger if the revenues from the green tax are earmarked for financing the rebate programme. However, a number of experts see the green tax as too broad and only of a low relevance that makes assessing such combinations difficult.

Differences can also be found when it comes to the rating of the degree of interaction between policy instruments of the category information. For some cases, the experts were even seeing a strongly reinforcing interaction (e.g. "Initiative EnergieEffizienz" and EU energy label) while the theoretical analysis shows a weakly reinforcing interaction. The experts were explaining this rating with the fact that they perceive both policy instruments as very suitable for improving domestic cold appliance energy efficiency. Further differences between the findings of the theoretical analysis and the "empirical" approach can be explained with the fact that the experts see no or only a very weak interaction in combinations with policy instruments of a low relevance for improving domestic cold appliance energy efficiency. Experts were rating combinations including at least one policy instrument that they perceived to be of a low relevance as neutral (e.g. minimum energy efficiency standard and green tax or "Initiative EnergieEffizienz" and green tax). Thus, the relevance of a policy instrument for realising energy savings seems to be an important factor for determining the degree of interaction in a combination of two policy instruments.

6.3.2 Suggestions for modifications of the interaction analysis

The chosen approach for analysing interactions between policy instruments on household energy efficiency in stage 1 has created results that correspond to the findings from the expert interviews in most parts. Most of the interviewed experts stated that a combination including a rather irrelevant policy instrument could weaken the degree of interaction. Therefore, the relevance of the policy instruments should be considered in the interaction analysis. For determining the degree of relevance, comparisons of the policy instrument's design with the design of similar policy instruments, a review of evaluation studies or expert assessments are suggested. Reinforcing or mitigating combinations including a policy instrument of a low relevance are suggested to be weakened by "1".

6.4 Main findings

In the following, the main findings on interactions between the selected policy instruments on domestic cold appliance energy efficiency are briefly summarised and reflected.

The policy space for policy instruments on domestic cold appliance energy efficiency in Germany seems to be filled out in a way that eases to realise synergies. The findings stemming from the interaction analysis and the expert interviews show that there is a weakly reinforcing interaction between most pairs of policy instruments. For some combinations, a neutral relationship is found while a mitigating interaction seems to be rarely the case. However, due to the absence of an effective rebate programme in Germany, the potential for strongly reinforcing interactions in this field of application is not realised. Furthermore, not all potentials for reinforcing interactions are fully taken advantage of. This is due to shortcomings in the design and implementation of certain policy instruments. However, besides these shortcomings, the chosen mix of policy instruments seems to be a good example for a package of policy instruments on residential electric appliance energy efficiency.

The EU energy label that is differentiating the market into segments according to the feature energy efficiency sets the framework for domestic cold appliance energy efficiency policy. The EU energy label prepares the ground and facilitates the adoption of further policy instruments on energy efficiency. Moreover, it enhances the effectiveness of other policy instruments that are implemented simultaneously or at a later point of time.

For targeting the upper segment of the market, several types of policy instruments are available. In general, all relevant actors for the upper market segment have to be targeted in order to transform the market towards a higher share of energy efficient appliances. In practice, this means that the supply of energy efficient domestic cold appliances is stimulated by setting incentives for manufacturers to bring forward very energy efficient appliances and for retailers to promote such appliances. Raising the consumers' awareness towards such saving options and providing motivation to consider energy saving options stimulate the demand for energy efficient appliances. "Pull" policy instruments for the upper segment of the market mainly include different types of information that are providing knowledge about energy efficiency, raising awareness towards energy saving options and motivation to consider energy efficiency. These policy instruments contribute in accelerating the market transformation process. In order to enhance the effect of information, different distribution channels like e.g. information campaigns, labels, databases or retailers can be used. The green tax is the only "pull" policy instrument falling into the category economic means in Germany. Nevertheless, the green tax does not seem to be an as important policy instrument for realising synergies as rebate programmes are perceived to be. This is mainly due to the fact that the relation to other policy instruments is missing. Furthermore, it is difficult for consumers to link the green tax to domestic cold appliances because of its broad design. However, the policy instrument is regarded as contributing in raising the awareness towards the costs of electricity consumption. Therefore, the green tax might indirectly contribute in raising the effectiveness of other policy instruments like the EU energy label or information campaigns that are directly targeting domestic cold appliances. Furthermore, combinations of "pull" policy instruments including policy instruments of the type energy+ or rebate programmes targeting very energy efficient appliances could also significantly contribute in transforming the market. However, their potential is currently not utilised for the case of domestic cold appliances in Germany. This is mainly due to considerations related to the costs of rebate programmes and difficulties in implementing a policy instrument like energy+ for targeting domestic cold appliances.

"Push" policy instruments like a minimum energy efficiency standard or a voluntary commitment by the manufacturers are follow-up policy instruments which contribute in taking the least energy efficient appliances from the market. The EU energy label and "pull" policy instruments prepare the ground for such policy instruments. In turn, the implementation of "push" policy instruments usually makes the revision of "pull" or preparatory policy instruments necessary which again enhances their effectiveness. Thus, the proper chronological order of policy instruments contributes in realising synergies. However, such synergies can only be realised if the policy makers foresee a revision. Therefore, such policy instruments have to be designed in a way that allows revising them if necessary. Furthermore, the general development of the market also makes a revision of most policy instruments necessary from time to time.

7. Conclusions and recommendations

Main conclusions drawn from the analysis of policy instruments on domestic cold appliance energy efficiency in Germany are presented in this chapter. The conclusions are structured in summary answers to the research questions. Additionally, general implications and recommendations for the design of policy instruments on household energy efficiency and their evaluation are briefly raised. Finally, possible areas for further research are outlined and some concluding remarks made.

7.1 Revisiting the research questions

In the following, the research questions are revisited and attempt to answer them is given.

Research question 1: What can be learnt from evaluation studies and expert assessments about the "functioning" of selected policy instruments on domestic cold appliance energy efficiency?

The findings show that the EU energy label is the most important policy instrument for domestic cold appliance energy efficiency in Germany. The label categorised the market for domestic cold appliances according to energy efficiency, made energy consumption of such appliances visible and enhanced the diffusion of energy efficient appliances. Furthermore, the label acts on consumers (stimulates demand for energy efficiency), retailers (provides an additional sales argument) and manufacturers (leads to competition for energy efficiency). Finally, the EU energy label can be seen as a simple and relatively inexpensive policy instrument on domestic cold appliance energy efficiency. Pitfalls can be found in the facts that compliance of the retailers in some distribution channels in terms of proper labelling is lacking and that the revision process failed to rebase the energy efficiency classes of the label.

