DISS. ETH NO. 23268

INVESTIGATING ENERGY-FRIENDLY CONSUMER BEHAVIOR: THE ROLE OF LABELS, INFORMATION, AND DECISION-MAKING STRATEGIES IN THE CONTEXT OF ENERGY CONSUMPTION

A thesis submitted to attain the degree of
DOCTOR OF SCIENCES of ETH ZURICH
(Dr. sc. ETH Zurich)

presented by

SIGNE MARIA WAECHTER,
lic. phil., University of Zurich

born 18 February 1984
citizen of Brugg, AG and Brittnau, AG

accepted on the recommendation of
Prof. Dr. Michael Siegrist
Dr. Bernadette Sütterlin
Dr. Boris Krey

2016

This dissertation was made possible with the funding of the Swiss Federal Office for Energy (SFOE). It constitutes a part of the Swiss energy-economy-society (EES) program.

DEDICATION

Ziehende Landschaft

Man muss weggehen können
und doch sein wie ein Baum:
als bliebe die Wurzel im Boden,
als zöge die Landschaft und wir ständen fest.
Man muss den Atem anhalten,
bis der Wind nachlässt
und die fremde Luft um uns zu kreisen beginnt,
bis das Spiel von Licht und Schatten,
von Grün und Blau,
die alten Muster zeigt
und wir zuhause sind,
wo es auch sei,
und niedersitzen können und uns anlehnen,
als sei es an das Grab
unserer Mutter.

Hilde Domin, 1959

To my mother, who is always in my heart.

Domin, H. (1994). *Nur eine Rose als Stütze. Gedichte*. Frankfurt am Main: Fischer Verlag GmbH.

TABLE OF CONTENTS

TABLE OF CONTENTS **i**

LIST OF FIGURES **v**

LIST OF TABLES **vii**

CHAPTER I **1**

GENERAL INTRODUCTION

1.1 Introduction **2**

1.2 The European Union energy label **4**

1.3 Consumers' interaction with energy labels and energy-related information **9**

1.4 Judgment, decision-making, and the idea of the rational consumer **11**

1.5 Measuring consumer behavior **14**

1.6 Overview of the dissertation **15**

References **16**

CHAPTER II **23**

THE MISLEADING EFFECT OF ENERGY EFFICIENCY INFORMATION ON PERCEIVED ENERGY FRIENDLINESS OF ELECTRIC GOODS

Abstract **24**

2.1 Introduction **25**

2.2 Study 1 – Detection of an energy efficiency fallacy **30**

2.3 Study 2 – Validation of the energy efficiency fallacy **34**

2.4 Study 3 – Impact of the energy efficiency fallacy **38**

2.5 General discussion **41**

References **44**

CHAPTER III **49**

DESIRED AND UNDESIRED EFFECTS OF ENERGY LABELS –
AN EYE-TRACKING STUDY

Abstract **50**

3.1 Introduction **51**

3.2 Materials and methods **59**

3.3 Results **69**

3.4 Discussion **76**

References **81**

Supporting Information **87**

CHAPTER IV **89**

DECISION-MAKING STRATEGIES FOR THE CHOICE OF ENERGY-FRIENDLY PRODUCTS

Abstract **90**

4.1 Introduction **91**

4.2 Methods **96**

4.3 Results **103**

4.4 Discussion **108**

References **112**

CHAPTER V **117**

LETTERS, SIGNS, AND COLORS: HOW THE DISPLAY OF ENERGY EFFICIENCY INFORMATION INFLUENCES CONSUMER ASSESSMENTS OF PRODUCTS

Abstract **118**

5.1 Introduction **119**

5.2 Study 1 **128**

5.3 Study 2 **132**

5.4 General discussion **134**

5.5 Limitations **137**

5.6 Conclusions **139**

References **139**

CHAPTER VI **145**

GENERAL DISCUSSION

6.1 Introduction **146**

6.2 Central findings **147**

6.3 Implications **152**

6.4 Limitations and ideas for further research **155**

6.5 Conclusion **157**

References **158**

SUMMARY **161**

ZUSAMMENFASSUNG **163**

ACKNOWLEDGMENTS **165**

CURRICULUM VITAE **166**

LIST OF FIGURES

Figure 1.1	Electric power consumption per capita from 1960 to 2012 for Switzerland (green), the EU (red), the Organization for Economic Co-operation and Development (OECD) members (purple), and the world (blue).	**3**
Figure 1.2	Distribution of the electricity consumption of Swiss households in 2013.	**4**
Figure 1.3	Energy label originally used for televisions.	**5**
Figure 1.4	Energy labels currently used for televisions and freezers.	**8**
Figure 2.1	These EU energy labels are used to inform consumers about the energy friendliness of electric goods.	**27**
Figure 2.2	These energy labels for a television were used in Study 1 for the four experimental conditions.	**32**
Figure 2.3	The graph shows the estimated electricity consumption for a television as a function of actual annual electricity consumption (high vs. low) and energy efficiency class (A vs. B).	**33**
Figure 2.4	The graph shows the distribution of participants' television recommendation for an energy-friendly person.	**36**
Figure 2.5	The graph shows the distribution of participants' freezer recommendation for an energy-friendly person.	**37**
Figure 2.6	Freezer and refrigerator EU energy labels with the adopted energy efficiency scale ranging from A^{+++} to D.	**40**
Figure 2.7	The graph shows the estimated energy consumption of a freezer compared with a refrigerator (A+++, 119 kWh/year) for the two experimental conditions.	**41**
Figure 3.1	EU energy label used for televisions.	**52**
Figure 3.2	Products with pictures and television features in the label condition.	**61**
Figure 3.3	Products with pictures and television features in the no-label condition.	**62**
Figure 3.4	Areas of interest (AOI) defined for the television task in the label condition.	**66**

Figure 3.5	Areas of interest (AOI) defined for the freezer task in the label condition.	**67**
Figure 3.6	Percentage of decision time spent on energy-related information as a function of label (with vs. without label) and focus (self vs. energy saving).	**71**
Figure 3.7	Mean fixation duration on energy information as a function of label (with vs. without label) and focus (self vs. energy saving).	**72**
Figure 3.8	Percentages of fixation count as a function of information format (energy efficiency vs. annual consumption), label (with vs. without label), and focus (self vs. energy saving).	**74**
Figure 4.1	Televisions with information and pictures.	**98**
Figure 4.2	Televisions with information, pictures, and corresponding energy labels.	**99**
Figure 5.1	EU energy label used for televisions (left) and cooling units (right).	**120**
Figure 5.2	Picture of the freezer and labels used in the control and the experimental conditions to denote that the product is of the highest energy-efficiency class.	**130**
Figure 5.3	Picture of the freezer and the labels used in the control and experimental conditions to denote that the product is of the second-highest energy-efficiency class.	**130**
Figure 5.4	Picture of the lamp and labels used in the control and the experimental conditions to denote that the product is of the highest energy-efficiency class.	**133**
Figure 5.5	Picture of the coffee machine and labels used in the control and the experimental conditions to denote that the product is of the second-highest energy-efficiency class.	**133**
Figure 6.1	Two examples for an additional scale showing the information about annual consumption.	**153**

LIST OF TABLES

Table 2.1	Results of the Two-Way Analysis of Variance for Energy Efficiency Class and Annual Electricity Consumption on Estimated Electricity Consumption.	**33**
Table 3.1	Task Instructions.	**65**
Table 3.2	Choice Frequencies in the Television and the Freezer Task.	**73**
Table 3.3	Fractions of Fixation Count of Information about Energy Efficiency vs. Information about Annual Energy Consumption of Television and Freezer.	**75**
Table 3.4	Mean Fixation Duration (ms) for Information about Energy Efficiency vs. Information about Annual Energy Consumption of Television and Freezer.	**76**
Table 4.1	Task Instructions	**97**
Table 4.2	Characterization of Consumers Applying Various Decision-making Strategies with regard to the Clustering and Descriptive Variables.	**107**
Table 4.3	Characterization of Consumers Applying the Different Decision-making Strategies with regard to Socio-demographic Variables.	**108**
Table 5.1	Perceived Energy Friendliness of the Two Products (Low vs. High Efficiency) and Perceived Gain Differences by Scale Design	**132**
Table 5.2	Perceived Energy Friendliness of the Two Products (Low vs. High Efficiency) and Perceived Gain Differences	**134**

CHAPTER I

GENERAL INTRODUCTION

1.1 Introduction

Almost ten years ago, Switzerland was at the crossroads of securing its future energy supply. In 2007, the Swiss Federal Council communicated to the public the new Swiss energy policy strategy to ensure that Switzerland would not face an energy gap in the future. The strategy consisted of four pillars: enhancement of energy efficiency, extension of renewable energy sources (e.g., hydropower), reliance on large power stations (e.g., gas plants, nuclear power plants), and energy imports (Bundesrat, 2007). In 2011, an earthquake with a magnitude of 9 on the open Richter scale hit Japan and caused a tsunami. A nuclear power plant was located in one of the most affected areas, Fukushima Daiichi. Due to the earthquake and the following tsunami, nuclear meltdowns occurred in four of the six reactors. This disaster directly contaminated thousands of people, water resources, plants, and animals—its long-term effects on health and the environment have yet to be examined (Hiyama et al., 2015; Reich & Goto, 2015). Worldwide, this catastrophic event rattled the perception of energy production. Switzerland, along with other countries (e.g., Germany), announced its plans to phase out nuclear energy shortly after this event (Bundesrat, 2011).

Subsequently, a new strategy was formulated within the energy strategy for 2050 (i.e., "Energiestrategie 2050") (Bundesrat, 2013a). The most important modification consisted in the inclusion of the nuclear phase out as a main policy goal. Before Fukushima, the reliance on nuclear energy was a main pillar of the energy strategy. Besides the phase out, the goals of the new strategy were to reduce total energy and electricity consumption, enhance renewable energy systems, and reduce energy-induced carbon dioxide (CO_2) emissions without affecting the security of the energy supply and Switzerland's low energy prices (Bundesrat, 2013a). The enhancement of energy efficiency, that is, providing the same utility (e.g., the operation of a television) but with less energy consumption is crucial to reach this goal. The Swiss government implemented a series of regulations that required enhanced energy efficiency in various sectors, including household appliances such as refrigerators and freezers (Bundesrat, 2013b).

The household sector accounts for roughly 30% of the energy demand and is one of the fastest-growing areas for energy consumption (Prognos, 2014). Despite Switzerland's new energy strategy and increasing energy efficiency, household energy consumption has increased by 10.3% since 2000 and accounted for 260 petajoules (PJ) in 2013 (Prognos, 2014). Household electricity consumption has increased by 19.3%, plateauing at 67.6 PJ in 2013

(Prognos, 2014). This level of consumption greatly exceeds the household electricity consumption levels of the European Union (EU) and of the world (Fig. 1.1).

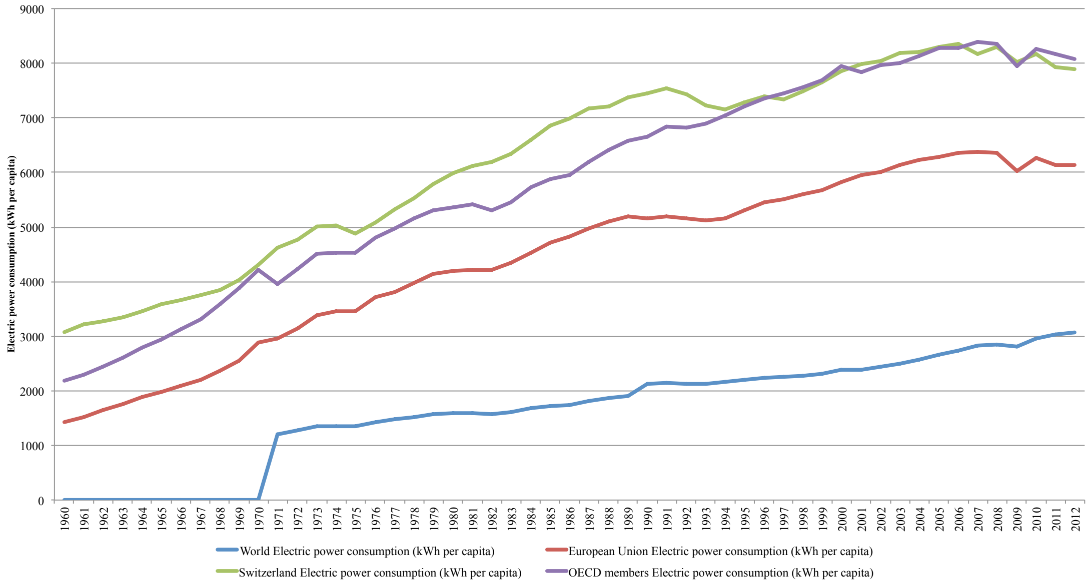


Figure 1.1. Electric power consumption per capita from 1960 to 2012 for Switzerland (green), the EU (red), the Organization for Economic Co-operation and Development (OECD) members (purple), and the world (blue) (Source: World Bank). The Data for the World is only available from 1970.

This development is worrying because the energy efficiency of appliances has been steadily improving for over fifteen years (VZBV, 2015). One reason for the increase in final energy consumption is population growth, and consequently, an increase in the number of households (BFS, 2014). Another reason for the lack of an energy decrease is the increasing amount of energy-consuming durables in Swiss households (Prognos, 2014) as well as a trend toward bigger products (Molenbroek et al., 2014) (household electricity consumption is depicted in Figure 1.2). Furthermore, the potential of energy efficiency has not yet been maxed out. Regulations have enforced market penetration with energy-efficient products, but it is still estimated that switching to the most efficient technologies could save up to 40% in electricity (IEA, 2009). This means that the products that consumers choose when purchasing energy-consuming durables are crucial for the future development of final energy consumption. The current development of final energy demand at the household level indicates that consumers might apply decision-making strategies that are not optimal in terms of energy friendliness (i.e., reduction of final energy consumption).

This dissertation focused on consumer behavior in the context of energy consumption. The research questions addressed include the investigation of consumers' information search behavior as well as the influence and evaluation of energy-related information. To understand this facet of consumer behavior it is important to develop adequate policy tools that are expedient in terms of accelerating energy-friendly consumer behavior. Misinterpretations and misconceptions about energy-related information could lead to biased decisions and slow down energy savings. Furthermore, the objective of this dissertation was to understand consumers' decision-making process and the strategies that they apply when choosing an energy-related appliance. The investigation of these research questions should reveal leverage points for future energy policy measurements and possible modifications of existing measurements should be tested.

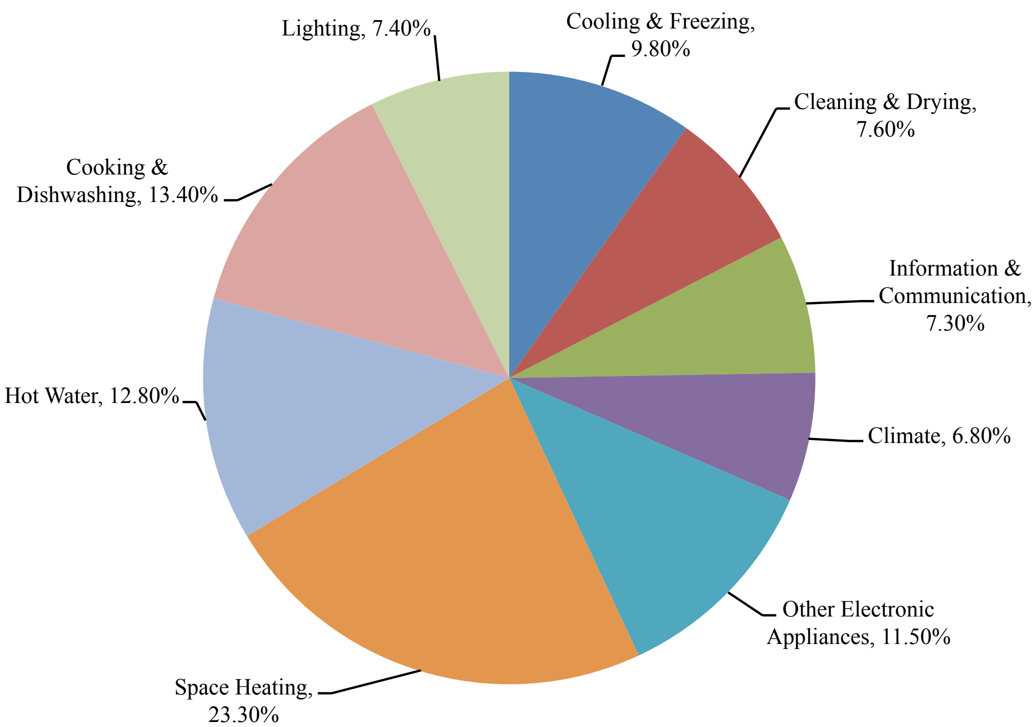


Figure 1.2. Distribution of the electricity consumption of Swiss households in 2013 (Source: Prognos, 2014).

1.2 The European Union energy label

1.2.1 History of the energy label

In 1992, the EU implemented an energy label for energy-consuming durables in order to empower consumers to make more informed decisions (Council of the European Communities, 1992). Switzerland adopted the energy label in line with many EU member states. In 2010, the label was re-designed and standardized for many products (European Council, 2010). Figure 1.3 shows the labels originally used for televisions. In order to assess the energy friendliness of a product, consumers are provided with two main sources of information on the energy label: its energy efficiency and its annual energy consumption. The annual consumption is calculated based on a generic use of the product over one year. The same generic use is assumed for all products of the same type. For example, for televisions, the assumed use is four hours per day. This value of the generic use is then calculated for one year. The information about annual consumption is therefore an absolute measurement of the energy consumption of a product within one product category. Energy efficiency information is depicted with a colored scale ranging from green for the best efficiency to yellow for medium efficiency to red for the worst efficiency. Furthermore, the energy efficiency scale consists of a letter ranking originally ranging from A to G, with A assigned for the most efficient products and G assigned for the least efficient products. The energy efficiency classification system varies between product categories; it is often based on a certain energy efficiency index that is, beside actual energy consumption, also influenced by other product attributes depending on the product category.

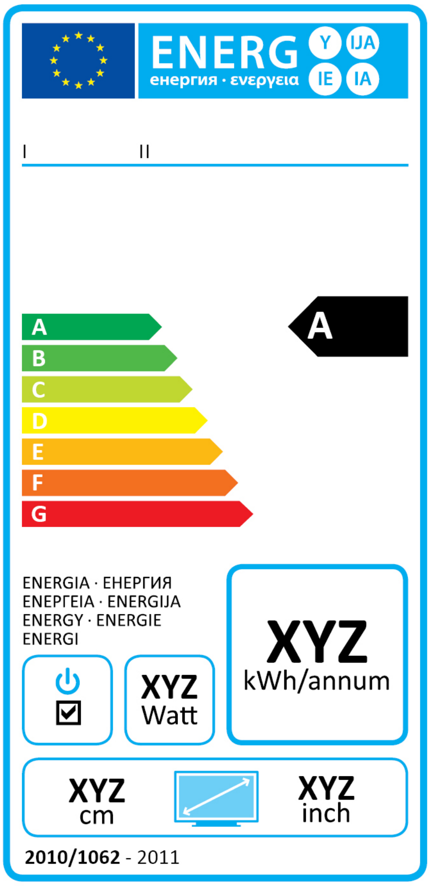


Figure 1.3. Energy label originally used for televisions.

The promotion of energy efficiency is at the core of many energy policies; thus, the energy efficiency scale also constitutes the most prominent information on the energy label. However, the interpretation of energy efficiency requires, to some extent, an understanding of the concept. Energy efficiency informs consumers about how efficiently a certain product uses its energy in relation to its size. This means that energy efficiency is relative and not absolute, which also has implications for the use and interpretation of the energy efficiency scale on the energy label. For example, for televisions, energy efficiency refers to their power consumption (wattage) per square decimeter (dm^2). Thus, a television with a large screen size (e.g., 65 inches) can be very efficient (e.g., energy efficiency rating A^{++}) but still consume more energy than a television with a smaller screen size (e.g., 48 inches) that is less energy efficient (e.g., energy efficiency rating A). Consequently, energy efficiency does not automatically imply low energy consumption, although it is often used in this sense even in political communications. For instance, the Swiss Federal Office for Energy states the following on its homepage: "It is now possible to identify the energy consumption of a television set at a glance: the energy label contains a scale indicating the efficiency categories, green = highest efficiency, red = lowest efficiency." In this statement, the differentiation between energy consumption and energy efficiency is very vague; however, for consumers, it is important to know that the energy efficiency scale on the energy label is not equivalent to absolute energy consumption and is therefore inadequate for comparing differently sized products in terms of energy-friendliness. Even for equally sized products, comparing their energy efficiency ratings might be misleading because the absolute energy consumption within the same energy efficiency rating can vary quite a bit due to the classification system (Molenbroek et al., 2014). Hence, to compare different products, the information about the actual consumption, that is, the annual consumption depicted in kilowatt hours per year (e.g., 150 kWh/annum) should be used. This technical information reflects an absolute measurement and is size-independent; however, research has shown that consumers are not very good at judging absolute energy consumption (Pierce, Schiano, & Paulos, 2010). More precisely, the estimations of the energy consumption of different products by consumers are rather imprecise and tend to underestimate consumption differences between products (Attari, DeKay, Davidson, & Bruine de Bruin, 2010). A study conducted in Japan found that consumers are not aware of electricity rates and prices (Yamamoto, Suzuki, Fuwa, & Sato, 2008). These studies suggest that consumers are rather unfamiliar with energy and energy-related information.

1.2.2 Further development of the energy label

Since the implementation of the energy label in 1992, the energy efficiency of household appliances has been increasing constantly (VZBV, 2015). This effect can be classified as a success on the part of the energy label to promote the development of energy-efficient appliances. Due to rapid technological development and the ban of inefficient products on the market, the majority of products entered the best efficiency class (A), whereas products with lower efficiency ratings were no longer available on the market. Although this increase proved that the energy label had a positive impact on the market by pushing for the development of energy-efficient products, for consumers, this meant that they were confronted with a wide selection of products that could not be further differentiated within their initial energy efficiency rating. To counter this problem, the EU decided to implement additional classes above the best efficiency rating (A) by marking products with plus signs (A^{+}, A^{++}, A^{+++}). Hence, since 2010, the energy efficiency scale for several appliances contains up to three additional A^{+} classes (European Council, 2010). The EU retained the seven-stage scale by removing classes at the other end of the scale (i.e., efficiency classes E to G). For example, for freezers and refrigerators, the energy efficiency scale now ranges from A+++ to D, whereas for coffee machines, it still ranges from A to G. The currently used labels for televisions and freezers are shown in Figure 1.4.

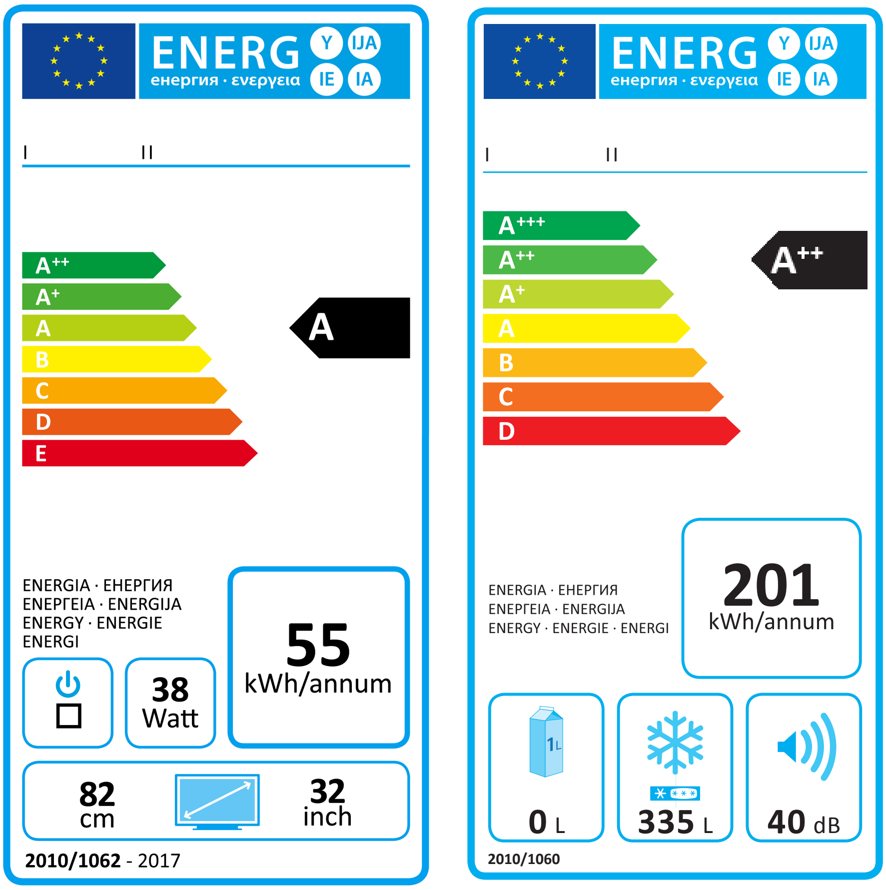


Figure 1.4. Energy labels currently used for televisions and freezers.

Several studies have shown that consumers' willingness to pay for energy efficiency decreased with the implementation of these plus classes (Heinzle & Wüstenhagen, 2012; Ölander & Thøgersen, 2014). An evaluation report of the energy labeling directive came to similar conclusions, stating that the new plus classes were not optimal in terms of promoting energy-efficient appliances (Molenbroek et al., 2014). Furthermore, market analysis shows that for most products, not all energy efficiency classes are represented on the market (VZBV, 2015). The Swiss government implemented minimal standards for the energy efficiency of certain new product categories. For example, freezers have to be classified as at least A^{++} (BFE, 2009). This means that only products from the two best energy efficiency classes are available, although the energy label still depicts the classes from A^{+++} to D. Hence, the success of the energy label has provoked a potentially confusing situation for consumers. They might not be aware of the fact that the energy efficiency scale shows efficiency classes that are not available on the market. Consequently, they might assume that choosing a product with an A^{++} rating is very energy-friendly, not realizing that it is a product with the lowest efficiency class available. In addition, it seems very likely that consumers do not differentiate between the best efficiency classes—they might just treat the efficiency rating as a sign that the energy efficiency of a product is high. This assumption seems especially likely because research has shown that consumers prefer labeling types that work as seals of approval (e.g., Energy Star) compared to information disclosure labels (Banerjee & Solomon, 2003).

1.3 Consumers' interaction with energy labels and energy-related information

1.3.1 Relevance for consumers

Labels can be helpful for consumers when it comes to assessing the environmental impact of consumer goods. Thøgersen (2005) stated that an effective label should empower consumers to make informed decisions. According to Thøgersen, labels have to fulfill three primary requirements (Thøgersen, 2005). First, producers and retailers have to use and implement the labels. This means that a label is usually more effective if it is mandatory compared to voluntary. Other studies also support this assumption, showing that strong governmental support increases the success of a label (Banerjee & Solomon, 2003; Wiel & McMahon, 2003). Second, consumers have to trust the label and the depicted information. Like the first precondition, consumers' trust is usually higher with greater governmental support (Thøgersen, 2005). Finally, consumers need the required knowledge to understand and correctly apply the label. This last point is often crucial. Consumers often claim to be familiar with certain labels, but when it comes to describing or interpreting the labels and the information depicted, many consumers show insufficient knowledge (Banerjee & Solomon, 2003). For example, a study sponsored by the American Council for an Energy-Efficient Economy (ACEEE) revealed that many information cues on the "US Label Energy Guide," a label comparable to the EU energy label, were misinterpreted, and consumers failed to correctly apply the information that was depicted (Egan, Payne, & Thorne, 2000). Moreover, the authors stated that consumers tend to use the guide as a seal of approval, similar to Energy Star. In a meta-evaluation of different US eco-labeling programs, Banarjee and Solomon (2003) concluded that consumers often struggle to interpret technical information on labels (e.g., kWh). Labels working as seals of approval are therefore generally preferred by consumers (Banerjee & Solomon, 2003). A recent evaluation of the EU energy label also showed that consumers have only partial knowledge about the label (Molenbroek et al., 2014). Although most consumers were able to identify the most efficient product via the energy efficiency scale, every fourth consumer was not. Moreover, many consumers do not clearly understand the difference between the relative rating of the energy efficiency scale and the absolute consumption in kilowatt hours (Molenbroek et al., 2014; Waide & Watson, 2013). Consequently, the identification of the most efficient product is not equivalent to the identification of the most energy-friendly product—the product with the lowest actual consumption. In sum, most consumers understand that the energy efficiency rating starts with the best rating at the top of the scale in the green shaded area, but many people lack a more profound understanding of the concept of energy efficiency and the other elements on the energy label.

1.3.2 Potential undesired consumer behavior triggered by policy tools

Ecolabels and energy efficiency standards are powerful policy tools and can be very effective in reaching energy goals; however, evaluating and monitoring the implemented measures is important to ensure that they work as intended (Wiel & McMahon, 2003). A non-optimal use and interpretation of the EU energy label could backfire and inhibit the success of energy policies. One observed effect includes so-called behavioral spillover effects, that is, effects on a behavior that were not intended by an intervention but were caused by it (Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014). Spillover effects can be positive or negative. Lanzini and Thøgersen (2014) have, for example, observed positive spillover effects from the purchase of “green” (i.e., ecolabeled or organic) products in an intervention study in Denmark. Students that were encouraged to buy green products showed more other pro-environmental behaviors, such as recycling or using public transport, compared to a control group. Negative spillover effects include a wide range of differently termed phenomena such as—in the economics literature—rebound effect. Psychological research provided an explanation for the occurrence of these effects as being caused by a moral licensing effect (Truelove et al., 2014). In environmental psychology, moral licensing refers to the feeling that one pro-environmental action gives one the license to engage in a less environmentally friendly action. For example, residents who were exposed to a water conservation campaign reduced their water consumption, but at the same time, they tended to increase their electricity consumption (Tiefenbeck, Staake, Roth, & Sachs, 2013). Moral licensing is not exclusive to environmental behavior and has been observed in various fields. In economics, the rebound effect is more specific to energy, as it describes the differences in net energy savings and increased energy efficiency. This effect is also known as the energy efficiency gap (Allcott & Greenstone, 2013). The magnitude of this gap is difficult to assess and is the subject of ongoing discussion, as the estimates by engineers are often overly optimistic in terms of potential energy savings. Further, the economic estimates depend on certain indicators, which might overlook some influential costs or benefits (Allcott & Greenstone, 2013). Nevertheless, these potential side effects can also have implications for the energy label. Moral licensing could lead to the choice of bigger products or increased usage due to a product’s excellent energy efficiency rating. For example, one could assume that as long as the energy efficiency is high, they are licensed to choose a bigger television. The reliance on the energy efficiency depicted on the energy label could therefore contribute to an increasing energy efficiency gap, delaying the decrease in final energy demand. Hence, it is worthwhile to study consumers' decision-making processes and identify potential misconceptions that could be decelerating the success of energy-saving goals.

1.4 Judgment, decision-making, and the idea of the rational consumer

1.4.1 Humans' tendency to rely on heuristics and the resulting biased decisions

The energy label provides all of the information necessary to make an informed decision and to choose a product with low energy consumption. However, human information-processing (i.e., the judgment of information provided and the subsequent decision-making process) is often not completely rational and might be biased. The reason for this behavior is that humans are susceptible to decision heuristics (Evans, 2006; Gigerenzer & Gaissmaier, 2011; Kahneman, 2011; Kahneman & Tversky, 1979; Scheibehenne, Miesler, & Todd, 2007; Tversky & Kahneman, 1974). A heuristic is a mental shortcut that is applied to reach an efficient decision. Heuristics constitute daily life and can be applied consciously or unconsciously. Whether applied on purpose or not, all heuristics neglect part of the information given.

The reliance on decision heuristics can provide both adequate and inadequate judgments (Gigerenzer & Gaissmaier, 2011). For example, the "less is more" decision rule, applied by businesspeople to differentiate between active and inactive customers by just taking into account whether they had bought something in the past few months, has been found to provide reliable results (Wubben & von Wangenheim, 2008). On the other hand, reliance on heuristics often leads to biased decisions. For example, it has been shown that for the judgment of a certain risk (e.g., the risk for a heart attack among teenagers), the availability—the ease of thinking of such events among one's own acquaintances——influences the risk assessment (Tversky & Kahneman, 1974). Consequently, whether this risk assessment is close to the correct statistical number is highly subjective. Another heuristic that has been found to influence judgment and decision-making is the affect heuristic (Slovic, Finucane, Peters, & MacGregor, 2007). The affect heuristic postulates that the affect triggered by certain pictures, attributes, or just cues that we are more familiar with can bias the decision-making process

(Slovic et al., 2007). Exact and familiar information that humans are frequently confronted with (e.g., school grades) tends to cause a stronger positive or negative affect than complex or ambiguous information (e.g., technical information). This is because the first type of information can be mapped into an affective response more easily and thus has a strong affective frame. These cues receive more weight in decision-making because the affect helps to connect them to a meaning (R. S. Wilson & Arvai, 2006). Consequently, the latter type of information is less influential in the decision-making process. As a result, decisions can be biased by the cue that is more easily mapped into an affective frame of reference because it provokes a stronger positive or negative affect. Marketers have made use of this for years, for example, by connecting positive images with cigarette consumption (Slovic et al., 2007). It has also been found that the extent to how strongly certain cues convey a symbolically significant meaning potentially biases human judgment and decision-making (Sütterlin & Siegrist, 2014). When it comes to the judgment of the energy-friendliness of behavior, the symbolically significant meaning of information cues can cause serious misperceptions. Sütterlin and Siegrist (2014) have shown that people tend to underestimate the energy consumption of an energy-friendly car (i.e., a Toyota Prius) compared to the energy consumption of a sport utility vehicle (SUV), although they were informed that the distance covered by the Prius driver was much larger than that of the SUV driver. Whether a cue is symbolically significant or not depends on various aspects, including social norms. Therefore, its symbolically significant meaning can also change over time. To summarize, the reliance on heuristics and the existence of certain misperceptions influence consumer behavior, such as when purchasing a new product.

Translating the described effects to the energy label, it seems possible that the energy label might trigger heuristic processing because some of the information depicted is more accessible and more salient than other cues. More precisely, the display of energy efficiency information with a color code and a letter rating is more familiar to consumers compared with information about actual consumption that is shown in kilowatt hours per year. Consequently, a heuristic processing of the energy label might result in a biased judgment of the energy-friendliness of different products.

1.4.2 Energy-friendly decision-making

How information is framed and presented to consumers is crucial and can determine the direction of a decision. For example, changing the default option for electricity from the local utility company from the cheapest, less environmentally friendly electricity to “green” electricity, such as water power, increases consumption of “green” electricity because people tend to stick to the default option (Pichert & Katsikopoulos, 2008). In addition, framing an identical outcome as a loss or gain can result in different choices (Davis, 1995; Gifford & Comeau, 2011; Tversky & Kahneman, 1986). Gifford and Comeau (2011) studied the influence of differently framed messages on people's intention to act on climate change. They examined the effects of sacrifice-oriented messages that emphasized fear appeals versus motivational-oriented messages that stressed a better quality of life. The results suggested that messages with a motivational orientation were much more effective. Furthermore, as pointed out in the previous section (c.f. section 1.4.1), the human tendency to apply heuristics can bias decisions due to the differing accessibility and saliency of information. In this context, very little is known about the role of the energy label. Further studies are therefore needed to investigate how consumers integrate the energy label.

However, decision-making is not only constituted by external factors but also by individual factors. One theory that has been applied extensively in environmental and social psychology in order to explain human behavior is the theory of planned behavior (Ajzen, 1991). The theory of planned behavior assumes that a behavior is determined by the intention to show this behavior, the perceived behavioral control over the behavior, and social norms and attitudes toward the behavior. A meta-analysis of the theory of planned behavior has supported the efficacy of this theory for different fields (Armitage & Conner, 2001). Many studies have investigated the influence of attitudes toward the environment on energy-friendly decisions, but they have had mixed results (Gaspar & Antunes, 2011; Thøgersen, 2000). In a review article, Brohmann,(Brohmann, Heinzle, Rennings, Schleich, & Wüstenhagen, 2009) conclude that no clear relation between attitudes toward the environment and actual environmentally friendly behavior can be determined.

Research focusing on the role of intention for behavior concluded that there often exists an intention–behavior gap (Sheeran, 2002). Therefore, researchers have tried to better understand what constitutes energy-friendly behavior by looking at the role of socio-demographic factors such as gender, education, age, and household characteristics (Kollmuss & Agyeman, 2002). Gender, educational level, and household characteristics have been identified as important variables for pro-environmentally friendly behavior, but the correlations are often weak (Teisl, Rubin, & Noblet, 2008; C. Wilson & Dowlatabadi, 2007; Yang, Solgaard, & Haider, 2015). A different research direction is in the study of the role of values for energy-friendly behavior. Schwartz (1994) suggested a value scale that could be used to predict human behavior in different fields. Steg, Perlaviciute, van der Werff, and Lurvink (2014) empirically distinguished four value types: hedonic, egoistic, altruistic, and biospheric values. Hedonic values reflect the wish to improve one's well-being and reduce one's effort. This value type has been found to be the most relevant for the prediction of environmentally related attitudes, preferences, and behaviors.

Furthermore, certain skills might be required to correctly apply the information provided to perform energy-friendly behaviors. For example, interpreting the numerical value of kilowatt hours (e.g., 120 kWh/year) might come more naturally to some people than to others. In this context, a person's numeracy level might be important. Numeracy describes one's ability to understand and process mathematical concepts and probabilities (Peters et al., 2006; Weller et al., 2013). More numerate people should derive more sense from numerical information about energy consumption and should be less susceptible to misinterpretations of the energy label. Numeracy has frequently been studied for the perception of risk and uncertainty (Keller & Siegrist, 2009), for information-processing (Keller, Kreuzmair, Leins-Hess, & Siegrist, 2014), and for choice behavior (Visschers & Siegrist, 2010). However, there is also some evidence that it might play a role in energy-friendly judgment and decision-making. For example, in a study by Attari et al. (2010), people with higher numeracy scores made more accurate estimates of the energy consumption of different electronic products.

1.5 Measuring consumer behavior

Different methods have been applied to investigate consumer behavior. In psychology, surveys (either paper-and-pencil or online) are often used to assess stated preferences by asking people to indicate their (dis-)agreement with certain items on a Likert scale. Furthermore, psychological experiments can be applied by systematically varying different variables. Observational studies, such as in a shop, or qualitative interviews with consumers are also commonly applied to study consumer behavior (Young, Hwang, McDonald, & Oates, 2010). What all these methods often lack is an objective component. Eye-tracking technology provides such an objective measurement to further understand consumer behavior by measuring the eye movements of participants during a given task. Many disciplines have applied eye tracking for hypothesis testing (Holmqvist et al., 2011); its application in social sciences, such as psychology, has grown in the past years (Mele & Federici, 2012). Eye movements can provide insights into problem-solving, cognitive loads during a certain task, and can be applied for the investigation of search strategies and information integration. The reasoning behind this application constitutes the eye–mind hypothesis (Just & Carpenter, 1976). This hypothesis states that where people look is where they pay attention. Human gaze behavior can be described with fixations (i.e., the eye stands still) and saccades (i.e., the movement of the eye between two fixations). Areas of information that were fixated more often are assumed to be informative and important to the person (Poole, Ball, & Phillips, 2005). However, the determination and interpretation of the eye-tracking parameter is not always conclusive. It depends on the research questions, the experimental design, and the researchers' interpretations. More precisely, different conclusions can be drawn from one parameter and different parameters can be used to support the same hypotheses. Therefore, eye-tracking studies are time-consuming to analyze and challenging to draw conclusive results from. Nevertheless, eye-tracking research has been found to be a helpful addition to many studies and research questions. A study by (Siegrist, Leins-Hess, & Keller, 2015) used eye tracking to assess which nutrition presentation formats are most effective. Other research investigated the influence of design features on consumers' gaze behavior (Antúnez et al., 2013).

Eye tracking is also an adequate method to detect and understand decision heuristics. Glöckner and Herbold (2011) found that people making decisions under risk tend to rely on compensatory decision rules. For hypothesis testing, they analyzed different eye-tracking parameters, such as decision time, distribution of fixations, and fixation durations. Stüttgen, Boatwright, and Monroe (2012) have shown that consumers often apply a satisfying choice rule for the choice of instant noodles by investigating their gaze behavior over different stages of the search and decision-making process.

1.6 Overview of the dissertation

This section provides an overview of the five chapters that constitute this dissertation. The dissertation begins with a general introduction. Chapter II presents indications for a so-called energy efficiency fallacy. In Chapters III and IV, the energy label and consumers' decision-making processes are investigated by means of eye tracking. Chapter V presents a modification of the energy label to accelerate energy-friendly decisions. Finally, the dissertation concludes with a general discussion.

Chapter II: The misleading effect of energy efficiency information on the perceived energy-friendliness of electric goods

In Chapter II, the insights gained by qualitative interviews with Swiss consumers indicate that consumers do not correctly use and apply the information provided on the energy label when judging the energy-friendliness of electric goods. A series of online experiments support the hypothesis of a so-called energy efficiency fallacy. This fallacy refers to people's tendency to rely on energy efficiency information and neglect other relevant information for the assessment of a product's energy-friendliness. The results suggest that this tendency to concentrate on energy efficiency information could lead to a general shift in the perception of excessively consuming household appliances. More precisely, consumers perceive the energy consumption of such products as low due to their high energy efficiency ratings.