Rebate programmes can be successful in supporting the market transformation towards a higher share of energy efficient domestic appliances as experience shows. However, this policy instrument is not applied on a large scale in Germany and its implementation is very unlikely in the short and mid-term. Rebates act on the consumers since they provide a financial incentive to invest in a certain energy saving option. This creates a higher demand for domestic cold appliances qualified for the rebate that makes retailers to change their product ranges accordingly and manufacturers to supply eligible appliances. Marketing and information activities related to the rebate programme can ensure a high participation rate. However, rebate programmes are perceived to be a relatively costly policy instrument for improving domestic cold appliance energy efficiency. Additional critical issues can be uncertainties about the share of free-riders, the treatment of the replaced appliances and the fact that rebate programmes might create wrong associations among consumers towards very energy efficient domestic cold appliances, i.e. consumers might get the feeling that energy efficiency does not make sense from an economic point of view.

A minimum energy efficiency standard and a voluntary commitment are regarded to be substitutes. Both policy instruments aim at taking the least energy efficient domestic cold appliances from the market and contribute in simplifying domestic cold appliance energy- efficiency policy and reducing the information requirements for consumers. Furthermore, a voluntary commitment allows addressing the upper segment of the market while a standard is restricted to solely the lower segment. Country specific differences can also be taken into account with a voluntary commitment while a minimum energy efficiency standard is applied

all over Europe. However, the impact of both policy instruments depends on how ambitious the set threshold on minimum energy efficiency requirements is. For instance, the market in Germany already anticipated the minimum energy efficiency standard as it was implemented. The threat of regulation contributes in making a voluntary commitment more effective as the experience shows. Furthermore, both policy instruments need proper monitoring and enforcement in order to have a full impact.

Information campaigns like the example of the "Initiative EnergieEffizienz" in Germany can contribute in raising the consumers' awareness towards energy saving options and provide motivation to realise such options in the long term. Furthermore, this policy instrument also allows targeting consumers indirectly via multipliers for information. Such multipliers could be retailers of domestic cold appliances that are motivated and educated to use energy efficiency as an additional sales argument. However, the effect of an information campaign like the "Initiative EnergieEffizienz" depends much on the visibility, the design and chosen target groups. Furthermore, significant effects of an information campaign can only be observed after a longer period of time in most cases.

The energy+ project was aiming at bringing very energy efficient domestic cold appliances with the help of the cooperative procurement approach forward. Furthermore, it contributed in preparing the domestic cold appliances market for a revision of the EU energy label. For this purpose, incentives on the demand (lower appliance price due to cooperative procurement) and supply side (marketing tools for very energy efficient appliances) of domestic cold appliances were set. However, it was not possible to organise buyer groups for domestic cold appliances due to the decentralised structure of the demand side in Germany. The lessons of the energy+ project show that cooperative procurement of very energy efficient domestic cold appliances is not practicable in countries such as Germany. Nevertheless, it showed that activities of a motivating characteristic targeting the supply side could contribute in bringing very energy efficient domestic cold appliances forward.

A green tax targeting the residential electricity consumption addresses both the investment decision and proper utilisation of an energy saving option. As the German example of a green tax shows has such a tax the ability to make consumers to consider electricity costs by setting financial incentives. Furthermore, this contributes in bringing the issue of energy efficiency on the public agenda. However, a green tax is not perceived to be an appropriate policy instrument for the case of domestic cold appliance energy efficiency since the tax is regarded to be too broad. This increases the difficulties for the consumers to link the tax with an investment decision in favour of an energy efficient domestic cold appliance.

Research question 2: What can be learnt from theory and practice about interactions between selected policy instruments on domestic cold appliance energy efficiency?

In general, the policy space for policy instruments on domestic cold appliance energy efficiency in Germany seems to be filled out in a way that facilitates realising synergies. Most investigated pairs of policy instruments show a reinforcing relationship. For a few combinations a neutral relationship was found while a mitigating relationship seems to be hardly ever the case. Therefore, the chosen mix of policy instruments seems to be a good example for a package of policy instruments on domestic appliance energy efficiency.

The findings on interactions between the selected policy instruments show that the EU energy label sets the framework for policy instruments on domestic cold appliance energy efficiency by preparing the ground in terms of categorising the market according to energy consumption. This eases the adoption of further policy instruments and allows realising syner-

gies. The "Initiative EnergieEffizienz", rebate programmes and motivating measures also addressing the supply side like energy+ are policy instruments for targeting the upper market segment with very energy efficient domestic cold appliances. Furthermore, the green tax can also have an impact on this segment of the market. In general, it was found that combinations of policy instruments targeting the upper segment of the market as well as the EU energy label are complementary policy instruments and reinforcing. Weakly reinforcing interactions are the case for pairs of policy instruments not belonging to the category economic means. Therefore, a strongly reinforcing interaction can be realised in combinations including a rebate programme. Nevertheless, pairs of policy instruments consisting of a green tax are found to be weakly reinforcing respective neutral since the green tax is seen as a policy instrument which is difficult to link to the case of domestic cold appliances. The EU energy label and policy instruments targeting the upper market segment prepare the ground for a minimum energy efficiency standard or a voluntary agreement. In turn, a voluntary commitment or a minimum energy efficiency standard makes the revision of such "preparatory" policy instruments necessary. Such a revision enhances the effectiveness of preparatory policy instruments. It was found that the right chronological order of policy instruments over time allows realising weakly reinforcing interactions.

Neutral relationships were found in combinations of policy instruments addressing the implementation on the one side and the utilisation of domestic cold appliances on the other side. Furthermore, combinations consisting of a policy instrument with a relatively low relevance, of different energy efficiency classes or with non-overlaps in time are also seen as neutral. For instance, combinations consisting of a rebate programme for very energy efficient domestic cold appliances are found to be neutral due to the fact that a rebate programme is not implemented on the national level in Germany.

7.2 Implications and recommendations for the design of policy instruments and policy evaluation

This section briefly shows the implications of the main findings of this research and gives recommendations for the design of policy instruments on household energy efficiency and their evaluation.

Design of policy instruments on household energy efficiency

In order to enhance the effectiveness of the EU energy label, it is suggested to provide retailers with motivation to comply with the label. Furthermore, a rebasing of the energy efficiency classes may contribute in making the label more comprehensive for consumers. The revision process could be carried out periodically and as a follow-up to the introduction of a minimum energy efficiency standard or voluntary agreement.

Making only very energy efficient appliances eligible for a rebate and linking the proper scrapping to the payment might improve the effectiveness of a rebate programme. Moreover, rebate programmes have to be integrated into information campaigns for increasing the participation rate.

In order to improve the effectiveness of a minimum energy efficiency standard, standards could be designed in a way which allows a periodically revision. Voluntary commitments could be made effective if an ambitious target is set and participants are complying. Compliance might be achieved by showing that the alternative in case of non-compliance would be regulation.

Effective information campaigns on household energy efficiency need a clear focus and a comprehensive message that is easy to follow by the target group. Furthermore, such campaigns have to be carried out over a longer period of time in order to achieve effectiveness.

Policy instruments of the type energy+ (a cooperative procurement element is included) could be made more effective if the demand side is bundled with the help of support organisations like consumers counselling centres or environmental NGOs.

The effect of a green tax could be enhanced if the tax rate is significant for the consumers and continuously increased. In order to increase the acceptance of a green tax, the revenues could be earmarked for measures targeting household energy efficiency.

In general, it is proposed to design policy instruments or packages of policy instruments in a way which allows realising synergies with other policy instruments. This might be achieved by a flexible and dynamic design as well as integration into the goals and objectives of already existing policy instruments. For instance, the introduction of a well-designed rebate programme targeting very energy efficient household appliances in Germany would allow realising strong synergies with other policy instruments like the EU energy label or information campaigns. Furthermore, the implementation of policy instruments targeting the supply side of domestic household appliances additional to policy instruments targeting the demand side may also contribute in accelerating the market transformation. However, the design and implementation of individual policy instruments or packages of policy instruments is constrained by the political reality in many cases.

Evaluation of policy instruments

Policy evaluation is crucial in order to learn more about the functioning of policy instruments on household energy efficiency. An improved understanding of the functioning eases designing and implementing effective policy instruments. Furthermore, understanding how combinations of different policy instruments addressing the same field of application interact with each other could enable policymakers to design sound packages of policy instruments. Therefore, it is suggested to foresee the evaluation of policy instruments before and after a new policy instrument is implemented. Moreover, it is proposed to design policy instruments in a way that facilitates their evaluation. For instance, this could be continuous monitoring of certain indicators or mandatory provision of relevant data by the different actors.

7.3 Concluding remarks

The functioning of individual policy instruments on household energy efficiency and interactions between such policy instruments influence the costs and effectiveness of policy instruments. However, especially the understanding of interactions between policy instruments is still an unexplored field and very seldom raised in policy evaluation studies. Furthermore, there are difficulties in applying methods in order to investigate interactions. For instance, there is hardly any evidence in evaluation studies about interactions, experts are having contradicting opinions when it comes to assessing interactions or the method for mapping interactions as suggested by Boonekamp (2005) could be influenced by personal judgement.

Therefore, further research is needed in order to facilitate the introduction of packages of policy instruments that allow realising synergies or reaching an energy saving target as set by e.g. the proposed EU directive on energy end-use efficiency and energy services in a cost minimising way.

In order to gain a deeper understanding of the functioning of policy instruments on household energy efficiency, it might be interesting to investigate factors influencing the retailers to use energy efficiency as an argument during the sales talk. Furthermore, a detailed investigation of the mechanisms influencing the investment decision of a consumer could also provide results that facilitate designing policy instruments like information campaigns on household energy efficiency. In order to deepen the knowledge on interactions between policy instruments on household energy efficiency, it would be interesting to further investigate mechanisms and factors that cause interactions between policy instruments. Based on that, next steps could be to explore which combinations of policy instruments will show strong interaction and which combination will hardly show any interaction. A further question related to that could be to investigate what factors and mechanisms will cause a weak interaction to become a strong interaction. Such research could for instance be based on case studies of different regions and countries with dissimilar combinations of policy instruments. Furthermore, comparing different fields of application could also be an approach for investigating the above outlined fields of research.

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Abbreviations

BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
BMWA	Bundesministerium für Wirtschaft und Arbeit
DEnA	Deutsche Energie Agentur
CECED	European Committee of Manufacturers of Domestic Equipment
CO_2	Carbon dioxide
DM	Deutsche Mark
DSM	Demand side management
EEI	Energy Efficiency Index
EC	European Commission
EU	European Union
GDP	Gross Domestic Product
GWh	Gigawatt hours
IEA	International Energy Agency
KWh	Kilowatt hours
LCP	Least cost planning
MWh	Mega watt hours
NGO	Non-governmental organisation
RD&D	Research, Development and Demonstration
STAWAG	Stadtwerke Aachen
TWh	Terawatt hours
UK	United Kingdom
ZVEI	Hausgeräte-Fachverbände im Zentralverband Elektrotechnik- und Elektronikindustrie e.V.

Appendix I: List of interviewed experts

Table A-1: List of interviewed experts

Name	Position	Organisation	Type and date of interview
Agricola, Annegret-Cl.	Head of Division energy efficiency in the electricity sector	Deutsche Energie – Agentur GmbH (DEnA) [German Energy Agency GmbH]	Personal interview 2005-07-13
Barthel, Dr. Claus	Senior Research Fellow Research Group "Future Energy and Mobility Structures"	Wuppertal Institute for Climate, Environment and Energy	Personal interview 2005-07-11
Bertoldi, Dr. Paolo	Principal Administrative Officer Renewable Energies Unit (RE) Institute for Environment and Sustainability (IES)	European Commission Directorat General Joint Research Centre (DG JRE)	Telephone interview 2005-07-11
Krawinkel, Dr. Holger	Head of Department Housing, Energy and Environment	Verbraucherzentrale Bundesverband (VzBv) [Federation of German Consumer Organisations]	Personal interview 2005-07-22
Leffler, Dr. Norbert	Principal Administrative Officer Division IX C 6 – Special questions related to the rational use of energy and energy efficiency	Bundesministerium für Wirtschaft und Arbeit (BMWA), [Federal Ministry of Economy and Labour]	Personal interview 2005-07-21
Meli, Luigi	Director General	European Committee of Manufacturers of Domestic Equipment (CECED)	Personal interview 2005-07-12
Mordziol, Christoph	Principal Administrative Officer Section 14.4 Rational Energy Use	Umweltbundesamt (Uba) [Federal Environmental Agency]	Personal interview 2005-07-21
Ostertag, Dr. Katrin	Researcher, Project coordinator Division Sustainability and Infrastructures	Fraunhofer Institute Systems and Innovation Research	Personal interview 2005-07-18
Schlegelmilch, Kai	Principal Administrative Officer Division Z III 6 – Climate Protection Programme of the Federal Government, Environment and Energy	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) [Federal Ministry for the Environment, Nature Conservation and Nuclear Safety]	Personal interview 2005-07-21
Schlomann, Barbara	Senior Scientist Division Energy Technology and Energy Policy	Fraunhofer Institute Systems and Innovation Research	Personal interview 2005-07-18
Thomas, Stefan	Director of the Research Group "Energy, Transport and Climate policy"	Wuppertal Institute for Climate, Environment and Energy	Personal interview 2005-07-15
Waide, Dr. Paul	Senior Policy Analyst Division Energy efficiency and Environment	International Energy Agency/Long-term co-operation and Policy Analysis Office (IEA/LTO)	Telephone interview 2005-07-26