Chapter III: Desired and undesired effect of energy labels – An eye-tracking study

The goals of Chapter III are to investigate the impact of the energy label on consumers' choices and how consumers integrated energy-related information. Furthermore, the study attempts to provide evidence for the existence of an energy efficiency fallacy triggered by the energy label. The study uses eye-tracking methodology as an objective measurement to investigate these research questions.

Chapter IV: Decision-making strategies for the choice of energy-friendly products

Understanding how an energy-friendly decision is reached is crucial for the development of helpful consumer information as well as for the improvement of existing policy tools, such as the energy label. Therefore, Chapter IV focuses on energy-friendly decision-making strategies. Participants are asked to identify the most energy-friendly product. Based on their gaze behavior, participants are allocated to three different strategies. The results show that none of the strategies were 100% successful for the identification of the most energy-friendly product.

Chapter V: Letters, signs, and colors: How the display of energy efficiency information influences consumers' assessment of a product's energy-friendliness

Chapter V presents an approach to accelerate energy-friendly decisions. Previous studies suggested that the energy label was the cause for an overdue focus on energy efficiency; however, energy efficiency as a concept is very important, as it constitutes the core of many energy policies (Bundesrat, 2013c). Furthermore, many consumers state that they take energy efficiency into account when making a decision. Hence, the question here is how the negative impact of the energy efficiency fallacy can be turned into a positive effect.

Chapter VI: General discussion

Chapter VI summarizes the main findings of the dissertation and draws conclusions based on the results. Furthermore, limitations and suggestions for further research are discussed. Finally, implications for energy policies and the development of policy tools to accelerate energy-friendly purchase decisions are provided.

References

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. doi:Doi 10.1016/0749-5978(91)90020-T

Allcott, H., & Greenstone, M. (2013). Is There an Energy Efficiency Gap? *Energy Efficiency: Towards the End of Demand Growth*, 133-161. doi:Doi 10.1016/B978-0-12-397879-0.00005-0

Antúnez, L., Vidal, L., Sapolinski, A., Giménez, A., Maiche, A., & Ares, G. (2013). How do design features influence consumer attention when looking for nutritional information on food labels? Results from an eye-tracking study on pan bread labels. *International Journal of Food Sciences and Nutrition, 64*(5), 515-527. doi:10.3109/09637486.2012.759187

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*, 471-499. doi:Doi 10.1348/014466601164939

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences, 107*(37), 16054-16059. doi:10.1073/pnas.1001509107

Banerjee, A., & Solomon, B. D. (2003). Eco-labeling for energy efficiency and sustainability: a meta-evaluation of US programs. *Energy Policy, 31*(2), 109-123. doi:http://dx.doi.org/10.1016/S0301-4215(02)00012-5

BFE. (2009). *Factsheet: Revison of the energy regulation [Faktenblatt: Revision der Energieverordnung]*. Bern.

BFS. (2014). *Population growth and size [Bevölkerungswachstum und -bestand]*. online Retrieved from http://www.bfs.admin.ch/bfs/portal/en/index/themen/01/02/blank/key/bevoelkerungsstand.html.

Brohmann, B., Heinzle, S., Rennings, K., Schleich, J., & Wüstenhagen, R. (2009). *What is driving sustainable energy consumption? A survey of the empirical literature*. 09. EEDAL. Retrieved from www.alexandria.unisg.ch/publications/51846 (accessed: 22.07.2014)

Bundesrat. (2007). *Bundesrat beschliesst neue Energiepolitik*. online Retrieved from http://www.bfe.admin.ch/energie/00588/00589/00644/index.html?lang=de&msg-id=10925.

Bundesrat. (2011). *Federal Council decides to gradually phase out nuclear energy [Bundesrat beschliesst im Rahmen der neuen energiestrategie schrittweisen Ausstieg aus der Kernenergie]*. online: Bundesamt für Energie (BFE) Retrieved from http://www.admin.ch/aktuell/00089/index.html?lang=de&msg-id=39337 (accessed: 25.12.2013).

Bundesrat. (2013a). *Communication referring to the first regulation of the energy-strategy 2050 and the popular initiative "nuclear phase out" [Botschaft zum ersten Massnahmepaket der Energiestrategie 2050 und zur Volksinitiative "Für den geordneten Ausstieg aus der Atomenergie (Atomausstiegsinitiative)"]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from https://www.admin.ch/opc/de/federal-gazette/2013/7561.pdf.

Energy Bill [Energiegesetz], (2013b).

Bundesrat. (2013c). *Federal Council communicates the energy-strategy 2050 [Bundesrat verabschiedet Botschaft zur Energiestrategie 2050]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from http://www.uvek.admin.ch/dokumentation/00474/00492/index.html?lang=de&msg-id=50123 (accessed: 25.12.2013).

Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances, (1992).

Davis, J. J. (1995). The Effects of Message Framing on Response to Environmental Communications. *Journalism & Mass Communication Quarterly, 72*(2), 285-299.
Egan, C., Payne, C. T., & Thorne, J. (2000). Interim findings of an evaluation of the U.S. EnergyGuide label.
Directive 2010/30/EU of the European Union and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, (2010).
Evans, J. B. T. (2006). The heuristic-analytic theory of reasoning: Extension and evaluation. *Psychonomic Bulletin & Review, 13*(3), 378-395. doi:10.3758/BF03193858
Gaspar, R., & Antunes, D. (2011). Energy efficiency and appliance purchases in Europe: Consumer profiles and choice determinants. *Energy Policy, 39*(11), 7335-7346. doi:10.1016/j.enpol.2011.08.057
Gifford, R., & Comeau, L. A. (2011). Message framing influences perceived climate change competence, engagement, and behavioral intentions. *Global Environmental Change-Human and Policy Dimensions, 21*(4), 1301-1307. doi:10.1016/j.gloenvcha.2011.06.004
Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*(1), 451-482. doi:doi:10.1146/annurev-psych-120709-145346
Glöckner, A., & Herbold, A.-K. (2011). An eye-tracking study on information processing in risky decisions: Evidence for compensatory strategies based on automatic processes. *Journal of Behavioral Decision Making, 24*(1), 71-98. doi:10.1002/bdm.684
Heinzle, S., & Wüstenhagen, R. (2012). Dynamic Adjustment of Eco-labeling Schemes and Consumer Choice – the Revision of the EU Energy Label as a Missed Opportunity? *Business Strategy and the Environment, 21*(1), 60-70. doi:10.1002/bse.722
Hiyama, A., Taira, W., Nohara, C., Iwasaki, M., Kinjo, S., Iwata, M., & Otaki, J. M. (2015). Spatiotemporal abnormality dynamics of the pale grass blue butterfly: three years of monitoring (2011-2013) after the Fukushima nuclear accident. *Bmc Evolutionary Biology, 15*. doi:ARTN 15
10.1186/s12862-015-0297-1
Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & van de Weijer, J. (2011). *Eye Tracking - A comprehensive guide to methods and measures*. New York: Oxford University Press.
IEA. (2009). *Gadgets and Gigawatts*: OECD Publishing.
Just, M. A., & Carpenter, P. A. (1976). Eye fixations and cognitive processes. *Cognitive Psychology, 8*(4), 441-480. doi:http://dx.doi.org/10.1016/0010-0285(76)90015-3
Kahneman, D. (2011). *Thinking, fast and slow*. London: Penguin.
Kahneman, D., & Tversky, A. (1979). Prospect Theory - Analysis of Decision under Risk. *Econometrica, 47*(2), 263-291. doi:Doi 10.2307/1914185
Keller, C., Kreuzmair, C., Leins-Hess, R., & Siegrist, M. (2014). Numeric and graphic risk information processing of high and low numerates in the intuitive and deliberative decision modes: An eye-tracker study. *Judgment and Decision Making, 9*(5), 420-432.
Keller, C., & Siegrist, M. (2009). Effect of Risk Communication Formats on Risk Perception Depending on Numeracy. *Medical Decision Making, 29*(4), 483-490. doi:10.1177/0272989x09333122
Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*(3), 239-260. doi:10.1080/13504620220145401
Lanzini, P., & Thogersen, J. (2014). Behavioural spillover in the environmental domain: An intervention study. *Journal of Environmental Psychology, 40*, 381-390. doi:10.1016/j.jenvp.2014.09.006

Mele, M., & Federici, S. (2012). Gaze and eye-tracking solutions for psychological research. *Cognitive Processing, 13*(1), 261-265. doi:10.1007/s10339-012-0499-z

Molenbroek, E., Smith, M., Groenenberg, H., Waide, P., Attali, S., Fischer, C., . . . Fong, J. (2014). *Final technical report. Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive ENER/C3/2012-523*. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

Ölander, F., & Thøgersen, J. (2014). Informing Versus Nudging in Environmental Policy. *Journal of Consumer Policy*, 1-16. doi:10.1007/s10603-014-9256-2

Peters, E., Vastfjall, D., Slovic, P., Mertz, C. K., Mazzocco, K., & Dickert, S. (2006). Numeracy and decision making. *Psychological Science, 17*(5), 407-413. doi:DOI 10.1111/j.1467-9280.2006.01720.x

Pichert, D., & Katsikopoulos, K. V. (2008). Green defaults: Information presentation and pro-environmental behaviour. *Journal of Environmental Psychology, 28*(1), 63-73. doi:10.1016/j.jenvp.2007.09.004

Pierce, J., Schiano, D. J., & Paulos, E. (2010). *Home, Habits, and Energy: Examining Domestic Interactions and Energy Consumption*. Paper presented at the CHI 2010: Home Eco Behavior, Atlanta, GA, USA.

Poole, A., Ball, L., & Phillips, P. (2005). In Search of Salience: A Response-time and Eye-movement Analysis of Bookmark Recognition. In S. Fincher, P. Markopoulos, D. Moore, & R. Ruddle (Eds.), *People and Computers XVIII — Design for Life* (pp. 363-378): Springer London.

Prognos. (2014). *Energy consumption of households 2000 - 2013 [Der Energieverbrauch der privaten Haushalte 2000 - 2013]*. Retrieved from Basel:

Reich, M. R., & Goto, A. (2015). Towards long-term responses in Fukushima. *Lancet, 386*(9992), 498-500.

Scheibehenne, B., Miesler, L., & Todd, P. M. (2007). Fast and frugal food choices: Uncovering individual decision heuristic. *Appetite, 49*, 578-589.

Sheeran, P. (2002). Intention—Behavior Relations: A Conceptual and Empirical Review. *European Review of Social Psychology, 12*(1), 1-36. doi:10.1080/14792772143000003

Siegrist, M., Leins-Hess, R., & Keller, C. (2015). Which front-of-pack nutrition label is the most efficient one? The results of an eye-tracker study. *Food Quality and Preference, 39*(0), 183-190. doi:http://dx.doi.org/10.1016/j.foodqual.2014.07.010

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Steg, L., Perlaviciute, G., van der Werff, E., & Lurvink, J. (2014). The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions. *Environment and Behavior, 46*(2), 163-192. doi:10.1177/0013916512454730

Stüttgen, P., Boatwright, P., & Monroe, R. T. (2012). A Satisficing Choice Model. *Marketing Science, 31*(6), 878-899.

Sütterlin, B., & Siegrist, M. (2014). The reliance on symbolically significant behavioral attributes when judging energy consumption behaviors. *Journal of Environmental Psychology, 40*, 259-272. doi:DOI 10.1016/j.jenvp.2014.07.005

Teisl, M. F., Rubin, J., & Noblet, C. L. (2008). Non-dirty dancing? Interactions between eco-labels and consumers. *Journal of Economic Psychology, 29*(2), 140-159. doi:10.1016/j.joep.2007.04.002

Thøgersen, J. (2000). Psychological determinants of paying attention to eco-labels in purchase decisions: Model development and multinational validation. *Journal of Consumer Policy, 23*(3), 285-313. doi:10.1023/A:1007122319675

Thøgersen, J. (2005). How May Consumer Policy Empower Consumers for Sustainable Lifestyles? *Journal of Consumer Policy, 28*(2), 143-177. doi:10.1007/s10603-005-2982-8

Tiefenbeck, V., Staake, T., Roth, K., & Sachs, O. (2013). For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy, 57*(0), 160-171. doi:http://dx.doi.org/10.1016/j.enpol.2013.01.021

Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Global Environmental Change-Human and Policy Dimensions, 29*, 127-138. doi:10.1016/j.gloenvcha.2014.09.004

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131. doi:10.2307/1738360

Tversky, A., & Kahneman, D. (1986). Rational Choice and the Framing of Decisions. *Journal of Business, 59*(4), S251-S278. doi:Doi 10.1086/296365

Visschers, V. H. M., & Siegrist, M. (2010). When reduced fat increases preference. How fat reduction in nutrition tables and numeracy skills affect food choices. *Appetite, 55*(3), 730-733. doi:10.1016/j.appet.2010.09.001

VZBV. (2015). *Market research on energy labeling of household appliances [Marktcheck zum Stand der Energieverbrauchskennzeichnung von Haushaltsgeräten]*. Retrieved from Mainz: http://www.effizienzwende.de/media/news/marktcheck-energielabel-langfassung-vzbv-vz-rheinland-pfalz-maerz-2015.pdf

Waide, P., & Watson, R. (2013). *Energy labeling - The new European energy label: Assessing consumer comprehension and effectiveness as a market transformation tool.* Retrieved from http://clasp.ngo/en/Resources/Resources/PublicationLibrary/2013/Assessing-Consumer-Comprehension-of-the-EU-Energy-Label.aspx

Weller, J. A., Dieckmann, N. F., Tusler, M., Mertz, C. K., Burns, W. J., & Peters, E. (2013). Development and testing of an abbreviated numeracy scale: A Rasch analysis approach. *Journal of Behavioral Decision Making, 26*(2), 198-212. doi:10.1002/bdm.1751

Wiel, S., & McMahon, J. E. (2003). Governments should implement energy-efficiency standards and labels—cautiously. *Energy Policy, 31*(13), 1403-1415. doi:http://dx.doi.org/10.1016/S0301-4215(02)00199-4

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annual Review of Environment and Resources, 32*(1), 169-203. doi:10.1146/annurev.energy.32.053006.141137

Wilson, R. S., & Arvai, J. L. (2006). When less is more: How affect influences preferences when comparing low and high‐risk options. *Journal of Risk Research, 9*(2), 165-178. doi:10.1080/13669870500419503

World Bank. Retrieved from http://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC

Wubben, M., & von Wangenheim, F. (2008). Instant customer base analysis: Managerial heuristics often "Get It Right". *Journal of Marketing, 72*(3), 82-93. doi:DOI 10.1509/jmkg.72.3.82

Yamamoto, Y., Suzuki, A., Fuwa, Y., & Sato, T. (2008). Decision-making in electrical appliance use in the home. *Energy Policy, 36*(5), 1679-1686. doi:10.1016/j.enpol.2008.01.022

Yang, Y., Solgaard, H. S., & Haider, W. (2015). Value seeking, price sensitive, or green? Analyzing preference heterogeneity among residential energy consumers in Denmark. *Energy Research & Social Science, 6*, 15-28. doi:http://dx.doi.org/10.1016/j.erss.2014.11.001

Young, W., Hwang, K., McDonald, S., & Oates, C. J. (2010). Sustainable consumption: green consumer behaviour when purchasing products. *Sustainable Development, 18*(1), 20-31. doi:10.1002/sd.394

CHAPTER II

THE MISLEADING EFFECT OF ENERGY EFFICIENCY INFORMATION ON PERCEIVED ENERGY FRIENDLINESS OF ELECTRIC GOODS

Signe Waechter, Bernadette Sütterlin, Michael Siegrist

Manuscript published as:

Waechter, S., Sütterlin, B., & Siegrist, M. (2015). The misleading effect of energy efficiency information on perceived energy friendliness of electric goods. *Journal of Cleaner Production, 93*(0), 193-202.

Abstract

The European Union energy label informs consumers at the point of sale about the energy efficiency and electricity consumption of various electric goods. The label should enable consumers to purchase energy-friendly products (i.e., products with low energy consumption), thereby making a significant contribution to the reduction of overall energy consumption. This paper offers a systematic analysis of consumers' interpretation of the energy label. The results of a set of experimental studies revealed that consumers tend to base their estimates of a product's energy consumption mainly on the energy efficiency class (e.g., A) communicated on the energy label and largely ignore information about annual electricity consumption (e.g., 120 kWh/year). Thereby, consumers potentially overestimate the energy friendliness of a product assigned a high energy efficiency rating. This also holds true when consumers directly compare two products in terms of energy friendliness. Thus, participants chose a higher-consuming product because it had a high energy efficiency rating. High energy efficiency ratings (e.g., A^{+++}) can distort consumers' perceptions of product categories that consume excessively (e.g., freezers). Participants were seduced into thinking that a high energy efficiency rating (e.g., A^{++}) means the energy consumption of energy hogs is no longer problematic. This paper provides evidence that the energy label could have a contrary effect than the one intended due to people's susceptibility to an energy efficiency fallacy. This misinterpretation of the energy label could further explain why overall energy demand is increasing despite enhanced energy efficiency. Finally, implications for policy makers and further research for enhancement of the energy label are discussed.

2.1 Introduction

Everyone uses electricity: To heat the coffee machine in the morning, to press the button for the elevator, and to turn the lights on in the evening. In short, electricity ensures the smooth functioning of modern society. Today, a life without electricity is unthinkable. Industries, transport systems, service providers, and the public depend on electricity. Since 2000, the demand of energy in Europe has been increasing (Eurostat, 2012). How to produce and how to use electricity have become an issue of interest internationally. Along with other European countries (e.g., Germany), Switzerland is seeking to decrease its electricity consumption, mostly through energy efficiency and voluntary curtailment behavior (Bundesrat, 2013). In Europe, energy efficiency is viewed as essential to ensure future energy supplies (European Council, 2012).

Households roughly account for 30% of total energy demands (BFE, 2013; Eurostat, 2012), with home appliances, such as televisions, freezers, and washing machines, consuming large amounts of energy. For example, according to *EnergieSchweiz* (2013), 8.7 million freezers and refrigerators are in use in Switzerland, and they consume about 2.5 billion kilowatt-hours (kWh) in one year. Considering the energy consumption of consumer electronics (e.g., televisions, laptops) and household appliances (e.g., freezers, dishwashers) worldwide, the amount of energy needed for these products is enormous. Consumers' decisions about which products to purchase strongly influence overall energy consumption. The promotion of energy-efficient appliances has substantial potential to reduce overall energy consumption. An energy label that helps consumers to make energy friendly purchase decisions when buying electrical appliances seems a promising tool for enhancing energy savings. The Council of the European Communities introduced such an energy label for various electric goods in 1992 (Council of the European Communities, 1992). In 2010, a renewal of the guidelines by the European Union (EU) standardized the energy label for various products (European Council, 2010, 2012). The label is mandatory for more than 10 product categories, such as light bulbs, kitchen devices, and consumer electronics, in more than 27 countries in Europe (European Council, 2010). However, a precondition for the efficacy of the energy label helping consumers to make more energy friendly purchase decisions (and thus reduce energy consumption) is that consumers correctly interpret the information provided on the energy label. Little is known about whether consumers correctly use the information provided. This lack of evidence for the effectiveness and evaluation of the energy label is remarkable given the broad use of the label.

2.1.1 The European Union Energy Label

By introducing the energy label, the European Parliament aimed to inform consumers about a product's energy friendliness, more precisely, about a products' performance regarding energy use. The label must be visible to consumers, which means it has to be placed on the product at the point of sale. To estimate the energy friendliness of a product, two sources of information are provided on the label: information about its energy efficiency and electricity consumption (Fig. 1 a, b). Electricity consumption is communicated as annual energy consumption in kWh and as power consumption in watts (W). Annual electricity consumption refers to generic use of the product over one year. This number (kWh/year) is calculated the same way for all products of the same type assuming the same generic use (e.g., televisions: use of 4 h per day over one year; freezers: plugged in over one year). Therefore, it can be classified as an absolute measure within one product category. Energy efficiency is expressed with the letters A to G (Fig. 2.1a). "A" indicates that a product is among the most energy efficient on the market, and "G" indicates that a product is among the least energy efficient. This schema communicates the energy efficiency performance of a product in a simple way. Energy efficiency is a measurement of how efficiently an electric product uses energy in relation to its size. For example, the energy efficiency of a television is calculated by the power consumption (W) per squared decimeter (dm^2) of the screen. Due to this calculation method, this classification system is not absolute, but relative. Thus, the energy efficiency class should only be used to compare products within the same product category (e.g., only for televisions that are the same size). This means both a small and big television can have the same energy efficiency rating (e.g., A), because they use the energy with equal efficiency per dm^2 of the screen. The actual energy consumption, however, is in this case different because they differ in size. That is, the smaller product would have lower energy consumption. Therefore, and this is the crucial point, two different-size televisions cannot be compared using the energy efficiency rating, but the actual electricity consumption should be used for a comparison. Unfortunately, this information is not clearly communicated on the energy label. The present research aims to test whether this might be a source of confusion for consumers.

Following the introduction of the energy label in 1992, the technology of electrical appliances soon outperformed the original energy efficiency rating on the energy label. More precisely, a multitude of products had top ratings (e.g., energy efficiency class A), whereas products in the lower efficiency classes were no longer available (e.g., energy efficiency class G). Consequently, the energy efficiency scale for some electrical appliances (e.g., freezers) that originally ranged from A to G changed from A to D, with additional plus markers (e.g.,

A^{++}) to signify differences between products with energy efficiency A (Fig. 2.1b). As technology advanced at different speeds for different products, the scale now differs between different types of products. For example, the scale for freezers ranges from A^{+++} to D, whereas it remains A to G for dryers.

(a) (b)

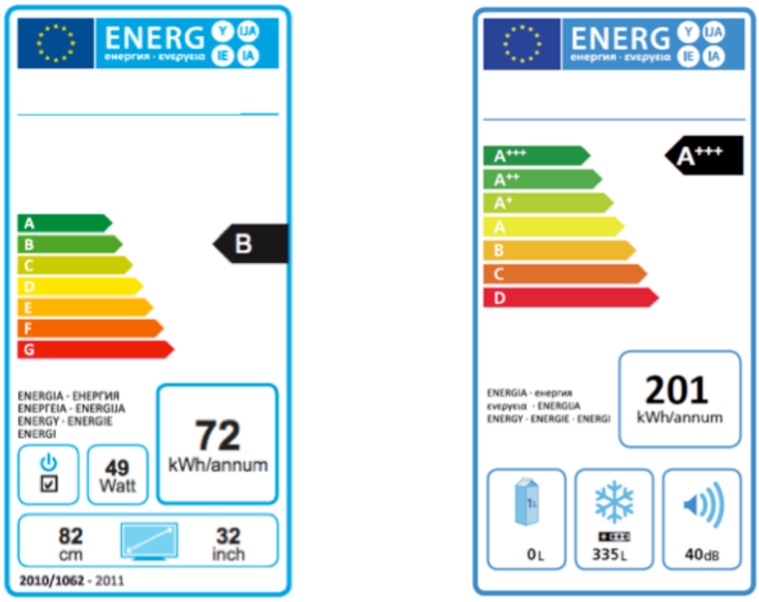


Figure. 2.1. These EU energy labels are used to inform consumers about the energy friendliness of electric goods. (a) EU energy label used for televisions with an energy efficiency scale ranging from A to G. (b) EU energy label used for freezers and refrigerators with the adopted energy efficiency scale ranging from A+++ to D.

2.1.2 Consumers' Interaction with Labels

The implementation of a label in the market raises several questions regarding the label's functionality and intended goal. There is little doubt that ecolabels can contribute to informing consumers about the environmental adequacy of a product and, thus, support sustainable purchase behavior (e.g., Thøgersen, Haugaard, & Olesen, 2010; Wang, Liu, & Qi, 2014). A study conducted in China showed that consumers generally tend to pay more attention to products that have energy efficiency labels than they do to unlabeled products (Shen & Saijo, 2009). Furthermore, some studies showed that consumers value the energy efficiency of a product quite highly and that people are willing to pay more for products with a higher energy efficiency rating (Sammer & Wüstenhagen, 2006a, 2006b). In studies of consumers' environmental attitudes, some researchers conclude that pro-environmental attitude is a positive predictor for consideration of ecolabels (Thøgersen, 2000). However, in a review article on sustainable consumption, Brohmann et al. (2009) concluded that there is no clear relation between attitude and sustainable behavior. The same held true for customers' sociodemographic characteristics: Some studies showed that such characteristics seemed to have little influence on consideration of the energy label (e.g., Mills & Schleich, 2010) whereas others suggested that low income, for example, enhanced the relevance of energy efficiency ratings (e.g., C. D. Anderson & Claxton, 1982). To sum up, the literature suggests that consumers pay attention to ecolabels, but the influence of consumers' attitude and sociodemographics on their consideration of ecolabels remains uncertain.

The characteristics of labels seem to play a role in whether consumers consider the labels during purchase decisions. For example, in a study conducted in the United States, Teisl et al. (2008) investigated the reaction of people to different information presentation formats on an ecolabel for vehicles. The researchers concluded that the information about the environmental friendliness of a vehicle should be presented relative to vehicles of the same class (e.g., a van compared to all other vans) and not only relative to a broader baseline (e.g., a van compared to all other vehicles). Regarding the EU energy label, the energy efficiency information in the current format is a relative comparison and not an absolute one. No research has been conducted to investigate whether consumers are aware of this fact and, if they are not, what this could mean for consumers' interpretation of the energy label and their decisions.

Dendler (2014) discusses the problems of existing labels and mentions that consumers often fail to grasp the detailed meaning of certain information. This is especially the case when concentrating on simplified and salient information. Studies investigating consumers' understanding of labels revealed that they often lack knowledge about the specific meaning of the information provided, which can hinder pro-environmental behavior (Vicente-Molina, Fernández-Sáinz, & Izagirre-Olaizola, 2013). Given these difficulties, it can be hypothesized that "consumers might perceive the eco-label as any other brand, placing more importance on the subjective meaning than the actual content of the label" (Pedersen & Neergaard, 2006, p. 19, p. 19).

2.1.3 Judgment and Decision Making Related to Energy Friendly Purchase Behavior

Although energy efficiency seems to be an important purchase criterion, a so-called *energy efficiency gap* exists (Jaffe & Stavins, 1994). From a psychological point of view, this effect can be subordinated to the *intention-behavior gap*, referring to the fact that, in theory, people might say, for example, they prefer green energy (Pichert & Katsikopoulos, 2008), whereas, in practice, they often buy inefficient goods or use nonrenewable energy sources (for an overview, see Kollmuss & Agyeman, 2002). This gap is rooted partly in people's tendency to apply heuristics and in their susceptibility to decision biases. More precisely, people do not always decide rationally by taking all pieces of information into account, but instead use mental shortcuts to reach decisions (e.g., Kahneman, 2011). The format and framing of information drive these decision strategies and affect consumers' purchase behavior (for an overview, see C. Wilson & Dowlatabadi, 2007). The affect heuristic postulates that attributes, pictures, or other type of information (e.g., memories) that are connected with an affect can potentially bias a decision (Slovic, Finucane, Peters, & MacGregor, 2007). The ease or precision of how a concept or an attribute can be mapped into an affective impression can provoke a positive or negative affect. People have a stronger affect towards a concept that is exact, such as one with which they are frequently confronted (e.g., school grades), than towards a concept or an attribute that is ambiguous, such as technical or numerical information (e.g., wattage) to which they are rarely exposed (Slovic et al., 2007). Consequently, these exact and unambiguous attributes have more weight in our decision making compared with concepts that have no clear affective frame (R. S. Wilson & Arvai, 2006). Applying this idea to the interpretation and use of the energy label, it may mean that people base their decisions on the letters of the energy efficiency scale, as they translate a clear good or bad response and thus are presumably linked to a stronger good or bad affect. Electricity consumption information (kWh) is rather ambiguous, and consumers might lack precise knowledge on what constitutes high or low usage with regard to kW hours. Thus, electricity-consumption information does not possess a clear affective message and might therefore receive less weight in the decision-making process. Allcott (2011) provided some support for the aforementioned assumptions, showing that consumers do not devote much attention to fuel costs and that they struggle with correctly estimating the energy costs of different vehicles. Additionally, consumers underestimate the differences in energy consumptions of different products, for example, between a laptop computer and a desktop computer (Attari, DeKay, Davidson, & Bruine de Bruin, 2010). This inability to interpret some parts of the provided information (e.g., actual electricity consumption [kWh]), together with inattention, could enforce consumers' tendency to place undue emphasis and weight on energy efficiency information while ignoring information about actual energy consumption. As a result, they may incorrectly interpret and apply the information provided on the energy label in purchase decisions and purchase products that are energy efficient but still consume a considerable amount of energy. Thus, the energy savings due to improved energy efficiency may be less than predicted. Moreover, a rebound effect could occur, that is, an increase in the overall energy consumption (Greening, Greene, & Difiglio, 2000).

2.1.4 Aims of the Present Research

The EU energy label was introduced to facilitate the purchase of energy friendly electrical appliances. The label should help consumers choose a product that consumes the least amount of electricity possible. Most research on the energy label has focused on examining whether consumers pay attention to it, how much they value the energy efficiency of a product, and which consumer characteristics predict sustainable consumption. However, a precondition for the effectiveness of the label is that consumers correctly apply it. Although policy makers rely on an effective energy label, the interaction between the energy label and consumers has not yet been systematically evaluated. Therefore, the aim of this study was to examine whether consumers correctly interpret the information provided on the energy label and whether this information helps in selecting an appliance that uses the least amount of energy. Based on the findings of previous studies on the interpretation of information provided on the label (e.g., Pedersen & Neergaard, 2006) and people's tendency to focus mainly on highly accessible attributes (e.g., Gigerenzer & Gaissmaier, 2011; Slovic et al., 2007), it seems plausible to assume that the energy efficiency class on the current energy label might drive consumers' estimation of the energy friendliness of a product because they focus mainly on the energy efficiency class while ignoring actual electricity consumption. This paper aims to show that the present label can mislead consumers' interpretations of the energy friendliness of a product, potentially resulting in the purchase of a product that performs badly in terms of energy consumption. Furthermore, it aims to demonstrate that the current energy label can even diminish the perceived environmental questionability of products that are typically seen as high energy consuming products (i.e., very environmentally unfriendly), such as freezers, which could increase the purchase and/or use of these products.

2.2 Study 1 – Detection of an Energy Efficiency Fallacy

The energy efficiency information provided on the EU energy label is a potential source of misunderstanding, because the efficiency rating is relative to the size of the product and not absolute for all products of the same category. In other words, a large TV could belong to a better energy class (e.g., A^{++}) compared with a small TV (e.g., A) even though the latter uses less energy. This means, for the interpretation of the energy efficiency rating, consumers needs to consider the size of the product (e.g., screen size for a television). Based on heuristic thinking, the authors assumed that the energy efficiency class dominates the perception of the electricity consumption and that the information about the annual consumption (kwh/year) is ignored. More precisely, the authors hypothesized that the estimated electricity consumption of electric goods would be lower for products in a better energy efficiency class, even if the more-efficient product actually consumes more electricity (kWh). Furthermore, people are expected to make comparable estimates for the electricity consumption of products that are in the same energy efficiency class, but actually consume different amounts of electricity.

As a first approach, short interviews with consumers of electric goods were conducted. The interviews indicated that consumers confuse information about energy efficiency and actual electricity consumption, and lack awareness of the relative nature of the energy efficiency scale. Hence, the qualitative interviews confirmed the hypotheses regarding the misleading effect of the energy label. In the next step, online experiments were conducted to test the hypotheses on a quantitative level.

2.2.1 Participants

An invitation to participate was sent to 300 members of an online panel administered by the authors of whom 169 completed the study. Based on the Internet protocol (IP) addresses, participants who had participated more than once were identified and only the data from the first participation were used. The final sample consisted of 166 participants. The mean age was 58 years (*SD* = 14), and their age ranged from 23 to 89 years. Of the sample, 62% participants were male, and 38% were female. In total, participants engaged in three experiments that were all thematically related to energy issues.

2.2.2 Materials and Procedures

Different energy labels for a television were designed. The television was chosen for two reasons. First, the energy label is mandatory for this product. Thus, it is reasonable to assume that people have seen it in the stores and are somewhat familiar with it. Second, the energy label for televisions is simple and contains only a few pieces of information. A realistic energy label for a television (energy efficiency: A; energy consumption: 118 kWh/year) with a screen size of 120 cm (47 inch) was taken as the starting point for constructing the study material. Two factors were manipulated: energy efficiency class (high: A vs. low: B) and actual annual electricity consumption[1] (high: 118 kWh vs. low: 72 kWh). The levels of each factor were balanced resulting in four different energy labels, respectively, in four experimental conditions: (a) Energy efficiency class A with a high electricity consumption of 118 kWh/year, (b) energy efficiency class A with a low electricity consumption of 72 kWh/year, (c) energy efficiency class B with a high electricity consumption of 118 kWh/year, and (d)

[1] The value for the annual electricity consumption of a television is based on daily use of 4 h over 1 year.

energy efficiency class B with a low electricity consumption of 72 kWh/year. All other information elements on the energy label were the same for all four conditions (Fig. 2.2).

Participants were first informed about the procedure and the topic of the survey, and they were guaranteed anonymity. After answering sociodemographic questions, participants were randomly assigned to one of the four experimental conditions. They saw a picture of a television with the respective energy label and answered the following question: “Miss Meier wants to buy herself a television and looks at different models. How high do you rate the electricity consumption of this television?” Participants had to adjust a slider on a scale ranging from 0 = *very low,* to 50 = *moderate,* to 100 = *very high*. Finally, participants were thanked for their contribution, and they received a short report about the findings as an incentive a few weeks later.

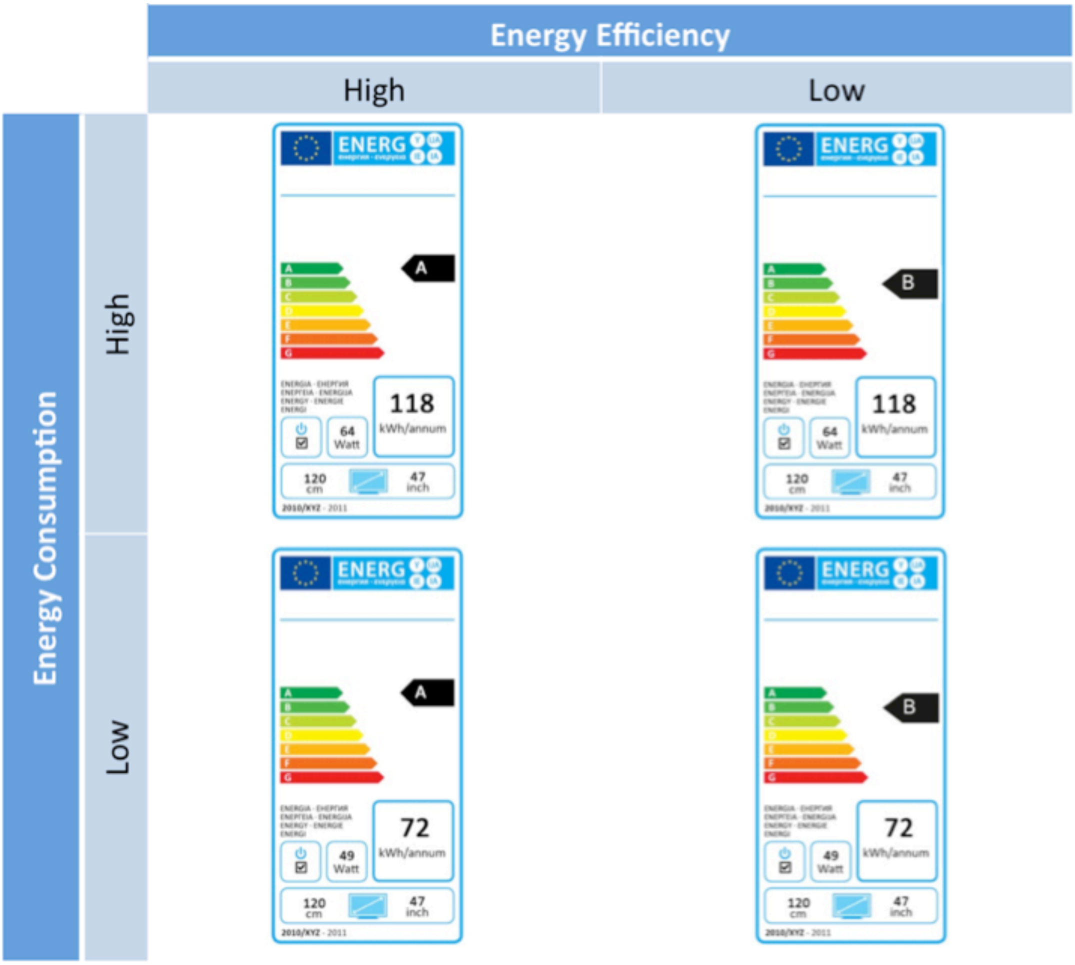


Figure 2.2. These energy labels for a television were used in Study 1 for the four experimental conditions.

2.2.3 Results and Discussion

A 2 x 2 ANOVA was conducted with the between-subject factors energy efficiency class (high = A vs. low = B) and actual annual electricity consumption (high = 118 kWh/year vs. low = 72 kWh/year) and with the dependent variable electricity consumption estimation. The results of the ANOVA are presented in Table 2.1. Only the main effect of the factor energy efficiency class was significant whereas the main effect of the factor annual electricity consumption and the interaction between the two factors were not significant.

Table 2.1

Results of the Two-Way Analysis of Variance for Energy Efficiency Class and Annual Electricity Consumption on Estimated Electricity Consumption.

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Energy Efficiency Class	1	20227.11	20227.11	48.37	<.001	.230
Annual Electricity Consumption	1	0.47	0.47	0.00	.973	.000
Efficiency x Consumption	1	808.29	808.29	1.93	.166	.012
Error	162	67735.67	418.12			

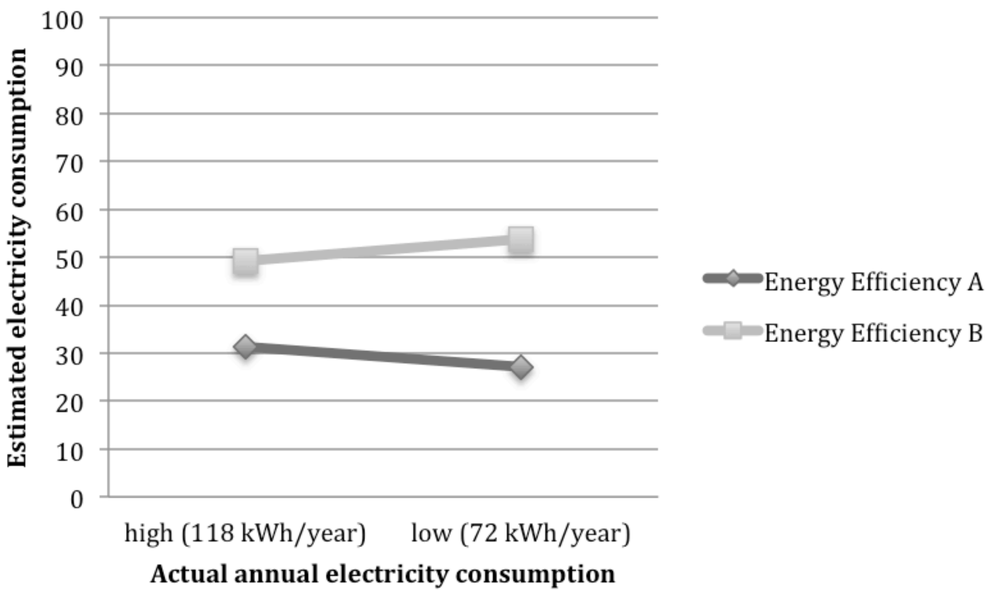


Figure 2.3. The graph shows the estimated electricity consumption for a television as a function of actual annual electricity consumption (high vs. low) and energy efficiency class (A vs. B).

To further investigate the significant main effect of the factor energy efficiency class, a simple main-effect analysis was conducted. This analysis separately tested the effect of energy efficiency class (A vs. B) on the two levels of the factor annual electricity consumption (high vs. low) (Fig. 2.3). Results provided further support for our hypothesis, showing that on the individual levels of the factor electricity consumption the effect of the energy efficiency label (A vs. B) was significant, $F(1, 162) = 15.11$, $p > .001$ (electricity consumption: high) and $F(1, 162) = 35.71$, $p > .001$ (electricity consumption: low). This means people judged the electricity consumption of a television based on the efficiency class despite differences in actual electricity consumption (kWh). Thus, a television with a good efficiency rating (i.e., A) is automatically associated with low energy consumption, and a television with a worse efficiency rating (i.e., B) is perceived as a product that consumes a lot of energy. This effect will henceforth be termed the *energy efficiency fallacy*. According to the evaluability hypothesis (Hsee, 1996, 1998), a possible explanation might be that energy efficiency information is easier to evaluate independently without having the possibility of comparing different options compared to the information about electricity consumption. Several studies showed that consumers have only a little knowledge about electricity consumption (e.g., Yamamoto, Suzuki, Fuwa, & Sato, 2008). Thus, participants might have struggled with whether the presented number of kWh/year was high or low.

When thinking about real purchase situations, it has to be investigated whether the effect of ignoring information about the actual electricity consumption (kWh/year) still emerges when people can compare two products and, therefore, have the opportunity to directly compare the number of kilowatt-hours. If the evaluability hypothesis held true, in this case the participants would be able to identify the more energy friendly product.