Appendix II: Expert interviews

Letter of Confirmation

#

Our appointment for an interview at # – Interactions between policy instruments

Dear #,

thank you very much for your interest in an interview for my Masters thesis. In response to our conversation of June #, I confirm the arranged appointment for an interview at **#, #**. I will call / visit you at that time.

What is it about?

The proposed EU directive on energy end-use efficiency foresees that member states have to realise additional energy savings of about 1% (1.5% for the public sector) compared to the general trend. Further, these energy savings have to be proven to the European Commission.

In order to be able to prove the success and to identify the contribution of certain measures and policy instruments for reaching this target, the energy savings have to be captured and evaluated. For this purpose, knowledge about the different policy instruments on the one hand as well as possible interactions between them on the other hand is crucial.

Against this background, this Masters thesis investigates interactions between policy instruments on energy end-use efficiency. The case of domestic cold appliances (refrigerators and freezers) is chosen for this purpose. How does policy instrument X work? Are there any interactions with other policy instruments? Are these interactions mitigating or reinforcing? What could be the magnitude of such interactions? What factors are causing these interactions? How could one investigate and measure interactions between policy instruments? I am are very much interested in your opinion and assessment of such and other questions.

Please find enclosed additional background information as well as a short version of the interview guidelines. Likewise, please find enclosed an interaction matrix that you may fill out before the interview. If you have any further questions, please do not hesitate to contact Christian Michelsen (phone: +49 202 2492-258).

Thank you very much in advance.

Kind regards,

Christian Michelsen
MSc Candidate at the International Institute for Industrial Environmental Economics (IIIEE)

Enclosures

Background information[55]

Topic
Interactions between policy instruments on domestic cold appliance energy efficiency in Germany

Central question
From an expert's point of view, how do you see or assess:

(i) the *functioning* of selected policy instruments on domestic cold appliance energy efficiency, and

(ii) *interactions* between such policy instruments.

The interview will be focused on the policy instrument #.

Outline of the interview
The interview is divided into three parts. Part 1 includes specific questions on policy instrument # and your understanding of interactions between selected policy instruments. Part 2 makes inquiries on your opinion and assessment of certain hypothesises on selected policy instruments and possible interactions between them. Part three concludes with some final questions. The length of the interview is estimated to be approximately 45 minutes. The evaluation of the interview will be carried out anonymous.

Interactions between policy instruments
Interactions between policy instruments can either be reinforcing, neutral or mitigating. A reinforcing relationship can be observed if the energy savings due to a combination of both policy instruments are higher than the sum of the energy savings arising from the individual policy instruments.[56]

Background
The rational use of energy - also called energy end-use efficiency – is due to different aspects such as security of energy supply, competitiveness of the economy or environmental protection an important topic on the political agenda in both the EU and Germany.
Against this background, an EU directive on energy end-use efficiency (COM (2003) 739) was proposed in the year 2003. Furthermore, a green paper on energy efficiency was published in 2005 (COM (2005) 265 final).
A central part of the proposed EU directive on energy end-use efficiency is that the EU member states have to realise additional energy savings of 1% (1.5% for the public sector) per year (compared to the general trend).
The way how the proposed directive is implemented is left open to the EU member states. Thus, the member states are free to decide on how the planned energy savings are allocated

[55] The interview is part of Christian Michelsen's Masters Thesis on "Interactions between policy instruments on domestic cold appliance energy efficiency". Christian Michelsen studies the MSc programme "Environmental Management and Policy" at the International Institute for Industrial Environmental Economics (IIIEE), Lund University, Sweden. This thesis is co-supervised by the Wuppertal Institute for Climate, Environment and Energy (Germany). Contact: Email: christian.michelsen@student.iiiee.lu.se, Phone: +49 202 2492-258.

[56] Example: Policy instrument A would lead to energy savings of 50 MWh and policy instrument B to the same amount of savings. Thus, the sum of the individual energy savings due to both policy instruments would be 100 MWh. However, a combination of policy instrument A and B would realise energy savings of about 120 MWh. Additional energy savings of about 20 MWh would occur in this case. Thus, a combination of both policy instruments would reinforce their individual energy savings effect.

among the different sectors of the economy and what kind of policy instruments and measures are used for achieving these savings.
In order to show that the mandatory target of additional energy savings of 1% (1.5%) has been achieved, member states are obliged to report on the savings due to the implemented policy instruments and measures.
The question of what the contribution of a specific policy instrument or mix of policy instruments in achieving certain energy savings (e.g. due to the diffusion of energy efficient A+ and A++ cold appliances) was arises in this regard.
Moreover, the possibility for interactions between policy instruments - in terms of reinforcement or mitigation - makes such an evaluation even more difficult.
This question does not only become relevant ex-post (after the implementation of a policy instrument or package of policy instruments) but also ex-ante (before the implementation of a policy instrument or package of policy instruments).
In order to be able to estimate the contribution to the energy savings target in advance, knowledge about the functioning of individual policy instruments as well as the likely magnitude of interactions between policy instruments is necessary.

Selected policy instruments
For the purpose of this thesis, the following seven policy instruments on domestic cold appliance energy efficiency in Germany were chosen:

Policy instrument	Short description
EU energy label	Domestic cold appliances have to be labelled according to their energy consumption and energy efficiency class [very low energy consumption (class A+ and A++) to very high energy consumption (class G)]
Minimum energy efficiency standard	Minimum energy efficiency standard for domestic cold appliances banning all appliances of the categories E-G and most appliances belonging to the category D
Rebate programmes	Financial support when purchasing energy efficient cold appliances for private use. This instrument was mainly used by energy companies in the 1990s on the regional level. A recent example in Germany is the rebate programme of the "Stadtwerke Aachen" or the national rebate programme in the Netherlands.
Green tax ("Ökosteuer")	Cross-sector instrument, taxation of electricity consumption (private households: 20.50 Euro/MWh).
DEnA "Initiative Energy efficiency"	National motivation and information campaign on energy efficiency targeting consumers. Information for (i) consumers in what respect energy could be saved due to the optimal use of cold appliances and the right purchasing decision (e.g. size of the appliances), as well as (ii) support and education of retailers (free information and marketing materials on energy efficient cold appliances).
Voluntary commitment of the manufacturers (2002 – 2010)	EU-wide commitment of the manufacturers (i) to ban the sale of cold appliances belonging to an energy efficiency category below B, (ii) to lower the fleet consumption to an energy efficiency index of 55% (57%) until 2006, and (iii) to provide consumers with information on the proper usage of cold appliances.
Energy+	EU-wide procurement project for very energy efficient domestic cold appliances of the categories A+ and A++

Interview guideline

Starting point

- Thank you very much for your interest in an interview for my Masters thesis.
- May I record our conversation? This would make following your thoughts and a later evaluation of the interview much easier for me. The evaluation of the interview is anonymous.
- Something about myself: postgraduate student at the IIIEE, cooperation with the Wuppertal Institute in Germany during the thesis period
- Short explanation of the scope and objectives of the Masters thesis (see background information): Interactions between policy instruments aiming at enhancing energy end-use efficiency of domestic cold appliances; proposed EU directive on energy end-use efficiency foresees that the additional and mandatory energy savings have to be monitored, thus policy instruments have to be evaluated and possible interactions between them taken into account when reporting on progress towards the target.
- The approximately duration of the interview will be about 45 minutes.
- The interview will be based on the guidelines and information I have sent you (Short explanation of the interview framework).

<u>Part 1:</u> Questions on the functioning of policy instrument # and interactions between selected policy instruments on domestic cold appliance energy efficiency

- **Specific questions on policy instrument #**
  - Background
    - What market failure is addressed?
    - What phase of the market transformation is addressed (early, take-off and mature)?
    - Where all political groups in favour of introducing such a policy instrument?
    - What is the main target group?
  - Design
    - How would you describe the degree of complexity in the design of the policy instrument?
    - What are the underlying assumptions about the functioning of the policy instrument?
    - Where there any changes in the design after the implementation of the instrument?
    - What share of the target group was planned to be reached?
    - What was the influence of lobby groups when designing such a policy instrument?
  - Implementation
    - What is the acceptance of the policy instrument?
    - What unforeseen events where occurring during the implementation?
    - What advantages/disadvantages has the instrument compared to other policy instruments?
  - Relevance of policy instrument #
    - What is the relevance of the following selected policy instruments for the achievements until now? Please answer by ranking the relevance according to a scale from 1 to 5. If possible, please motivate your answer.

        - EU energy label
        - Minimum energy efficiency standard for cold appliances
        - Rebate programmes
        - DENA Initiative energy efficiency
        - Energy+ (procurement)
        - Voluntary commitment of the manufacturers
        - Green tax
    - If possible, please estimate the energy savings (saved tons CO_2) due to policy instrument # in Germany (European Union).
    - If possible, please estimate the savings due to the other instruments.
    - Which policy instruments should be strengthened in the future? Please name the most important policy instruments and motivate your answer.
- **Specific questions on interactions between policy instruments**
  - Questions on your general idea and understanding of interactions between policy instruments on domestic cold appliance energy efficiency
    - What is your underlying understanding or theory about interactions between policy instruments on domestic cold appliance energy efficiency? Please explain.
    - What factors might contribute to interactions between policy instruments on domestic cold appliance energy efficiency? Please name and explain the most important ones.
  - Questions on interactions between policy instrument # and other selected policy instruments (please use the attached interaction matrix)
    - Are there any interactions between policy instrument # and other policy instruments? Please answer with the help of the attached interaction matrix.
      - What is the magnitude of the different interactions? Please make an estimation by using a scale from -2 (strongly mitigating effect) to 2 (strongly reinforcing effect).
      - What are the underlying factors causing the different interactions? If possible, please name them and motivate your answer.

<u>Part 2:</u> Questions on your assessment of hypothesizes on the functioning of selected policy instruments and interactions between them

- **Hypothesizes on the functioning of selected policy instruments on domestic cold appliance energy efficiency and interactions between them**
  - What is your opinion on the following hypothesizes? Please indicate if you approve or reject them (or do not have an opinion) by using a scale from -3 (strong rejection) to +3 (strong approval). Note: Energy savings are understood as effect of a policy instrument in this case.
    - The effect of procurement programmes such as energy+ can be enhanced through a rebate programme and information on energy efficient appliances.
    - The effect of labels, information and education of retailers can be enhanced through a rebate programme.
    - Rebate programmes alone are the best information programmes and do not need to be combined with additional policy instruments such as labels or information campaigns.

        - Labels and information campaigns on energy efficient appliances are mitigating each other.
        - The effect of information, labels or education of retailers can be enhanced with the help of a green tax.
        - The effect of voluntary commitments by manufacturers can be enhanced if they are combined with other policy instruments such as rebate programmes or information campaigns.
    - Further discussion of the hypothesizes
        - In your point of view, what is missing in the above hypothesizes?
        - What additional interactions would you see?

<u>Part 3:</u> Final questions

- **Clarification of open questions / Concluding questions**
    - What would be an optimal mix of policy instruments for realizing energy saving options related to domestic cold appliances? Please motivate your answer.
    - What stage of the market transformation process are the different instruments most suitable for (early, take-off and mature stage)? Please motivate your answer.
    - How would you investigate interactions between policy instruments? Please give a brief explanation.
        - What would be your approach?
        - How would you measure or quantify the outcome of such interactions?
    - Do you know any useful literature on this topic?
    - Do you know any other experts who might be interesting to talk to?
- **End of the interview**
    - Thank you very much for participation and help!
    - Contact details of other experts
    - Copies of literature

Appendix III: Domestic cold appliances

Refrigeration cycle

Refrigeration is the withdrawal of heat from a substance or space so that a level of temperature lower than that of the natural surroundings is achieved (Kuehn et al., 1998).

Refrigeration may be produced by: (i.) thermoelectric means, (ii.) vapour compression systems, (iii.) expansion of compressed gases, (iv.) throttling or unrestrained expansion of gases (Kuehn et al., 1998).