Furthermore, it could be argued that electricity consumption might be of low interest in the case of entertainment goods as other features are more important (i.e., technical features, design) to consumers. Therefore, it has to be investigated whether this effect can also be found for other product categories that are generically associated with a high use of energy (e.g., freezer) and have less emotional value.

2.3 Study 2 – Validation of the Energy Efficiency Fallacy

The aim of Study 2 was to investigate whether the energy efficiency fallacy also emerges when people are confronted with two products at the same time, enabling them to directly compare the values of the product features. Furthermore, Study 2 aimed at providing evidence that the energy efficiency fallacy also holds true for product categories of less emotional value.

2.3.1 Participants

An invitation to participate was sent to 330 members of an online panel provided by a market research institute (*Respondi*). Data were collected from June 3 to June 7, 2013. The participants received an incentive for their participation (CHF 3 ≈ EUR 2.50). In total, 326 individuals completed the survey. The same procedure as in Study 1 was used to ensure that nobody participated twice in the study. Additionally, 21 participants who spent less than 3 minutes on the entire study were deleted, because it can be assumed that in this case participants did not fulfill the task seriously. The final sample (n = 305) consisted of 161 men (53%) and 144 women (47%). The mean age was 47 years (SD = 13), and age ranged from 18 to 70 years. Before the experiment started, participants answered questions related to a different study thematically unrelated to the study presented here.

2.3.2 Materials and Procedures

Descriptions of two televisions and two freezers were used. The descriptions contained information usually provided in the store (television: e.g., display technology, configurations; freezer: e.g., volume, hours of safe storage by power failure) and the corresponding energy label. The two televisions differed in energy efficiency class, size, and annual electricity consumption (kWh/year). Two televisions with conflicting performances regarding energy efficiency and actual electricity consumption were chosen. That is, the larger television (screen size = 47 in) had an energy efficiency rating of A^{+} but had high electricity consumption of 118 kWh/year, and the smaller television (screen size = 32 inch) had an energy efficiency rating of B but had lower electricity consumption of 72 kWh/year. Similar testing material was prepared for two freezers. The bigger freezer (volume = 335 l) consumed 191 kWh/year and was classified as A^{+++} regarding energy efficiency. The smaller freezer (volume = 90 l) had an annual electricity consumption of 144 kWh and was categorized as A^{++} regarding energy efficiency. All labels used for this study were chosen from existing energy labels for televisions and freezers, and were not altered. This means the products presented to the participants and, consequently, the corresponding energy labels were realistic and could have been found on the market when the survey took place.

In the first task, participants were presented the two televisions and were asked which television they would recommend to a person with high energy consciousness. Participants were not asked to choose a product for themselves to ensure that they would not base their decision on personal preferences (i.e., size of the screen) and would not make tradeoffs regarding energy efficiency (i.e., in relation to the size of the television). The two products were presented simultaneously side by side on one page. The presentation order of the two products changed randomly between the subjects to control for possible order effects. The second task was identical to the first task except that participants had to choose a freezer instead of a television.

2.3.3 Results and Discussion

Frequency analysis revealed that 44.6% of the sample recommended the television with the higher energy efficiency class but with higher actual electricity consumption (Fig. 2.4). In the freezer choice task, 72.8% of the participants chose the freezer with the higher energy efficiency class but higher actual electricity consumption (Fig. 2.5). Overall, only 20.7% of all participants in both tasks chose the product with lower electricity consumption. Results suggest that a majority of the participants based their decision on the energy efficiency information. The difference in the percentages for the TV and freezer tasks might be due to the different emotional attachment to these products. A television fulfills various functions (e.g., status symbol, symbol of affinity for technology of its owner) in addition to its actual purpose (i.e., transmitting moving images) whereas a freezer keeps its actual purpose as a cooling unit. People might spend more time on and evaluate more information for a product they are emotionally attached to, which can explain the higher number of correct answers in the television task.

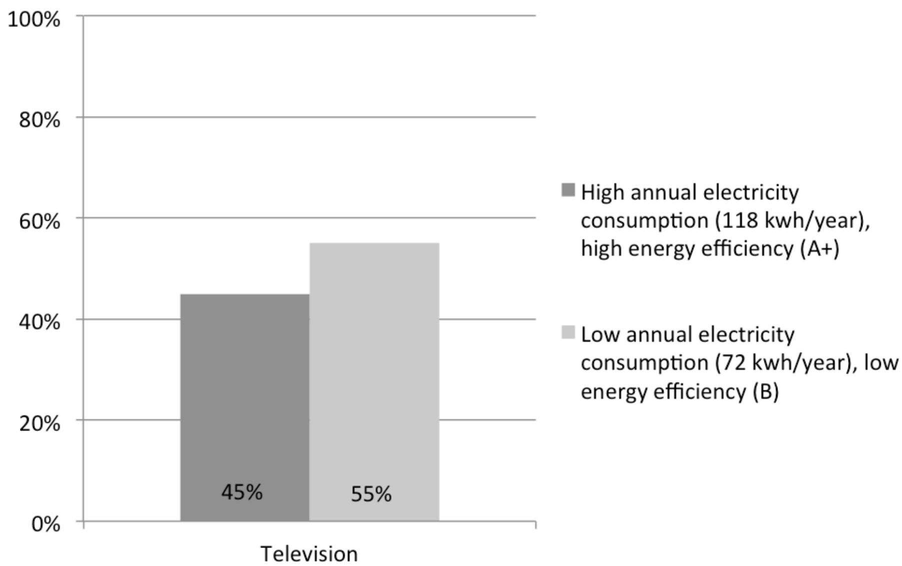


Figure 2.4. The graph shows the distribution of participants' television recommendation for an energy-friendly person.

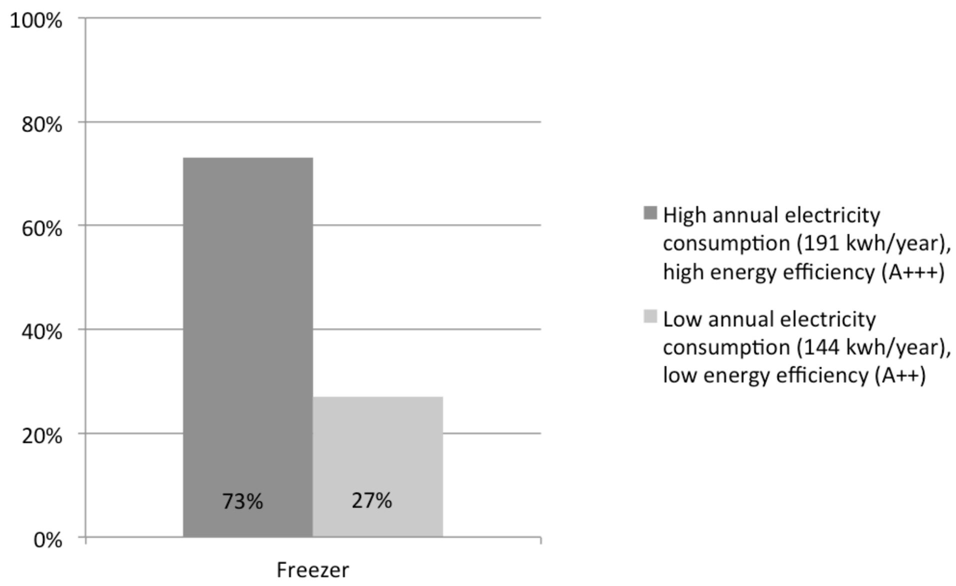


Figure 2.5. The graph shows the distribution of participants' freezer recommendation for an energy-friendly person.

It seems plausible to assume that people were differently motivated to evaluate the energy label and might therefore integrate more or less information in their decision. The amount of information integrated can be indirectly measured using response time. A person who evaluates more information presumably needs more time for the decision. This assumption was tested using independent *t*-test with response time as the dependent variable. For the TV choice task, the difference in the response time of the two TV choice groups, namely, the ones choosing the higher consuming product (M = 57.18, SD = 55.08) and the ones choosing the lower consuming product (M = 66.00, SD = 57.69), did not reach significance, $t(303)$ = 1.36, p = .089 (one-tailed), d = .16. For the freezer choice task, however, the response time of the two freezer choice groups differed significantly, $t(106)$ = 2.92, p = .002 (one-tailed), d = .41. Participants who chose the freezer with higher electricity consumption answered significantly quicker (M = 36.66, SD = 28.95) than participants who chose the freezer with lower electricity consumption (M = 52.75, SD = 46.93). In the TV task, participants who chose the lower consuming television and those who chose the higher consuming television spent an equal amount of time on the decision. With this in mind, the number of incorrect answers (45%) in the TV task is even more concerning. However, it might explain why more participants chose correctly in the TV task compared with the freezer task. These findings indicate that the amount of information integrated in decision making (assessed by the time spent on finding the answer) might influence whether information on actual energy consumption is considered or not.

The evaluability hypothesis (Hsee, 1996, 1998) can be eliminated as a possible explanation for the fallacy. According to the evaluability hypothesis, participants should have chosen correctly in the setting of Study 2, because they had the opportunity to directly compare the information provided, and thus evaluability was given for the energy efficiency as well as for the electricity consumption information. Consequently, whether consumers consider the information depends neither on the evaluability of the information nor on the possibility of comparison. The findings suggest that energy efficiency information is more strongly anchored in consumers' mindsets and consumers might rely on a different decision strategy.

2.4 Study 3 – Impact of the Energy Efficiency Fallacy

People's focus on energy efficiency information could even result in an overestimation of the energy friendliness of an entire product category that generally stands for high energy consumption (e.g., freezer). If the energy efficiency fallacy also occurs when comparing the energy consumption of products of different product categories – one representing high and one representing low energy-consuming goods – the energy friendliness of the energy-intensive category could generally be overestimated. Finding an effect for such a comparison would show the severity of the misleading effect of energy efficiency information on estimated electricity consumption. The investigation of this issue was the subject of this study.

2.4.1 Participants

The same sample as in Study 1 was used for Study 3, as part of the same online survey.

2.4.2 Materials and Procedures

In this study, a refrigerator was contrasted with a freezer because freezers represent a product category generally associated with high electricity consumption. Refrigerators, however, consume clearly less electricity, but are comparable in terms of technical conditions (e.g., always on the grid, cooling function). Thus, comparing these two products provides a clear reference point for participants' estimation of electricity consumption.

The testing material consisted of a picture of a refrigerator and a freezer with the corresponding energy labels. The two products were presented simultaneously side by side on one page. Existing energy labels for a refrigerator and a freezer were chosen. The energy label of the freezer was altered in terms of the energy efficiency class, resulting in two experimental conditions: (a) a freezer with high energy efficiency (A^{+++}) and high actual electricity consumption (201 kWh/year) and (b) a freezer with low energy efficiency (A^{+}) and high actual electricity consumption (201 kWh/year). Figure 2.6 presents the two experimental conditions; condition (a) represents the performance of the freezer regarding energy efficiency information and actual energy consumption as indicated on the existing label. The label of the refrigerator which was presented in each condition next to the freezer was always the same: high energy efficiency (A^{+++}) and low actual electricity consumption (119 kWh/year); that is, the information on the refrigerator label was not modified. In experimental condition (a), the energy efficiency class of the freezer was the same as that of the refrigerator (A^{+++}); however, the actual electricity consumption was higher (201 vs. 119 kWh/year). In condition (b), the energy efficiency class of the freezer was lower than that of the refrigerator (A^{+} vs. A^{+++}), and the actual electricity consumption was higher (201 vs. 119 kWh/year). Participants were asked to rate how much electricity the freezer consumed compared to the refrigerator using a slider. The answer scale ranged from 0 = *consumes much less*, to 50 = *consumes about the same,* to 100 = *consumes much more*. To ensure that participants understood the task correctly, a control condition was included. In the control condition, the information provided on the energy label of the freezer (A^{+++}, 122 kWh/year) was comparable to that of the refrigerator (A^{+++}, 119 kWh/year). Assuming correct understanding of the task, participants were expected to rate the energy consumption of the freezer as equivalent to that of the refrigerator. Findings confirmed that participants understood the task correctly.[2]

Hypothesizing that the energy efficiency class determines how the electricity consumption of a freezer in relation to a refrigerator is perceived, the following results were expected: The electricity consumption in condition (a) (high efficiency) should be rated lower compared with condition (b) (low efficiency) as we expected the participants to mainly consider the energy efficiency class for their estimation. Thus, in condition (a), the estimate of the electricity consumption of the freezer relative to the fridge should approach the level of the refrigerator.

Participants were randomly assigned to one of the two experimental conditions or the control condition. A few weeks later, participants received a short report about the findings as an incentive.

[2] Results suggest that participants understood the task correctly as they rated the energy consumption of the freezer in relation to the refrigerator as equally (i.e., $M \approx 50$), $M = 51.53$ ($SD = 16.77$).

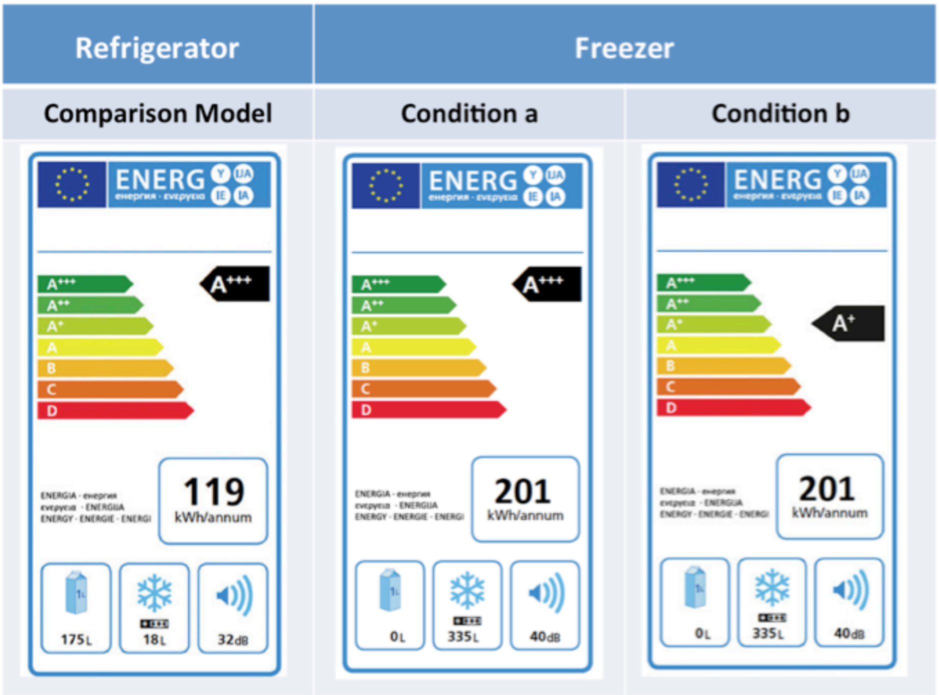


Figure 2.6. Freezer and refrigerator EU energy labels with the adopted energy efficiency scale ranging from A^{+++} to D. These labels were used as stimulus material in Study 3.

2.4.3 Results and Discussion

To test the assumptions concerning the electricity consumption rating of a freezer in relation to a refrigerator, an independent *t*-test (one-tailed) with the factor experimental condition as the independent variable and the electricity consumption rating as the dependent variable was conducted. There was a significant difference in the electricity consumption ratings between the two experimental conditions, $t(106) = 2.10$, $p = .020$, $d = .40$. The electricity consumption of the freezer in relation to that of the refrigerator was rated significantly lower if it was assigned a A^{+++} efficiency rating (condition a), $M = 67.20$ ($SD = 27.32$), than if it had a A^{+} efficiency rating (condition b), $M = 77.07$ ($SD = 21.26$), even though the actual electricity consumption of the two freezers was the same (Fig. 2.7). This result shows that the energy efficiency fallacy might distort the perceived electricity consumption (i.e., energy friendliness) of a product category that generally consumes an excessive amount of energy. This finding strengthens the hypothesis that the energy efficiency class is used as the basis for judgments, although participants could have compared the information on actual electricity consumption (kWh/year). Thus, the energy efficiency class A^{+++} seduced participants into thinking that the freezer consumes almost the same as the refrigerator, although the electricity consumption was still considerably higher.

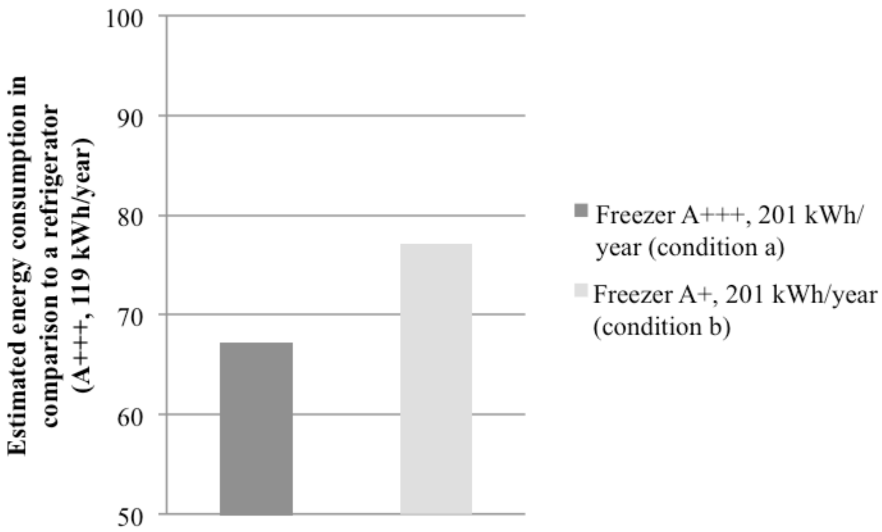


Figure 2.7. The graph shows the estimated energy consumption of a freezer compared with a refrigerator (A+++, 119 kWh/year) for the two experimental conditions. Scale range: 0 = *consumes much less*, 50 = *consumes about the same*, 100 = *consumes much more*.

2.5 General Discussion

The EU energy label is one of the main pillars for reducing overall energy consumption and enhancing consumers' sustainable consumption. The label is mandatory for different products, such as freezers and televisions, in many European countries (Directive 2010/30/EU). Despite its widespread use, the way in which consumers apply the information provided on the label and the psychological and, subsequently, economical (side) effects of their interpretation have not been systematically investigated.

2.5.1 The Energy Efficiency Fallacy

As demonstrated in this paper, serious problems in consumers' decision making may be triggered by this energy label. A set of experiments highlighted the potentially misleading effect of the label and the provided energy efficiency information when estimating the energy friendliness of electric goods. A single evaluation task (Study 1) showed that participants deduced the energy consumption (i.e., the energy friendliness) of a television mainly from the energy efficiency information, thereby largely ignoring information on actual electricity consumption. This holds true even if participants have the opportunity to compare all the information presented on the energy label to a reference point, and thus the ease of evaluation of the two informational attributes is equal (Study 2). This strategy is problematic, as the energy efficiency class provides only relative information about the energy consumption, respectively, the energy friendliness of a product. Consequently, people could end up buying a television that consumes more energy because they assume that a high energy efficiency rating automatically implies low energy consumption. This energy efficiency fallacy could be one reason for the current trend towards larger products which led to an increase in absolute energy consumption (Molenbroek et al., 2014).

The energy efficiency fallacy is not exclusive to a certain product range but applies to different product categories, including products that are stereotypes for excessively consuming products (e.g., freezers). Moreover, the energy efficiency fallacy may result in an overestimation of the energy friendliness of high consuming products and, consequently, may create the impression that their energy consumption is less problematic as they are classified as energy efficient (Study 3). This means that, due to a good energy efficiency rating, consumers could feel licensed to buy products that are energy hogs (e.g., freezer, dryer). Participants fail to readjust their first judgment caused by the energy efficiency rating sufficiently. This behavior reflects heuristic decision making. In line with the affect heuristic, the information about energy efficiency serves as the affective cue due to its salience (i.e., color-code schema) and the ease of interpretation (i.e., simple letter coding, e.g., A to G). Thus, the high energy efficiency rating of a product, such as the television with an energy efficiency rating "A" in Study 1, provokes a positive affect that persists in people's minds and dominates their estimates of energy friendliness and electricity consumption. Other type of information with less affective connotation is not sufficiently integrated in the decision-making process.

The strength of the misleading effect of the energy label presumably varies between consumers and between product types. Consumers' characteristics, such as attitudes, technological affinity, knowledge, and sociodemographic background (e.g., income, job situation), might alter the influence of energy efficiency information on the judgment of the energy friendliness of a product, the extent and direction of the information search, and, consequently, purchase decisions (for an overview, see Abrahamse, Steg, Vlek, & Rothengatter, 2005).

2.5.2 Limitations

Certain limitations of this study should be noted. The choices in the experiments reported here were hypothetical and may not fully reflect real purchase situations. The authors of the present paper do not make any predictions of how often consumers are confronted with situations comparable to those used in the experiments described in this paper. Other attributes might constitute, respectively, restrict consumers' consideration set. For example, they could choose only between freezers of the same size due to space limitations. However, it is plausible to assume that for some products, such as televisions, consumers have not yet decided on a size. Moreover, the price is often one of the most important purchase criteria (R. C.

Anderson & Hansen, 2004; Sonnenberg, Erasmus, & Schreuder, 2014). The price is not only influenced by the size of the product, but also by other factors, such as brand, energy efficiency and technical features. Consumers' consideration sets might therefore contain products of similar prices, but of different sizes. Thus, consumers would be in a choice situation as hypothesized in the studies reported here.

In a real purchase situation, consumers might possibly use a different strategy to evaluate the energy label. For example, they could ask salespeople for clarification (e.g., Sammer & Wüstenhagen, 2006b). However, there is little reason to assume that the psychological effects of the energy label detected in this paper only appear in an experimental setting and not in real life. Especially, because the energy labels (i.e., the cues) used in the experiments presented here are realistic and are identical to those of products currently available on the market. Thus, a strong relation to reality was ensured in all three experiments. This means consumers are plausibly confronted with similar energy labels and, consequently, with products with potentially conflicting performances regarding the energy efficiency class and actual energy consumption in a typical purchase situation. Hence, consumers might show similar decision-making processes and behavior.

Finally, this research was conducted with an online panel, and participants may be better-educated and more interested in the topic compared with the general population. This means the effect may have been underestimated in the experiments. Therefore, more research is required to assess the dispersion of the energy efficiency fallacy.

2.5.3 Conclusions and Implications

Europe strives towards reducing energy consumption. A key approach to achieve this goal is the more efficient use of energy. Unintended effects of implemented measures, such as biased decision making due to the misinterpretation of the energy label, can seriously delay or even impede the aspired energy goals.

The present studies help explain the increase in overall energy consumption by systematically investigating consumers' interpretation and use of the energy label, one of the most important policy tools for reaching energy goals. Results suggest that due to consumers' susceptibility to the energy efficiency fallacy triggered by the current energy label, consumers might purchase products that are in fact not as energy-friendly as they might think. Moreover, the energy label might result in a rebound effect (Greening et al., 2000) as people could assume that purchasing larger and/or more electric goods is no longer problematic if they are assigned a high-efficiency rating. Subsequently, they might buy larger appliances, use them more frequently, and/or replace products more often. Thus, the expected benefit of the energy label might be neutralized, or absolute energy consumption might even be increased.

Therefore, the findings of the present paper suggest that the energy efficiency fallacy needs to be tackled to lead consumers toward sustainable purchase behavior. Information about actual energy consumption on the energy label needs to become more accessible and of equal value to energy efficiency information. A study investigating labeling of carbon footprints in the tourism sector, for example, has shown that a combination of color and factual information facilitates comprehensibility (Gössling & Buckley, 2014). Regarding the energy label, actual energy consumption (e.g., kwh/year) could be communicated additionally with color coding (e.g., traffic light). Studies in the food domain suggest that traffic lights help consumers to better understand the information and constitute a consumer-friendly presentation format for nutritional information (e.g., Siegrist, Leins-Hess, & Keller, 2015). This idea could also be applied to the energy efficiency scale to stress the differences within the best categories. In the case of the freezer, for example, all currently available products are colored green and have plus-markers (e.g., A^{+++}). This means the energy label presents energy efficiency classes that are no longer available on the market. This might further mislead consumers and impede energy savings. Reducing the energy efficiency scale into a three-stage traffic light (e.g., red – orange – green) could facilitate the meaning of the scale.

Several questions remain unanswered and should be addressed in future studies. The assumption that the energy efficiency information on the energy label acts as an affective cue due to its salience and evaluability provides a plausible explanation for the energy efficiency fallacy. However, as these experiments did not measure affect, further research should be conducted to confirm the assumption about the role of affect. Moreover, in-depth interviews with consumers could provide helpful insights regarding the reasons for the fallacy.

Acknowledgment

This study was funded by the Swiss Federal Office of Energy (SFOE). Further, the authors would like to kindly thank editor Rodrigo Lozano and three anonymous reviewers for their valuable feedback and suggestions on an earlier draft.

References

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology, 25*(3), 273-291. doi:http://dx.doi.org/10.1016/j.jenvp.2005.08.002

Allcott, H. (2011). Consumers' perceptions and misperceptions of energy costs. *American Economic Review, 101*(3), 98-104. doi:10.1257/aer.101.3.98

Anderson, C. D., & Claxton, J. D. (1982). Barriers to consumer choice of energy efficient products. *Journal of Consumer Research, 9*(2), 163-170. doi:10.2307/2489125

Anderson, R. C., & Hansen, E. N. (2004). The impact of environmental certification on preferences for wood furniture: A conjoint analysis approach. *Forest Products Journal, 54*(3), 42-50.

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences, 107*(37), 16054-16059. doi:10.1073/pnas.1001509107

BFE. (2013). *Swiss energy statistics 2012 [Schweizerische Gesamtenergiestatistik 2012]*. Retrieved from Bern:

Brohmann, B., Heinzle, S., Rennings, K., Schleich, J., & Wüstenhagen, R. (2009). *What is driving sustainable energy consumption? A survey of the empirical literature*. 09. EEDAL. Retrieved from www.alexandria.unisg.ch/publications/51846 (accessed: 22.07.2014)

Bundesrat. (2013). *Federal Council communicates the energy-strategy 2050 [Bundesrat verabschiedet Botschaft zur Energiestrategie 2050]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from http://www.uvek.admin.ch/dokumentation/00474/00492/index.html?lang=de&msg-id=50123 (accessed: 25.12.2013).

Dendler, L. (2014). Sustainability meta labelling: an effective measure to facilitate more sustainable consumption and production? *Journal of Cleaner Production, 63*(0), 74-83. doi:/10.1016/j.jclepro.2013.04.037

EnergieSchweiz. (2013). *Energy label for cooling and freezing appliances [Energieetikette für Kühl- und Gefriergeräte]*. EnergieSchweiz Retrieved from http://www.bfe.admin.ch/energieetikette/00887/00891/index.html?lang=de&dossier_id=05364.

Directive 2010/30/EU of the European Union and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, (2010).

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (2012).

Eurostat. (2012) Energy, transport and environment indicators. Luxembourg: Publications Office of the European Union.

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*(1), 451-482. doi:doi:10.1146/annurev-psych-120709-145346

Gössling, S., & Buckley, R. (2014). Carbon labels in tourism: persuasive communication? *Journal of Cleaner Production*(0). doi:http://dx.doi.org/10.1016/j.jclepro.2014.08.067

Greening, L. A., Greene, D. L., & Difiglio, C. (2000). Energy efficiency and consumption — the rebound effect — a survey. *Energy Policy, 28*(6–7), 389-401. doi:10.1016/S0301-4215(00)00021-5

Hsee, C. K. (1996). The evaluability hypothesis: An explanation for preference reversals between joint and separate evaluations of alternatives. *Organizational Behavior and Human Decision Processes, 67*(3), 247-257. doi:10.1006/obhd.1996.0077

Hsee, C. K. (1998). Less is better: when low-value options are valued more highly than high-value options. *Journal of Behavioral Decision Making, 11*(2), 107-121. doi:10.1002/(SICI)1099-0771(199806)11:2<107::AID-BDM292>3.0.CO;2-Y

Jaffe, A. B., & Stavins, R. N. (1994). The energy-efficiency gap What does it mean? *Energy Policy, 22*(10), 804-810. doi:10.1016/0301-4215(94)90138-4

Kahneman, D. (2011). *Thinking, fast and slow*. London: Penguin.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*(3), 239-260. doi:10.1080/13504620220145401

Mills, B., & Schleich, J. (2010). What's driving energy efficient appliance label awareness and purchase propensity? *Energy Policy, 38*(2), 814-825. doi:http://dx.doi.org/10.1016/j.enpol.2009.10.028

Molenbroek, E., Smith, M., Groenenberg, H., Waide, P., Attali, S., Fischer, C., . . . Fong, J. (2014). *Final technical report. Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive ENER/C3/2012-523*. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

Pedersen, E. R., & Neergaard, P. (2006). Caveat emptor – let the buyer beware! environmental labelling and the limitations of 'green' consumerism. *Business Strategy and the Environment, 15*(1), 15-29. doi:10.1002/bse.434

Pichert, D., & Katsikopoulos, K. V. (2008). Green defaults: Information presentation and pro-environmental behaviour. *Journal of Environmental Psychology, 28*(1), 63-73. doi:10.1016/j.jenvp.2007.09.004

Sammer, K., & Wüstenhagen, R. (2006a). The influence of eco-labelling on consumer behavior - a discrete choice experiment for the purchase of light bulbs [Der Einfluss von Öko-Labelling auf das Konsumentenverhalten - ein Discret Choice Experiment zum Kauf von Glühbirnen]. In Reinhard Pfriem, Ralf Antes, Klaus Fichter, Martin Müller, Niko Paech, Stefan Seuring, & B. Siebenhüner (Eds.), *Innovationen für Nachhaltige Entwicklung*. Wiesbaden: Deutscher Universitätsverlag.

Sammer, K., & Wüstenhagen, R. (2006b). The influence of eco-labelling on consumer behaviour – results of a discrete choice analysis for washing machines. *Business Strategy and the Environment, 15*(3), 185-199. doi:10.1002/bse.522

Shen, J., & Saijo, T. (2009). Does an energy efficiency label alter consumers' purchasing decisions? A latent class approach based on a stated choice experiment in Shanghai. *Journal of Environmental Management, 90*(11), 3561-3573. doi:10.1016/j.jenvman.2009.06.010

Siegrist, M., Leins-Hess, R., & Keller, C. (2015). Which front-of-pack nutrition label is the most efficient one? The results of an eye-tracker study. *Food Quality and Preference, 39*(0), 183-190. doi:http://dx.doi.org/10.1016/j.foodqual.2014.07.010

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Sonnenberg, N. C., Erasmus, A. C., & Schreuder, A. (2014). Consumers' preferences for eco-friendly appliances in an emerging market context. *International Journal of Consumer Studies, 38*(5), 559-569. doi:10.1111/ijcs.12120

Teisl, M. F., Rubin, J., & Noblet, C. L. (2008). Non-dirty dancing? Interactions between eco-labels and consumers. *Journal of Economic Psychology, 29*(2), 140-159. doi:10.1016/j.joep.2007.04.002

Thøgersen, J. (2000). Psychological determinants of paying attention to eco-labels in purchase decisions: Model development and multinational validation. *Journal of Consumer Policy, 23*(3), 285-313. doi:10.1023/A:1007122319675

Thøgersen, J., Haugaard, P., & Olesen, A. (2010). Consumer responses to ecolabels. *European Journal of Marketing, 44*(11), 1787 - 1810.

Vicente-Molina, M. A., Fernández-Sáinz, A., & Izagirre-Olaizola, J. (2013). Environmental knowledge and other variables affecting pro-environmental behaviour: comparison of university students from emerging and advanced countries. *Journal of Cleaner Production, 61*(0), 130-138. doi:http://dx.doi.org/10.1016/j.jclepro.2013.05.015

Wang, P., Liu, Q., & Qi, Y. (2014). Factors influencing sustainable consumption behaviors: a survey of the rural residents in China. *Journal of Cleaner Production, 63*(0), 152-165. doi:http://dx.doi.org/10.1016/j.jclepro.2013.05.007

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annual Review of Environment and Resources, 32*(1), 169-203. doi:10.1146/annurev.energy.32.053006.141137

Wilson, R. S., & Arvai, J. L. (2006). When less is more: How affect influences preferences when comparing low and high ‐ risk options. *Journal of Risk Research, 9*(2), 165-178. doi:10.1080/13669870500419503

Yamamoto, Y., Suzuki, A., Fuwa, Y., & Sato, T. (2008). Decision-making in electrical appliance use in the home. *Energy Policy, 36*(5), 1679-1686. doi:10.1016/j.enpol.2008.01.022

CHAPTER III

DESIRED AND UNDESIRED EFFECTS OF ENERGY LABELS – AN EYE-TRACKING STUDY

Signe Waechter, Bernadette Sütterlin, Michael Siegrist

Manuscript published as:

Waechter, S., Sütterlin, B., & Siegrist, M. (2015). Desired and Undesired Effects of Energy Labels—An Eye-Tracking Study. *PLoS ONE, 10*(7).

Abstract

Saving energy is an important pillar for the mitigation of climate change. Electric devices (e.g., freezer and television) are an important player in the residential sector in the final demand for energy. Consumers' purchase decisions are therefore crucial to successfully reach the energy-efficiency goals. Putting energy labels on products is often considered an adequate way of empowering consumers to make informed purchase decisions. Consequently, this approach should contribute to reducing overall energy consumption. The effectiveness of its measurement depends on consumers' use and interpretation of the information provided. Despite advances in energy efficiency and a mandatory labeling policy, final energy consumption per capita is in many countries still increasing. This paper provides a systematic analysis of consumers' reactions to one of the most widely used eco-labels, the European Union (EU) energy label, by using eye-tracking methodology as an objective measurement. The study's results partially support the EU's mandatory policy, showing that the energy label triggers attention toward energy information in general. However, the energy label's effect on consumers' actual product choices seems to be rather low. The study's results show that the currently used presentation format on the label is insufficient. The findings suggest that it does not facilitate the integration of energy-related information. Furthermore, the current format can attract consumers to focus more on energy-efficiency information, leading them to disregard information about actual energy consumption. As a result, the final energy consumption may increase because excellent ratings on energy efficiency (e.g., A^{++}) do not automatically imply little consumption. Finally, implications for policymakers and suggestions for further research are discussed.

3.1 Introduction

Reducing energy consumption is a declared goal in many countries (e.g., OECD/IEA, 2013). Important reasons for decreasing energy use include economic and ecological benefits. Moreover, reducing energy plays an important role in mitigating climate change. For example, less energy consumption can help reduce carbon emissions, requiring fewer power plants now and in the future (e.g., Soytas, Sari, & Ewing, 2007; Zhang & Cheng, 2009). Considering the fast growth of the global population, this undertaking is as important as it is challenging. Households are responsible for approximately 30% of the final energy consumption (BFE, 2013; Boardman, 2004; Eurostat, 2012). In private households, about 70% of energy is used for heating, approximately 15% for warm water, and about 12% for household appliances and consumer electronics such as televisions, computers, refrigerators, and freezers (IEA, 2003; Prognos, 2012). Consequently, households or more precisely, consumers constitute a segment that needs to be addressed to reach energy-saving goals. In many countries, the reduction of energy consumption is tackled by trying to enhance energy efficiency (European Council, 2012; Wiel, 2000). For example, the European Union (EU) plans to save up to 20% of its members' energy consumption by 2020, mostly by increasing energy efficiency (European Council, 2010, 2012). Hence, the EU released minimum standards regarding energy efficiency in several domains, such as buildings, household appliances, and consumer electronics. Consequently, new products on the market have to fulfill these requirements; the sale of energy-inefficient products is restricted as well (Wiel & McMahon, 2003).

In 1992, the Council of the European Communities introduced an energy label to target consumers' decision making at the point of sale (Council of the European Communities, 1992). The energy label should facilitate an energy-friendly choice of electric goods. The energy label provides two sources of information—energy efficiency and actual energy consumption—to assess the energy friendliness of an appliance. Information about a product's energy efficiency is communicated with its letter rating on a scale and its place on a certain spectrum of color codes. The letter scale originally ranged from A to G, with A as the most efficient and G as the least efficient products. However, the rapid development of highly energy-efficient items and the ban on inefficient ones on the market required the introduction of new rating classes to differentiate among products with the best (A) rating on energy efficiency. Therefore, plus markers (e.g., A^+) were also implemented (European Council, 2010, 2012). For some products, the energy-efficiency rating now ranges from A^{+++} to D (e.g., freezer), whereas for others, it encompasses A^+ to F (e.g., television) or continues as simply A to G (e.g., coffee machines). An additional cue for a product's energy efficiency is the color code that displays its rating (Fig. 3.1). The color code ranges from red to green, where red represents poor performance in terms of energy efficiency, while green signifies excellent performance.

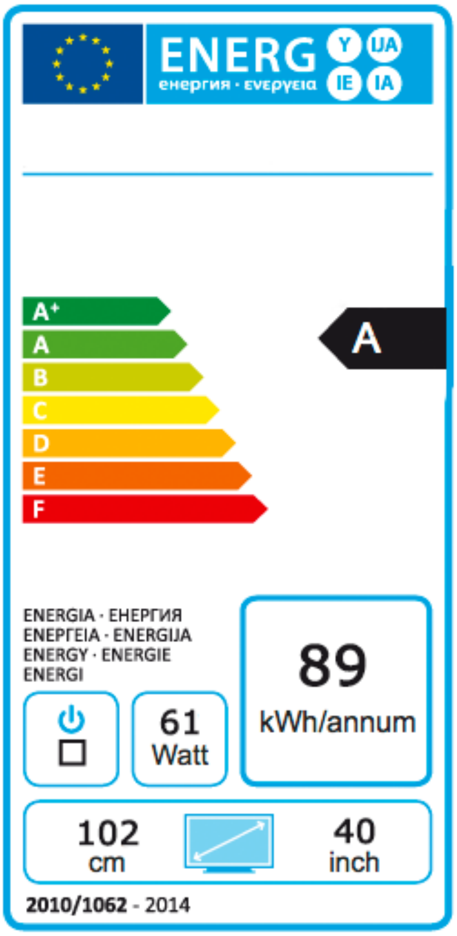


Figure 3.1. EU energy label used for televisions.

The energy-efficiency letter rating reflects the power consumption of a product, based on its size. For example, a television's energy efficiency is basically calculated by the power consumption (watt) per square decimeter (dm^2) of the visible screen. According to this performance the products are assigned a letter ranking. This means that both a small and a large television can have the same energy efficiency rating (e.g., A), because per dm^2 their energy consumption levels are equal. However, the actual energy consumption levels are different, because they differ in size (i.e., the larger television has a greater dm^2). Thus, for consumers it is not self-explanatory how the letter categorization system of the energy-efficiency rating (e.g., A^+) reflects this relative calculation. Hence, this classification should not be used to compare different-sized products, such as a 50-inch against a 60-inch television, to assess their energy friendliness (i.e., find the product with the lowest consumption). The information about a product's actual energy consumption is communicated in kilowatt-hours per year (e.g., 100 kwh/annum). Thus, other than the energy-efficiency rating, annual consumption is an absolute numerical value that allows comparison among differently sized products.

The energy label is mandatory for a wide range of electric devices, including household appliances (e.g., refrigerator and dryer) and consumer electronics (e.g., television) and it has to be placed on the products sold in stores. Furthermore, the energy-label requirement is constantly broadened to new product types. It constitutes one of the most important policy tools of the EU to reach the targeted energy goals, namely the reduction of energy consumption by increasing energy efficiency (European Council, 2010, 2012). The energy efficiency of household appliances (e.g., washing machines and freezers) and consumer electronics (e.g., televisions and laptops) has been improving since the introduction of the energy label in 1992. However, the actual residential electricity consumption had been increasing by 2% per year from 2001 to 2011 (de Almeida, Fonseca, Schlomann, & Feilberg, 2011). This trend can partially be explained by a higher level of amenities, a general enhancement of basic comfort and population growth (BFE, 2013; de Almeida et al., 2011). Although some European countries (e.g., the United Kingdom) managed to substantially decrease their consumption per capita over the past years, overall for the EU's 27 member states, the final consumption only shrank very little, and many countries even increased their energy consumption (Eurostat, 2012). Trend observations by the World Bank have shown that this effect also holds true for the rest of the world (Otto, Kaiser, & Arnold, 2014; World Bank). Of special concern is that the Organisation for Economic Cooperation and Development (OECD) countries still account for 65% of the residential electricity consumption worldwide (IEA, 2009). This means that the increasing trend of energy consumption cannot be explained by the development of non-OECD countries. Moreover, information and communication technologies and consumer electronics have been identified as the most quickly growing sector in terms of final electricity consumption (IEA, 2009). To successfully reduce energy consumption, it is therefore important to investigate the reasons for the undesirable increase in energy consumption. Previous evaluations of actual energy use have already revealed an energy-efficiency gap, pointing out the difference between actual and estimated potential energy savings (Jaffe & Stavins, 1994). Allcott and Greenstone recently referred to this gap as "investment inefficiencies […]: a wedge between the most-minimizing level of energy efficiency and the level actually realized" (2013, p. 134). Experts disagree about the magnitude of the energy-efficiency gap because most estimates do not rely on randomized controlled trials but on engineering analysis and many interventions are not as energy saving as estimated by technicians (Allcott &

Greenstone, 2013; Stawreberg & Wikström, 2011). However, according to the International Energy Agency (IEA), switching to the most efficient products could save about 40% of residential electricity consumption (IEA, 2009). Gillingham and Palmer (2013) concluded in a review article that behavioral effects or more precisely, consumers' purchase decisions constitute one reason for the energy-efficiency gap. This conclusion stands in contrast to findings of recent studies that highlighted the relevance of energy efficiency to consumers (Davis, 2008; Heinzle & Wüstenhagen, 2009; Sammer & Wüstenhagen, 2006). For example, a study involving German television users found that willingness to pay increased with higher energy efficiency (Heinzle & Wüstenhagen, 2009). A study in the United States showed that consumers indicated a higher willingness to pay for products labeled with the Energy Star® (Ward, Clark, Jensen, Yen, & Russell, 2011). Therefore, the question is raised why there is a mismatch between consumer statements and actual energy consumption. Expressed differently, what psychological effects might impede energy savings resulting from energy-efficiency measures?