Vapour compression systems are normally used for domestic cold appliances. Here, cooling is accomplished by evaporation of a liquid refrigerant under reduced pressure and temperature. The fluid enters the compressors (1) where the temperature is increased by mechanical compression (2). The vapour condenses at this pressure, and the resultant heat is relieved to the surrounding. The high-pressure liquid (3) then passes through an expansion valve through which the fluid pressure is lowered. The low-pressure fluid enters the evaporator (4) where it evaporates by absorbing heat from the refrigerated space, and re-enters the compressor. The whole cycle is repeated (Kuehn et al., 1998). Figure A-1 gives a simplified illustration of the refrigeration cycle.

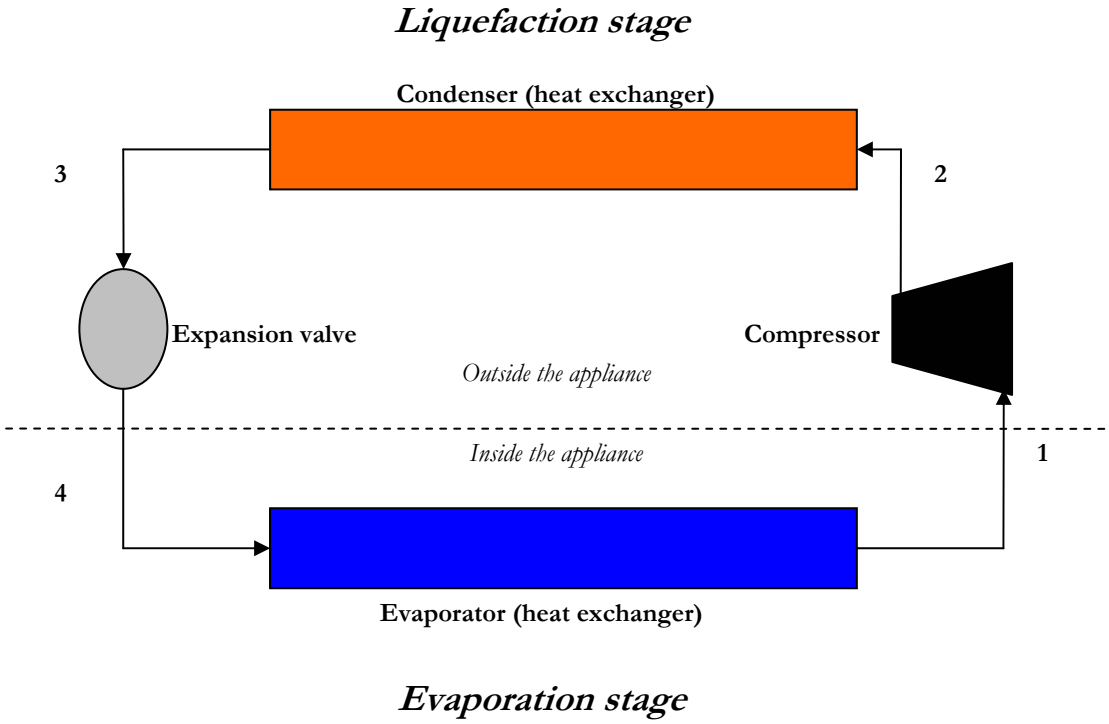

Figure A-1: Vapour compression refrigeration cycle (Source: Kuehn et al., 1998; modified by the author)

The energy efficiency index (EEI)

The energy efficiency classes are categorised according to different levels of the EEI (ADEME et al., 2000). The EEI is defined for each domestic cold appliance category and compares the energy consumption of an appliance to the consumption of an average appli-

ance in the years 1990 to 1992. By calculating the measured model's electricity consumption divided by the energy consumption for a unit of the same adjusted volume of an average appliance the EEI is determined and expressed in percentage (%). Table A-2 gives an overview over the EEIs of the different energy efficiency classes.

Table A-2: Relative efficiency grades used in the EU energy label for domestic cold appliances (Source: ADEME et al., 2000)

Energy efficiency index, I (%)	Energy efficiency class
30 < I	A++
30 ≤ I < 42	A+
42 ≤ I < 55	A
55 ≤ I < 75	B
75 ≤ I < 90	C
90 ≤ I < 100	D
100 ≤ I < 110	E
110 ≤ I < 125	F
125 ≤ I	G

The EU energy label

Figure A-2 shows the generic background of the EU energy label for domestic cold appliances. A strip with relevant data for the appliance has to be stuck on it by the retailers.

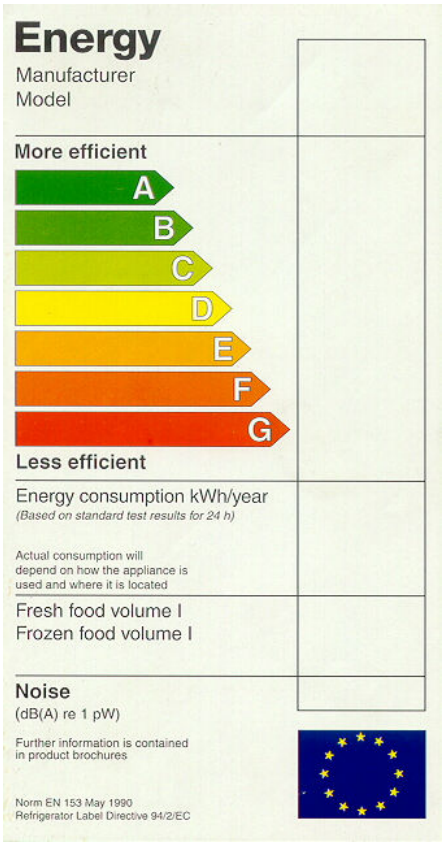

Figure A-2: The EU energy label for domestic cold appliances

Appendix IV: Interaction analysis

The following figure (figure A-3) illustrates the seven steps of the interaction analysis applied in section 6.1 of this thesis and suggested methods for investigating the different steps:

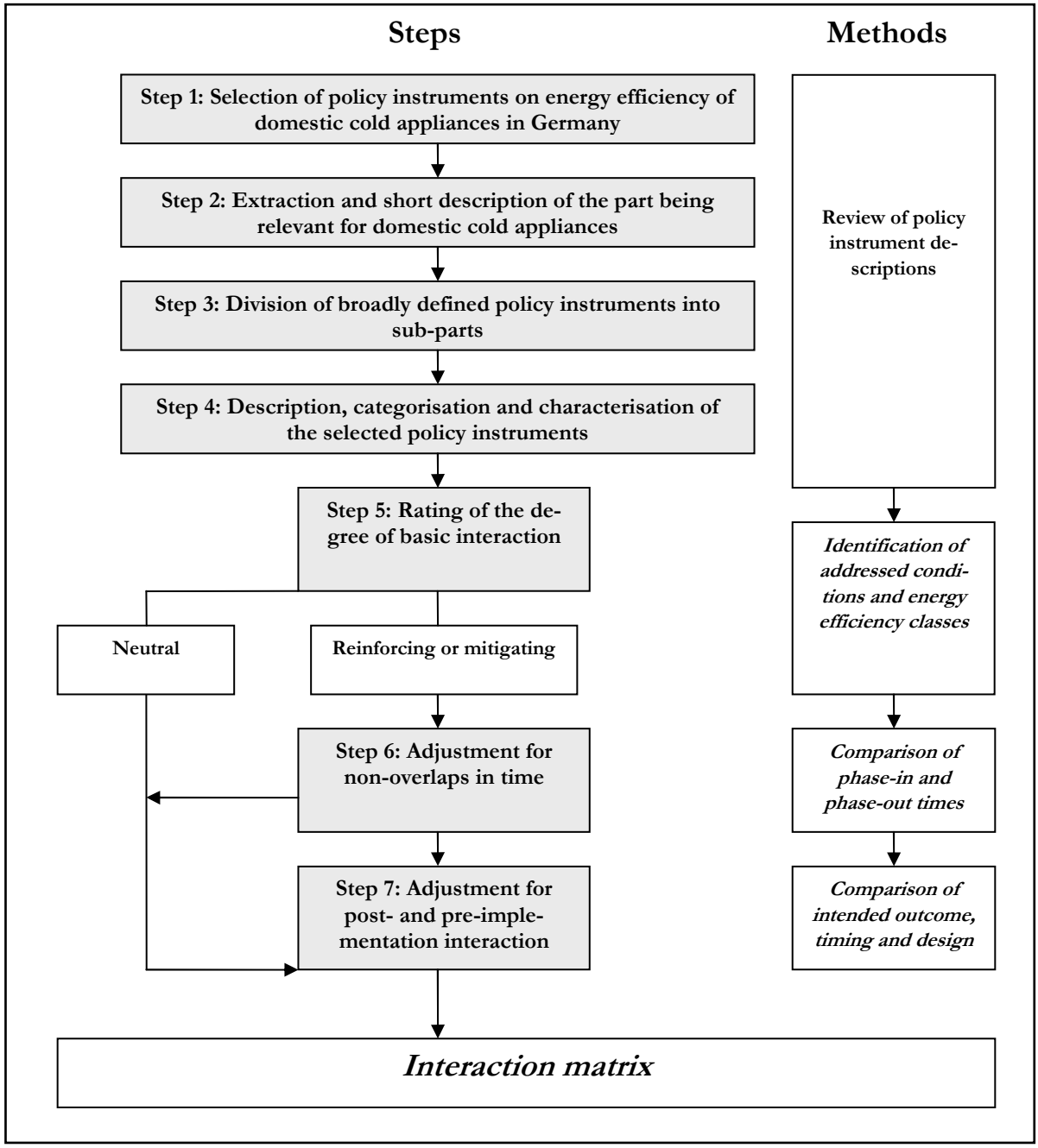

Figure A-3: Steps of the interaction analysis and suggested methods [based on Boonekamp (2005), modified by author for the purpose of this thesis]

In the following, the data gathered for the different steps of the analysis are presented. This is done in order to make the different steps of the analysis transparent. The data that were used for determining the degree of interaction of the different cells in the interaction matrix is shown in table A-8 in the end of this section.

Steps 1-4

The data obtained from the screening of the selected policy instruments (steps 1-4) are summarised in table A-3. Steps 1 to 4 have already been carried out in section 4.2.2 of this thesis.

Table A-3: Selected policy instruments on domestic cold appliance energy efficiency in Germany

No.	Policy instrument	Short description of relevant section	No.	Sub-parts	Category	Characteristic
1	Minimum energy efficiency standard	Minimum energy efficiency standard for domestic cold appliances	**1**	No subparts	Regulation *on appliance*	Coercive *targeted* Supply
2	EU energy label	Mandatory labelling of domestic cold appliances according to their energy consumption	**2a**	"Old" EU energy label (A-G)	Information *on appliance*	Persuasive *targeted* Demand
			2b	"Revised" EU energy label (A++ - G)	Information *on appliance*	Persuasive *targeted* Demand
3	Rebate programmes	Rebates for very energy efficient domestic cold appliances	**3**	No subparts	Economic means *(appliance)*	Persuasive *targeted* Demand
4	Green tax	Taxation of electricity consumption of private households	**4**	No subparts	Economic means *(use / appliance)*	Coercive *broad* Demand
5	"Initiative Energie-Effizienz"	Motivation and information campaign related to energy efficiency of domestic cold appliances addressing consumers and retailers	**5a**	(a) Motivation to consider energy efficiency related to domestic cold appliances	Information *on use and appliance*	Persuasive *broad* Demand
			5b	(b) Information on energy efficient use	Information *on use*	Coercive *targeted*
			5c	(c) Information and education of retailers	Information *on appliance*	Coercive *targeted* Demand
6	Energy+	Cooperate procurement of very energy efficient domestic cold appliances at the European level; Marketing channel for manufacturers: list for A+ and A++ appliances, energy+ award competition	**6a**	(a) Procurement of very energy efficient appliances	Other policy instruments *(appliance)*	Persuasive *targeted* Supply
			6b	(b) Information on very energy efficient domestic cold appliances	Information *on appliance*	Persuasive *targeted* Demand
7	Voluntary commitment on Reducing Energy Consumption of Household Refrigerators, Freezers and their Combinations	Voluntary Commitment on minimum energy efficiency standards of domestic cold appliances	**7a**	(a) Voluntary commitment	Other policy instruments *(appliance)*	Coercive *targeted* Supply
			7b	(b) Information on energy efficient use	Information *on use*	Coercive *targeted*

Step 5: Rating of the degree of basic interaction

In a first step, the addressed conditions for realising an energy saving option by each of the selected policy instruments are identified (see table A-4).

Table A-4: Conditions for realising energy saving options addressed by the selected policy instruments

No. of policy instrument	Implementation conditions				Proper utilisation condition
	Availability	Awareness	Institutional restrictions	Incentive / Motivation	
1					
2a				Social	
2b				Social	
3				Financial	
4				Financial	
5a				Social	
5b					
5c				Social	
6a				Social	
6b				Social	
7a					
7b					

Finally, the addressed energy efficiency classes are identified (table A-5).