Recent research revealed that the energy-efficiency gap was aggravated by insufficient implementation of the EU policy on the energy label (e.g., not placed on products in stores) and institutional problems, such as weak support by different stakeholders (e.g., nongovernment organizations) (Dendler, 2014; Molenbroek et al., 2014). Additionally, the energy label is not yet mandatory for online shops that are gaining market share (Retailresearch, 2014). Other developments indicate undesirable consumer behavior, such as the observed trend toward larger appliances (Boardman, 2004; Molenbroek et al., 2014). This trend suggests that it may be essential to consider psychological side effects triggered by the energy label and the promotion of energy efficiency (e.g., Merritt, Effron, & Monin, 2010; Molenbroek et al., 2013; Thøgersen & Ölander, 2003; Waechter, Sütterlin, & Siegrist, 2015). A recent study found evidence for consumers' misinterpretation of energy efficiency showing their tendency to focus excessively on energy-efficiency information and to neglect actual energy consumption when making estimates of a product's energy friendliness (Waechter et al., 2015). This study indicated the participants' susceptibility to the so-called energy-efficiency fallacy. This fallacy refers to people's tendency to assess a product's performance in terms of energy consumption based on its energy-efficiency rating. This derivation is problematic, as explained in the previous section, because the energy efficiency rating on the energy label only provides a suitable basis for comparison with similar products (i.e., products of the same category *and* size). However, if two products differ in size, the energy-efficiency rating does not provide an adequate information basis for selecting the product with less energy consumption. Moreover, the study by Waechter and colleagues (2015) had detected that excellent energy-efficiency ratings (e.g., A^{+++}) could even distort the perception of entire product categories. This means that consumers' perception of product categories that are generally associated with high energy consumption (i.e., freezers) can shift to energy friendliness due to people's reliance on energy-efficiency information, although the actual consumption of such products is still high. This energy-efficiency fallacy is a matter of concern because the promotion of energy efficiency constitutes the core of energy strategies in various countries (Bundesrat, 2013; European Council, 2012; Walton, 2014). Similar concerns can be found in the literature, criticizing the policy to concentrate merely on the promotion of energy efficiency (Herring, 2006; International Risk Governance Council, 2013; OECD/IEA & AFD, 2008). It has been argued that the promotion of energy efficiency and the energy-efficiency rating on the energy label critically neglect the role of actual energy consumption (e.g., IEA, 2009; Tiefenbeck, Staake, Roth, & Sachs, 2013; Wiel & McMahon, 2003). Thus, the energy label may in fact enhance energy consumption by misleading consumers to overestimate the role of energy efficiency. Based on these theoretical and empirical considerations, it seems questionable whether the energy label causes the desired effects regarding consumers' decision making. In other words, what is the energy label's performance level concerning consumers' energy-friendly decision making and purchase behaviors?

3.1.1 Consumers' Decision-making Process

Consumers are confronted with a wide range of information at the point of sale. Ideally, they evaluate all information provided and make an informed decision. However, research on decision making suggests that this ideal behavior is not what can commonly be expected. On the contrary, people tend to rely on cognitive shortcuts, such as heuristic strategies, to reach a decision (e.g., Slovic, Finucane, Peters, & MacGregor, 2007; Tversky & Kahneman, 1974). People often use heuristics when they want to avoid cognitive effort. Heuristic processes can be conscious or unconscious, but what they all have in common is ignoring part of the information (Gigerenzer & Gaissmaier, 2011). For information processing, this means that consumers do not integrate all the information provided on products but base their decisions on a limited number of information cues.

The presentation format of information is crucial in determining whether or not a certain cue is evaluated. More precisely, information that is presented in a salient and accessible format is more likely to be integrated compared to information that is more complex or not prominently presented (Theeuwes, 1992). The second type of information is therefore often less influential in the decision-making process. For example, a study by Schulte-Mecklenbeck and colleagues (2013) investigating consumers' food choices revealed that participants chose a meal mainly based on how appealing it looked on a picture (i.e., easily accessible), not based on nutritional values (i.e., complex information). Hence, product labeling seems an adequate way to reach consumers because information can be presented in a noticeable and accessible format (e.g., use of colors and pictograms). For example, a study by Siegrist and colleagues (2015) examining different nutrition labels showed that the traffic light system helped consumers process information efficiently and quickly. The same was true for the effect of the Energy Star label, which allowed participants to quickly derive a product's energy friendliness (Ward et al., 2011). Consequently, the use of labels is perceived as an adequate way to inform consumers and to evoke awareness of the label's objectives. It is often claimed that one benefit of labels is that they convey information in an easily accessible format and can help to close a possible information gap (e.g., Banerjee & Solomon, 2003; Shen & Saijo, 2009; Siegrist et al., 2015). Therefore, our hypotheses regarding the energy label's benefits were the following:

Hypothesis 1: Presenting consumers with the energy label influences how intensively (i.e., how long) they focus on energy-related information.

Hypothesis 2: The integration of energy-related information is easier (i.e., less time is needed to process the information) if the energy label is available as an additional source of information.

Hypothesis 3: The presentation of the energy label alters consumers' product choices.

However, some studies suggested that labels could lead to imperfect communication because consumers failed to grasp the detailed meaning of some cues (Dendler, 2014; Galarraga Gallastegui, 2002; van Amstel, Driessen, & Glasbergen, 2008) and simply used the labels as signs of approval, instead of an actual source of information (e.g., Bradu, Orquin, & Thøgersen, 2014; Sörqvist et al., 2013). For example, a meta-study of eco-labeling systems in the United States (Banerjee & Solomon, 2003) showed that those that functioned as seals of approval (e.g., Energy Star) were preferred by consumers. The authors concluded that only a few consumers were willing and able to use and interpret technical information provided on labels.

This issue highlights an important drawback of fast and frugal decision-making strategies. Such heuristics are efficient as long as the information that serves as a basis for the decision is precise and not contradictory (Gigerenzer & Gaissmaier, 2011). If this is not the case, heuristic decision making can lead to the neglect of important information (e.g., Kralik, Xu, Knight, Khan, & Levine, 2012) and result in biased decisions and misjudgments. Based on previous literature, it is known that the salience, accessibility, or symbolic meaning of cues can bias information search and decision making (e.g., Kahneman, 2011; Slovic et al., 2007; Sütterlin & Siegrist, 2014). For example, the affect heuristic (Slovic et al., 2007) states that salient and accessible cues are easily mapped into an affective response (e.g., green energy-efficiency rating) compared with ambiguous information cues, such as technical or numerical information (e.g., kilowatt-hours). Consequently, the cues linked to a stronger affect receive more weight in the decision making and substitute for the less accessible cues (Gigerenzer & Gaissmaier, 2011). The influence of symbolically significant information was shown in a study by Sütterlin and Siegrist (2014). People relied on the symbolically significant information (i.e., the car type—driving a Prius vs. driving a sport utility vehicle [SUV]) when they were asked to judge the environmental impact of driving behaviors. Other relevant information with less symbolic significance (e.g., actual distances covered) was largely ignored. As a result, people judged the Prius driver's behavior as more energy friendly than that of the SUV driver, although the latter actually covered a much shorter distance and therefore used less fuel (i.e., more environment-friendly behavior).

These findings also have implications for the promotion of energy-friendly consumer behavior. Regarding the EU energy label, information about energy efficiency (e.g., A) that is communicated with a single letter and a prominent color code is more easily accessible and may represent a stronger symbolic meaning than the numerical information format of actual electricity consumption (e.g., 50 kwh/annum). Several studies have shown that consumers often have difficulties in understanding information about actual electricity consumption (e.g., expressed in kilowatt-hours per year) and deciding whether a certain energy consumption is high or low (e.g., Egan, Payne, & Thorne, 2000; Shippee, 1980). Furthermore, information about the actual electricity consumption of devices is rather unimportant for consumers' decisions (Heinzle, 2012). The current presentation format of energy-efficiency information on the energy label may therefore be a potential trigger for heuristic thinking processes and can lead to the disregard for important information, such as the actual electricity consumption. Consequently, consumers may choose efficient products that still consume a considerable amount of energy, based on the mistaken notion that energy efficiency implies low energy consumption. Thus, understanding consumers' information-processing and decision-making strategies is necessary in order to assess the effectiveness of policy tools, such as the EU energy label. We therefore formulated the following hypotheses regarding consumers' evaluation of the information on the energy label:

Hypothesis 4: The presentation of the energy label guides consumers to focus more often on energy-efficiency information and less on actual energy consumption.

Hypothesis 5: Integration of energy-efficiency information is easier (i.e., less time is needed to process the information) than that of actual energy consumption.

3.1.2 Consumers' Product Choices

Product choice is strongly influenced by personal preferences, for instance, regarding product brand, price sensitivity, and space restrictions. To account for this effect in choice tasks, we introduced two different treatments—a self-focus condition where participants were asked to choose for themselves and an energy-saving focus where participants were asked to choose a product for a person who would want to use as little energy as possible. The self-focus condition of the factor focus thereby corresponded to a realistic purchase situation and allowed the assessment of the energy label's influence on information search behavior in a free-choice setting. This means that participants were expected to choose and to evaluate the information provided according to their own individual preferences (e.g., price, size, and design). To understand the evaluation of energy-related information and to have a condition without the influence of personal preferences, the second condition with the energy-saving focus was included. In this condition, participants were expected to ignore personal preferences and to decide based on energy-related information in order to recommend the most energy-friendly product. The goal was to understand consumers' use and interpretation of energy-related information and to assess a possible impact of the energy label on this behavior. Regarding the effect of the focus condition, we formulated the following hypothesis:

Hypothesis 6: The focus on energy-related information is higher in the energy-saving focus condition compared to the self-focus condition.

Furthermore, the energy-saving focus condition would allow testing the degree of complexity of the different energy-related information.

3.1.3 Methodological Approach

To address the research questions, two hypothetical choice experiments for two consumer products (televisions and freezers) were designed. Data for the study were collected through eye tracking to gain an objective understanding of consumers' information search behavior.

In the past years, eye tracking has regularly been used to study consumer behavior (for an overview, see Orquin & Mueller Loose, 2013). This methodology provides an objective measurement to understand better how consumers process information, such as product labels. For example, eye tracking has been successfully used to evaluate the effectiveness and perception of nutritional labels (e.g., Ares et al., 2013; Graham, Orquin, & Visschers, 2012; Siegrist et al., 2015) and is a promising method to detect and improve knowledge of decision-making strategies (e.g., Stüttgen, Boatwright, & Monroe, 2012). However, this study is the first eye-tracking approach investigating the impact of the EU energy label. Based on the eye-tracking data, this paper unveils the influence of the energy label on consumers' information search behavior. It shows that the energy label can lead to misperceptions and unwanted effects that may potentially impede energy-saving goals. Furthermore, it provides important implications for policymakers and further research.

3.2 Materials and Methods

3.2.1 Ethic Statements

This study complies with all current laws and regulations of Switzerland, and the ethical review committee of the ETH Zurich approved all procedures.

3.2.2 Participants

An invitation letter was sent to a random sample of 500 households in the German-speaking part of Switzerland, drawn from the electronic telephone directory. The letter briefly explained the study's objectives and procedure and announced a follow-up phone call over the next few days to ask about their interest to participate. Additionally, participants were recruited via a free advertisement on a newsletter. The exclusion criteria for participation included ages younger than 20 and over 65 years, wearing eyeglasses or hard contact lenses, or suffering from eye diseases. For eye-tracking studies, participants should not be over 65 years old because aging tends to cause drooping eyelids, which hinder good calibration (Holmqvist et al., 2011). Participants with eyeglasses were also excluded because small scratches and/or reflections on the glasses pose a problem for the eye tracker. Furthermore, eye diseases such as cataracts can lead to calibration problems. The experiment lasted around 45 minutes; the participants received CHF 40 (≈USD 42) as an incentive.

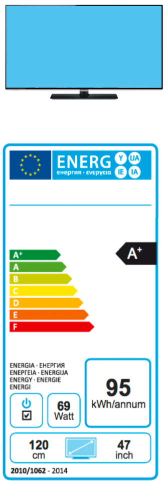
In total, 123 people from the population of the German-speaking part of Switzerland agreed to participate in the experiment. Due to incompatibility issues between six participants and the eye tracker, they had to be excluded. This led to a final sample of 63 women and 54 men (N = 117). The mean age was 36 years (SD = 11). The majority of the participants (55.6%) had at least completed high school. One participant reported having a slight case of strabismus. However, since the calibration was good and the tracking ratio was high (i.e., percentage of non-zero gaze positions divided by sampling frequency and multiplied by run duration), the person was not excluded from the study (Holmqvist et al., 2011). All participants had normal or corrected-to-normal eye vision.

3.2.3 Stimuli for the Eye-tracking Experiment

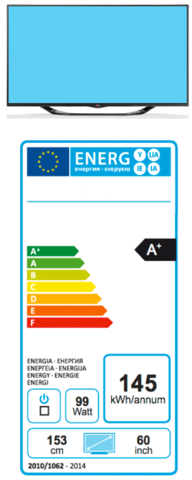
To investigate the impact of the energy label on consumers, we chose two product categories that participants would be familiar with: freezers and television. The television was included because it is frequently bought and used by the general population. On the other hand, the freezer was selected as a stereotype for excessive consumption of products. The two items also differed regarding emotional involvement. It seemed plausible to assume that a television would evoke more interest and technical affinities, whereas in most cases, a freezer would merely represent a cooling unit for food storage. Thus, by including a typical household appliance and a typical consumer electronics product, more general conclusions about the importance of product-specific evaluations of the energy label could be drawn from the results

The stimuli materials consisted of the descriptions of four models per product category, including pictures of these products, prices, and additional information usually provided in stores (freezer: e.g., volume capacity, energy efficiency, and type of compartments; television: screen size, wattage, and technical features). The chosen products varied regarding energy efficiency, energy consumption, price, size/volume, and technical features. The products represented a selection as could be found in an online shop. The most energy-efficient product was not automatically the most energy-friendly one. The four products were presented simultaneously on one page (Figs. 3.2 and 3.3; S3.1 and S3.2 Figs.), and the participants were asked to choose one of the products.

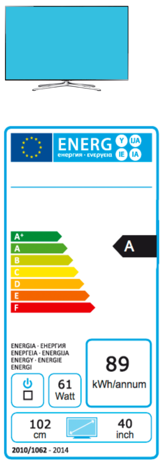
Television PF	Price: 1‘199.-
Screen Size	47 in (120 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	Yes
Image Display	3D / 2D
Features	PayTV, Memory Card, 3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	95 kWh
Power	69 Watt



Television ME	Price: 2‘259.-
Screen Size	60 in (153 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	No
Image Display	3D / 2D
Features	3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	145 kWh
Power	99 Watt



Television UE	Price: 799.-
Screen Size	40 Zoll (102 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	4 HDMI-Anschlüsse
Energy Efficiency Ra-ting	A
Annual Energy Consumption	89 kWh
Power	61 Watt



Television LS	Price: 2‘850.-
Screen Size	70 Zoll (178 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	BlueRay-Player, Speicherkarte
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	197 kWh
Power	135 Watt

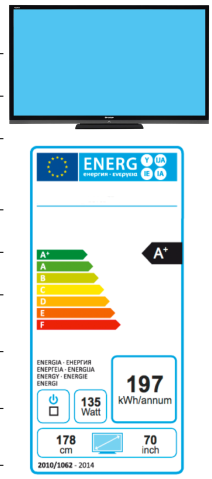


Figure 3.2. Products with pictures and television features in the label condition. The participants were asked to choose a product either for themselves or for a person who would want to use the least possible amount of energy.

Television PF	Price: 1‘199.-
Screen Size	47 in (120 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	Yes
Image Display	3D / 2D
Features	PayTV, Memory Card, 3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	95 kWh
Power	69 Watt

Television ME	Price: 2‘259.-
Screen Size	60 in (153 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	No
Image Display	3D / 2D
Features	3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	145 kWh
Power	99 Watt

Television UE	Price: 799.-
Screen Size	40 Zoll (102 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	4 HDMI-Anschlüsse
Energy Efficiency Ra-ting	A
Annual Energy Consumption	89 kWh
Power	61 Watt

Television LS	Price: 2‘850.-
Screen Size	70 Zoll (178 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	BlueRay-Player, Speicherkarte
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	197 kWh
Power	135 Watt

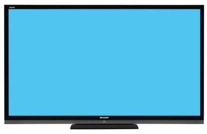


Figure 3.3. Products with pictures and television features in the no-label condition. The participants were asked to choose a product either for themselves or for a person who would want to use the least possible amount of energy.

3.2.4 Experimental Design and Procedure

The iViewX RED500 eye tracker (SMI, Germany) was used. This system provides a binocular sampling rate of 50Hz and an accuracy of 0.4°. Participants' eye movements are observed with an infrared-sensitive video camera placed below the computer monitor. Specialized software generates x- and y-coordinates for the gaze point on the monitor screen. Experiment Centre 3.3, an application provided by SMI, was used to design and run the experiment.

All participants first read and signed a consent form, acknowledging that their gaze behavior would be recorded, their data would be treated anonymously, and they could quit the study at any time without providing a reason.

To provide good data quality, the eye tracker needed to be calibrated for each subject. The participants were seated in front of the eye tracker at a distance of approximately 70 centimeters with a visual angle of approximately 2 Degrees. The master computer was placed on a second desk, approximately 1.5 meters away from the one with the eye tracker. The examiner explained the device and the calibration to the participants and verified that they had understood the procedure. To minimize body movements, the participants were instructed to place their elbows on the table and to rest their chins in their hands. However, slight head movements to the right or the left would not affect data quality. When the chosen position was comfortable for the participants, the examiner started the calibration on the master computer. The calibration with a deviation of $y < 1.5°$ and $x < 1.5°$ was accepted (Holmqvist et al., 2011). The calibration was repeated up to four times per task. The participants were then reminded to remain in their position and to keep their head movements to a minimum.

Subsequently, the instruction for the first task was shown on the screen, and when the participants confirmed that they had read the instruction and had no further questions, the examiner activated the next page with the four products that participants had to view in order to make a choice. When the participants articulated their choice (i.e., by saying the name of the selected product), the examiner immediately pressed the space button, and a blank page followed. By pressing the space button, a time stamp was taken, which could afterwards be used as a measurement of the time that the participants needed for the decision. The examiner noted the participants' respective choices. Before the second task started, the system was recalibrated. The procedure for the second task was identical to that of the first one, except that the participants now had to choose among four models of another product category (i.e., freezers in the first task and televisions in the second task or vice versa). After the second task, the examiner asked a few qualitative questions about the decision-making process.[1] Finally, the participants were asked to fill out a paper-and-pencil questionnaire assessing their sociodemographic information. There were no time restrictions for the experiment.

We used a 2x2 between-subjects design with the factor choice-focus (choice for oneself [self-focus] vs. choice for a person who would want to save energy [energy-saving focus]) and the factor label (label vs. no label). This procedure resulted in four experimental conditions: (1) choosing a product for oneself, with information in a table format (without energy labels); (2) choosing a product for oneself, with information in a table format and the corresponding energy labels; (3) choosing a product for a person who would want to save en-

[1] The qualitative questions were used to gain additional insights into the participants' information search and decision-making behavior, complementary to the eye-tracking data. The questions were semi-standardized, and the qualitative part lasted for around 5 minutes. They were exploratory in nature and not systematically analyzed for this study.

ergy, with information in a table format (without energy labels); and (4) choosing a product for a person who would want to save energy, with information in a table format and the corresponding energy labels. Except for including or excluding the energy labels, the stimuli materials were identical for all four conditions.

The factor focus was only relevant for the task instruction informing the participants that they would see four products, from which they had to choose one (for themselves or for another person). Table 3.1 presents the instructions for the conditions of the factor focus for the television task. The instruction for the freezers was identical, except that “television” was replaced with “freezer.” The participants were first asked to choose a freezer and subsequently a television or vice versa. The presentation order of the categories changed randomly among the subjects to control for possible order effects. The factor levels (i.e., factor label: label vs. no label; factor focus: self vs. energy saving) did not change during the experiment.

Table 3.1

Task Instructions.

Focus	Instruction
Self	Please imagine that you would like to buy a new television. On the next page, you will be presented with four televisions, out of which you can choose one. Look at the pictures and the information as you would at home on your computer screen. Please decide which television you would buy. Tell the examiner the name of the chosen product. The name is shown on the top left of each product and consists of two characters (e.g., SZ). Take as much time as you need. Please look at the screen during the whole time and try to sit very still. If you have any questions regarding the task, please ask the examiner. If you do not have further questions, inform the examiner that you understood the task and she/he will activate the next page.
Energy saving	Please imagine that a person who wants to use the least possible amount of energy would like to buy a new television. Four televisions are the choices and the person asks for your advice. On the next page, you will be presented with the four televisions, out of which you should choose one. Look at the pictures and the information as you would at home on your computer screen. Please decide which television you would recommend to the person. Tell the examiner the name of the chosen product. The name is shown on the top left of each product and consists of two characters (e.g., SZ). Take as much time as you need. Please look at the screen during the whole time and try to sit very still. If you have any questions regarding the task, please ask the examiner. If you do not have further questions, inform the examiner that you understood the task and she/he will activate the next page.

Note. Instructions Used for the Television Choice Task: with self-focus (i.e., hypothetical purchase for oneself) and energy-saving focus (i.e., hypothetical recommendation to a person who would want to save energy).

3.2.5 Eye-tracking measures

The raw data of the eye tracker was imported into BeGaze (SMI, BeGaze 3.3) for data analysis. In eye-tracking research, two eye movements are mostly of interest: fixations and saccades (e.g., Glöckner & Herbold, 2011; Shi, Wedel, & Pieters, 2013; Siegrist et al., 2015). A fixation is measured when the eye remains still for a certain time period, whereas saccades describe the eye's rapid movements from one fixation to another. We used the default event detection algorithm provided by the eye tracking software. The parameters for fixation detection are defined with a minimal duration of 80ms and a maximal dispersion of 100 pixels. According to the eye-mind hypothesis, fixations reflect cognitive processes (Just & Carpenter, 1976). This means that what we look at is also what we pay attention to in most cases (e.g., Holmqvist et al., 2011; Le Meur & Le Callet, 2009; Velichkovsky, Rothert, Kopf, Dornhöfer, & Joos, 2002). For further analysis, areas of interest (AOIs) were defined for each item presented to the participants (Figs. 3.4 and 3.5). To assess the participants' evaluation of the information presented, three parameters within the defined AOIs were derived for data analysis: mean fixation durations, dwell times, and number of fixations. The space outside the AOIs (i.e., whitespace) was excluded for the analysis (Holmqvist et al., 2011). Outliers did not distort the results.[2]

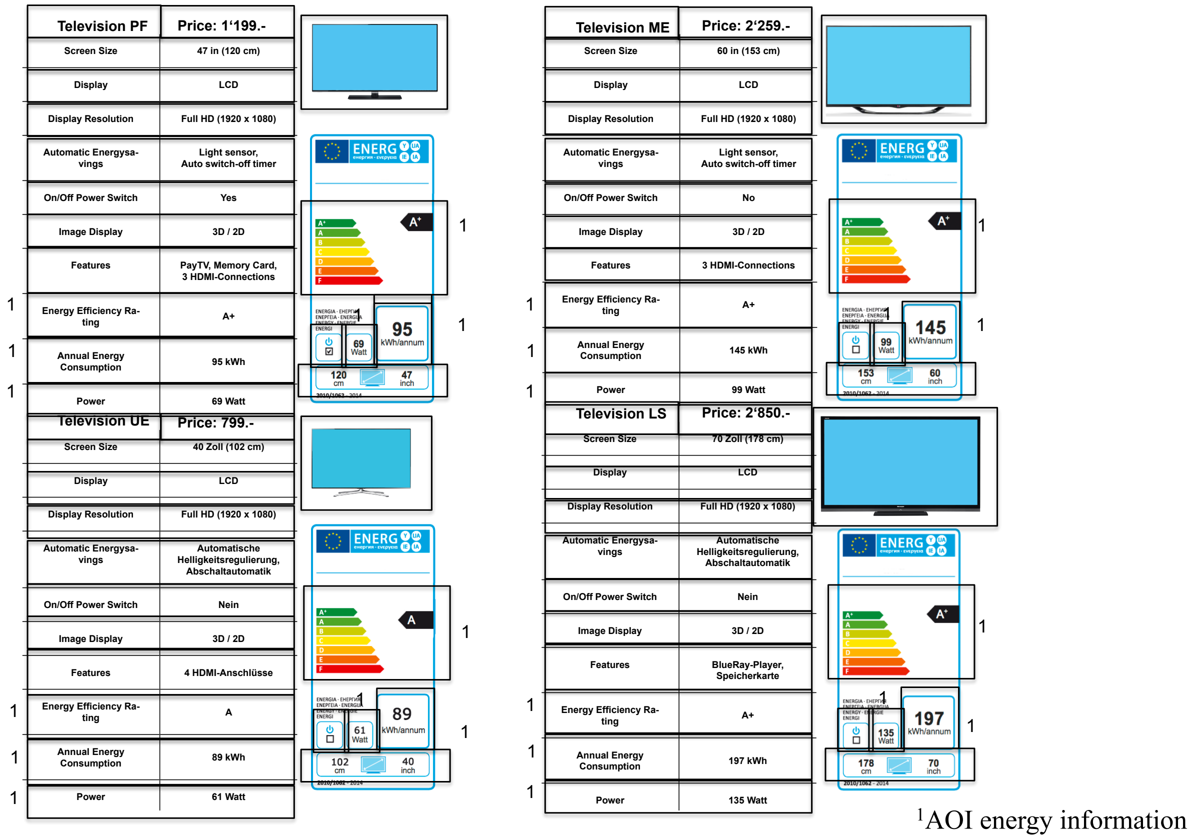


Figure 3.4. Areas of interest (AOI) defined for the television task in the label condition. Each box represents an AOI used for data analysis. The AOIs marked with number 1 were combined with the AOI energy information.

[2] Only few outliers and extreme scores were identified in the data. We did not exclude any outliers, but if necessary, an adequate transformation was applied and used for the analysis.

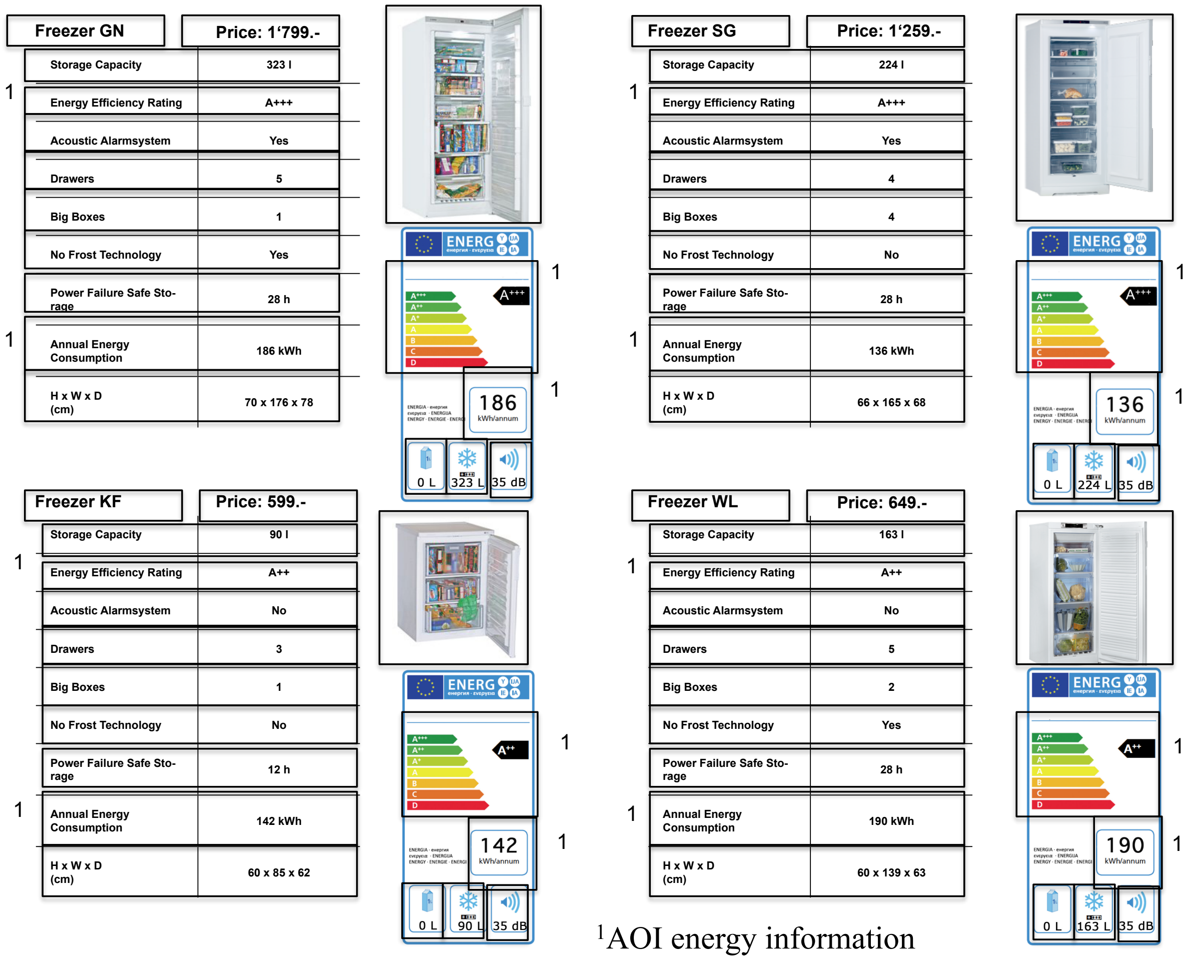


Figure 3.5. Areas of interest (AOI) defined for the freezer task in the label condition. Each box represents an AOI used for data analysis. The AOIs marked with number 1 were combined with the AOI energy information.

Dwell time. Sometimes called gaze duration, dwell time is calculated by summing up all fixations and saccades that hit a particular AOI (i.e., time the gaze stayed on an AOI). It is an indicator of the attention distribution over the different AOIs. Longer dwell times reflect deeper information processing (Henderson & Hollingworth, 1999). They are also associated with interest and informativeness (Pieters, Rosbergen, & Hartog, 1996); people tend to gaze more often at data that is more important and interesting to them (Orquin & Mueller Loose, 2013). Thus, this parameter was used to test the energy label’s influence on the participants’ interest in and attention to energy-related information (i.e., Hypothesis 1 and Hypothesis 6).

Mean fixation duration. Mean fixation duration is calculated by dividing the fixation times by the fixation count. This means that it is not directly affected by the amount of information provided to a person, but it is an indicator of the complexity of the integrated information (e.g., Unema & Rotting, 1990). There are no definitive thresholds for the classification of the mean fixation durations (Duchowski, 2007a; Holmqvist et al., 2011). Longer mean fixation durations are associated with more complex information integration, whereas shorter mean fixation durations reflect easier information integration (Glöckner & Herbold, 2011; Horstmann, Ahlgrimm, & Glöckner, 2009; Velichkovsky et al., 2002). This parameter was used to probe whether presenting the energy label would facilitate the integration of energy-related information (i.e., Hypothesis 2). Furthermore, this parameter was applied to assess the complexity of energy-efficiency information compared to information about annual consumption (i.e., Hypothesis 5).

Number of fixations. Also known as fixation density, fixation count is a frequently used metrics in eye-tracking research, especially in usability and reading research (e.g., Goldberg & Kotval, 1999; Poole, Ball, & Phillips, 2005; Tatler, Wade, Kwan, Findlay, & Velichkovsky, 2010). Fixations on a certain area suggest that this information is important and noticeable to a person (Poole et al., 2005). This means that areas with more fixations receive more attention than those with fewer fixations. Many factors influence where people look; however, the visual features of the material presented and each participant's intention play important roles (Duchowski, 2007b). Higher importance is therefore associated with a higher count of fixations (Djamasbi, Samani, & Mehta, 2012). We used this variable to test whether the salient and easily accessible presentation format of energy-efficiency information on the energy label would mislead participants to pay closer attention to this information, whereas the numerical information about annual consumption would attract significantly less attention (i.e., Hypothesis 4).

3.3 Results

3.3.1 Effect of Energy Label on Availability of Energy-related Information

3.3.1.1 General consideration of energy-related information

Hypothesis 1 stated that presenting the energy labels next to the products would enhance the focus on energy-related information. We used the dwell time for the AOI energy information (see Fig. 3.3 for television and Fig. 3.4 for freezer) as a measurement for the participants' consideration of energy-related information. Because there were no time restrictions, the decision time differed substantially among subjects (decision time for television in seconds [s]: M [SD] = 68.76 [39.92]; freezer: M [SD] = 64.37 [36.73]. However, there was no significant difference in decision time between the label and the no-label condition in the two focus conditions. There was a significant difference between the decision time for television (M [SD] = 67.65 [43.57]) and freezer (M [SD] = 60.04 [34.91] in the condition energy-saving focus, t (58) = 2.19, p = .033. The difference in the self-focus condition did not reach significance (p = .758). The participants with a longer decision time consequently tended to take a longer dwell time for the AOI energy information and vice versa (television: $r = .72$, $p < .01$; freezer: $r = .71$, $p < .01$). To control for these individual differences in decision times, we calculated the relative time by dividing the dwell time for the AOI energy information by the total time needed for decision making in this task (Ashby, Dickert, & Glöckner, 2012). Thus, the relative dwell time reflected the relevance of energy-related information (i.e., measured with the percentage of time that a participant spent on such information during the task). A lower percentage would therefore reflect lower attention (i.e., relevance) toward energy information and vice versa. A similar procedure was used by Ashby and colleagues (Ashby, Walasek, & Glöckner, 2015).

A two-way ANOVA was conducted, with the dependent variable relative dwell time on energy information and the factors label (with vs. without label) and focus (self vs. energy saving) as the independent variables. The results revealed a significant main effect of the factor label on the time spent on energy-related information for the television task, $F(1, 113) = 10.61$, $p < .001$, and the freezer task, $F(1, 113) = 5.17$, $p = .025$. There was also a significant main effect of the factor focus, $F(1, 113) = 46.62$, $p < .001$ (television); $F(1, 113) = 34.34$, $p < .001$ (freezer). The interaction of the factors label and focus did not reach the level of significance, $F(1, 113) = 0.16$, $p = .689$ (television); $F(1, 113) = 0.15$, $p = .695$ (freezer).[3] The re-

[3] The findings of the analysis of the absolute time spent on energy-related information were mostly consistent with the results of the relative time. The results revealed a significant main effect of the factor focus for the tele-

sults of the ANOVA are presented in Fig. 3.6. In a further step, a simple main effect analysis of the two factors label and focus was conducted to test for differences in their individual levels (Field, 2013). This meant that the effect of the factor focus was separately assessed for each level of the factor label. In this case, the self-focus and the energy-saving focus conditions were separately compared on each level of the factor label (i.e., with label and without label). Likewise, the label and the non-label conditions were separately compared on each level of the factor focus. In line with our hypothesis, the effect of the factor label on the individual levels of the factor focus was significant in the television task, $F(1, 113) = 6.63$, $p = .011$ (self-focus) and $F(1, 113) = 4.12$, $p = .045$ (energy-saving focus). However, in the freezer task, the effect was non-significant: $F(1, 113) = 3.52$, $p = .063$ (self-focus) and $F(1, 113) = 1.78$, $p = .184$ (energy-saving focus). This meant that providing the energy label enhanced the relevance and salience of energy-related information in the television task but not in the freezer task.

Furthermore, there was a significant effect of the factor focus on the individual levels of the factor label (i.e., with label vs. without label); television: $F(1, 113) = 26.82$, $p < .001$ (without label) and $F(1, 113) = 20.13$, $p < .001$ (with label); freezer: $F(1, 113) = 20.07$, $p < .001$ (without label) and $F(1, 113) = 14.57$, $p < .001$ (with label). This meant that the participants with an energy-saving focus spent more time on energy-related information compared with those with a self-focus (see Datasets S3.1 and S3.2 for detailed information about participants' attention distribution). This result was consistent with Hypothesis 6 and indicated the success of the manipulation.

---

vision task, $F(1, 113) = 7.79$, $p = .006$, and the freezer task, $F(1, 113) = 5.57$, $p = .020$. The main effect of the factor label was significant in the freezer task, $F(1, 113) = 4.18$, $p = .043$, and marginally significant in the television task, $F(1, 113) = 3.22$, $p = .075$.

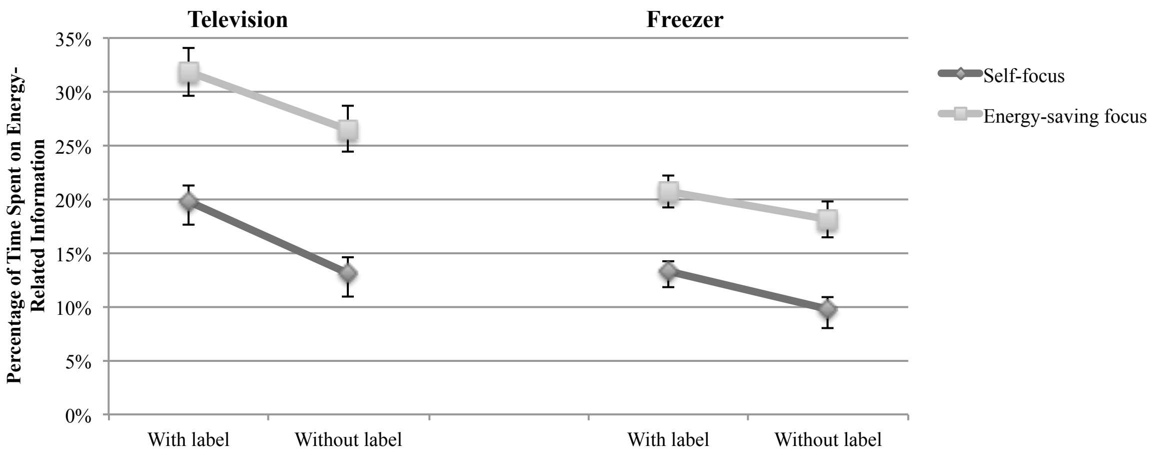


Figure 3.6. Percentage of decision time spent on energy-related information as a function of label (with vs. without label) and focus (self vs. energy saving). The error bars represent the standard error.

3.3.1.2 Facilitation of integration of energy-related information

According to Hypothesis 2, energy-related information should be more accessible and easier to understand if the energy label was provided as an additional source of information compared to a presentation in a table format only (i.e., condition without the energy label). As stated, mean fixation duration is a parameter used to assess the complexity of integrated information. Shorter mean fixation durations reflect easier information integration, whereas longer mean fixation durations are associated with more complex processes of information integration.

A two-way ANOVA was conducted with the factors label and focus as independent variables and the mean fixation duration for energy information as the dependent variable. There were no significant main effects of the factor label, $F(1, 110) = 0.66$, $p = .420$ (television); $F(1, 111) = 0.37$, $p = .542$ (freezer). The main effect of the factor focus was non-significant for the television, $F(1, 110) = 0.21$, $p = .648$, but significant for the freezer, $F(1, 111) = 4.51$, $p = .036$. The interaction between the factors focus and label was not significant, $F(1, 110) = 1.05$, $p = .307$ (television); $F(1, 111) = 0.12$, $p = .732$ (freezer). The results (Fig. 3.7) indicated that energy-related information was not easier to understand if the label was presented to the participants compared with presenting the energy-related information in a table format only. A possible explanation for the significant main effect of the factor focus in the freezer task might be that the participants who chose for themselves were scanning the information rather than integrating it and therefore had shorter mean fixation durations.

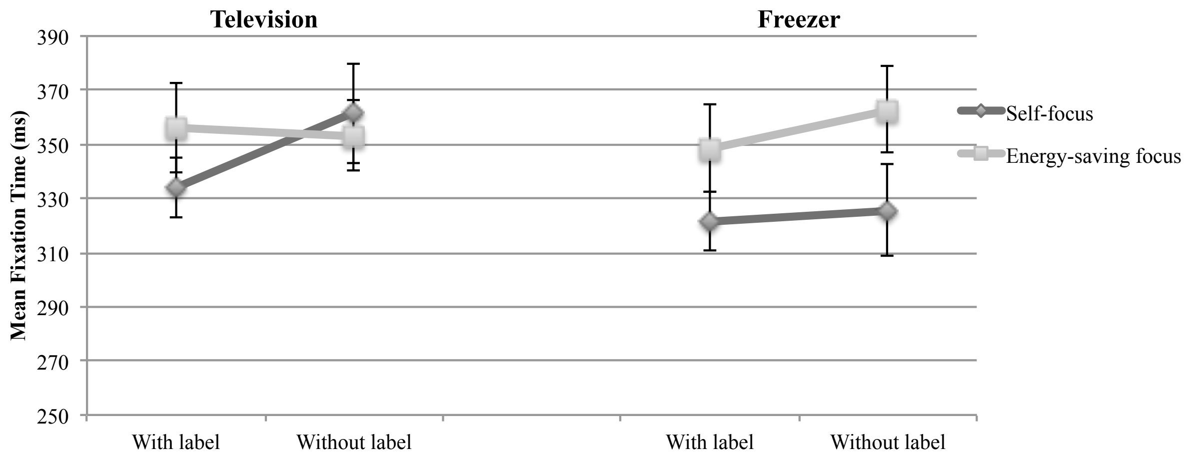


Figure 3.7. Mean fixation duration on energy information as a function of label (with vs. without label) and focus (self vs. energy saving). The error bars represent the standard error.

3.3.1.3 Energy-friendly Choices

Hypothesis 3 stated that the energy label might alter participants' choices. In both tasks, one product each was the most energy-friendly choice due to its lowest annual energy consumption—freezer SG and television UE. Subsequently, participants' choices were categorized as either energy friendly (i.e., freezer SG and television UE) or energy unfriendly to test whether providing the energy label resulted in more energy-friendly product choices. Subsequently, a Chi-square test of independence for the factor choice (i.e., energy friendly vs. not energy friendly) over the four experimental conditions (i.e., self-focus with label, self-focus without label, energy-saving focus with label, and energy-saving focus without label) was calculated. In the television task, a Chi-square test of independence revealed a marginally significant difference between the distributions of observed cases and expected cases in the four experimental conditions, $X^2(3, 117) = 6.55$, $p = .088$. For the freezer task, the Chi-square test of independence was significant for the four conditions, $X^2(3, 117) = 17.46$, $p < .001$. Table 3.2 exhibits the choices in the television and the freezer task for each condition. The analysis of the frequencies suggested that the significant effect was due to the factor focus. More precisely, participants with an energy-saving focus chose the energy-friendly product more often compared with participants with a self-focus.[4] However, providing the energy labels as a source of information did not result in a higher number of energy-friendly product choices

[4] A logistic regression with the factors label and focus as predictors on the dependent variable choice supports this result, revealing only the factor focus as a significant predictor for the choice (i.e., energy friendly vs. not energy friendly).

(consult Datasets S3.1 and S3.2 for further information about participants' attention distribution).[5]

Table 3.2

Choice Frequencies in the Television and the Freezer Task.

Product	Focus	Label	n	Energy-friendly choice	Not energy-friendly choice
Television	Self	yes	28	5	23
		no	30	8	22
	Energy saving	yes	29	14	15
		no	30	10	20
Freezer	Self	yes	28	16	12
		no	30	13	17
	Energy saving	yes	29	24	5
		no	30	26	4

3.3.2 Energy-Efficiency Class vs. Annual Energy Consumption

3.3.2.1 Relevance of information presentation format

To test Hypothesis 4, we compared the percentages of fixations on the information related to energy efficiency and annual energy consumption, respectively. These variables were computed by summing up the fixations on the AOIs containing the information about energy efficiency and annual consumption, respectively, and dividing this number by the number of all fixations during a task. This procedure resolved the problem of different information loads (i.e., different numbers of AOIs) in the conditions with and without the label.

First, a mixed ANOVA was conducted with the between-subjects factor focus (self-focus vs. energy-saving focus) and factor label (with vs. without label) and the within-subjects factor information format (energy efficiency vs. annual energy consumption). The count of fixation on these information areas divided by the total count of fixations in all AOIs constituted the dependent variable. The results revealed a significant main effect for label (television: $F(1, 113) = 19.43$, $p < .001$; freezer: $F(1, 113) = 12.14$, $p = .001$) and for focus (television: $F(1, 113) = 41.21$, $p < .001$; freezer: $F(1, 113) = 33.65$, $p < .001$). There was a significant interaction information format x focus, $F(1, 113) = 5.47$, $p = .021$ (television); $F(1, 113) = 5.58$, $p = .020$ (freezer) (see Fig. 3.8). In the television task, there was a significant interaction information format x label, $F(1, 113) = 15.76$, $p < .001$. In the freezer task, the inter-

[5] There were no effects of sociodemographic variables (e.g., household size) with regard to the choice distribution.

action did not reach significance, F(1, 113) = 3.43, p = .066. All remaining effects were non-significant (F < 2.56, p > .112).[6]

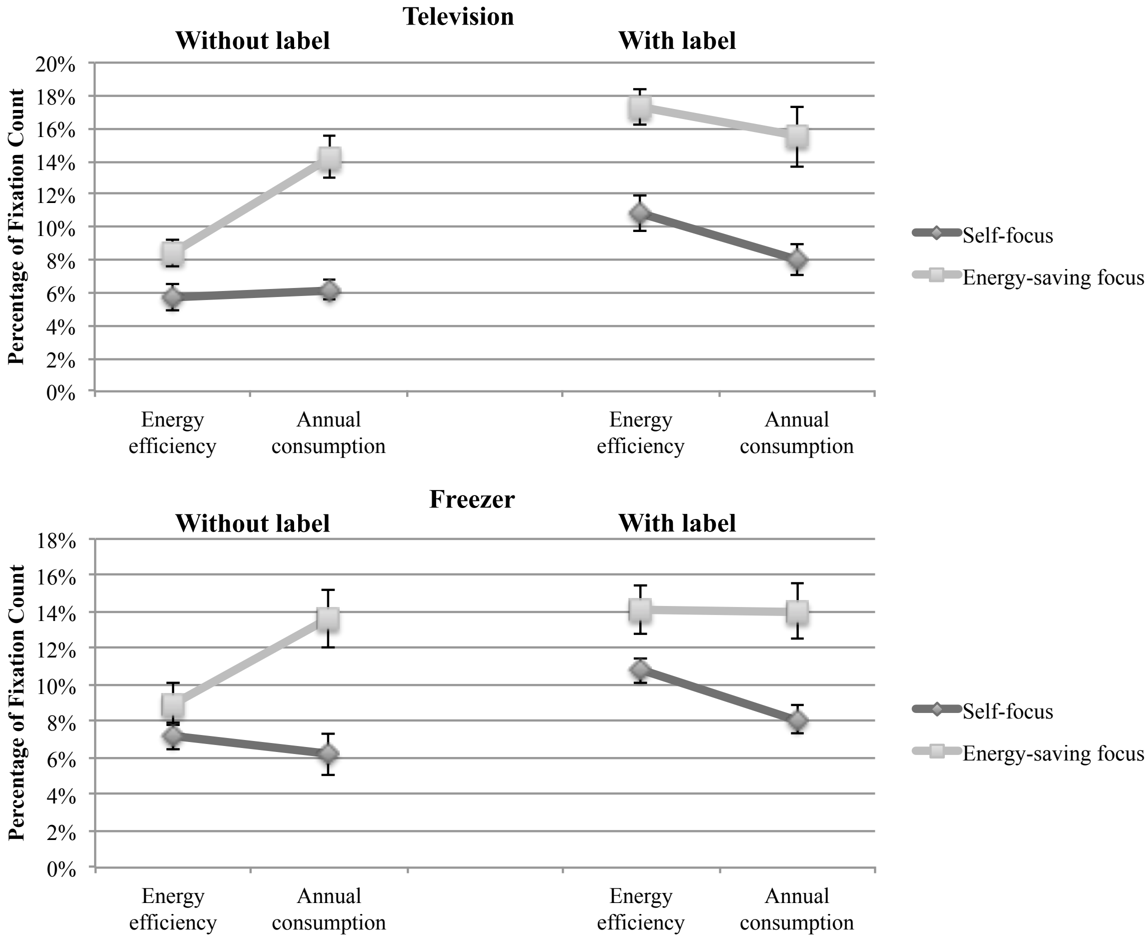


Figure 3.8. Percentages of fixation count as a function of information format (energy efficiency vs. annual consumption), label (with vs. without label), and focus (self vs. energy saving). The error bars represent the standard error.

To break down the interaction effects of the mixed ANOVA, we conducted a follow-up analysis with paired t-tests for each experimental condition. The results provided additional support for our hypothesis of an energy-efficiency fallacy triggered by the energy label

[6] The same analysis was conducted with the absolute fixation count on energy efficiency and annual consumption as dependent variables (i.e., factor information format). The results were mostly consistent with the reported analysis revealing a significant main effect for the factor label (television: F(1, 113) = 5.44, p = .021; freezer: F(1, 113) = 9.93, p = .002) and for the factor focus in the television task, F(1, 113) = 7.92, p = .006. The main effect of focus in the freezer task was marginally significant, F(1, 113) = 3.31, p = .071. The interaction information format x focus was significant for television, F(1, 113) = 9.40, p = .003, and for freezer, F(1, 113) = 10.22, p = .002. The same was true for the interaction information format x label (television: F(1, 113) = 20.66, p < .001; freezer: F(1, 113) = 5.52, p = .021).

(Table 3.3). If the participants with an energy-saving focus were not influenced by the energy label (no-label condition), they showed a desired behavior by looking more often at the information about annual consumption, which would be more relevant for assessing a product's energy friendliness. The participants who chose a product for themselves paid equal attention to both information formats. However, in the condition with the label, the participants with the energy-saving focus abandoned the desired behavior, more precisely, they looked with the same frequency at the information about energy efficiency and annual consumption. Moreover, the participants with a self-focus were driven toward energy-efficiency information, which could result in less energy-friendly purchase decisions (e.g., choosing a bigger television due to a better energy-efficiency rating).

Table 3.3

Fractions of Fixation Count of Information about Energy Efficiency vs. Information about Annual Energy Consumption of Television and Freezer.

				Energy Efficiency	Annual Consumption	
Product	Label	Focus	n	M (SD)	M (SD)	t-test results[1]
Television	yes	Self	28	0.11 (0.06)	0.08 (0.05)	$t(27) = 1.99$, $\mathbf{p = .029}$, $d = .376$
	yes	Energy saving	29	0.17 (0.09)	0.16 (0.10)	$t(28) = 0.87$, $p = .197$, $d = .161$
	no	Self	30	0.06 (0.04)	0.06 (0.03)	$t(29) = 0.78$, $p = .234$, $d = .143$
	no	Energy saving	30	0.08 (0.04)	0.14 (0.07)	$t(29) = 5.49$, $\mathbf{p < .001}$, $d = 1.198$
Freezer	yes	Self	28	0.11 (0.04)	0.08 (0.04)	$t(28) = 3.10$, $\mathbf{p = .003}$, $d = .584$
	yes	Energy saving	29	0.14 (0.07)	0.14 (0.08)	$t(28) = 0.06$, $p = .477$, $d = .014$
	no	Self	30	0.07 (0.04)	0.06 (0.06)	$t(29) = 0.79$, $p = .218$, $d = .144$
	no	Energy saving	30	0.09 (0.06)	0.14 (0.09)	$t(29) = 2.25$, $\mathbf{p = .016}$, $d = .440$

Note. Results of paired t-tests, including means and standard deviations. Significant results are in boldface. Detailed analysis showed that the majority of the participants looked at the information about energy efficiency and annual consumption of each product. Thus, the effect was not due to the data on one product.

[1]One-tailed p-values are indicated.

3.3.2.2 Complexity of energy-related information

We hypothesized that the information about annual energy consumption (kWh) would be more complex than that about energy efficiency (Hypothesis 5). To test Hypothesis 5, mean fixation durations for these two informational attributes were compared. As previously mentioned, longer mean fixation durations reflect more complex information processing, whereas shorter mean fixation durations are associated with easier information integration. The results of a two-way mixed ANOVA revealed a significant main effect of the within-subjects factor information format, $F(1, 105) = 26.90$, $p < .001$ (television); $F(1, 97) = 44.95$, $p < .001$ (freezer). Additionally, the interaction between the factors information format and label was significant in the television task, F(1, 105) = 5.15, p = .025, but not in the freezer task, F(1, 97) = 1.03, p = .314. The remaining effects were all non-significant (F < 3.18, p > .077).

Table 3.4 shows the results of the dependent t-tests conducted after investigating the effects in a two-way mixed ANOVA. In all conditions, mean fixation duration was lower for energy efficiency than for annual energy consumption. The difference was significant in all conditions except one (self-focus without the label), indicating that the information about annual energy consumption was more challenging to understand compared to energy-efficiency information. The significant interaction between the factors information format and label in the television task suggested that the label has an influence on the accessibility of information about annual consumption and energy-efficiency information. Thus, the complexity of energy-consumption information and the accessibility of energy-efficiency information might explain why consumers tended to focus more on energy efficiency.

Table 3.4

Mean Fixation Duration (ms) for Information about Energy Efficiency vs. Information about Annual Energy Consumption of Television and Freezer.

				Energy Efficiency	Annual Consumption	
Product	Label	Focus	n	M (SD)	M (SD)	t-test results[1]
Television	yes	Self	27	308.75 (70.70)	357.57 (78.94)	*t*(26) = 2.71, ***p* = .006**, *d* = .523
	yes	Energy saving	28	316.31 (92.22)	403.02 (99.69)	*t(27)* = 5.11, ***p* < .001**, *d* = .965
	no	Self	25	333.19 (79.90)	346.22 (106.76)	*t(24)* = 0.59, *p* = .280, *d* = .118
	no	Energy saving	29	328.09 (82.57)	368.06 (84.63)	*t(28)* =2.51**, *p* = .009**, *d* = .466
Freezer	yes	Self	27	298.92 (57.69)	341.24 (88.02)	*t(26)* = 2.26, ***p* = .016**, *d* = .435
	yes	Energy saving	27	295.71 (99.64)	387.28 (98.36)	*t(26)* = 3.75**, *p* < .001**, *d* = .684
	no	Self	21	312.28 (72.15)	405.08 (126.45)	*t(20)* = 3.62, ***p* = .001**, *d* = .791
	no	Energy saving	26	309.16 (98.91)	397.88 (99.48)	*t(25)* = 3.57, ***p* < .001**, *d* = .700

Note. Results of paired t-tests, including means and standard deviations. Significant results according to the Bonferroni-corrected, dependent t-tests (p < .013) are in boldface. Detailed analysis showed that the majority of the participants looked at the information about energy efficiency and annual consumption of each product. Thus, the effect was not due to the data on one product.

[1]One-tailed p-values are indicated.

3.4 Discussion

This study tested six hypotheses regarding the impact of the energy label and the information provided on it on consumers' information search and decision-making behavior. We confirm that the energy label increases the focus on energy-related information (Hypothesis 1), especially in the energy-saving focus condition (Hypothesis 6). Additionally, we showed that the energy label leads to a stronger focus on energy-efficiency information (Hypothesis 4), and that this information is easier to integrate (Hypothesis 5). However, the presence of the energy label does not result in more energy-friendly choices (Hypothesis 3) or facilitate the integration of energy-related information (Hypothesis 2).

The energy label's goal is to inform consumers about the performance of different products in terms of energy friendliness. However, a precondition is that consumers pay attention to the label and more specifically, to the information it provides. This study's results suggest that the energy label may be able to enhance the focus on energy-related information in general. The mere presence of the energy label triggers the study's participants to pay more attention to energy-related information. The label can therefore serve as a trigger for energy information, suggesting a higher awareness of environmental considerations. However, this effect can only be found for the television, but not for the freezer. This means that the energy label does not enhance the focus on energy-related information in the freezer task. More research is needed to investigate whether this is also the case with other products and how this issue can be tackled to ensure the energy label's effectiveness. This is a crucial point because information that is not considered is unlikely to influence the decision-making process (Gigerenzer & Gaissmaier, 2011; Weber & Johnson, 2009). Expressed differently, the consideration of energy-related information may be the first step toward a more sustainable purchase decision. Nonetheless, the energy label's impact on enhancing an energy-friendly purchase decision seems rather weak; the results revealed no differences in participants' choices between the label and the no-label conditions. This finding is consistent with those of other studies investigating the impact of energy labels and energy-related information on consumer choices (Mcneill & Wilkie, 1979; Wilson & Dowlatabadi, 2007). The results suggest that personal preferences for other attributes (e.g., price and size) are presumably much more important than energy-related information (Sammer & Wüstenhagen, 2006). Therefore, the energy label's effect may not show up in the final decision, especially because of the participants' limited selection of only four products, heavily restricting the variance of energy-friendly product choices.

Information provided on labels needs to be salient and accessible (Graham et al., 2012). This means that the label should be as simple as possible without losing precision about its meaning. If this condition is fulfilled, labels can be helpful tools to reach consumers and to communicate the information (Anderson & Claxton, 1982; Gössling & Buckley, 2014; Pedersen & Neergaard, 2006; Siegrist et al., 2015; van Amstel et al., 2008; Ward et al., 2011). However, this study's results have shown some important drawbacks of the energy label with regard to information transfer. One vital concern is that the current presentation format of the energy label fails to facilitate the integration of energy-related information. In other words, the participants do not find it easier to understand energy-related information (e.g., kilowatt-hours), with or without the energy label. Furthermore, the information presentation format on the energy label can even lead to biased information search behavior. The results suggest that the energy label influences the participants to pay less attention to actual energy consumption and to focus more on energy-efficiency information. This so-called energy-efficiency fallacy is problematic because the energy-efficiency rating (e.g., A^{+}) is relative to the product size and can therefore not be used to compare different-sized products. To find the most energy-friendly product, consumers need to compare the information about actual electricity consumption (e.g., 100 kwh/year). The longer mean fixation durations indicate that actual energy consumption is hard to understand, and more importantly, it is harder to understand than energy-efficiency information. In the condition without the energy label, information complexity has no effect on the participants' attention distribution. This means that they pay about the same attention to information about energy efficiency and energy consumption. The crucial point is that in the condition with the energy label, information complexity suddenly comes into play, shifting the participants' equal attention distribution toward energy-efficiency information. These findings indicate that the energy label seems to trigger heuristic information search behavior, that is, reliance on the information that is easier to integrate. A stronger focus on the energy label might thereby boost the energy-efficiency fallacy. Consequently, if the information search is guided toward energy efficiency, it can result in nonoptimal purchase decisions in terms of final energy consumption. The tendency to rely on energy-efficiency information and to neglect actual energy consumption when estimating the energy friendliness of electric goods may further explain why overall energy consumption is still increasing despite advancements in energy efficiency (Waechter et al., 2015). However, the interaction between the information format (i.e., energy efficiency vs. annual consumption) and the label is not significant in the freezer task, indicating that the impact of the misleading effect of energy efficiency varies between product types. This means that although the energy label is generic for all product types, its effect on consumers' decision making depends on the specific product type.

The detected preference for energy efficiency is in line with the findings of various studies (e.g., Sammer & Wüstenhagen, 2006; Shen & Saijo, 2009; Waechter et al., 2015). The present study's result suggests that one reason for this consumer behavior (i.e., disregard for actual energy consumption) may be due to the complexity of the information format. The findings are consistent with those of other studies showing consumers' scant awareness of the actual energy consumption of electric goods (Attari, DeKay, Davidson, & Bruine de Bruin, 2010) and their struggles with the interpretation of technological terms (Banerjee & Solomon, 2003).

3.4.1 Implications

Several implications for policymakers can be derived from the presented results. The promotion of energy efficiency and the implementation of policy tools, such as the energy label, seem to be less efficient than expected. Hence, the mandatory labeling policy is insufficient to enhance sustainable energy consumption. Other policy measures may be needed to successfully reach the energy-saving goals. Furthermore, information presentation formats on labels triggering heuristic thinking can be helpful (Gigerenzer & Gaissmaier, 2011); however, if the basis for the decision is ambiguous, heuristics can result in a biased decision (Kahneman, 2011). The problem lies in the rating system of energy efficiency that does not allow an overall assessment of a product's performance in terms of energy friendliness. Therefore, it seems worthwhile to consider a rating system that allows the comparison of different-sized products. Consequently, consumers can be sure that if they choose the best-rated product, it is in fact the one with the least consumption.

To further overcome the energy-efficiency fallacy, new solutions for communicating information about actual energy consumption should be considered. In the current communication format, information about annual consumption is harder to understand and less prominent compared to energy-efficiency information. A possible reason is that energy efficiency is communicated with a pictogram (i.e., letter scale and colored) (Siegrist et al., 2015). This means that processing energy consumption information should be facilitated and must become more accessible and salient on the energy label. For example, a study in the tourism sector has found that the combination of color and factual information facilitates comprehensibility (Gössling & Buckley, 2014). Adding a graphic cue for an appliance's performance that is based on its actual consumption, compared to those of all other appliances, can be beneficial for consumers (Teisl, Rubin, & Noblet, 2008). Moreover, the energy consumption of an average appliance can be added to provide a reference point for the kilowatt-hour number. Facilitating information about energy consumption could help neutralize the effect of the energy-efficiency fallacy.

3.4.2 Limitations and Future Research Directions

A number of limitations need to be kept in mind when interpreting the results presented in this study. Although the analysis was based on an objective measurement method (i.e., eye tracking), the results were retrieved from a simulated experiment; thus, it might only partially reflect real-life and consumer decisions, respectively. For example, the participants might have paid more attention to actual energy-consumption information because they might have felt obligated to study the materials presented more carefully, due to the simulated setting, than they would in reality. Furthermore, the presentation design of the material had to be optimized for the eye tracker, which means that it differs from the presentation design of existing online shops and is somewhat artificial. However, many online shops provide a selection of products for direct comparison that is comparable to the presentation design in the study. Additionally, all relevant energy-related information was depicted in the experiment, whereas in real life, some information—in most cases, about actual energy consumption—is often missing. The observed information search bias toward energy efficiency might therefore even be stronger when consumers would be in a real purchase situation.

The validity of eye-tracking data has been proven in many studies in various fields (for an overview, see Gegenfurtner, Lehtinen, & Säljö, 2011; Orquin & Mueller Loose, 2013) and it provides an objective measurement of participants' gaze behavior. However, the data needs interpretation and is therefore never absolutely conclusive. Furthermore, we could not rule out that the stimulus material itself had an impact on participants' viewing behavior. Although the participants were randomly assigned to the experimental conditions, certain aspects of the stimulus material, such as the saliency of the different pictures of the products or the colorful energy labels, might have affected the results. Moreover, the participants' physical constitution (e.g., tired), interest, and motivation might be influential factors that could not be absolutely controlled for. For example, freezers were probably of less interest to the participants than televisions (e.g., due to the latter's more technical features and higher status symbol) (Dwayne Ball & Tasaki, 1992).[7] A reduced interest in freezers (i.e., reduced cognitive effort) could explain why the participants were rather scanning energy-related information in the freezer task (Glöckner & Herbold, 2011). Information complexity also provides an adequate explanation for participants' gaze behavior or more precisely, for the energy-efficiency fallacy. Additional research should be conducted to study which information presentation format can help overcome the fallacy and lead to unbiased information search behavior.

Furthermore, this study was not designed to investigate consumers' final decisions but the process (i.e., information search and decision-making behavior) that would eventually

[7] This perception of product categories is consistent with findings of previously conducted qualitative interviews conducted by the authors of this paper with consumers who had just bought an electric good.

lead to the final decision. Hence, more research is needed to verify the rather low impact of the energy label on the purchase decisions detected in this study. For example, field or conjoint-based experiments could reveal the importance of the energy label for consumers' product choices in a more sensitive way. In assessing the impact of the misleading effect of the energy label (i.e., energy-efficiency fallacy) on product choice, no final conclusion could be drawn from the results presented here because the choice was binary with regard to energy friendliness (i.e., energy friendly vs. not energy friendly). More precisely, to assess the fallacy's impact on consumer decisions, a more sensitive measurement would be needed to detect differences in consumer choices. Further research could investigate the extent to which consumers would be misled by the energy label.

Finally, this study concentrated on a typical consumer product (i.e., television) and a typical household appliance (i.e., freezer) because it was not feasible to test all product types with a labeling obligation. The results revealed differences between the two product types regarding the energy label's impact. Further research should investigate to what extent the presented findings can be generalized to other products. Furthermore, the detected differences between products reinforce the importance of including various products when evaluating the energy label.

References

Allcott, H., & Greenstone, M. (2013). Is There an Energy Efficiency Gap? *Energy Efficiency: Towards the End of Demand Growth*, 133-161. doi:Doi 10.1016/B978-0-12-397879-0.00005-0

Anderson, C. D., & Claxton, J. D. (1982). Barriers to consumer choice of energy efficient products. *Journal of Consumer Research, 9*(2), 163-170. doi:10.2307/2489125

Ares, G., Giménez, A., Bruzzone, F., Vidal, L., Antúnez, L., & Maiche, A. (2013). Consumer visual processing of food labels: Results from an eye-tracking study. *Journal of Sensory Studies, 28*(2), 138-153. doi:10.1111/joss.12031

Ashby, N. J. S., Dickert, S., & Glöckner, A. (2012). Focusing on what you own: Biased information uptake due to ownership. *Judgment and Decision Making, 7*(3), 254-267.

Ashby, N. J. S., Walasek, L., & Glöckner, A. (2015). The effect of consumer ratings and attentional allocation on product valuations. *Judgment and Decision Making, 10*(2), 172 - 184.

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences, 107*(37), 16054-16059. doi:10.1073/pnas.1001509107

Banerjee, A., & Solomon, B. D. (2003). Eco-labeling for energy efficiency and sustainability: a meta-evaluation of US programs. *Energy Policy, 31*(2), 109-123. doi:http://dx.doi.org/10.1016/S0301-4215(02)00012-5

BFE. (2013). *Swiss energy statistics 2012 [Schweizerische Gesamtenergiestatistik 2012]*. Retrieved from Bern:

Boardman, B. (2004). Achieving energy efficiency through product policy: the UK experience. *Environmental Science & Policy, 7*(3), 165-176. doi:http://dx.doi.org/10.1016/j.envsci.2004.03.002

Bradu, C., Orquin, J., & Thøgersen, J. (2014). The mediated influence of a traceability label on consumer’s willingness to buy the labelled product. *Journal of Business Ethics, 124*(2), 283-295. doi:10.1007/s10551-013-1872-2

Bundesrat. (2013). *Federal Council communicates the energy-strategy 2050 [Bundesrat verabschiedet Botschaft zur Energiestrategie 2050]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from http://www.uvek.admin.ch/dokumentation/00474/00492/index.html?lang=de&msg-id=50123 (accessed: 25.12.2013).

Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances, (1992).

Davis, L. W. (2008). Durable goods and residential demand for energy and water: evidence from a field trial. *The RAND Journal of Economics, 39*(2), 530-546. doi:10.1111/j.0741-6261.2008.00026.x

de Almeida, A., Fonseca, P., Schlomann, B., & Feilberg, N. (2011). Characterization of the household electricity consumption in the EU, potential energy savings and specific policy recommendations. *Energy and Buildings, 43*(8), 1884-1894. doi:http://dx.doi.org/10.1016/j.enbuild.2011.03.027

Dendler, L. (2014). Sustainability meta labelling: an effective measure to facilitate more sustainable consumption and production? *Journal of Cleaner Production, 63*(0), 74-83. doi:/10.1016/j.jclepro.2013.04.037

Djamasbi, S., Samani, A., & Mehta, D. (2012). *Eye Movements, Perceptions, and Performance.* Paper presented at the eighteenth Americas Conference on Information Systems (AMCIS), Seattle, Washington.

Duchowski, A. (2007a). Eye Movement Analysis *Eye Tracking Methodology* (pp. 137-153): Springer London.

Duchowski, A. (2007b). Visual Attention *Eye Tracking Methodology* (pp. 3-13): Springer London.

Dwayne Ball, A., & Tasaki, L. H. (1992). The Role and Measurement of Attachment in Consumer Behavior. *Journal of Consumer Psychology, 1*(2), 155-172. doi:http://dx.doi.org/10.1016/S1057-7408(08)80055-1

Egan, C., Payne, C. T., & Thorne, J. (2000). Interim findings of an evaluation of the U.S. EnergyGuide label.

Directive 2010/30/EU of the European Union and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, (2010).

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (2012).

Eurostat. (2012) Energy, transport and environment indicators. Luxembourg: Publications Office of the European Union.

Field, A. P. (2013). *Discovering statistics using IBM SPSS statistics : and sex and drugs and rock 'n' roll* (4th edition. ed.). Los Angeles: Sage.

Galarraga Gallastegui, I. (2002). The use of eco-labels: a review of the literature. *European Environment, 12*(6), 316-331. doi:10.1002/eet.304

Gegenfurtner, A., Lehtinen, E., & Säljö, R. (2011). Expertise differences in the comprehension of visualizations: a Meta-analysis of eye-tracking research in professional domains. *Educational Psychology Review, 23*(4), 523-552. doi:10.1007/s10648-011-9174-7

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*(1), 451-482. doi:doi:10.1146/annurev-psych-120709-145346

Gillingham, K., & Palmer, K. (2013). *Bridging the energy efficiency gap: Insights for policy from economic theory and empirical analysis*. Retrieved from http://ideas.repec.org/p/rff/dpaper/dp-13-02.html

Glöckner, A., & Herbold, A.-K. (2011). An eye-tracking study on information processing in risky decisions: Evidence for compensatory strategies based on automatic processes. *Journal of Behavioral Decision Making, 24*(1), 71-98. doi:10.1002/bdm.684

Goldberg, J. H., & Kotval, X. P. (1999). Computer interface evaluation using eye movements: methods and constructs. *International Journal of Industrial Ergonomics, 24*(6), 631-645. doi:Doi 10.1016/S0169-8141(98)00068-7

Gössling, S., & Buckley, R. (2014). Carbon labels in tourism: persuasive communication? *Journal of Cleaner Production*(0). doi:http://dx.doi.org/10.1016/j.jclepro.2014.08.067

Graham, D. J., Orquin, J. L., & Visschers, V. H. M. (2012). Eye tracking and nutrition label use: A review of the literature and recommendations for label enhancement. *Food Policy, 37*(4), 378-382. doi:http://dx.doi.org/10.1016/j.foodpol.2012.03.004

Heinzle, S. (2012). Disclosure of Energy Operating Cost Information: A Silver Bullet for Overcoming the Energy-Efficiency Gap? *Journal of Consumer Policy, 35*(1), 43-64. doi:10.1007/s10603-012-9189-6

Heinzle, S., & Wüstenhagen, R. (2009). *Consumer survey on the new format of the European Energy Label for televisions - Comparison of a "A-G closed" versus a "beyond A" scale format*. ZEW. Mannheim.

Henderson, J. M., & Hollingworth, A. (1999). High-level scene perception. *Annual Review of Psychology, 50*(1), 243-271. doi:doi:10.1146/annurev.psych.50.1.243

Herring, H. (2006). Energy efficiency - a critical view. *Energy, 31*(1), 10-20. doi:10.1016/j.energy.2004.04.055

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & van de Weijer, J. (2011). *Eye Tracking - A comprehensive guide to methods and measures*. New York: Oxford University Press.

Horstmann, N., Ahlgrimm, A., & Glöckner, A. (2009). How distinct are intuition and deliberation? An eye tracking analysis of instruction-induced decision modes. *Judgment and Decision Making, 4*(5), 335-354.

IEA. (2003). *Cool Appliances: Policy Strategies for Energy-Efficient Homes*: OECD Publishing.

IEA. (2009). *Gadgets and Gigawatts*: OECD Publishing.

International Risk Governance Council. (2013). *The rebound effect: Implications of consumer behaviour for robust energy policies*. Retrieved from Lausanne:

Jaffe, A. B., & Stavins, R. N. (1994). The energy-efficiency gap What does it mean? *Energy Policy, 22*(10), 804-810. doi:10.1016/0301-4215(94)90138-4

Just, M. A., & Carpenter, P. A. (1976). Eye fixations and cognitive processes. *Cognitive Psychology, 8*(4), 441-480. doi:http://dx.doi.org/10.1016/0010-0285(76)90015-3

Kahneman, D. (2011). *Thinking, fast and slow*. London: Penguin.

Kralik, J. D., Xu, E. R., Knight, E. J., Khan, S. A., & Levine, W. J. (2012). When Less Is More: Evolutionary Origins of the Affect Heuristic. *PLoS ONE, 7*(10), e46240. doi:10.1371/journal.pone.0046240

Le Meur, O., & Le Callet, P. (2009, 7-10 Nov. 2009). *What we see is most likely to be what matters: Visual attention and applications.* Paper presented at the Image Processing (ICIP), 2009 16th IEEE International Conference on.

Mcneill, D. L., & Wilkie, W. L. (1979). Public-Policy and Consumer Information - Impact of the New Energy Labels. *Journal of Consumer Research, 6*(1), 1-11. doi:Doi 10.1086/208743

Merritt, A. C., Effron, D. A., & Monin, B. (2010). Moral self-licensing: When being good frees us to be bad. *Social and Personality Psychology Compass, 4*(5), 344-357. doi:10.1111/j.1751-9004.2010.00263.x

Molenbroek, E., Cuijpers, M., Janeiro, L., Smith, M., Surmeli, N., Waide, P., . . . Fong, J. (2013). *Evaluation of the Energy Labelling Directive and specific apsects of Ecodesign Directive - Background report I.* Retrieved from http://www.energylabelevaluation.eu/eu/home/welcome

Molenbroek, E., Smith, M., Groenenberg, H., Waide, P., Attali, S., Fischer, C., . . . Fong, J. (2014). *Final technical report. Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive ENER/C3/2012-523*. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

OECD/IEA. (2013). *Energy Policy Highlights*. Retrieved from

OECD/IEA, & AFD. (2008). *Promoting energy efficiency investments. Case studies in the residential sector*. Retrieved from Paris:

Orquin, J. L., & Mueller Loose, S. (2013). Attention and choice: A review on eye movements in decision making. *Acta Psychologica, 144*(1), 190-206. doi:http://dx.doi.org/10.1016/j.actpsy.2013.06.003

Otto, S., Kaiser, F. G., & Arnold, O. (2014). The Critical Challenge of Climate Change for Psychology Preventing Rebound and Promoting More Individual Irrationality. *European Psychologist, 19*(2), 96-106. doi:Doi 10.1027/1016-9040/A000182

Pedersen, E. R., & Neergaard, P. (2006). Caveat emptor – let the buyer beware! environmental labelling and the limitations of ‘green’ consumerism. *Business Strategy and the Environment, 15*(1), 15-29. doi:10.1002/bse.434

Pieters, R. G. M., Rosbergen, E., & Hartog, M. (1996). Visual Attention to Advertising: The Impact of Motivation and Repetition. *Advances in Consumer Research, 23*(1), 242-248.

Poole, A., Ball, L., & Phillips, P. (2005). In Search of Salience: A Response-time and Eye-movement Analysis of Bookmark Recognition. In S. Fincher, P. Markopoulos, D. Moore, & R. Ruddle (Eds.), *People and Computers XVIII — Design for Life* (pp. 363-378): Springer London.

Prognos. (2012). *Energyperspectives for Switzerland until 2050 [Die Energieperspektiven für die Schweiz bis 2050]*. Retrieved from Basel: http://www.bfe.admin.ch/themen/00526/00527/index.html?lang=de&dossier_id=05673

Retailresearch. (2014). Online Retailing: Britain, Europe and the US 2014. Retrieved from http://www.retailresearch.org/onlineretailing.php

Sammer, K., & Wüstenhagen, R. (2006). The influence of eco-labelling on consumer behaviour – results of a discrete choice analysis for washing machines. *Business Strategy and the Environment, 15*(3), 185-199. doi:10.1002/bse.522

Schulte-Mecklenbeck, M., Sohn, M., de Bellis, E., Martin, N., & Hertwig, R. (2013). A lack of appetite for information and computation. Simple heuristics in food choice. *Appetite, 71*(0), 242-251. doi:http://dx.doi.org/10.1016/j.appet.2013.08.008

Shen, J., & Saijo, T. (2009). Does an energy efficiency label alter consumers' purchasing decisions? A latent class approach based on a stated choice experiment in Shanghai. *Journal of Environmental Management, 90*(11), 3561-3573. doi:10.1016/j.jenvman.2009.06.010

Shi, S. W., Wedel, M., & Pieters, F. G. M. (2013). Information acquisition during online decision making: A model-based exploration using eye-tracking data. *Management Science, 59*(5), 1009-1026. doi:doi:10.1287/mnsc.1120.1625

Shippee, G. (1980). Energy consumption and conservation psychology: A review and conceptual analysis. *Environmental Management, 4*(4), 297-314. doi:10.1007/BF01869423

Siegrist, M., Leins-Hess, R., & Keller, C. (2015). Which front-of-pack nutrition label is the most efficient one? The results of an eye-tracker study. *Food Quality and Preference, 39*(0), 183-190. doi:http://dx.doi.org/10.1016/j.foodqual.2014.07.010

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Sörqvist, P., Hedblom, D., Holmgren, M., Haga, A., Langeborg, L., Nöstl, A., & Kågström, J. (2013). Who Needs Cream and Sugar When There Is Eco-Labeling? Taste and Willingness to Pay for “Eco-Friendly” Coffee. *PLoS ONE, 8*(12), e80719. doi:10.1371/journal.pone.0080719

Soytas, U., Sari, R., & Ewing, B. T. (2007). Energy consumption, income, and carbon emissions in the United States. *Ecological Economics, 62*(3–4), 482-489. doi:http://dx.doi.org/10.1016/j.ecolecon.2006.07.009

Stawreberg, L., & Wikström, F. (2011). Does the energy labelling system for domestic tumble dryers serve its purpose? *Journal of Cleaner Production, 19*(12), 1300-1305. doi:http://dx.doi.org/10.1016/j.jclepro.2011.03.016

Stüttgen, P., Boatwright, P., & Monroe, R. T. (2012). A Satisficing Choice Model. *Marketing Science, 31*(6), 878-899.

Sütterlin, B., & Siegrist, M. (2014). The reliance on symbolically significant behavioral attributes when judging energy consumption behaviors. *Journal of Environmental Psychology, 40*(0), 259-272. doi:http://dx.doi.org/10.1016/j.jenvp.2014.07.005

Tatler, B. W., Wade, N. J., Kwan, H., Findlay, J. M., & Velichkovsky, B. M. (2010). Yarbus, eye movements, and vision. *Iperception, 1*(1), 7-27. doi:10.1068/i0382

Teisl, M. F., Rubin, J., & Noblet, C. L. (2008). Non-dirty dancing? Interactions between eco-labels and consumers. *Journal of Economic Psychology, 29*(2), 140-159. doi:10.1016/j.joep.2007.04.002

Theeuwes, J. (1992). Perceptual selectivity for color and form. *Perception & Psychophysics, 51*(6), 599-606. doi:10.3758/BF03211656

Thøgersen, J., & Ölander, F. (2003). Spillover of environment-friendly consumer behaviour. *Journal of Environmental Psychology, 23*(3), 225-236. doi:http://dx.doi.org/10.1016/S0272-4944(03)00018-5

Tiefenbeck, V., Staake, T., Roth, K., & Sachs, O. (2013). For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy, 57*(0), 160-171. doi:http://dx.doi.org/10.1016/j.enpol.2013.01.021

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131. doi:10.2307/1738360

Unema, P., & Rotting, M. (1990). Differences in Eye-Movements and Mental Workload between Experienced and Inexperienced Motor-Vehicle Drivers. *Visual Search*, 193-202.

van Amstel, M., Driessen, P., & Glasbergen, P. (2008). Eco-labeling and information asymmetry: a comparison of five eco-labels in the Netherlands. *Journal of Cleaner Production, 16*(3), 263-276. doi:http://dx.doi.org/10.1016/j.jclepro.2006.07.039

Velichkovsky, B. M., Rothert, A., Kopf, M., Dornhöfer, S. M., & Joos, M. (2002). Towards an express-diagnostics for level of processing and hazard perception. *Transportation*

Research Part F: Traffic Psychology and Behaviour, 5(2), 145-156. doi:http://dx.doi.org/10.1016/S1369-8478(02)00013-X

Waechter, S., Sütterlin, B., & Siegrist, M. (2015). The misleading effect of energy efficiency information on perceived energy friendliness of electric goods. *Journal of Cleaner Production, 93*(0), 193-202. doi:http://dx.doi.org/10.1016/j.jclepro.2015.01.011

Walton, K. C. (2014). Renewable energy for low income clients: benefits beyond the money. *2013 Ises Solar World Congress, 57*, 826-833. doi:DOI 10.1016/j.egypro.2014.10.291

Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., & Russell, C. S. (2011). Factors influencing willingness-to-pay for the ENERGY STAR® label. *Energy Policy, 39*(3), 1450-1458. doi:http://dx.doi.org/10.1016/j.enpol.2010.12.017

Weber, E. U., & Johnson, E. J. (2009). Mindful Judgment and Decision Making. *Annual Review of Psychology, 60*, 53-85.

Wiel, S. (2000). Musings on regulatory policy as a driver of technology. *Environmental Science & Policy, 3*(1), 7-8. doi:http://dx.doi.org/10.1016/S1462-9011(00)00014-9

Wiel, S., & McMahon, J. E. (2003). Governments should implement energy-efficiency standards and labels—cautiously. *Energy Policy, 31*(13), 1403-1415. doi:http://dx.doi.org/10.1016/S0301-4215(02)00199-4

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annual Review of Environment and Resources, 32*(1), 169-203. doi:10.1146/annurev.energy.32.053006.141137

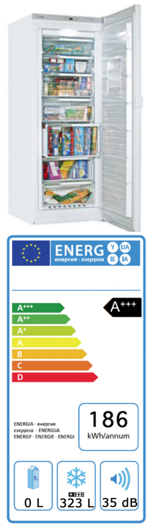
World Bank. Retrieved from http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE

Zhang, X.-P., & Cheng, X.-M. (2009). Energy consumption, carbon emissions, and economic growth in China. *Ecological Economics, 68*(10), 2706-2712. doi:http://dx.doi.org/10.1016/j.ecolecon.2009.05.011

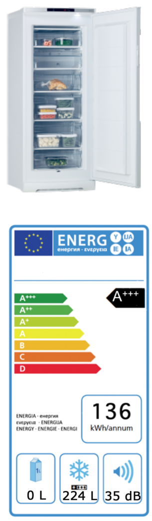
Supporting Information

S3.1 Fig. Products with pictures and freezer features in the label condition.