Table A-5: Addressed energy efficiency classes by the selected policy instruments

	A++	A+	A	B	C	D	E	F	G
1									
2a									
2b									
3									
4									
5a									
5b									
5c									
6a									
6b									
7a									
7b									

By combining the data from steps 1-4 on the policy instruments' categories, characteristics and sizes (table A-3) with the data from the tables A-4 and A-5, the degree of basic interaction (reinforcing, mitigating or neutral) of the different cells is determined.

Step 6: Adjustment for non-overlaps in time

The phase-in and phase-out times are identified (table A-6).

Table A-6: Phase-in and phase-out times of selected instruments

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1											
2a											
2b											
3 [57]											
4											
5											
6											
7											

Step 7: Adjustment for post- and pre-implementation interaction

Combinations of policy instruments with a neutral relationship and different timing are analysed in order to identify post- or pre-implementation interaction. The assessment of post- or pre-implementation interaction is based on a comparison of the timing, design, and intended outcome of each selected policy instrument. Data from tables A-3 and A-6 were used for this purpose.

Pre-implementation interaction

In order to identify cells with pre-implementation interaction, the chronological sequence of introduced policy instruments was compared. The chronological sequence "preparatory policy instrument – follow-up policy instrument – revised preparatory policy instrument – revised follow-up policy instrument, etc." was assumed to be reinforcing. The reinforcing relationship is one-side in such combinations, i.e. a preparatory policy instrument prepares the ground for a more effective follow-up policy instrument. Table A-7 identifies preparatory and follow-up policy instruments.

Table A-7: Preparatory and follow-up policy instruments

Preparatory policy instrument	Follow-up policy instrument	Revised preparatory policy instrument	Revised follow-up policy instrument
"Old" EU energy label	Minimum energy efficiency standard	"revised" EU energy label	Voluntary agreement
	Energy+		

Rebate programmes, the green tax and information campaigns are also assumed belonging to the group of preparatory policy instruments. However, they are not considered to have an influence since these policy instruments are only implemented on the national level. Thus, their influence on instruments on the EU level is perceived to be low or even not existent.

[57] Rebate programmes in Germany are of a regional nature and restricted in time. Most rebate programmes have been phased out from the end of the 1990s on. Currently, there are only a few rebate programmes left in Germany. Therefore, it is assumed that the overlap in time with other policy instruments is not existent from 1998 on. However, there are overlaps in time on the regional level where rebate programmes are still applied. Here, interactions with other policy instruments could take place.

Post-implementation interaction
Post-implementation interaction was tried to be identified by analysing the cells according to non- interaction at the implementation of the policy instruments but with interaction when it comes to the resulting energy savings effect. Comparing the design and intended outcome of the combined policy instruments did this. Post-implementation interaction was not identified among the selected policy instruments on energy efficiency of domestic cold appliances in Germany.[58]

Interaction matrix
Table A-8 shows the resulting interaction matrix and the reasoning behind the rating. The first line shows the reason for a certain interaction, the second line the reason why the interaction is weakened, and the third line the resulting degree of interaction. In the following, the meanings of the inscriptions of the cells in table A-8 are explained.

Cell colours and inscription:

- Yellow coloured cells: Mutually reinforcing combinations
    - Com 1: Complementary policy instruments of different categories
    - Com 2: Complementary policy instruments of the same categories
    - Com 3: Complementary policy instruments (supply/demand)
    - Category: No direct financial incentives included in the combination
    - Size: At least one policy instrument is of the size "broad"
- Light grey coloured cells: Pre-implementation interaction
    - Pre: Pre-implementation interaction
- Dark grey coloured cells: Mutually mitigating combinations
    - Overlap: Overlap in conditions addressed
    - Size: At least one policy instrument is of the size "broad"
- Non-coloured cells: Neutral combinations
    - Class: non-overlap in energy efficiency class
    - Conditions: different conditions (implementation/utilisation)
    - Time: Non-overlap in time

[58] An example for post-implementation interaction could be interactions between a policy instrument targeting domestic cold appliances and a policy instrument targeting the lifestyle like food habits of consumers. A trend towards consuming more fresh instead of frozen food would reduce the demand for freezers and thus reduce the impact of policy instruments targeting the diffusion of very energy efficient freezers. However, such interactions are not the scope of this thesis.

Policy instrument		***1***									
Label (2)	(2a)	Pre **1**	***2a***								
	(2b)	Pre **1**	Pre **1**	***2b***							
Rebate (3)		Class **0 (0)**	Com 1 **0 (2)**	Com 1 **0 (2)**	***3***						
Green tax (4)		Overlap Size **-1**	Com 1 Size **1**	Com 1 Size **1**	Overlap Size **0 (-1)**	***4***					
DEnA (5)	(5a)	Class **0**	Com 2 Size **1**	Com 2 Size **1**	Com 1 Size **0 (1)**	Com 1 Size **1**	***5a***				
	(5b)	Conditions **0**	Conditions **0**	Conditions **0**	Conditions **0 (0)**	Com 1 Size **1**	Com 2 Category **1**	***5b***			
	(5c)	Class **0**	Com 2 Category **1**	Com 2 Category **1**	Com 1 **0 (2)**	Com 1 Size **1**	Com 2 Size **1**	Conditions **0**	***5c***		
Energy+ (6)	(6a)	Pre **1**	Pre **1**	Pre **1**	Com 3 **0 (2)**	Com 3 Size **1**	Com 3 Category **1**	Conditions **0**	Com 3 Category **1**	***6a***	
	(6b)	Pre **1**	Pre **1**	Pre **1**	Com 1 **0 (2)**	Com 1 Size **1**	Com 2 Size **1**	Conditions **0**	Com 2 Category **1**	Com 3 Category **1**	***6b***
Voluntary (7)	(7a)	Class **0**	Time **0**	Pre **1**	Com 3 **0 (2)**	Com 3 Size **1**	Com 3 Category **1**	Conditions **0**	Comp 3 Category **1**	Pre **1**	Pre **1**
	(7b)	Conditions **0**	Conditions **0**	Conditions **0**	Conditions **0 (0)**	Com 1 Size **1**	Com 2 Size **1**	Overlap **-2**	Conditions **0**	Conditions **0**	Conditions **0**

7a
Conditions **0**

Table A-8: Detailed analysis of the different cells