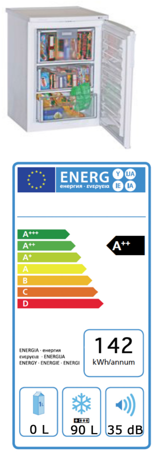
Freezer GN	Price: 1'799.-
Storage Capacity	323 l
Energy Efficiency Rating	A+++
Acoustic Alarmsystem	Yes
Drawers	5
Big Boxes	1
No Frost Technology	Yes
Power Failure Safe Storage	28 h
Annual Energy Consumption	186 kWh
H x W x D (cm)	70 x 176 x 78



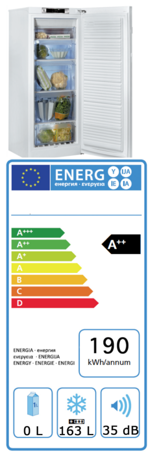
Freezer SG	Price: 1'259.-
Storage Capacity	224 l
Energy Efficiency Rating	A+++
Acoustic Alarmsystem	Yes
Drawers	4
Big Boxes	4
No Frost Technology	No
Power Failure Safe Storage	28 h
Annual Energy Consumption	136 kWh
H x W x D (cm)	66 x 165 x 68



Freezer KF	Price: 599.-
Storage Capacity	90 l
Energy Efficiency Rating	A++
Acoustic Alarmsystem	No
Drawers	3
Big Boxes	1
No Frost Technology	No
Power Failure Safe Storage	12 h
Annual Energy Consumption	142 kWh
H x W x D (cm)	60 x 85 x 62



Freezer WL	Price: 649.-
Storage Capacity	163 l
Energy Efficiency Rating	A++
Acoustic Alarmsystem	No
Drawers	5
Big Boxes	2
No Frost Technology	Yes
Power Failure Safe Storage	28 h
Annual Energy Consumption	190 kWh
H x W x D (cm)	60 x 139 x 63



S3.2 Fig. Products with pictures and freezer features in the no-label condition.

Freezer GN	Price: 1‘799.-
Storage Capacity	323 l
Energy Efficiency Rating	A+++
Acoustic Alarmsystem	Yes
Drawers	5
Big Boxes	1
No Frost Technology	Yes
Power Failure Safe Storage	28 h
Annual Energy Consumption	186 kWh
H x W x D (cm)	70 x 176 x 78

Freezer SG	Price: 1‘259.-
Storage Capacity	224 l
Energy Efficiency Rating	A+++
Acoustic Alarmsystem	Yes
Drawers	4
Big Boxes	4
No Frost Technology	No
Power Failure Safe Storage	28 h
Annual Energy Consumption	136 kWh
H x W x D (cm)	66 x 165 x 68

Freezer KF	Price: 599.-
Storage Capacity	90 l
Energy Efficiency Rating	A++
Acoustic Alarmsystem	No
Drawers	3
Big Boxes	1
No Frost Technology	No
Power Failure Safe Storage	12 h
Annual Energy Consumption	142 kWh
H x W x D (cm)	60 x 85 x 62

Freezer WL	Price: 649.-
Storage Capacity	163 l
Energy Efficiency Rating	A++
Acoustic Alarmsystem	No
Drawers	5
Big Boxes	2
No Frost Technology	Yes
Power Failure Safe Storage	28 h
Annual Energy Consumption	190 kWh
H x W x D (cm)	60 x 139 x 63

S3.1 Dataset. Count of fixations on all areas of interest in the condition without the energy label. Available online: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0134132

S3.2 Dataset. Count of fixations on all areas of interest in the condition with the energy label. Available online: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0134132

CHAPTER IV

DECISION-MAKING STRATEGIES FOR THE CHOICE OF ENERGY-FRIENDLY PRODUCTS

Signe Waechter, Bernadette Sütterlin, Michael Siegrist

Manuscript submitted for publication as:

Waechter, S., Sütterlin, B., & Siegrist, M. (2015). Decision making strategies for the choice of energy-friendly products.

Abstract

Although energy efficiency of many products has been improving constantly, residential energy consumption is not decreasing as much as desired. Therefore, the goal of the European Union (EU) and many other countries is to encourage energy-friendly product choices (i.e., choice of products with low energy consumption). In a purchase situation, consumers are confronted with a wide range of energy-related information that can influence the decision-making process. Understanding how consumers reach a decision based on the information provided and identifying decision-making strategies that are beneficial or destructive in terms of energy friendliness is crucial for the improvement of existing energy-policy measures and, consequently, for the successful achievement of target energy saving goals. This paper provides insights from an exploratory eye-tracking study (N = 59) investigating consumers' decision-making process. Participants were required to identify the most energy-friendly television (i.e., the television with lowest energy consumption). Cluster analysis revealed three consumer segments with different decision-making strategies: the energy-directed lexicographic, unsystematic lexicographic, and unsystematic exhaustive strategies. The energy-directed lexicographic strategy resulted in 60% optimal choices in terms of energy friendliness, unsystematic lexicographic in 33%, and unsystematic exhaustive in 38%. No decision-making strategy resulted in 100% optimal choices in terms of energy friendliness. Findings emphasize that lexicographic strategies can successfully identify energy-friendly products when the correct information (i.e., actual energy consumption) is used. However, a lexicographic strategy can be very misleading and result in non-optimal choices in terms of energy-friendliness when it is based on ambiguous information (i.e., energy efficiency information) that does not enable a conclusive decision. Further, this paper discusses implications for policy-makers and marketers for the promotion of energy-friendly consumer behaviour.

4.1 Introduction

Governments and non-governmental organizations (NGOs) spend a vast amount of money, time, and research to succeed in the reduction of energy consumption. Many countries, including Switzerland and several member states of the European Union (EU), announced their pursuance this goal (e.g., Bundesrat, 2013b; European Council, 2012; OECD/IEA, 2013). The main strategy to attain this goal is by increasing energy efficiency. For example, the EU set minimal energy efficiency standards for household appliances and consumer electronics and implemented the inclusion of an energy label on every product that provides information about a products' energy-friendliness (European Council, 2012). In Switzerland, the sale of inefficient products has been restricted and it is mandatory for new products to fulfil the required energy efficient standards (Bundesrat, 2013a). These regulations have been successful, as the energy efficiency of electronic products is constantly increasing (Molenbroek et al., 2014). However, the enhancement of energy efficiency is not sufficient for attaining the targeted energy-saving goals. One reason for this development is the increase of energy consumption at the household level, with a total increase of 26% since 1990 (Eurostat, 2014). Residential energy consumption accounts for approximately 30% of the final energy consumption (Eurostat, 2014; Prognos, 2014). Most energy is used for heating; however, a substantial share (i.e., approximately 13%) of the household energy demand is for household appliances and consumer electronics, like televisions (IEA, 2003; Prognos, 2014). The increase in energy consumption on the household level is partially due to population growth and enhanced material wealth (OECD/IEA, 2013). However, part of the increase in energy consumption is related to the fact that products are getting bigger and bigger. For example, an analysis of televisions' screen size showed an increase of 20% from 2007 to 2013 (Michel, Attali, & Bush, 2014). Despite the technological development (e.g., replacement of cathode ray tube televisions by more efficient LED televisions), the energy consumption of televisions has only slightly decreased (FIMRT, 2012; Prognos, 2012). Given that despite energy-friendly technological innovations, energy consumption at the household level is still increasing, the question arises whether the implemented policy tools, such as the energy label for electrical appliances, are not as successful as they need to be in order to achieve a decrease in final consumption.

Consumers' choice of electric goods is of interest to policy-makers and marketers, as consumers goods are responsible for a substantial amount of overall energy consumption (IEA, 2009). Therefore, it is of special interest to identify decision-making strategies that are beneficial or destructive in terms of energy friendliness (i.e., choosing products with low energy consumption). However, thus far, little is known about this field of consumer decision-making. This study aims to extend the knowledge on energy-friendly decision-making by identifying and describing different strategies that consumers apply when choosing an electric good (i.e., television).

4.1.1 Decision-making Strategies

Decisions are part of people's daily life. Many of these daily decisions are made fast and without much cognitive effort, while others require more substantial considerations. What all decisions do have in common is that they rely on some sort of a strategy. The strategies can vary from being very rudimental to highly elaborated depending on the person, the context, and many other factors including the motivation, the provided options, and the type of product (Bettman, Johnson, & Payne, 1991). This is also true for the decision-making processes related to the purchase of electric goods.

Decision-making strategies can be allocated to two frameworks, namely, lexicographic strategies or weighted additive strategies (Weber & Johnson, 2009). Weighted additive strategies assume that people assign a weight to each attribute, sum them up, and choose the product with the highest sum (i.e., highest value to person). One very unattractive attribute can thereby be compensated by other attractive attributes. Therefore, these strategies are also referred to as compensative strategies. On the other hand, lexicographic strategies assume that one attribute is the most important one and the comparison proceeds along this criterion. If one option performs best in terms of this attribute, this option will be chosen. If two options perform equally well, the comparison continues along the second most important attribute. Unattractive attributes can thereby not be compensated. Therefore, lexicographic strategies are allocated to non-compensatory strategies.

Weighted additive strategies are particularly dominant in economic and marketing research, and assume that humans evaluate and integrate all information provided and choose the option with the highest value (for a critical review, see Camerer & Loewenstein, 2004; Stüttgen, Boatwright, & Monroe, 2012). Although the theory of bounded rationality (Tversky & Kahneman, 1974) has become more relevant in the mentioned fields, acknowledging that the assumption of a purely rational, utility-maximizing decision-making behaviour might be restrained (Kahneman, 2011), many classical approaches to studying decision-making (e.g., conjoint-analysis) often still assume a weighted additive decision-making process (Netzer et al., 2008). Moreover, these studies usually provide estimates of the revealed importance of different attributes, but they miss monitoring the process prior to the final decision, including the dynamic component (e.g., direction of search) of the decision-making process (e.g., Heinzle & Wüstenhagen, 2012; Yamamoto, Suzuki, Fuwa, & Sato, 2008). This is of special concern, because research on decision-making has shown that people often do not integrate all information provided into the decision but often make choices based on a few attributes. Much well-known work regarding such decision-making behaviour has been conducted by Gigerenzer and colleagues (Gigerenzer & Gaissmaier, 2011). Like many other researchers (Chase, 1978; Schwartz et al., 2002; Simon, 1955), they underscore that humans often make fast and frugal decisions without considering all the information. The use of such fast and frugal decision heuristics can result in high-quality decisions and can be helpful in many daily situations (Goldstein & Gigerenzer, 2009). However, it has been shown that the use of such heuristics can also potentially lead to biased decisions, because what all heuristics do have in common is that they ignore part of the information (Gigerenzer & Gaissmaier, 2011). For example, how information is framed (e.g., positive vs. negative) strongly influences people's choices (Kahneman & Tversky, 1979). Furthermore, certain aspects of the information format, such as the evaluability and saliency of the information, are crucial to whether a certain piece of information is integrated (Hsee, 1996; Slovic, Finucane, Peters, & MacGregor, 2007; Sutterlin & Siegrist, 2014). The opposition between the two frameworks has nourished the development of different decision-making strategies as well as the research on decision-making in past years, including studies on decision-process tracing by means of eye tracking (Stüttgen et al., 2012). Research suggests that not one framework (weighted additive vs. lexicographic) alone can explain it all, but that decision-making strategies are task-dependent and adaptable to the environment (Bettman et al., 1991). One person might use different strategies in comparable situations and others might use the same strategy in very different situations (Shi, Wedel, & Pieters, 2013; Söllner, Bröder, Glöckner, & Betsch, 2014).

A lot of research has been conducted to investigate consumers' decision-making strategies regarding food choices (e.g., Scheibehenne, Miesler, & Todd, 2007; Schulte-Mecklenbeck, Sohn, de Bellis, Martin, & Hertwig, 2013) or decision-making strategies under uncertainty (e.g., Fiedler & Glöckner, 2012; Kahneman & Tversky, 1979; Pachur, Hertwig, Gigerenzer, & Brandstatter, 2013; Tversky & Kahneman, 1974). However, little is known about the decision-making strategies for the purchase of energy-consuming durables. We want to investigate which decision-making strategies consumers apply and which of these strategies are expedient in terms of energy-friendliness. Therefore, the aim of this study is to investigate which decision-making strategies consumers apply when purchasing electric goods and which of these strategies are expedient in terms of energy friendliness. Furthermore, we aim to understand the role of personal characteristics, such as age, gender, and attitude towards energy conservation. Investigating consumers' judgment and decision-making behaviour when it comes to energy-related purchase decisions will enable us to detect barriers and drivers for the choice and use of energy-friendly products and develop tools to enable and promote effective energy-saving purchase behaviour.

4.1.2 The EU Energy Label

The EU energy label is a mandatory label for various household appliances (e.g., freezers, refrigerators, and washing machines) and consumer electronics (e.g., televisions). An energy efficiency rating is depicted on the energy label that indicates how efficiently the product uses the energy. Originally, the rating scale ranged from A to G, with A assigned for the most efficient products and G for the least efficient products. The rapid development of more efficient products required the introduction of additional ratings to differentiate between the most efficient products. These new categories are marked with a plus (e.g., A^{+}). This development occurred at a different speed in various product categories and, consequently, the energy efficiency rating scale now differs between product types.

A crucial characteristic of the depicted energy efficiency rating is that it is relative to the size of the products. This implies that big products can be very energy-efficient and be assigned a good energy efficiency rating, but still consume a considerable amount of energy due to their size. For example, a television with a screen size of 60 inches (in.) consuming 101kWh/year is assigned an A^{++} rating, whereas a television with a screen size of 32 in. consuming 50kWh/year is assigned an A rating (Energie Agentur Elektrogeräte, 2015). Therefore, this rating system can be misleading, because the best energy-efficient product is not automatically the most energy-friendly choice. Hence, in order to determine the most energy-friendly product from among numerous products, consumers should study the information on the actual energy consumption displayed on the energy label in kilowatt-hours per year (i.e., XY kWh/annum), because this information is depicted in absolute terms. Nevertheless, understanding this information might be challenging, as it requires at least some technological knowledge or a strong interest in the topic. Otherwise it is difficult to judge whether a certain amount of kWh/year is high or low. Research has shown that this task is difficult to achieve for consumers (Attari, DeKay, Davidson, & Bruine de Bruin, 2010).

Energy-efficiency information is depicted more prominently and saliently on the energy label due to the colour code and letter rating. Consequently, the latter information is less likely to be considered in the decision-making process. In line with this, recent research has shown that consumers tend to judge a product's energy-friendliness based on its energy efficiency rating neglecting information about its actual energy consumption and, consequently, overestimate the energy friendliness of products with good energy-efficiency ratings (Waechter, Sütterlin, & Siegrist, 2015b). This focus on energy-efficiency information can even shift the perception of entire product categories that are usually associated with high energy consumption, such as freezers. This energy efficiency fallacy might partially explain why consumers choose bigger products, because they merely rely on energy-efficiency information. This is particularly problematic, because the percentage of products with the best energy-efficiency rating is higher for bigger products than for smaller products (VZBV, 2015). This could further contribute to the explanation of the appearance of an energy-efficiency gap. The energy-efficiency gap refers to a discrepancy between the potential of energy saving (e.g., due to technology) and the actual market situation (Allcott & Greenstone, 2013; Jaffe & Stavins, 1994).

The extent of this gap is part of an ongoing discussion between experts, as the calculation of the potential and actual savings are rather complex. However, Gillingham and Palmer (2014) stated that behavioural aspects, like consumers' purchase decisions, are a major reason why the estimated energy savings have not been achieved yet. As mentioned earlier, consumers' tendency to overestimate the relevance of energy efficiency information when judging the energy friendliness of products is one possible reason for the aforementioned trend towards bigger products, thereby boosting final energy consumption. Furthermore, apart from the fact that even bigger products are available on the market, the number of televisions and other consumer electronics per household is also rising (Molenbroek et al., 2014; Prognos, 2012). This trend could be due to the fact that consumers might feel compelled to purchase more products as long as they are assigned an excellent energy-efficiency rating. More precisely, consumers might assume that the energy consumption of products with excellent efficiency ratings is no longer problematic. This so-called moral-licensing effect has, for example, been observed in a study by Tiefenbeck et al. (Tiefenbeck, Staake, Roth, & Sachs, 2013). They showed that people increased their electricity consumption when they had received a positive feedback regarding their decreased water consumption. This backfiring effect is referred to as a negative spillover effect (for a review, see Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014). In economics, this concept is known as the rebound effect and it constitutes a major part in the explanation of the energy efficiency gap (Gillingham & Palmer, 2014). Therefore, studying consumers' decision-making strategies is essential to prevent such undesired behavioural effects. We need to understand how consumers process the information provided, which pieces of information they integrate, and how this ultimately affects their decision-making process and product choice. Based on the knowledge and insights gained on how consumers use and apply the information provided, existing energy-policy measurements, such as the energy label, can subsequently be improved and adapted in order to enable consumers to make an informed decision and identify the most energy-friendly product.

4.2 Methods

4.2.1 Participants

A random sample of 500 households in the German-speaking part of Switzerland was drawn from the electronic telephone directory; the households were advised via an invitation letter about the study's objectives and procedure. After a few days, the households were contacted by phone and asked about their willingness to participate in the study. In addition, a free advert in a newsletter also provided information about the study and included the option of signing up for it. The exclusion criteria for participation consisted of wearing eyeglasses or hard contact lenses, or suffering from eye diseases, because these factors can pose a problem for the eye tracker (e.g., due to reflections on the eyeglasses). Additionally, participants were required to be in the age group of between 20 and 65 years. The maximum age limit was set at 65 years because aging tends to cause drooping eyelids, which can lead to calibration problems. The experiment was conducted alongside a second unrelated study. It took participants less than one hour to complete the two studies and they received CHF 40 (≈USD 42) as an incentive.

In total, 62 people from the population of the German-speaking part of Switzerland participated in the experiment. Three participants were excluded from the final sample due to calibration problems on the eye tracker. Thus, the final sample comprised 33 women and 26 men ($N = 59$) and the mean age was 37 years ($SD = 11$). The education level was high, with 28.8% of the participants having an university degree and 52.5% having finished high school or similar. The majority of the participants were tenants (86.4%), and the number of people living in a household was 2.3 people, on average. All participants had normal or corrected-to-normal eye vision.

4.2.2 Stimuli Material

The material for the eye tracking study consisted of the descriptions of four different television models as usually provided in online stores (e.g., price, picture, and technical information) (Fig. 1). The four televisions were all available on the market at the time that the study was conducted. We chose televisions because it is a product that most consumers are familiar with. Furthermore, the screen size of televisions has increased over the past years (VZBV, 2015) and televisions have changed from being single-purpose products to a product that provides a multitude of different activities (e.g., internet, game stations, etc.) (FIMRT, 2012). This development is one reason for the increase in energy consumption at household levels, despite technological progress (e.g., LCD televisions) and enhanced energy efficiency (Michel et al., 2014; Prognos, 2012). A big television still consumes more energy than a small television; therefore, a decision based solely on energy efficiency is not sufficient to identify the product with the lowest energy consumption.

Participants were shown four televisions, including their pictures and additional information such as technical features and price, on the screen and were asked to indicate which one they would recommend to a person who wants to use a television with the least possible amount of energy consumption. The instruction that participants received is presented in Table 1. We opted against a personal choice, because the focus was to understand energy-friendly decision-making strategies. Personal choices would be strongly affected by personal preferences, such as the size of the television, which would impede the assessment of the decision-making strategy related to the purchase of energy-friendly appliances. By instructing participants to identify the most energy-friendly product, we were able to control for the effect of personal preferences.

Table 4.1

Task Instructions.

Instructions
Please imagine that a person wants to buy a television that consumes the least possible amount of energy. The choice has to be made from among four televisions, and the person asks for your advice. The next page presents the four televisions, out of which you have to choose one. Look at the pictures and the information as you would at home on your computer screen. Please decide which television you would recommend to the person. Tell the examiner the name of the chosen product. The name is displayed on the top left corner of each product and consists of two characters (e.g., SZ). Take as much time as you need. Please look at the screen the entire time and attempt to sit very still. If you have any questions regarding the task, please ask the examiner. If you do not have further questions, inform the examiner that you have understood the task and he/she will activate the next page.

The energy label plays a crucial role in energy policies and should empower consumers to identify energy-friendly products. In order to ascertain the influence of energy labels on the decision-making process, half of the participants were provided with television descriptions as presented in Figure 4.1 and the other half (i.e., label condition) received the energy labels of the televisions as additional information (Fig. 4.2).

Television PF	Price: 1'199.-
Screen Size	47 in (120 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	Yes
Image Display	3D / 2D
Features	PayTV, Memory Card, 3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	95 kWh
Power	69 Watt

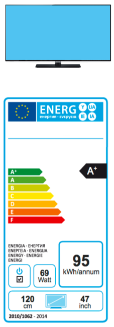
Television ME	Price: 2'259.-
Screen Size	60 in (153 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	No
Image Display	3D / 2D
Features	3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	145 kWh
Power	99 Watt

Television UE	Price: 799.-
Screen Size	40 Zoll (102 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	4 HDMI-Anschlüsse
Energy Efficiency Ra-ting	A
Annual Energy Consumption	89 kWh
Power	61 Watt

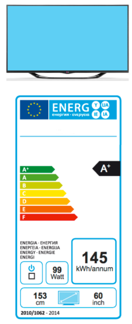
Television LS	Price: 2'850.-
Screen Size	70 Zoll (178 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	BlueRay-Player, Speicherkarte
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	197 kWh
Power	135 Watt

Figure 4.1. Televisions with information and pictures. Participants were asked to identify the most energy-friendly product.

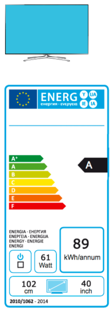
Television PF	Price: 1‘199.-
Screen Size	47 in (120 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	Yes
Image Display	3D / 2D
Features	PayTV, Memory Card, 3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	95 kWh
Power	69 Watt



Television ME	Price: 2‘259.-
Screen Size	60 in (153 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Light sensor, Auto switch-off timer
On/Off Power Switch	No
Image Display	3D / 2D
Features	3 HDMI-Connections
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	145 kWh
Power	99 Watt



Television UE	Price: 799.-
Screen Size	40 Zoll (102 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	4 HDMI-Anschlüsse
Energy Efficiency Ra-ting	A
Annual Energy Consumption	89 kWh
Power	61 Watt



Television LS	Price: 2‘850.-
Screen Size	70 Zoll (178 cm)
Display	LCD
Display Resolution	Full HD (1920 x 1080)
Automatic Energysa-vings	Automatische Helligkeitsregulierung, Abschaltautomatik
On/Off Power Switch	Nein
Image Display	3D / 2D
Features	BlueRay-Player, Speicherkarte
Energy Efficiency Ra-ting	A+
Annual Energy Consumption	197 kWh
Power	135 Watt

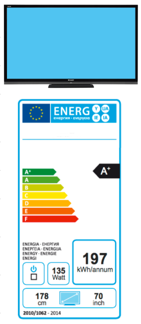


Figure 4.2. Televisions with information, pictures, and corresponding energy labels. Participants were asked to identify the most energy-friendly product.

4.2.3 Procedure

The data for this study were collected using the iViewx RED500 eye tracker manufactured by SMI, Germany. This system provides a binocular sampling rate of 50Hz and an accuracy of 0.4° of visual angle. The eye tracker uses an infrared-sensitive video camera placed below the computer monitor to observe participants’ eye movements. Software provided by SMI generates x- and y-coordinates for the gaze points on the monitor screen, and the default classification algorithm was employed to define fixations. The experiment was designed and run by Experiment Centre 3.3 (SMI, Germany).

Before the actual experiment began, all participants read and signed a consent form. With their signature, participants acknowledged that their gaze behaviour would be recorded, that the data would be treated anonymously, and that they could quit the experiment at any time without providing a reason. Participants were then asked to sit in front of the eye tracker at a distance of approximately 70 centimetres with a visual angle of approximately 2°. The master computer on which the experiment was run was placed on a second desk at a distance of approximately 1.5 meters from the eye tracker. The examiner explained the device and the procedure, and started the calibration. After a successful calibration, the instruction for the first task was shown on the screen. The examiner activated the next page when the participants confirmed that they had read and understood the instruction. When the participants articulated their choice (by saying the name of the selected television), the examiner immediately pressed the space button and a blank page appeared. This procedure enabled the calculation of the time each participant needed for making the decision. After the task on the eye tracker, the examiner asked some qualitative questions regarding the decision-making process. Finally, participants were asked to fill in a paper-and-pencil questionnaire.

4.2.4 Segmentation Variables

4.2.4.1 Parameters of Decision-making Strategies

Direction of Information Search. It is assumed that search strategies differ in their proportion of within- vs. between-options transitions (Payne, Bettman, & Johnson, 1988; Schulte-Mecklenbeck et al., 2013). For this analysis, each information cue (e.g., annual consumption) for each option was defined as an area of interest (AOI). If two subsequent fixations were on two AOIs belonging to the same option, the transition was classified as a within-option. If two subsequent fixations were on two AOIs belonging to different options but containing the same information, the transition was classified as between-option. These transitions were the basis for the calculation of a ratio of within- vs. between-option transitions to determine the search direction. The determination of the search direction was based on the search metric (SM) index (Böckenholt & Hynan, 1994; Schulte-Mecklenbeck et al., 2013):

$$SM = \frac{\sqrt{N}\left(\left(\frac{A * O}{N}\right)(WO - BO) - (O - A)\right)}{\sqrt{A^2(O-1) + O^2(A-1)}}.$$

In the above equation, N represents the total number of transitions, A the number of attributes, and O the number of options. WO denotes within-option transitions and BO between-option transitions. An SM value above 0 indicates a within-option information search and a value below 0 indicates a between-option information search. In this study, the mean of the SM-index was rather high (M [SD] = 12.26 [5.39]), thereby indicating participants' tendency to use a predominantly within-option acquisition pattern.

Importance of Attributes. Decision-making strategies differ in terms of how the attention is distributed over the attributes, that is, how much weight (i.e., importance) is assigned to the attributes. The importance—that is, the weight of an attribute—was assessed by how often the AOIs corresponding to this attribute were acquired across the various choice options in relation to the total number of transitions (Gidlof, Wallin, Dewhurst, & Holmqvist, 2013; Schulte-Mecklenbeck et al., 2013). This procedure yielded the weight of each attribute. Subsequently, the coefficient of variation (CV) for the estimated attributes' weights was calculated:

$$CV = \frac{\sigma}{\mu}$$

In the equation above, μ denotes the mean of the weights of all attributes and σ denotes the standard deviation of these weights. A value below 1 is considered low in variance, that is, all attributes are of similar importance. A value above 1 is considered high in variance, that is, some attributes are more important than others (Schulte-Mecklenbeck et al., 2013). The mean of the CV was M (SD) = 0.84 (0.47).

Completeness of Information Search. A third classifier for the decision-making strategy was the completeness of information search. This value was calculated by counting the AOIs that were not acquired. A lower number of not-acquired AOIs indicated a more complete information search, whereas a higher number of not-acquired AOIs indicated a more limited information search. On average, 19 attributes (SD = 12) were not acquired per participant.

Decision Time. The last indicator for the decision-making strategy used was the total time in milliseconds (ms) that each participant took to reach the decision. On average, participants took 67652.05 ms (SD = 43569.64) for the decision.

Attention to Energy-related Information. In order to identify the most energy-friendly product, participants need to inspect energy-related information. Therefore, we calculated the proportion of time spent on energy-related information relative to the time spent on all information by dividing the gaze times on all energy-related AOIs by the decision time. This procedure provided the Energy-Gaze-Proportion (EGP) with values between 0 and 1 (Ashby, Dickert, & Glöckner, 2012; Ashby, Walasek, & Glöckner, 2015). Higher values indicate stronger attention to energy-related information. On average, participants spent 29% (SD = 12) of their decision time on energy-related information.

4.2.4.2 Descriptive variables

Choice. Participants were instructed to choose the most energy-friendly product out of the four provided televisions (see Fig. 1). The television with the lowest annual consumption (i.e., television UE) was coded as the most energy-friendly choice and all other televisions were coded as choices that were not energy-friendly. Accordingly, participants' choices were classified as either energy-friendly or energy-unfriendly. In total, only 40.7% of the participants chose the product with the lowest consumption.

Energy-efficiency Information. As indicated in the previous section, energy-efficiency information can be imprecise in terms of energy friendliness. Therefore, reliance on this information could lead to non-optimal decisions in terms of absolute energy consumption, because a big television can be very efficient but still consume a considerable amount of energy. To generate a measure of the proportion of participants' attention toward energy-efficiency information, the fixations on all AOIs containing energy-efficiency information were summed up and divided by the number of all fixations during the task.

Actual Energy Consumption. In order to objectively identify the optimal product in terms of absolute energy consumption, participants should rely on information on actual energy consumption (i.e., XY kWh/year). The same procedure as that for energy-efficiency information was applied to generate a measure of participants' attention on the crucial information related to annual consumption. That is, all fixations on AOIs containing information on actual energy consumption were counted and divided by the number of all fixations during the task.

Attitude towards Energy Conservation. Research on the relation between environmental behavior and environmental attitude is contradictory (for an overview, see Brohmann, Heinzle, Rennings, Schleich, & Wüstenhagen, 2009). Some studies indicate that a pro-environmental attitude is a positive predictor for the consideration of ecolabels (Thøgersen, 2000), whereas other researchers found no clear connection (Gaspar & Antunes, 2011). Attitude towards energy conservation was assessed using 12 statements. Participants were requested to indicate their agreement with each item on a six-point scale ranging from 1 (do not agree at all) to 6 (absolutely agree). The reliability of the scale was good with Cronbach's alpha of .79.

Objective Numeracy. Numeracy is defined as the ability to understand and interpret probabilities, fractions, and ratios (Fagerlin et al., 2007). The interpretation of energy-related information, particularly annual-consumption information, might pose a problem to people with lower numeracy skills. A study by Attari et al. (2010) has found that participants with higher numeracy scores were better in estimating the energy consumption of different products. However, to the best of our knowledge, no study investigating the relation of numeracy and energy literacy has been conducted thus far. Furthermore, several studies have shown that the choice of decision-making strategy and selection of attributes for the decision are correlated with numeracy (Keller, Kreuzmair, Leins-Hess, & Siegrist, 2014; Peters et al., 2006). In this study, the objective numeracy measurement by Weller et al. (2013) was used, because it provides a short and reliable assessment of participants' numeracy skills. This Rasch-based questionnaire comprises eight mathematical problems of increasing difficulty. Participants' answers were subsequently coded as correct (1) or incorrect (0). The reliability of the scale was satisfying (Cronbach's alpha = .63).

4.3 Results

4.3.1 Correlation of Decision-making Parameters

All four decision-making parameters were highly correlated ($p < .01$). The SM index correlated positively with the decision time ($r = .75$) and negatively with CV ($r = -.77$) and the completeness of information search ($r = -.83$). This implies that an increase in the SM index (i.e., stronger within-option search) is more time-consuming, leads to a more equal importance distribution, and increases the amount of acquired information. CV positively correlates with the completeness of information search ($r = .77$) and negatively with the decision time ($r = -.54$). That is, a higher preference for certain attributes goes along with a limited information search and faster decision. Furthermore, the decision time is negatively correlated with the completeness of information search ($r = -.88$), thereby indicating that the acquisition of more information needs more time.

4.3.2 Identification of Consumers with Different Decision-making Strategies

A cluster analysis was conducted to identify groups of people with different information-search and decision-making behaviours. The cluster analysis was based on the described decision-making variables: SM index, CV, completeness of information search, and decision time. Attention to energy-related information was also included in the cluster analysis, because the consideration of energy-related information constitutes the base for an energy-friendly decision-making strategy. Before conducting the cluster analysis, the variables were transformed to diminish the influence of outliers. For the variables SM index, decision time, and attention to energy-related information, the square root was extracted and CV was log transformed. Subsequently, all variables were z-standardized to ensure equal weight of all segmentation variables (Aldenderfer & Blashfield, 1984). Ward's method was applied and the squared Euclidean distance was used as the proximity measure for the cluster analysis. Thereafter, the range of possible cluster solutions was determined on the basis of the agglomeration schedule. The elbow plot suggested a two-, three-, or four-cluster solution. The two-cluster solution was rejected, because too much variance of the clustering variables was lost. In the four-cluster solution, the means of the clustering variables within the clusters provided an undifferentiated picture. The three-cluster solution provided a meaningful differentiation regarding the clustering variables used, as was expected based on the decision-making theory. A subsequently conducted ANOVA with the three clusters supported the solution, thereby revealing significant differences between the clusters for all clustering variables (Table 2). To further validate the cluster solution, we tested for significant differences between the clusters with the descriptive variables. The results were significant for all descriptive variables, except for the attitude towards energy conservation (Tables 2 and 3).

We identified three consumer segments with different decision-making strategies: consumers with an *energy-directed lexicographic* strategy (16.9%), an *unsystematic-lexicographic* strategy (15.3%), and an *unsystematic-exhaustive* strategy (67.8%). The three groups were tested for homogeneity by calculating the F-values for all clustering variables for each group (Aldenderfer & Blashfield, 1984; Backhaus, Erichson, Plinke, & Weiber, 2003). The F-value is the quotient of the variance of a variable within a group and the variance of the variable in the survey population. A cluster is considered completely homogeneous if all F-values are smaller than one. The unsystematic lexicographic and unsystematic exhaustive groups were completely homogenous. The energy-directed lexicographic group was almost homogenous with one F-value greater than one. In the next section, the three groups are described with regard to both the clustering and descriptive variables.

Characterization of the Different Decision-making Strategies

The Energy-directed Lexicographic Strategy. Participants relying on this strategy had a tendency towards a between-option search, and they had a clear preference for energy-related attributes (Table 2). They spent almost half of their decision time on energy-related information, ignored a big portion of the irrelevant (i.e., not energy-related) information, and reached the decision quickly. The analysis of the choice showed that this strategy resulted in 60% of the cases in optimal choices in terms of energy-friendliness. Participants applying this strategy had a higher numeracy and 60% of them had a higher education. Further, females and males were equally likely to apply this strategy (Table 3). The analysis of the attention distribution on energy efficiency and annual consumption showed that participants who employed this strategy focused significantly more on the latter information—that is, the essential, actually relevant, information—to determine the most energy-friendly product (Table 2). This strategy was more often used in the condition with the energy label. To summarize, the energy-directed lexicographic strategy can be described as a fast and frugal decision-making strategy (Gigerenzer & Gaissmaier, 2011), because it ignores part of the (irrelevant) information and the direction of the search is towards between-options. It is an expedient heuristic, because the focus is mostly on energy-related attributes with a peak at the most important attribute. However, a pre-condition to make this lexicographic strategy that focuses on energy-related information successful is the comprehension of the meaning of the provided information and knowledge on which information needs to be considered, as this was the case for the majority of the group. Applying this strategy without a focus on annual consumption, but by first comparing energy efficiency information, does not lead to the optimal product choice. In 40% of the cases, participants with this strategy did not choose the product with the least consumption. They overlooked the product with the lowest actual consumption, because its energy efficiency rating is lower than that of the other three products.

The Unsystematic Lexicographic Strategy. This strategy involves a tendency toward a between-option search with clear preferences for some attributes. However, the preference was less pronounced compared with the energy-directed lexicographic strategy (Table 2). Similar to this strategy, participants using the unsystematic lexicographic strategy reached the decision quickly and ignored a large portion of the information. The analysis of the choices revealed that only 33% of the choices could be classified as optimal when using this strategy. This low rate of optimal choices can be explained with the importance distribution of participants relying on this strategy. First, they spent significantly less time of their decision-making time on energy-related information—that is, only 14%. Second, they spent more time on information on energy efficiency than on actual energy consumption (Table 2). This behaviour cannot result in a high number of optimal choices, because the strategy is biased towards ambiguous information (i.e., energy efficiency) that does not permit a conclusive decision in terms of energy friendliness. Further analysis revealed that only male participants with low numeracy skills and a low level of education applied this strategy (see Table 2 for numeracy and Table 3 for gender and education). Overall, the unsystematic lexicographic strategy can be defined as a fast heuristic, but with limited success due to generally little consideration of energy-related information and the tendency, once energy-related information is considered, to focus on the less relevant one—that is, the energy efficiency rating.

The Unsystematic Exhaustive Strategy. The third decision-making strategy is an additive strategy with a clear within-option search (Table 2). Participants relying on this strategy did not have a clear preference for certain attributes and evaluated almost all information. The decision time with this strategy is rather long, with only 29% of the time spent on energy-related information. This strategy resulted in 38% of the cases in the optimal decision. The choice result was not affected by whether participants were presented the energy labels. Participants using this strategy showed a levelled attention distribution on energy efficiency and annual consumption without a preference for one of the two information types (Table 2). Younger participants were more likely to use this strategy compared to the other two strategies. Furthermore, they had a lower numeracy level than participants using an energy-directed lexicographic strategy. Females applied this strategy more often than males. Summing up, the unsystematic exhaustive decision-making strategy contrasts with the two other strategies, as it cannot be classified as a fast and frugal decision heuristic. Participants' attention (i.e., importance) was equally distributed over the attributes, thereby failing to assign more weight to the relevant information. This resulted in the high number of non-optimal choices. The lower numeracy suggests that this strategy was applied by participants who were somewhat overstrained by the technical and numerical information.

Table 4.2

Characterization of Consumers Applying Various Decision-making Strategies with regard to the Clustering and Descriptive Variables.

	Energy-directed lexicographic (n = 10)	Unsystematic lexicographic (n = 9)	Unsystematic exhaustive (n = 40)
Clustering variables			
SM Index**[1]	5.89^{a}	9.16^{a}	14.55^{b}
CV**[2]	1.49^{a}	1.01^{a}	0.63^{b}
Completeness**[3]	36.10^{a}	28.78^{a}	12.70^{b}
Decision time (ms)**	26144.30^{a}	37668.78^{a}	84775.22^{b}
EGP**[4]	0.45^{a}	0.14^{b}	0.29^{c}
Descriptive variables			
Correct choice (%)	60^{a}	33^{a}	38^{a}
Energy efficiency*[5]	0.21^{a}	0.10^{b}	0.11^{b}
Annual consumption**[5]	0.27^{a}	0.06^{b}	0.14^{c}
Numeracy^{+}	5.40^{a}	4.00^{b}	4.12^{b}
Attitude energy	3.78^{a}	3.28^{a}	3.83^{a}

Note. Analysis of variance (ANOVA) revealed a significant effect of all clustering variables and three of the descriptive variables. Significant effects are marked with an asterisk, (*p < .05, **p < .01). Marginally significant effects are marked with a cross ($^{+}$p < .10). Different letters indicate significant differences between the groups, p < 0.05, using the Games-Howell post-hoc test.

[1]Lower values indicate a tendency toward between-option search and higher values a tendency toward within-option search.

[2]Values below 1 indicate no preferences (i.e., equal importance distribution) and values over 1 indicate preferences for selected attributes.

[3]Higher numbers represent a more directed information search (i.e., less complete information search).

[4]The ratio of time spent on energy-related information.

[5]The ratio of fixations spent on energy efficiency and annual consumption, respectively.

Table 4.3

Characterization of Consumers Applying the Different Decision-making Strategies with regard to Socio-demographic Variables.

	Energy-directed lexicographic (n = 10)	Unsystematic-lexicographic (n = 9)	Unsystematic-exhaustive (n = 40)
Age (years)	40.60^{a}	46.22^{a}	33.90^{b}
Female (%)**	50^{b}	0^{a}	70^{b}
Tenants (%)	80^{a}	89^{a}	88^{a}
High educational level (%)[1]	60^{a}	33^{a}	48^{a}

Note. ANOVA revealed a significant effect of age. Chi square tests of independence were conducted to test for significant dependences for the categorical variables. Different letters indicate significant differences between the groups, $p < 0.05$, using the Hochberg's GT2 post-hoc test. Significant effects are marked with an asterisk (* $p < 0.05$, **$p < 0.01$).

[1]Primary school, high school, and vocational school were coded as low educational level. Grammar school and technical college were coded as intermediate educational level. University was coded as high educational level.

4.4 Discussion

Consumers make purchase decisions every day. Understanding how beneficial and destructive decision-making strategies look like in terms of energy-friendly product choices enables the development and adjustment of policy tools to support and sustain energy-friendly consumer behaviour. The results of this study suggest that consumers rely on different decision-making strategies when attempting to make an energy-friendly choice. In this study, we identified three consumer types who apply different decision-making strategies to determine the most energy-friendly television. The results revealed that people applying a lexicographic strategy with a directed focus on energy-related information were most likely to choose the most energy-friendly product, since they considered the relevant information—that is, the products' annual energy consumption. However, even with this strategy, not all participants made the optimal choice. Relying on a lexicographic strategy without a directed focus on energy-related information (i.e., unsystematic lexicographic strategy) or on an additive strategy without a preference for the critical information (i.e., unsystematic exhaustive strategy) was barely successful, because only a few participants chose the product with the least consumption. Further analysis revealed that when consumers applied these unsystematic strategies, the relevant information (i.e., annual consumption) did not receive sufficient attention and consequently could not influence the final decision. Participants over-weighted energy efficiency information when applying the unsystematic lexicographic strategy. This finding is consistent with the results of other studies showing consumers' tendency to rely on energy-efficiency information when estimating the energy-friendliness of products (Waechter, Sütterlin, & Siegrist, 2015a; Waechter et al., 2015b). The lower numeracy level in this group could be one explanation for this so-called energy-efficiency fallacy, as low numerates tend to prefer graphical icons (e.g., energy efficiency letter rating) over numerical information (Keller et al., 2014). Participants applying the unsystematic exhaustive strategy did study the relevant information. However, they assigned equal weight to the relevant information on annual consumption as well as to the energy efficiency information and they, in general, weighted all provided information equally, even the information that was not related to energy consumption.

Thus, the information processing patterns of the unsystematic lexicographic and the unsystematic exhaustive strategies suggest that participants using these strategies might have struggled with the interpretation of the information provided and were unable to correctly integrate it in the decision-making process. Women were more likely to apply the unsystematic exhaustive strategy compared to the unsystematic lexicographic strategy. This may be because women are more risk-averse (Byrnes, Miller, & Schafer, 1999) and tend to strive to complete tasks as diligently and carefully as possible (Masson et al., 2004). For the other measured variables, such as attitude towards energy conservation and other socio-demographic information, no differences were found for the three strategies.

Summing up, a lexicographic strategy that focuses on energy-related information can be very effective if the emphasis is placed on the relevant information (i.e., information on annual consumption). On the other hand, even an exhaustive and thorough strategy can be very ineffective if the consumer struggles to understand or adequately classify (i.e., weight) the information provided. Furthermore, lexicographic strategies that rely on ambiguous information—in this case, information on energy efficiency that is not suitable for identifying the product with the lowest actual consumption (i.e., the most energy-friendly product)—are rarely effective.

4.4.1 Implications

The manner in which information is presented affects and shapes decision-making strategies and the resultant choices, respectively. Research on decision-making suggests that information on energy efficiency is more likely to be evaluated due to its salient and easily accessible format compared to the technical and more complex information on actual energy consumption (Waechter et al., 2015a, 2015b; Weber & Johnson, 2009). This study has demonstrated that decision-making strategies relying on this piece of information are less successful for energy-friendly decisions. One way to overcome this issue is to facilitate the correct interpretation of energy-related information, particularly information on annual consumption. This could help consumers to identify the most energy-friendly product when confronted with different products.

Results suggest that people with lower numeracy skills and a lower educational level, in particular, are susceptible to such misleading strategies as the energy-efficiency fallacy. This raises concern for the prominent and salient presentation of energy efficiency on the energy label as well as the prevalent promotion of energy efficiency on a political level. Furthermore, there is a growing body of opinion that enhancing energy efficiency is not enough for reducing energy consumption (IEA, 2009; Molenbroek et al., 2013; Otto, Kaiser, & Arnold, 2014). Therefore, it seems that it is important to communicate the relevance of actual energy consumption for the energy-friendliness of electric goods, for example, by enhancing the accessibility and saliency of annual consumption on the energy label. This method to change the environment/context in order to implicitly modify behaviour is also known as nudging and it has the potential to be a powerful intervention tool (Keller, Markert, & Bucher, 2015; Ölander & Thøgersen, 2014). The benefit of this method is that it does not forbid any options (e.g., products with high energy consumptions) or amend financial incentives, but it can alter a behavior by changing the "choice architecture", that is, how choices are presented (Thaler & Sunstein, 2008). A change of the presentation format of annual consumption on the energy label—for example, by providing a reference point—could therefore work as a "nudge". Consequently, information on annual consumption could become more influential in the decision-making process, particularly when applying a lexicographic strategy (Slovic et al., 2007).

The attitude towards energy conservation and socio-demographic factors did not differ between the selected consumer groups applying different decision-making strategies. This is good news for the promotion of energy-friendly purchase decisions, because the impact of an intervention is not limited to only a certain consumer segment. For example, clarifying the meaning of energy efficiency could improve the decision-making strategy for all the described consumer segments and, consequently, increase the number of optimal decisions in terms of energy friendliness. The results of this study have shown that the mere motivation to make an energy-friendly choice is not sufficient to actually make one when the energy-related information is incorrectly understood.

4.4.2 Limitations and Further Research

In this study, we did not investigate personal choices of consumers; instead, participants were asked to make an energy-friendly choice. The idea underlying this approach was to specifically investigate decision-making strategies for energy-friendly decisions to detect potential drivers and barriers for energy-friendly consumer choices. This idea is in line with the increasing recognition that a more substantial change in consumer behavior is required to successfully reach the targeted energy goals (Otto et al., 2014; Steg & Vlek, 2009; Stern, 2000). By assessing the decision-making behaviour via eye tracking, thereby relying on an objective behavioural measurement, the results of this study are less susceptible to potentially influential factors such as the social desirability response bias—the tendency to answer in a manner that one assumes is socially desirable (Randall & Fernandes, 1991). Therefore, the observed behaviour is closer to the "real behaviour" when it comes to energy-friendly product choices. Nevertheless, decision-making strategies in a real purchase situation might differ from the strategies found in this study.

Further, the nature of this study was rather explorative. It seems likely that this study is not exhaustive with regard to the identified strategies. Studies conducted in other fields suggest that consumers rely on a variety of decision-making strategies (Schulte-Mecklenbeck et al., 2013; Stüttgen et al., 2012); however, these studies did not assess energy-friendly decision-making strategies. Therefore, future studies should investigate the strategies applied in energy-related judgment and decision-making situations with a bigger and more representative sample. Moreover, studies with different products and in a non-laboratory setting could further help to understand how consumers make energy-friendly choices.

Finally, the data for this study was collected by means of eye tracking. Eye tracking data has been proven to be reliable and valid (Holmqvist et al., 2011); however, there are some limitations of this method that should be addressed. First, the interpretation of the eye-tracking parameters (e.g., fixation count) might vary between researchers (Holmqvist et al., 2011; Orquin & Mueller Loose, 2013). For example, the fixation count can reflect semantic importance (e.g., Poole, Ball, & Phillips, 2005) or difficulty related to the fixated information (Goldberg & Kotval, 1999). Second, eye-tracking data can be susceptible to potentially influential factors—such as motivation, fatigue, or interest—that could not be controlled for and might have affected the results. Third, the design of the stimuli material has to fulfil the requirements of the eye-tracker. In our case, all information had to fit on one page and it had to be readable from a distance of approximately 70cm. The presentation format/design used in this study was similar to the design of online shops to produce a realistic situation; however, a different design might have revealed slightly different results.

References

Aldenderfer, M. S., & Blashfield, R. K. (1984) Cluster Analysis. *Vol. No. 07-044. Sage University Paper series on Quantitative Applications in the Social Sciences*. Newbury Park, CA: Sage.

Allcott, H., & Greenstone, M. (2013). Is There an Energy Efficiency Gap? *Energy Efficiency: Towards the End of Demand Growth*, 133-161. doi:Doi 10.1016/B978-0-12-397879-0.00005-0

Ashby, N. J. S., Dickert, S., & Glöckner, A. (2012). Focusing on what you own: Biased information uptake due to ownership. *Judgment and Decision Making, 7*(3), 254-267.

Ashby, N. J. S., Walasek, L., & Glöckner, A. (2015). The effect of consumer ratings and attentional allocation on product valuations. *Judgment and Decision Making, 10*(2), 172 - 184.

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences, 107*(37), 16054-16059. doi:10.1073/pnas.1001509107

Backhaus, K., Erichson, B., Plinke, W., & Weiber, R. (2003). *Multivariate Methods of Analysis [Multivariate Analysemethoden]*. Berlin: Springer.

Bettman, J. R., Johnson, E. J., & Payne, J. W. (1991). Consumer decision making. *Handbook of consumer behavior, 44*(2), 50-84.

Böckenholt, U., & Hynan, L. S. (1994). Caveats on a process-tracing measure and a remedy. *Journal of Behavioral Decision Making, 7*(2), 103-117. doi:10.1002/bdm.3960070203

Brohmann, B., Heinzle, S., Rennings, K., Schleich, J., & Wüstenhagen, R. (2009). *What is driving sustainable energy consumption? A survey of the empirical literature*. 09. EEDAL. Retrieved from www.alexandria.unisg.ch/publications/51846 (accessed: 22.07.2014)

Energy Bill [Energiegesetz], (2013a).

Bundesrat. (2013b). *Federal Council communicates the energy-strategy 2050 [Bundesrat verabschiedet Botschaft zur Energiestrategie 2050]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from http://www.uvek.admin.ch/dokumentation/00474/00492/index.html?lang=de&msg-id=50123 (accessed: 25.12.2013).

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin, 125*(3), 367-383. doi:Doi 10.1037//0033-2909.125.3.367

Camerer, C. F., & Loewenstein, G. (2004). Behavioral Economics: Past, Present, Future. *Advances in Behavioral Economics*, 3-51.

Chase, W. G. (1978). Elementary information processes *Handbook of learning & cognitive processes: V. Human information* (pp. 19-90). Oxford, England: Lawrence Erlbaum.

Energie Agentur Elektrogeräte. (2015). TV Market Review [TV Marktübersicht]. Retrieved from www.eae-tv.ch

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (2012).

Eurostat. (2014) Energy, transport and environment indicators. Luxembourg: Publications Office of the European Union.

Fagerlin, A., Zikmund-Fisher, B. J., Ubel, P. A., Jankovic, A., Derry, H. A., & Smith, D. M. (2007). Measuring numeracy without a math test: Development of the subjective numeracy scale. *Medical Decision Making, 27*(5), 672-680. doi:10.1177/0272989x07304449

Fiedler, S., & Glöckner, A. (2012). The dynamics of decision making in risky choice: An eye-tracking analysis. *Frontiers in Psychology, 3*, 1-18.

FIMRT. (2012). *Discussion paper on the review of the Ecodesign and Energy Labelling Regulations for televisions and on the draft Regulation on electronic displays, including computer monitors*. online: Federal Institute for Materials Research and Testing [Bundesanstalt für Materialforschung und -prüfung] Retrieved from http://www.ebpg.bam.de/de/ebpg_medien/tren5/005_workd_12-08_revision.pdf (accessed: 26.6.2015).

Gaspar, R., & Antunes, D. (2011). Energy efficiency and appliance purchases in Europe: Consumer profiles and choice determinants. *Energy Policy, 39*(11), 7335-7346. doi:10.1016/j.enpol.2011.08.057

Gidlof, K., Wallin, A., Dewhurst, R., & Holmqvist, K. (2013). Using Eye Tracking to Trace a Cognitive Process: Gaze Behaviour During Decision Making in a Natural Environment. *Journal of Eye Movement Research, 6*(1).

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*(1), 451-482. doi:doi:10.1146/annurev-psych-120709-145346

Gillingham, K., & Palmer, K. (2014). Bridging the energy efficiency gap: Policy insights from economic theory and empirical evidence. *Review of Environmental Economics and Policy, 8*(1), 18-38. doi:10.1093/reep/ret021

Goldberg, J. H., & Kotval, X. P. (1999). Computer interface evaluation using eye movements: methods and constructs. *International Journal of Industrial Ergonomics, 24*(6), 631-645. doi:Doi 10.1016/S0169-8141(98)00068-7

Goldstein, D. G., & Gigerenzer, G. (2009). Fast and frugal forecasting. *International Journal of Forecasting, 25*(4), 760-772. doi:10.1016/j.ijforecast.2009.05.010

Heinzle, S., & Wüstenhagen, R. (2012). Dynamic Adjustment of Eco-labeling Schemes and Consumer Choice – the Revision of the EU Energy Label as a Missed Opportunity? *Business Strategy and the Environment, 21*(1), 60-70. doi:10.1002/bse.722

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & van de Weijer, J. (2011). *Eye Tracking - A comprehensive guide to methods and measures*. New York: Oxford University Press.

Hsee, C. K. (1996). The evaluability hypothesis: An explanation for preference reversals between joint and separate evaluations of alternatives. *Organizational Behavior and Human Decision Processes, 67*(3), 247-257. doi:10.1006/obhd.1996.0077

IEA. (2003). *Cool Appliances: Policy Strategies for Energy-Efficient Homes*: OECD Publishing.

IEA. (2009). *Gadgets and Gigawatts*: OECD Publishing.

Jaffe, A. B., & Stavins, R. N. (1994). The energy-efficiency gap What does it mean? *Energy Policy, 22*(10), 804-810. doi:10.1016/0301-4215(94)90138-4

Kahneman, D. (2011). *Thinking, fast and slow*. London: Penguin.

Kahneman, D., & Tversky, A. (1979). Prospect Theory - Analysis of Decision under Risk. *Econometrica, 47*(2), 263-291. doi:Doi 10.2307/1914185

Keller, C., Kreuzmair, C., Leins-Hess, R., & Siegrist, M. (2014). Numeric and graphic risk information processing of high and low numerates in the intuitive and deliberative decision modes: An eye-tracker study. *Judgment and Decision Making, 9*(5), 420-432.

Keller, C., Markert, F., & Bucher, T. (2015). Nudging product choices: The effect of position change on snack bar choice. *Food Quality and Preference, 41*, 41-43. doi:10.1016/j.foodqual.2014.11.005

Masson, A. M., Hoyois, P., Cadot, M., Nahama, V., Petit, F., & Ansseau, M. (2004). Girls are more successful than boys at the university. Gender group differences in models integrating motivational and aggressive components correlated with Test-Anxiety. *Encephale-Revue De Psychiatrie Clinique Biologique Et Therapeutique, 30*(1), 1-15.

Michel, A., Attali, S., & Bush, E. (2014). *Energy efficiency before and during the implementation of the Ecodesign and Energy Labeling regulations*. Retrieved from online: http://www.topten.eu/uploads/File/European_TV_market_2007%E2%80%932013_July14.pdf

Molenbroek, E., Cuijpers, M., Janeiro, L., Smith, M., Surmeli, N., Waide, P., . . . Fong, J. (2013). *Evaluation of the Energy Labelling Directive and specific apsects of Ecodesign Directive - Background report I*. Retrieved from http://www.energylabelevaluation.eu/eu/home/welcome

Molenbroek, E., Smith, M., Groenenberg, H., Waide, P., Attali, S., Fischer, C., . . . Fong, J. (2014). *Final technical report. Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive ENER/C3/2012-523*. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

Netzer, O., Toubia, O., Bradlow, E. T., Dahan, E., Evgeniou, T., Feinberg, F. M., . . . Rao, V. R. (2008). Beyond conjoint analysis: Advances in preference measurement. *Marketing Letters, 19*(3-4), 337-354. doi:10.1007/s11002-008-9046-1

OECD/IEA. (2013). *Energy Policy Highlights*. Retrieved from

Ölander, F., & Thøgersen, J. (2014). Informing Versus Nudging in Environmental Policy. *Journal of Consumer Policy*, 1-16. doi:10.1007/s10603-014-9256-2

Orquin, J. L., & Mueller Loose, S. (2013). Attention and choice: A review on eye movements in decision making. *Acta Psychologica, 144*(1), 190-206. doi:http://dx.doi.org/10.1016/j.actpsy.2013.06.003

Otto, S., Kaiser, F. G., & Arnold, O. (2014). The Critical Challenge of Climate Change for Psychology Preventing Rebound and Promoting More Individual Irrationality. *European Psychologist, 19*(2), 96-106. doi:Doi 10.1027/1016-9040/A000182

Pachur, T., Hertwig, R., Gigerenzer, G., & Brandstatter, E. (2013). Testing process predictions of models of risky choice: a quantitative model comparison approach. *Frontiers in Psychology, 4*. doi:Artn 646

Doi 10.3389/Fpsyg.2013.00646

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1988). Adaptive Strategy Selection in Decision-Making. *Journal of Experimental Psychology-Learning Memory and Cognition, 14*(3), 534-552. doi:Doi 10.1037//0278-7393.14.3.534

Peters, E., Vastfjall, D., Slovic, P., Mertz, C. K., Mazzocco, K., & Dickert, S. (2006). Numeracy and decision making. *Psychological Science, 17*(5), 407-413. doi:DOI 10.1111/j.1467-9280.2006.01720.x

Poole, A., Ball, L., & Phillips, P. (2005). In Search of Salience: A Response-time and Eye-movement Analysis of Bookmark Recognition. In S. Fincher, P. Markopoulos, D. Moore, & R. Ruddle (Eds.), *People and Computers XVIII — Design for Life* (pp. 363-378): Springer London.

Prognos. (2012). *Energy consumption of households 2000 - 2010 [Der Energieverbrauch der privaten Haushalte 2000 - 2010]*. Retrieved from Basel:

Prognos. (2014). *Energy consumption of households 2000 - 2013 [Der Energieverbrauch der privaten Haushalte 2000 - 2013]*. Retrieved from Basel:

Randall, D. M., & Fernandes, M. F. (1991). The Social Desirability Response Bias in Ethics Research. *Journal of Business Ethics, 10*(11), 805-817. doi:Doi 10.1007/Bf00383696

Scheibehenne, B., Miesler, L., & Todd, P. M. (2007). Fast and frugal food choices: Uncovering individual decision heuristic. *Appetite, 49*, 578-589.

Schulte-Mecklenbeck, M., Sohn, M., de Bellis, E., Martin, N., & Hertwig, R. (2013). A lack of appetite for information and computation. Simple heuristics in food choice. *Appetite, 71*(0), 242-251. doi:http://dx.doi.org/10.1016/j.appet.2013.08.008

Schwartz, B., Ward, A., Monterosso, J., Lyubomirsky, S., White, K., & Lehman, D. R. (2002). Maximizing versus satisficing: Happiness is a matter of choice. *Journal of Personality and Social Psychology, 83*(5), 1178-1197. doi:10.1037//0022-3514.83.5.1178

Shi, S. W., Wedel, M., & Pieters, F. G. M. (2013). Information acquisition during online decision making: A model-based exploration using eye-tracking data. *Management Science, 59*(5), 1009-1026. doi:doi:10.1287/mnsc.1120.1625

Simon, H. A. (1955). A Behavioral Model of Rational Choice. *Quarterly Journal of Economics, 69*(1), 99-118. doi:Doi 10.2307/1884852

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Söllner, A., Bröder, A., Glöckner, A., & Betsch, T. (2014). Single-process versus multiple-strategy models of decision making: Evidence from an information intrusion paradigm. *Acta Psychologica, 146*(0), 84-96. doi:http://dx.doi.org/10.1016/j.actpsy.2013.12.007

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309-317. doi:http://dx.doi.org/10.1016/j.jenvp.2008.10.004

Stern, P. C. (2000). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues, 56*(3), 407-424. doi:10.1111/0022-4537.00175

Stüttgen, P., Boatwright, P., & Monroe, R. T. (2012). A Satisficing Choice Model. *Marketing Science, 31*(6), 878-899.

Sutterlin, B., & Siegrist, M. (2014). The reliance on symbolically significant behavioral attributes when judging energy consumption behaviors. *Journal of Environmental Psychology, 40*, 259-272. doi:DOI 10.1016/j.jenvp.2014.07.005

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge. Improving decisions about health, wealth and happiness*. London, UK: Penguin.

Thøgersen, J. (2000). Psychological determinants of paying attention to eco-labels in purchase decisions: Model development and multinational validation. *Journal of Consumer Policy, 23*(3), 285-313. doi:10.1023/A:1007122319675

Tiefenbeck, V., Staake, T., Roth, K., & Sachs, O. (2013). For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy, 57*(0), 160-171. doi:http://dx.doi.org/10.1016/j.enpol.2013.01.021

Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Global Environmental Change-Human and Policy Dimensions, 29*, 127-138. doi:10.1016/j.gloenvcha.2014.09.004

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131. doi:10.2307/1738360

VZBV. (2015). *Market research on energy labeling of household appliances [Marktcheck zum Stand der Energieverbrauchskennzeichnung von Haushaltsgeräten]*. Retrieved from Mainz: http://www.effizienzwende.de/media/news/marktcheck-energielabel-langfassung-vzbv-vz-rheinland-pfalz-maerz-2015.pdf

Waechter, S., Sütterlin, B., & Siegrist, M. (2015a). Desired and Undesired Effects of Energy Labels—An Eye-Tracking Study. *PLoS ONE, 10*(7), e0134132. doi:10.1371/journal.pone.0134132

Waechter, S., Sütterlin, B., & Siegrist, M. (2015b). The misleading effect of energy efficiency information on perceived energy friendliness of electric goods. *Journal of Cleaner Production, 93*(0), 193-202. doi:http://dx.doi.org/10.1016/j.jclepro.2015.01.011

Weber, E. U., & Johnson, E. J. (2009). Mindful Judgment and Decision Making. *Annual Review of Psychology, 60*, 53-85.

Weller, J. A., Dieckmann, N. F., Tusler, M., Mertz, C. K., Burns, W. J., & Peters, E. (2013). Development and testing of an abbreviated numeracy scale: A Rasch analysis approach. *Journal of Behavioral Decision Making, 26*(2), 198-212. doi:10.1002/bdm.1751

Yamamoto, Y., Suzuki, A., Fuwa, Y., & Sato, T. (2008). Decision-making in electrical appliance use in the home. *Energy Policy, 36*(5), 1679-1686. doi:10.1016/j.enpol.2008.01.022

CHAPTER V

LETTERS, SIGNS, AND COLORS: HOW THE DISPLAY OF ENERGY-EFFICIENCY INFORMATION INFLUENCES CONSUMER ASSESSMENTS OF PRODUCTS

Signe Waechter, Bernadette Sütterlin, Jonas Borghoff, Michael Siegrist

Manuscript accepted for publication as:

Waechter, S., Sütterlin, B., Borghoff, J. & Siegrist, M. (2016). Letters, signs, and colors: How the display of energy-efficiency information influences consumer assessment of products. *Energy Research & Social Science.*

Abstract

The increase of energy efficiency is a major goal of many countries throughout the world. For the successful achievement, consumers must choose energy-efficient household appliances. The European Union (EU) has introduced an energy label for energy-related durables to empower consumers to make energy-friendly choices. Due to the great progress in energy efficiency and the ban of inefficient products on the market, only products in the top efficiency classes are available for many categories, while products in lower classes are no longer manufactured. However, the energy-efficiency scale on the label still displays a range of seven classes (e.g., A^{++} to E). This paper presents a systematic analysis of the influence of the presentation format of energy-efficiency information on consumers' assessments of products' energy friendliness. A series of experimental studies reveals that the display of a rating scale that includes only the energy-efficiency classes of products still available in the market (i.e., a shorter scale) enhances consumers' perceptions of the differences in energy friendliness between the classes. Consequently, the findings suggest that the format of the energy-efficiency scale significantly influences consumers' perceptions of the energy-efficiency gains of products in higher efficiency classes, positively affecting their motivation to choose the most energy-efficient products.

5.1 Introduction

The use of energy has become a fundamental element of global civilization. Most people do not care about the science behind technology, for example, why the lights turn on when they flip a switch. For consumers, at least in western countries, energy is always available and accessible. For many, energy scarcity is at most a childhood memory. However, political strategies to reduce energy consumption rely on consumers playing an active role, especially in the purchase of energy-related products (European Commission, 2015b). In 1992, the European Union (EU) introduced an energy label for household appliances, such as freezers and refrigerators, to empower consumers to make informed decisions. With the help of the label, consumers can choose the most energy-friendly products (Council Directive 1992/92/75/EEC). Since 1992, mandatory energy labeling has been extended to various other products, such as televisions (Directive 2010/30/EU). In 2010, after 18 years of implementation, the label was revised and standardized for different product types (Directive 2010/30/EU). In 2012, the importance of the labeling framework to the achievement of EU energy goals was once again emphasized, and labelling was extended to more energy-related products (Directive 2012/27/EU).

Fig. 5.1 shows the energy labels used for household refrigerating appliances (i.e., freezers and refrigerators) and televisions. The EU energy label is mandatory for various products in all EU member countries. In addition, Switzerland voluntarily adopted the label and has made its application mandatory. The EU energy label is also used as a prototype in other countries, such as China (Zeng, Yu, & Li, 2014).

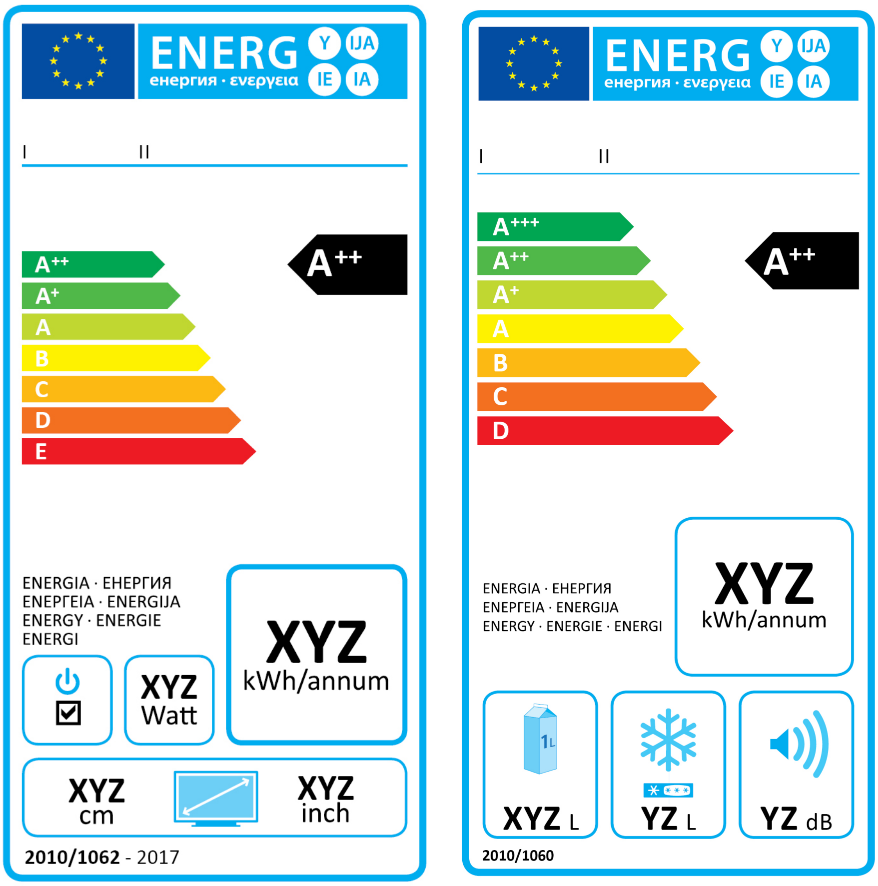


Figure 5.1. EU energy label used for televisions (left) and household refrigerating appliances (right).

Consumers are provided with two types of information on energy labels to assess the energy friendliness (i.e., energy-related performance) of a product: information about its energy efficiency and information about its actual energy consumption. Energy efficiency is communicated with a letter ranking and color code. The color code ranges from green to yellow to red, with different colors indicating energy-efficiency performance. Highly energy-efficient products are in the green-colored ranking and less energy-efficient products are in the red-colored ranking.

The letter ranking originally ranged from A to G, with A assigned to the most energy-efficient products and G assigned to the least energy-efficient products. Some products (e.g., freezers, dryers) were made very energy efficient in a short period of time. This necessitated an extension of the energy-efficiency scale to differentiate among products with the best energy-efficiency rating of A. The letter ranking, therefore, was extended with plus signs indicating different classes (i.e., A^+ to A^{+++}) for these product rankings. This means that, in addition to the original scale from A to G, there are other energy-efficiency scales with different letter ranges (e.g., A^{+++} to D). The actual energy consumption of products is measured in kilowatt-hours per year (i.e., XY kWh/annum).

These two types of information differ, however, in their ability to compare the energy friendliness of products. More precisely, energy efficiency tells how efficiently a product uses energy and is relative to the size of the product, whereas actual energy consumption is an absolute value. The energy-efficiency rating does not tell whether the product's total energy consumption is high or low. The product's actual energy consumption indicated in kWh/annum is numerical and provides an absolute basis to compare the energy-friendly performance of different products.

Political programs strongly connect energy savings with innovative technology and increased energy efficiency (Allen, Dietz, & McCright, 2015; Fri & Savitz, 2014). For example, the EU's plans to cut energy consumption 20% by 2020 rely on increasing energy efficiency (Eurostat, 2012). This approach depends on consumers to select the most energy-efficient products (Steg, Perlaviciute, & van der Werff, 2015). However, as recent research has shown, the way energy-related information is depicted on labels might result in misperceptions of products' energy friendliness. Consumers' accurate evaluation of products' energy efficiency and consequent motivation to choose the most energy-efficient product are crucial for the effectiveness of political programs to increase energy efficiency. Non-optimal consumer behavior could add to the observed energy-efficiency gap, that is, the gap between estimated potential energy savings based on technical, economic, and social factors compared to the amount of energy actually saved (Jaffe & Stavins, 1994). For example, household electricity consumption in the EU rose by 10% from 2002 to 2012 even though energy efficiency increased (Eurostat, 2012).

Therefore, the influence of communication and persuasive measures on consumers is a highly relevant research topic in energy and social sciences (Sovacool, 2014). It has been demonstrated that the provision of information alone is insufficient to initiate energy-friendly behavior for several reasons. One, consumers sometimes simply ignore information because it is not designed in an optimal way (Kempton & Layne, 1994). Second reason, communication might have unwanted consequences, such as negative spill-over effects (Tiefenbeck, Staake, Roth, & Sachs, 2013; Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014) and rebound effects (Greene, Kahn, & Gibson, 1999; Herring & Roy, 2007). In these scenarios, final energy demand actually increases after an energy-friendly action has been performed. For example, consumers' purchase of an energy-efficient household appliance leads to increased usage of it or other less energy-friendly actions, such as higher water consumption. Consequently, the question is whether existing information communication formats, such as the energy label, are adequate and effective or drive non-optimal consumer behavior. Consumers are crucial players in the distribution of energy, and how they behave and make decisions is relevant to the achievement of energy policy goals. The challenge for policy makers is to display information in the best format to reach consumers and foster energy-friendly behavior.

Psychological research can provide fruitful insights for designers, policy makers, and energy researchers focused on these topics. However, only a few papers in energy research have been conducted by or in collaboration with psychologists (Sovacool, 2014). This lack is a lost opportunity because psychology can reveal ways to influence consumers without creating the impression of heavy regulation or restraint on freedom of choice. Additionally, psychological theories can be helpful to understand and predict consumer behavior (Stern, 2011; Wilson & Dowlatabadi, 2007). Therefore, the authors of this paper aim to provide psychological insights into consumer behavior and judgment to improve future energy policy.

Most consumers recognize the energy label and claim to understand and use it in their decision making (European Commission, 2015a; Molenbroek et al., 2014). However, recent research has shown that the energy label is a cause of consumer behaviors suboptimal for energy savings. It was found that consumers tend to focus more on energy-efficiency information and to neglect information about actual energy consumption when assessing a product's energy friendliness (Waechter, Sütterlin, & Siegrist, 2015b). For consumers, information about actual energy consumption is more challenging to understand than information about energy efficiency (Waechter, Sütterlin, & Siegrist, 2015a). This finding is in line with research in other fields, such as risk-perception and decision-making research, suggesting that many decision makers have poor skills at using numerical information (Attari, DeKay, Davidson, & Bruine de Bruin, 2010; Peters et al., 2009; Peters et al., 2006). Instead of taking into account all information provided for the estimation of a products' energy friendliness, consumers rely on the more salient and easier to integrate information—that is, the energy-efficiency classification (Waechter et al., 2015b). Consequently, consumers tend to assume that good energy-efficiency ratings indicate low energy consumption and to choose bigger products with higher consumption because they have better energy-efficiency ratings. Moreover, this so-called energy-efficiency fallacy shifts consumers' perception of whole categories of products that used to be perceived as energy hogs (e.g., freezers). This fallacy relates to the rebound effect, or observed higher energy consumption with increased energy efficiency (e.g., implementation of energy-saving measures in homes), which offsets any energy savings (Greening, Greene, & Difiglio, 2000; Herring, 2006). Consumers' susceptibility to the energy-efficiency fallacy might partially explain the observed trend toward purchases of larger products (European Commission, 2015b). It is easier for bigger products to be classified in the best energy efficiency classes because an implicit bias in the efficiency calculations favors larger products (Michel, Attali, & Bush, 2015). Therefore, the energy-efficiency fallacy could contribute to the global increase in energy consumption.

An inadequate interpretation of the energy-efficiency rating of a product could even magnify this biasing effect. The current presentation format of the energy-efficiency label might foster such biased evaluations of products' energy efficiency. The introduction of the plus-classes has weakened consumers' perceptions of the relevance of energy efficiency in purchase decisions (Heinzle & Wüstenhagen, 2012; Ölander & Thøgersen, 2014). A conjoint analysis of consumers' television preferences found that consumers are less willing to pay for energy efficiency if the information is communicated with the new plus-sign classes than the original classes (Heinzle & Wüstenhagen, 2012). This finding implies that consumers assume that the differences between the new energy-efficiency classes are negligible and that all the products available on the market are very energy efficient. As a result, they might simply treat the energy-efficiency rating as a sign of approval giving them the license to choose a different, somewhat less efficient product than the most energy-efficient one. The energy-efficiency fallacy (i.e., the perceived interchangeability of energy efficiency and energy consumption) can produce rebound effects even more inhibiting to realization of the targeted energy savings than if consumers had chosen a better efficiency class. It, therefore, is crucial to increase perceived differences between energy-efficiency classes among consumers. In other words, consumers who tend to neglect information about actual consumption should, at least, choose the most energy-efficient product.

A second issue with the current energy-efficiency scale could also undermine the accuracy of interpretation and, consequently, the perceived relevance of differences between energy-efficiency ratings. In most cases, some energy-efficiency classes depicted on the energy label could be omitted because products are no longer available in these classes. For example, 98% of all televisions on the market have energy-efficiency ratings of A to A^{++}, but the energy label still shows all the classes from A^{++} to E (VZBV, 2015). The discrepancy is even more extreme for freezers. Since 2013, new freezers in Switzerland have to meet a minimum standard of A^{++}. This means that, by law, new products must be classified in the two highest energy-efficiency classes to be allowed for sale. The market situation in other countries has been similar since the EU issued a directive regulating the ecodesign requirements (e.g., energy efficiency) for new products and banning inefficient products from the market

(Directive 2009/125/EC). A market analysis in Germany has shown that 79% of all freezers fall into in the two best classes of A^{++} and A^{+++} (VZBV, 2015). Products with energy-efficiency ratings of D, C, B, and A are not available anymore, and products in the A+ category are only rarely available, but all these classes are still shown on the energy label. Consequently, many consumers assume that the whole range of efficiency classes on the energy label is available in the market (Waide & Watson, 2013).

This is problematic because consumers might use the (assumed) lowest energy-efficiency class depicted on the energy label as a reference point for assessing products' energy friendliness when making purchase decisions. More precisely, judgments of products' energy-efficiency ratings could be anchored on the lowest efficiency class in the efficiency scale. The more efficiency classes that fall between the efficiency class of the selected product and the lowest efficiency class in the efficiency scale, the more energy friendly the product is perceived to be. For example, the selection of a freezer with a rating of A^{+} could be perceived as energy friendly when evaluated on an energy-efficiency scale ranging from D to A^{+++}. Compared to the lowest efficiency class, the selected freezer falls within the upper range of efficiency. However, among the efficiency classes actually available in the market (i.e., A^{+} to A^{+++}), the selected product falls in the lowest efficiency rating. Thus, depending on the number of classes in the rating scale, the reference point (i.e., the lowest energy-efficiency class) that consumers might consider when assessing a product's energy friendliness changes. The initial value taken as the reference point (e.g., the lowest energy-efficiency rating depicted) could influence consumers' judgment of other information (e.g., the energy friendliness of a product) (Molenbroek et al., 2013b).

These types of biased judgments of products' energy consumption and subsequent suboptimal purchase decisions might be caused by the use of certain heuristics. People often display a tendency to apply heuristics when making a decision or a judgment (Gigerenzer & Gaissmaier, 2011; Kahneman, 2011; Slovic, Finucane, Peters, & MacGregor, 2007; B. Sütterlin & Siegrist, 2014). In many situations, people do not take into account all the pieces of information necessary to make rational decisions but, instead, use cognitive shortcuts to reach decisions (e.g., Broman Toft, Schuitema, & Thøgersen, 2014). In decision-making research, so-called dual-process theories are commonly encountered, suggesting the existence of two cognitive systems: a slow, analytic system (System 1) and a fast, associative system (System 2) (Chaiken & Trope, 1999; Evans, 2006; Kahneman & Frederick, 2002). System 1 is used to make a quick assessment that is then evaluated and corrected in System 2 to yield the final answer. However, the judgments made by System 1 are not always sufficiently corrected by

System 2, and the resulting decisions can be biased. Such insufficient evaluations are termed heuristic processing (Kahneman & Frederick, 2002). This process can be conscious or unconscious, but the tendency to apply heuristics to reach a decision has been found to be a frequently encountered consumer behavior (for an overview, see Bettman, Johnson, & Payne, 1991).

Heuristics might be efficient and cost effective, but reliance on them can lead to biased decisions and the neglect of some information. In the case of the energy label, the use of heuristics can be highly problematic and result in purchase decisions that are not optimal for energy friendliness. For example, the neglect of annual-consumption information and the misinterpretation of energy-efficiency information can lead to suboptimal product choices that contribute to higher final energy consumption. Not all consumer decisions are equally likely to be affected by heuristic decision making. For example, the application of heuristics seems less likely in more expensive purchases, such as that of a new car. Nevertheless, energy-relevant information might be neglected or partially considered because only a small segment of consumers can be classified as idealistic energy savers (Bernadette Sütterlin, Brunner, & Siegrist, 2011). Furthermore, systems 1 and 2 might make the final decision together, but the evaluation of certain information might still be dominated by System 1 and therefore follow heuristic processing (Kahneman & Frederick, 2002).

One very robust and prevalent heuristic effect is the anchor effect (for an overview, see Furnham & Boo, 2011). It describes the human tendency to use an initial value (e.g., a value initially provided, resulting from a partial calculation, or easily retrieved) as a starting point and to adjust it for subsequent estimates (e.g., estimating a probability, the result of a calculation), but the adjustments are frequently insufficient (Slovic & Lichtenstein, 1968; Tversky & Kahneman, 1974). For example, two groups of students were shown the same multiplication problem for 5 seconds, with the order of the numbers reversed (i.e., 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 vs. 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1). Within this short time period, students could only partially calculate the product. Students shown the multiplication problem starting with the lower values estimated a significantly lower result than students shown the multiplication problem starting with the higher number. Each group took the initial numbers as an anchor for the estimate but failed to sufficiently adjust for the following numbers (Tversky & Kahneman, 1974). The anchor effect, thus, can cause biased decisions because people's judgment rests on the reference point, and people typically insufficiently adjust for it (Cheek, Coe-Odess, & Schwartz, 2015). Such biased decisions caused by the provided anchor have also been observed in estimations and knowledge questions in various fields. For example, participants in one study estimated the likelihood of nuclear war to be higher when asked whether the likelihood was lower or higher than 90% compared to a likelihood of 1% (Plous, 1989). Similar effects with different anchors were found in estimations of the percentage of African countries in the United Nations (Tversky & Kahneman, 1974) and the length of the Mississippi River (McElroy & Dowd, 2007). In all these studies, the number provided as a constraint or reference point influenced the outcome of the estimates; in other words, a higher anchor led to higher estimates, and vice versa.

Cues do not have to be actively taken into account to act as anchors. Even incidental environmental anchors to which participants are not specifically asked to refer have been shown to influence decision making. For example, the number on a jersey can influence evaluations of an athlete's performance (Critcher & Gilovich, 2008). Anchoring has also been observed in more applied settings. For example, Northcraft and Neale (1987) asked real estate agents to promote a house and make pricing decisions. Participants were provided with an ample information packet, including the listing prices of the properties. The results showed that agents anchored the decisions on the provided listing prices, even though they stressed that this information should not be used (Northcraft and Neale (1987). Similar effects were found in a more recent study investigating the role of reference prices in online auctions (Wolk & Spann, 2008). Wolk and Spann (2008) showed that the reference prices provided influenced bidders when asked to name their own price for goods. In a study on consumers, Yadav (1994) observed that assessment of the attractiveness of item bundles was often anchored on the most important item. Participants did not always sufficiently adjust for this anchoring, which led them to choose less valuable bundles (Yadav, 1994).

Anchoring literature generally assumes that numerical values serve as anchors. It has been shown that consumers spontaneously link the letter ranking of the energy-efficiency scale with school grades, so the letters then reflect a numerical order (Waide & Watson, 2013). Furthermore, consumers' evaluations of the energy label seem to follow heuristic processing (i.e., dominated by System 1) rather than analytical processing (i.e., adjusted by System 2) (Waechter et al., 2015b). Therefore, it seems likely that consumers might take either the lowest or the highest efficiency class depicted on the efficiency scale as an anchor for evaluating products' efficiency ratings. If the highest efficiency class were taken, the length of the scale is irrelevant. However, as hypothesized, if consumers take the lowest efficiency class as an anchor, their perceptions of the higher efficiency classes could be affected, although judgment of an efficiency class should be independent of the other classes shown. Different estimates depending on the length of the scale, therefore, indicate an anchor effect. This tendency could also result in lower perceptions of the relevance of the differences between the plus-sign classes because they indicate less than one step on the scale when compared to the original classes.

Moreover, when the lowest energy-efficiency rating presented on the energy label acts as an anchor, displaying a rating scale, which includes classes for which products are no longer available on the market, can undermine the general evaluation of products' energy friendliness. When consumers are unaware that only products in the top energy-efficiency classes are available, they fail to adjust for this fact and take the lowest efficiency class as a reference for how good (i.e., energy friendly) a product or choice is. For example, choosing a product with an energy-efficiency rating of B on a scale ranging from A to G seems more energy friendly than choosing the same product rated on a scale ranging from A to C. In both cases, the second-best option is chosen. However, the distance to the worst option (i.e., the anchor) differs substantially, influencing the perception of the product's energy-efficiency rating (the upper end, middle, or lower end of the scale) and, ultimately, the perceived energy friendliness of the choice. Consequently, the perceived benefit of choosing the best option is much larger in the latter case. Therefore, showing only the energy-efficiency classes with products available on the market could motivate consumers to choose products in the best energy-efficiency class. In contrast, displaying efficiency classes no longer available on the market could result in suboptimal decisions which increase final energy consumption, especially because consumers tend to focus on energy-efficiency information (Waechter et al., 2015a).

The European Commission has acknowledged that the introduction of the new energy-efficiency classes with the plus signs has been suboptimal. The commission has proposed a draft regulation to redesign the energy-efficiency scale based on the original A to G scale (European Commission, 2015b). This redesign should ensure that the importance of energy efficiency is restored in consumers' perceptions. However, a return to the original ranking scale—that is, a scale without the plus-sign classes—would not solve the problem of misperceptions of product availability and the resulting biased perception by shifting the reference point. The effect might even be reinforced because more consumers might assume that products in all classes are available again and that the assumed available efficiency class (i.e., the anchor) is lower due to the re-scaling. The draft of the new labeling directive addresses this issue and suggests that the efficiency scale of the new energy label should not contain more classes of products than those available (European Commission, 2015b). However, this issue has received little attention so far, and studies on it are lacking. More systematic research is needed to confirm the importance of this step and its influence on consumers.

In summary, the current design of the energy label can lead to biased consumer decisions regarding energy friendliness (i.e., choice of products with higher consumption), boosting final energy consumption. The use of plus-sign classes might lower consumers' perceptions of the relevance of energy efficiency because these classes indicate high efficiency based on the A and green-color ratings. Consumers tend to perceive these classes as more homogenous than the A–G classes. Another source of suboptimal judgments and decisions is that the energy-efficiency scale contains classes not represented on the market anymore. This paper is aimed at providing evidence of the biasing influence of the presentation format of energy-efficiency information on judgments of products' energy friendliness and at testing possible modifications of the energy-efficiency scale that could help consumers make more energy-friendly decisions.

5.2 Study 1

Study 1 was aimed at testing different modifications of the scale design to identify what factors influence perception of products' energy efficiency and to determine how the label design can be improved to enhance the perceived benefit of energy-efficiency gains and encourage the choice of the most energy-efficient products. An additional goal was to investigate the impact of the reference point of the rating scale (i.e., the distance to the lowest class depicted on the scale) on evaluations of products' energy friendliness. A freezer was selected as the studied product to ensure a realistic setting for the judgment. Furthermore, to avoid misunderstanding of the term "energy efficiency," participants were asked about the perceived energy friendliness of the products presented. The term "energy friendliness" was chosen because consumers used it in qualitative interviews at the point of sale conducted by the authors of this paper.

5.2.1 Method

5.2.1.1 Participants

The authors invited 203 members of an online panel they administer to participate in a survey. In addition, the link to the study was sent to the members of a mailing list of the psychology department. In total, 183 members of the online panel and 69 subscribers to the mailing list participated. Multiple entries submitted by the same participants were identified by the Internet Protocol (IP) address, and only the data from the first entry or the completed entry were used. This resulted in a final sample of 217 participants, of whom 128 (59%) were male. The mean age was 51 (SD = 18).

5.2.1.2 Materials and procedures

Different energy-efficiency scales for the product category of freezer were designed for the experiment. The product category of freezer was chosen as the indicating product because freezers have high energy consumption. Therefore, consumers' perceived benefit of increased energy friendliness when switching from one energy-efficiency class to the next higher one should be high even for the scale with plus-sign categories. The original scale range currently used on freezers' energy labels (i.e., A^{+++} to D) with the original colors (i.e., green to red) was used as the control condition (Original scale). Three experimental scale designs were formulated: (a) Original Without Plus Signs scale, ranging from A to G with original colors; (b) Red-Green scale, ranging from A to G with only the A rating colored green and then shifting over yellow to red; (c) Short scale showing only three classes, ranging from A to C with traffic-light coloring (i.e., green, yellow, red). The four conditions are depicted in Figs. 2 and 3.

The Red-Green scale was used to investigate the effect of coloring on consumers' estimation of products' energy friendliness. The Short scale was included to test the biasing effect of depicting empty efficiency classes not represented on the market anymore and the resulting influence of the different reference point used in evaluations of products' efficiency ratings. The Short scale presents only the three classes available on the market. As mentioned, many product categories have only products in the three highest classes available on the market due to technological progress and legal regulations (VZBV, 2015).

We decided to re-color the three classes to retain the concept of the original design format of the energy label conveying the performance of a product with a letter ranking and a color code. Without re-coloring, the shortened scale would show only green classes. For each condition—the control condition and the three experimental conditions—two labels were generated: one indicating that a product has the best energy-efficiency rating (Fig. 5.2) and one indicating that a product has the second-best energy-efficiency rating (Fig. 5.3). These ratings changed according to the scale design used. Participants were randomly assigned to one of the four conditions. Two freezers with the corresponding efficiency scales were presented on the same page, and participants were informed that the two freezers were identical in size. The energy-efficiency rating is relative to the size of a product, so a large freezer with the highest efficiency rating might actually consume more energy than a freezer with a lower efficiency rating but smaller size. Therefore, it is crucial that participants perceived the two products as identical in size to control for any distortive influence on their energy-friendliness judgments due to assumed size differences. Participants were asked to separately estimate the energy friendliness of the two freezers by adjusting a slider below each picture using a scale ranging from 0 (not at all energy friendly) to 100 (very energy friendly). Participants did not see the underlying numerical scale of the slider.

Figure 5.2. Picture of the freezer and labels used in the control and the experimental conditions to denote that the product is of the highest energy-efficiency class.

Figure 5.3. Picture of the freezer and the labels used in the control and experimental conditions to denote that the product is of the second-highest energy-efficiency class.

5.2.2 Results and Discussion

We assessed the perceived gain in energy friendliness by subtracting the energy-friendliness estimation for product in the second-highest energy-efficiency class from the estimation for the product in the highest energy-efficiency class. Analysis of the difference revealed that the results from 7 participants had a value less than 0, indicating that they judged the freezer with the second-highest energy-efficiency rating as more energy friendly than the freezer with the highest energy-efficiency rating. In the following analysis, these 7 participants were excluded because they did not accurately understand the energy-efficiency scale ratings. A square root transformation was performed to ensure normal distribution of the dependent variable, which was the gain in perceived energy friendliness.

Analysis of variance (ANOVA) revealed that the scale conditions had a significant effect on the perceived gain in energy friendliness ($F(3, 206) = 14.57$, $p < .001$, $\omega = .40$). The means of the scale conditions are presented in Table 5.1. The highest perceived gain in energy friendliness when choosing a higher energy-efficiency class was detected for the Short scale. The least perceived gain was detected for the Original design. Using a scale without plus-sign classes (Original Without Plus Signs scale) had a marginally significant effect and led to a somewhat higher perceived gain than the scale with plus-sign classes (Original scale). Applying a different coloring (Red-Green scale) also marginally increased the perceived gain compared to the original coloring. These results support the hypothesis that consumers are susceptible to an anchor effect when using the energy label. More precisely, the number of efficiency classes and, therefore, the provided reference point affect consumers' perceptions of products' energy friendliness. Consequently, the change in the reference point by reducing the number of classes depicted in the scale to the classes actually available on the market has the greatest potential to increase consumers' perceived gain in energy friendliness and their motivation to choose the most energy-efficient product.

In this study, the effects of the format of the energy-efficiency scales on energy-friendliness evaluations were tested for the product category of freezer. It was possible that the effects of the different scale designs were lower for products generally associated with low energy consumption, such as coffee machines. Therefore, we conducted a follow-up experiment with the same set-up but two other product categories.

Table 5.1

Perceived Energy Friendliness of the Two Products (Low vs. High Efficiency) and Perceived Gain Differences by Scale Design (Untransformed Means and Standard Deviations)

		Estimations of Energy Friendliness					
		Low Efficiency		High Efficiency		Efficiency Gain	
Scale Design	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Original	51	66.25	21.15	87.67	15.90	21.41[b]	14.33
Original Without Plus Signs	52	57.77	22.62	86.23	14.54	28.46[a]	16.39
Red-Green	56	50.57	24.63	80.29	20.72	29.71[a]	20.26
Short	51	36.80	16.39	79.39	17.57	42.59[c]	17.91

Note. The ANOVA for the perceived gain in energy friendliness revealed a significant effect from scale design ($F(3, 206) = 14.57$, $p < .001$). Different letters indicate significant differences between conditions using the Tukey HSD post-hoc test. The letter c denotes a significance level of $p < .001$ and the letter b a marginal significance level of $p < .07$.

5.3 Study 2

The purpose of Study 2 was to test whether the effects of the different energy-efficiency scale designs on consumers' perception of products' energy friendliness could be generalized to other product categories associated with lower energy consumption. To test for generalizability, lamps and coffee machines were chosen as the study objects because most consumers are familiar with these types of products. Additionally, they consume less energy and probably are less strongly associated with energy consumption than freezers, which could lower the perceived benefit of switching between energy-efficiency classes.

5.3.1 Method

5.3.1.1 Participants

The sample for this study was recruited from an online panel provided by a market research institute (Respondi). Participants received an incentive for participation (CHF 3). In total, 330 individuals completed the survey. Participants engaged in an additional study that was thematically unrelated to the topic of this survey. The median of the time to complete the survey (Md = 15.75 min) was used as a threshold to identify people who too quickly clicked through the questionnaire. Participants who needed less than half of the median were excluded. This procedure resulted in a final sample of 321 participants. The mean age was 46 (SD = 17), and the sample consisted of 51.4% women.

5.3.1.2 Materials and procedure

The same study design and materials as in Study 1 were used in Study 2, except the freezer was replaced with a lamp in the first task and a coffee machine in the second task (Figs. 5.4 and 5.5). Participants were randomly assigned to one of the four scale conditions. After being asking for socio-demographic information, participants were presented with a task in which they had to indicate the energy friendliness of two lamps. Participants answered several questions from a thematically unrelated study and were then presented with the second task in which they had to judge the energy friendliness of two coffee machines.

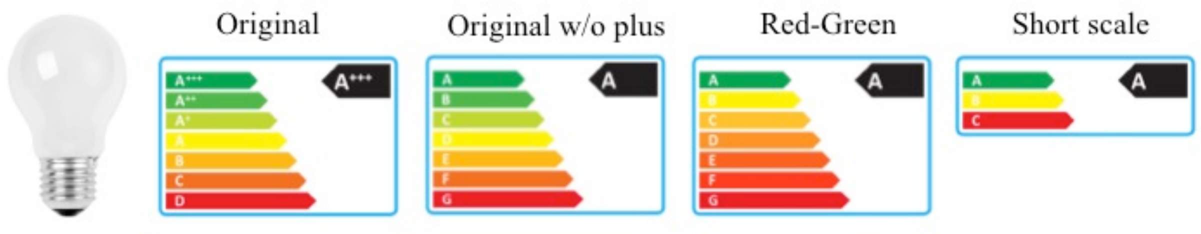


Figure 5.4. Picture of the lamp and labels used in the control and the experimental conditions to denote that the product is of the highest energy-efficiency class.

Figure 5.5. Picture of the coffee machine and labels used in the control and the experimental conditions to denote that the product is of the second-highest energy-efficiency class.

5.3.2 Results and Discussion

The perceived gain in energy friendliness was measured by calculating the difference between the energy-friendliness estimations of the two products with different energy-efficiency ratings (i.e., lower vs. higher energy efficiency) using the same method as in Study 1. As in Study 1, only participants whose results for perceived gains in energy friendliness had values higher than 0 in the lamp task and the coffee machine task were included in the analysis. The square root of both variables for perceived gain in energy friendliness was calculated because of the skewed distribution of the variables. An analysis of variance revealed that the scale conditions had significant main effects on the perceived gain in energy friendliness in the lamp task ($F(3, 240) = 7.71$, $p < .001$, $\omega = .28$) and the coffee machine task ($F(3, 240) = 6.29$, $p < .001$, $\omega = .25$). The means of the scale conditions are depicted in Table 5.2. Consistent with the results of Study 1, the Short scale resulted in the highest perceived gain in energy friendliness. Unlike in Study 1, using a scale design without plus-sign categories and applying different coloring had no effects.

Table 5.2

Perceived Energy Friendliness of the Two Products (Low vs. High Efficiency) and Perceived Gain Differences by Scale Design and Product Type (Untransformed Means and Standard Deviations Depicted)

			Estimations of Energy Friendliness					
			Low Efficiency		High Efficiency		Efficiency Gain	
Product Type	Scale Design	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Lamp	Original	61	59.31	22.76	86.82	20.04	27.51[a]	18.48
	Original Without Plus Signs	63	59.52	23.87	84.33	20.99	24.81[a]	16.37
	Red-Green	63	56.21	23.71	86.32	18.78	30.11[a]	22.19
	Short	57	41.18	17.04	80.40	20.50	39.23[b]	15.40
Coffee Machine	Original	61	66.82	17.55	90.13	13.03	23.49[a]	15.63
	Original Without Plus Signs	63	62.21	22.71	87.14	16.76	24.94[a]	17.77
	Red-Green	63	58.54	23.60	83.71	21.83	25.17[a]	19.43
	Short	57	41.95	17.67	77.74	22.78	35.79[b]	17.57

Note. ANOVA of the perceived gain in energy friendliness revealed significant effects from scale design for the lamp ($F(3, 240) = 7.71$, $p < .001$) and for the coffee machine ($F(3, 240) = 6.29$, $p < .001$). Different letters indicate significant differences between conditions ($p < .05$) using the Tukey HSD post-hoc test.

5.4 General Discussion

Evaluations of the energy label are highly promising, showing a wide distribution of labeled products in stores and high consumer awareness of the label (Molenbroek et al., 2013a). However, earlier research on the energy label's influence on consumers' judgment and decision making shows that the current format of the energy label has certain drawbacks. One of these drawbacks is lower consumer willingness to pay for energy efficiency since the introduction of the plus-sign classes into the energy-efficiency scale (Heinzle, 2012; Heinzle & Wüstenhagen, 2009; Heinzle & Wüstenhagen, 2012; Ölander & Thøgersen, 2014). Other studies show that consumers tend to neglect information about actual energy consumption when estimating the energy friendliness of products and to focus heavily on energy efficiency indicating that the energy label triggers heuristic processing (Waechter et al., 2015a, 2015b). This tendency might result in biased judgments and, consequently, suboptimal decisions in the purchase of energy-friendly products. In addition, the focus on energy efficiency might further undermine the choice of energy-friendly products if consumers' interpretations of energy-efficiency information are (negatively) influenced by the current presentation format, which could also foster suboptimal decisions. Together, these effects might contribute substantially to higher final energy consumption. The aim of the present paper was to investigate the impacts of different scale designs on consumers' energy-friendliness perceptions of different products.

The planned redesign of the energy-efficiency scale based on the original scale ranging from A to G seems to be a good measure (European Commission, 2015b). The re-design could increase consumers' willingness to pay for energy efficiency when it is communicated through the original classes (e.g., Ölander & Thøgersen, 2014). However, the use of the plus-sign classes is not the only problem in the current scale design. Therefore, the proposed revision of the labeling directive also suggests omitting from the label efficiency classes that are not available anymore (European Commission, 2015b). This paper provides empirical data and theoretical reasoning supporting this policy direction. The results of Studies 1 and 2 demonstrate the impacts of an anchor effect, revealing that consumers perceive the greatest difference in the energy friendliness of the energy-efficiency classes when the label depicts fewer classes (i.e., Short scale design). Not only whether the scale contains plus-sign classes but, more importantly, the number of classes depicted in the efficiency scale matters. Although the task was to estimate the energy friendliness of the products with the best and the second-best efficiency ratings, participants were influenced by the lowest efficiency class shown. In other words, participants used the lowest energy-efficiency class as the anchor for their assessment of products' energy-efficiency ratings. An anchor based on the lowest energy-efficiency class which lies farthest from the efficiency rating of a product generally results in higher perceived energy friendliness relative to the highest efficiency class. If the reference point (i.e., the lowest efficiency class indicated on the scale) and a product's efficiency rating are close to each other, the product is generally perceived as less energy friendly relative to the highest efficiency class. This effect was consistent over three product categories (freezers, lamps, and coffee machines).

Therefore, re-scaling the products by omitting the plus-sign classes is only somewhat helpful as long as the label depicts unnecessary classes (i.e., classes not represented on the market) of lower energy efficiency. Doing so artificially extends the scale with low efficiency classes, which automatically shifts the reference point used to evaluate products' energy friendliness and reduces the perceived gain in efficiency between higher energy-efficiency classes. Consequently, the energy-efficiency scale should be decreased to the number of classes actually represented on the market. This modification could benefit from consumers' tendency to heuristically process the energy label, thereby increasing their motivation to choose the most energy-efficient product. This approach is especially promising because other attempts to motivate consumers to choose the most energy-efficient product, for example, by depicting energy costs on the labels, have been found to be ineffective (Carroll, Denny, & Lyons, 2015; Kastner & Stern, 2015). This approach could be used to implicitly model consumers' behavior without imposing restrictions on them. The energy label could also be kept as lean as it is now, which is beneficial for consumers (Banerjee & Solomon, 2003; Dendler, 2014).

One could argue that the relevance of the energy-efficiency scale might be reduced on a general level if such a shortened scale were implemented. Based on the results of the studies presented, this argument cannot be ruled out. The results suggest that the effects of different scale designs might depend on the product category. For product categories that are generally associated with high energy consumption (i.e., freezers), the effect of changing the scale design seems to provide more benefits in perceived gain in energy efficiency. However, in the long term, to reduce final energy consumption and close the energy-efficiency gap, the exclusive promotion of energy efficiency is critical because consumers assume that high energy efficiency is equivalent to low energy consumption (Waechter et al., 2015b). Energy efficiency is a catchphrase in contemporary politics and forms the core of many energy policies because it promises the same level of comfort with less energy (Bundesrat, 2013). Unsurprisingly, then, energy efficiency easily comes to mind for many consumers when discussing the energy friendliness of energy-consuming goods. However, the reliance on energy efficiency is worthless if the presentation format of the scale introduces bias into consumers' judgments of products based on the energy-efficiency scale on the energy label. More precisely, when the lowest of the seven depicted energy-efficiency classes is taken as the anchor, the differences between the highest efficiency classes seem negligible. Redesigning the efficiency scale on the energy label could use consumers' tendency to focus on energy efficiency to encourage selection of the most energy-efficient product. The effectiveness of energy policy measures aimed at increasing energy efficiency could be increased. Nevertheless, in addition to promotion of energy efficiency, raising consumers' awareness of products' actual energy consumption could be necessary to achieve the targeted energy goals (Schmidt & Weigt, 2015).

5.5 Limitations

The results presented here are subject to some limitations. Participants were asked to make hypothetical estimations of perceived energy friendliness which might differ from estimations made in real purchase decisions. However, the anchor effect has been found to be very robust in different situations and contexts (e.g., Cheek et al., 2015; Furnham & Boo, 2011). Therefore, it is plausible that, in realistic situations, consumers might use the lowest energy-efficiency category as a reference point for their judgment and decision making.

In addition, participants were asked to estimate the energy friendliness of products based solely on the energy-efficiency scale provided. In a real purchase situation, consumers might consider more attributes to assess products' energy friendliness, and, consequently, the benefit of choosing a product with the highest energy-efficiency rating. However, a study by Waechter et al. (2015b) found that consumers tend to rely on energy-efficiency information and to neglect other information when assessing products' energy friendliness. Hence, it can be assumed that consumers will display similar behavior in real purchase decisions. However, not all consumers will consider energy-related information because they might consider other product attributes to be more important. Consequently, motivation to choose the most efficient product also depends on the weight placed on energy-related information in the decision-making process. In future studies, how to increase the importance of energy-related information to consumers who do not consider it in their decisions should be investigated.

Another limitation arises from the online collection of data from participants who might be better educated and more interested in the topic than the general population. This issue was especially concerning in Study 1, where the participants had a high mean age, and approximately 40% held a university degree. However, the effects were replicated in Study 2 with a younger and less educated sample. This suggests that the detected effect was underestimated in the experiments and that the Short scale might have an even stronger effect than that detected here.

In the studies presented here, the three-stage Short scale design was used for every product category to systematically test the effects of excluding efficiency classes no longer available on the market. However, we cannot rule out that participants might have perceived this label as completely new, not as modified. As suggested by range-frequency theory, an alternative explanation for the results is that participants subjectively mapped the answering scale on the three efficiency classes, leading to greater shifts between the classes than in the longer scale (Parducci, 1965, 1990). However, the rating scale included only the two extreme values of "very energy unfriendly" and "very energy friendly," and the slider did not reveal a numerical value, so participants did not have clear categories of efficiency classes to which they could assign numbers. In addition, the dependent variable (perceived energy friendliness) provides high external validity because consumers' judgments of products' energy friendliness are also subjective in real life. This label design could be implemented in a realistic environment (e.g., an online shop) with an additional dependent variable (e.g., purchase decision) to verify the effect in a real-life setting.

Some product categories have products available in more than three efficiency classes, so application of the Short scale in the real market could necessitate making it longer, although not as long as the currently used scale. However, this extension could reduce the impact of the effect found here. As well, some products, such as freezers, might have a longer scale than coffee machines, for example. Therefore, it should be investigated whether consumers might be confused if the efficiency scales for various products differed in length.

Finally, the impact of the scale format on estimations of perceived gains in energy friendliness was assessed only for a change from the second-most to the most efficient product. The perceived benefit for changes between other efficiency classes might be different. For example, based on the results, it can only be speculated whether a product with an F rating on an A–G scale would be perceived as energy friendly as a product with a B rating on an A–C scale. Nevertheless, after re-designing the energy labels, consumers still most likely will find products in the higher efficiency classes due to the rigorous push-and-pull mechanisms of the ecolabeling and ecodesign directives (i.e., ban on inefficient products in the market). Therefore, the comparisons used in these studies closely correspond to realistic purchase situations and reinforce the need to reduce the scale.

5.6 Conclusions

Consumers' responses to information are heavily determined by the presentation of information (Sovacool, 2014). This series of studies has shown that how energy-efficiency information is provided to consumers is crucial to its evaluation. The results of the presented studies suggest that redesigning the energy-efficiency scale on the energy label could serve as a powerful tool to increase consumers' awareness of the differences between the energy-efficiency categories. The elimination of efficiency classes no longer represented in the market could be effective at increasing motivation to choose the most efficient products and reducing the negative effect of consumers' susceptibility to the energy-efficiency fallacy (Waechter et al., 2015b). The studies show that this effect is not limited to a specific product type but can be observed in different product categories. To the best of the authors' knowledge, this study is the first to empirically test the impact of a shortened energy efficiency scale. However, more research is needed to assess how consumers might use and interpret such a redesigned label and how it might impact real purchase decisions.

Acknowledgment

This study was funded by the Swiss Federal Office of Energy (SFOE).

References

Allen, S., Dietz, T., & McCright, A. M. (2015). Measuring household energy efficiency behaviors with attention to behavioral plasticity in the United States. *Energy Research & Social Science, 10*, 133-140. doi:http://dx.doi.org/10.1016/j.erss.2015.07.014

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences, 107*(37), 16054-16059. doi:10.1073/pnas.1001509107

Banerjee, A., & Solomon, B. D. (2003). Eco-labeling for energy efficiency and sustainability: a meta-evaluation of US programs. *Energy Policy, 31*(2), 109-123. doi:http://dx.doi.org/10.1016/S0301-4215(02)00012-5

Bettman, J. R., Johnson, E. J., & Payne, J. W. (1991). Consumer decision making. *Handbook of consumer behavior, 44*(2), 50-84.

Broman Toft, M., Schuitema, G., & Thøgersen, J. (2014). The importance of framing for consumer acceptance of the Smart Grid: A comparative study of Denmark, Norway and Switzerland. *Energy Research & Social Science, 3*, 113-123. doi:/10.1016/j.erss.2014.07.010

Bundesrat. (2013). *Communication referring to the first regulation of the energy-strategy 2050 and the popular initiative "nuclear phase out" [Botschaft zum ersten Massnahmepaket der Energiestrategie 2050 und zur Volksinitiative "Für den geordneten Ausstieg aus der Atomenergie (Atomausstiegsinitiative)"]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from https://www.admin.ch/opc/de/federal-gazette/2013/7561.pdf.

Carroll, J., Denny, E., & Lyons, S. (2015). The Effects of Energy Cost Labelling on Appliance Purchasing Decisions: Trial Results from Ireland. *Journal of Consumer Policy*, 1-18. doi:10.1007/s10603-015-9306-4

Chaiken, S., & Trope, Y. (1999). *Dual-Process Theories in Social Psychology*. New York: Guilford Press.

Cheek, N. N., Coe-Odess, S., & Schwartz, B. (2015). What have I just done? Anchoring, self-knowledge, and judgments of recent behavior. *Judgment and Decision Making, 10*(1), 76-85.

Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances, (1992).

Critcher, C. R., & Gilovich, T. (2008). Incidental environmental anchors. *Journal of Behavioral Decision Making, 21*(3), 241-251. doi:10.1002/bdm.586

Dendler, L. (2014). Sustainability meta labelling: an effective measure to facilitate more sustainable consumption and production? *Journal of Cleaner Production, 63*(0), 74-83. doi:/10.1016/j.jclepro.2013.04.037

European Commission. (2015a). *Evaluation of the Energy Labelling and Ecodesign Directives*. online Retrieved from http://ec.europa.eu/energy/sites/ener/files/documents/1_EN_autre_document_travail_service_part1_v2.pdf.

European Commission. (2015b). *Proposal for a regulation of the European Parliament and of the council setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU.* online Retrieved from http://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v6.pdf.

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, (2009).

Directive 2010/30/EU of the European Union and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, (2010).

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (2012).

Eurostat. (2012). Europe in figures – Eurostat yearbook. Retrieved 16.12.2015 http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_in_figures_-_Eurostat_yearbook

Evans, J. B. T. (2006). The heuristic-analytic theory of reasoning: Extension and evaluation. *Psychonomic Bulletin & Review, 13*(3), 378-395. doi:10.3758/BF03193858

Fri, R. W., & Savitz, M. L. (2014). Rethinking energy innovation and social science. *Energy Research & Social Science, 1*, 183-187. doi:http://dx.doi.org/10.1016/j.erss.2014.03.010

Furnham, A., & Boo, H. C. (2011). A literature review of the anchoring effect. *The Journal of Socio-Economics, 40*(1), 35-42. doi:http://dx.doi.org/10.1016/j.socec.2010.10.008

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*(1), 451-482. doi:doi:10.1146/annurev-psych-120709-145346

Greene, D. L., Kahn, J. R., & Gibson, R. C. (1999). Fuel economy rebound effect for US household vehicles. *Energy Journal, 20*(3), 1-31.

Greening, L. A., Greene, D. L., & Difiglio, C. (2000). Energy efficiency and consumption — the rebound effect — a survey. *Energy Policy, 28*(6–7), 389-401. doi:10.1016/S0301-4215(00)00021-5

Heinzle, S. (2012). Disclosure of Energy Operating Cost Information: A Silver Bullet for Overcoming the Energy-Efficiency Gap? *Journal of Consumer Policy, 35*(1), 43-64. doi:10.1007/s10603-012-9189-6

Heinzle, S., & Wüstenhagen, R. (2009). *Consumer survey on the new format of the European Energy Label for televisions - Comparison of a "A-G closed" versus a "beyond A" scale format*. ZEW. Mannheim.

Heinzle, S., & Wüstenhagen, R. (2012). Dynamic Adjustment of Eco-labeling Schemes and Consumer Choice – the Revision of the EU Energy Label as a Missed Opportunity? *Business Strategy and the Environment, 21*(1), 60-70. doi:10.1002/bse.722

Herring, H. (2006). Energy efficiency - a critical view. *Energy, 31*(1), 10-20. doi:10.1016/j.energy.2004.04.055

Herring, H., & Roy, R. (2007). Technological innovation, energy efficient design and the rebound effect. *Technovation, 27*(4), 194-203. doi:10.1016/J.Technovation.2006.11.004

Jaffe, A. B., & Stavins, R. N. (1994). The energy-efficiency gap What does it mean? *Energy Policy, 22*(10), 804-810. doi:10.1016/0301-4215(94)90138-4

Kahneman, D. (2011). *Thinking, fast and slow*. London: Penguin.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: the psychology of intuitive judgment*. Cambridge: Cambridge University Press.

Kastner, I., & Stern, P. C. (2015). Examining the decision-making processes behind household energy investments: A review. *Energy Research & Social Science, 10*, 72-89. doi:http://dx.doi.org/10.1016/j.erss.2015.07.008

Kempton, W., & Layne, L. L. (1994). The Consumers Energy Analysis Environment. *Energy Policy, 22*(10), 857-866. doi:10.1016/0301-4215(94)90145-7

McElroy, T., & Dowd, K. (2007). Susceptibility to anchoring effects: How openness-to-experience influences responses to anchoring cues. *Judgment and Decision Making Journal, 2*(1), 48-53.

Michel, A., Attali, S., & Bush, E. (2015). *Energy efficiency of white goods in Europe: monitoring the market with sales data*. Retrieved from http://www.topten.eu/uploads/File/WhiteGoods_in_Europe_June15.pdf

Molenbroek, E., Cuijpers, M., Janeiro, L., Smith, M., Surmeli, N., Waide, P., . . . Fong, J. (2013a). *Evaluation of the Energy Labelling Directive and specific apsects of Ecodesign Directive - Background report I*. Retrieved from http://www.energylabelevaluation.eu/eu/home/welcome

Molenbroek, E., Cuijpers, M., Janeiro, L., Smith, M., Surmeli, N., Waide, P., . . . Fong, J. (2013b). *Evaluation of the Energy Labelling Directive and specific apsects of Ecodesign Directive - Background report II*. Retrieved from http://www.energylabelevaluation.eu/tmce/Background_document_II_-_Survey_results.pdf

Molenbroek, E., Smith, M., Groenenberg, H., Waide, P., Attali, S., Fischer, C., . . . Fong, J. (2014). *Final technical report. Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive ENER/C3/2012-523*. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

Northcraft, G. B., & Neale, M. A. (1987). Experts, Amateurs, and Real-Estate - an Anchoring-and-Adjustment Perspective on Property Pricing Decisions. *Organizational Behavior and Human Decision Processes, 39*(1), 84-97. doi:10.1016/0749-5978(87)90046-X

Ölander, F., & Thøgersen, J. (2014). Informing Versus Nudging in Environmental Policy. *Journal of Consumer Policy*, 1-16. doi:10.1007/s10603-014-9256-2

Parducci, A. (1965). Category Judgment - a Range-Frequency Model. *Psychological Review, 72*(6), 407-418. doi:DOI 10.1037/h0022602

Parducci, A. (1990). Response Bias and Contextual Effects: When Biased? In J.-M. F. Jean-Paul Caverni & G. Michel (Eds.), *Advances in Psychology* (Vol. Volume 68, pp. 207-219): North-Holland.

Peters, E., Dieckmann, N. F., Mertz, C. K., Vastfjall, D., Slovic, P., & Hibbard, J. H. (2009). Bringing Meaning to Numbers: The Impact of Evaluative Categories on Decisions. *Journal of Experimental Psychology-Applied, 15*(3), 213-227. doi:10.1037/a0016978

Peters, E., Vastfjall, D., Slovic, P., Mertz, C. K., Mazzocco, K., & Dickert, S. (2006). Numeracy and decision making. *Psychological Science, 17*(5), 407-413. doi:DOI 10.1111/j.1467-9280.2006.01720.x

Plous, S. (1989). Thinking the Unthinkable - the Effects of Anchoring on Likelihood Estimates of Nuclear-War. *Journal of Applied Social Psychology, 19*(1), 67-91. doi:DOI 10.1111/j.1559-1816.1989.tb01221.x

Schmidt, S., & Weigt, H. (2015). Interdisciplinary energy research and energy consumption: What, why, and how? *Energy Research & Social Science, 10*, 206-219. doi:http://dx.doi.org/10.1016/j.erss.2015.08.001

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Slovic, P., & Lichtenstein, S. (1968). Relative Importance of Probabilities and Payoffs in Risk Taking. *Journal of Experimental Psychology, 78*(3p2), 1. doi:DOI 10.1037/h0026468

Sovacool, B. K. (2014). What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Research & Social Science, 1*, 1-29. doi:http://10.1016/j.erss.2014.02.003

Steg, L., Perlaviciute, G., & van der Werff, E. (2015). Understanding the human dimensions of a sustainable energy transition. *Frontiers in Psychology, 6*. doi:10.3389/fpsyg.2015.00805

Stern, P. C. (2011). Contributions of Psychology to Limiting Climate Change. *American Psychologist, 66*(4), 303 - 314.

Sütterlin, B., Brunner, T. A., & Siegrist, M. (2011). Who puts the most energy into energy conservation? A segmentation of energy consumers based on energy-related behavioral characteristics. *Energy Policy, 39*(12), 8137-8152. doi:10.1016/j.enpol.2011.10.008

Sütterlin, B., & Siegrist, M. (2014). The reliance on symbolically significant behavioral attributes when judging energy consumption behaviors. *Journal of Environmental Psychology, 40*, 259-272. doi:DOI 10.1016/j.jenvp.2014.07.005

Tiefenbeck, V., Staake, T., Roth, K., & Sachs, O. (2013). For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy, 57*(0), 160-171. doi:http://dx.doi.org/10.1016/j.enpol.2013.01.021

Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Global Environmental Change-Human and Policy Dimensions, 29*, 127-138. doi:10.1016/j.gloenvcha.2014.09.004

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131. doi:10.2307/1738360

VZBV. (2015). *Market research on energy labeling of household appliances [Marktcheck zum Stand der Energieverbrauchskennzeichnung von Haushaltsgeräten]*. Retrieved from Mainz: http://www.effizienzwende.de/media/news/marktcheck-energielabel-langfassung-vzbv-vz-rheinland-pfalz-maerz-2015.pdf

Waechter, S., Sütterlin, B., & Siegrist, M. (2015a). Desired and Undesired Effects of Energy Labels—An Eye-Tracking Study. *PLoS ONE, 10*(7), e0134132. doi:10.1371/journal.pone.0134132

Waechter, S., Sütterlin, B., & Siegrist, M. (2015b). The misleading effect of energy efficiency information on perceived energy friendliness of electric goods. *Journal of Cleaner Production, 93*(0), 193-202. doi:http://dx.doi.org/10.1016/j.jclepro.2015.01.011

Waide, P., & Watson, R. (2013). *Energy labeling - The new European energy label: Assessing consumer comprehension and effectiveness as a market transformation tool.* Retrieved from http://clasp.ngo/en/Resources/Resources/PublicationLibrary/2013/Assessing-Consumer-Comprehension-of-the-EU-Energy-Label.aspx

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annual Review of Environment and Resources, 32*(1), 169-203. doi:10.1146/annurev.energy.32.053006.141137

Wolk, A., & Spann, M. (2008). The Effects of Reference Prices on Bidding Behavior in Interactive Pricing Mechanisms. *Journal of Interactive Marketing, 22*(4), 2-18. doi:10.1002/dir.20118

Yadav, M. S. (1994). How Buyers Evaluate Product Bundles - a Model of Anchoring and Adjustment. *Journal of Consumer Research, 21*(2), 342-353. doi:Doi 10.1086/209402

Zeng, L., Yu, Y., & Li, J. (2014). China's Promoting Energy-Efficient Products for the Benefit of the People Program in 2012: Results and analysis of the consumer impact study. *Applied Energy, 133*(0), 22-32. doi:http://dx.doi.org/10.1016/j.apenergy.2014.07.078

CHAPTER VI

GENERAL DISCUSSION

6.1 Introduction

Energy policy is a ballgame between economic claims and climate change policy. Discussions over trade-offs between these two sides have challenged world politics over the last twenty years. Following the impact of the catastrophic event in Fukushima in 2011, Switzerland made the momentous decision to phase out nuclear energy (Bundesrat, 2011). Research found that popular acceptance of nuclear energy heavily decreased after the disaster (Siegrist & Visschers, 2013); hence, Switzerland's decision met with widespread public support. Within the new energy strategy, Switzerland acknowledged the need to reduce energy consumption and to enhance renewable energy systems to prevent an energy gap in the future when phasing out nuclear energy (Bundesrat, 2013). However, since 2011, the impact of Fukushima has softened, as has been shown by a representative survey of the Swiss population by the market research institute GFS Zurich (Schaub, 2014). Consequently, in the last Swiss national elections, political parties fighting for a nuclear phase-out and sustainable energy consumption were heavily downgraded. Moreover, economic claims for an energy policy less restricted by the government regained strength; thus, the next legislation period could constitute a challenge for the Swiss energy strategy.

Swiss energy consumption has increased over the last 60 years (BFE, 2015). Population and economic growth are important drivers for this development. Consequently, household energy consumption has increased by 10.3%, and the electricity demand caused by electronic appliances in households increased by 19.3% from 2000–2013 (Prognos, 2014). Taking political and societal developments into account, the role of consumers in the development of the energy demand and energy consumption is more substantial than ever. In other words, while politicians fight over paragraphs, the actions undertaken by individuals are the starting point for energy savings.

In order to engage in energy-friendly behaviors, consumers need information that empowers them to make informed decisions at the point of sale. The energy label for energy-consuming durables could constitute such information. The energy label is mandatory for various products, such as freezers, televisions, and washing machines, and it has to be placed on the product in stores. The label contains information about the energy efficiency and the absolute energy consumption of the product. Nevertheless, a precondition for the success of such a label is consumers' correct interpretation and application of the information provided on it. Potential misinterpretations and misconceptions could backfire and impede potential energy savings. For example, a consumer could think the choice of a freezer with an efficiency rating of A^{++} is very energy-friendly, whereas this efficiency rating is actually the lowest allowed by law. Further, if consumers derive the energy-friendliness of a product based mainly on energy efficiency information, the decrease in final energy consumption might be restrained because an energy-efficient product can still consume a lot of energy. Furthermore, for researchers and policy makers, it is crucial to understand energy-friendly decision-making strategies. Two reasons support this claim. First, only if it is clear what constitutes such decisions can suitable policy measurements be developed and existing ones be improved. Second, by investigating energy-friendly decision-making strategies, non-optimal decision heuristics that could lead to biased decisions can be detected and targeted.

The goals of this dissertation therefore were to provide insights into consumers' use and interpretation of energy-related information, with a special focus on the energy label. Then, the influence of energy-related information and the energy label on consumers' product choices and decision-making strategies was investigated. Finally, possible improvements were tested in order to accelerate energy-friendly consumer behavior.

In the following section 6.2, the main findings of this dissertation are summarized and discussed. In the next section 6.3, implications for policy makers and researchers are presented. Before the conclusion, the main limitations of this dissertation are addressed.

6.2 Central Findings

6.2.1 Consumers are susceptible to biased judgments of a product's energy-friendliness triggered by energy-efficiency information

Although a lot of research has detected several leverage points to manipulate consumers' behavior, for example, by spraying a citrus scent in the cleaning section (Holland, Hendriks, & Aarts, 2005) or by playing specific folkloristic music in the wine section (North, Hargreaves, & McKendrick, 1999), research on consumer decision-making often still assumes that consumers act as rational beings. For example, the conjoint analysis, a method that is often used to model consumers' decision-making, relies on the assumption that consumers apply a weighted additive decision rule. This means that consumers are assumed to assign weights to all attributes of the products and choose the product that scores the highest. Consequently, if consumers are asked to choose the more energy-friendly television (i.e., the television with lower energy consumption) out of two televisions provided, according to this reasoning, consumers will compare all of the information provided and make the correct choice: the television with the lower energy consumption independent of other potentially contradictory information (i.e., energy efficiency rating). Unfortunately, consumers actually behave differently.

This dissertation has shown that consumers are susceptible to a so-called energy efficiency fallacy. This fallacy describes consumers' tendency to derive the energy-friendliness of a product from the information about energy efficiency. This decision heuristic suggests that for consumers, energy efficiency is equivalent to energy consumption. The results of the first study in Chapter II indicated that when energy efficiency was high, participants rated the consumption of a television as low and vice versa independent of the value of the energy consumption. Due to this heuristic processing, not all of the information provided was considered. Research on heuristics has found that more accessible and more salient information is more likely to constitute the decision (Slovic, Finucane, Peters, & MacGregor, 2007). Furthermore, prior experience and rapidly retrieved knowledge are often relied on to process information, influencing attention and triggering heuristic processing (Evans, 2006). This dissertation has shown that information about energy efficiency is easier to understand compared to information about actual consumption (cf. Chapter III). Due to the strong promotion of energy efficiency and the (assumed) simplicity of this information, energy efficiency is more accessible and more easily retrieved than information about actual energy consumption. Consequently, energy efficiency information constitutes a more accessible and reliable concept for consumers. The results of the studies presented here have shown that the tendency to focus more on energy efficiency in particular appears in combination with the energy label (cf. Chapter III). This suggests that due to the color code and the prominent spot on the energy label, the energy efficiency rating is also much more salient than information about actual consumption. As a result, the energy label is a potential trigger for heuristic processing that can lead to suboptimal decisions in terms of energy consumption.

This study found that the robustness of the energy efficiency fallacy was impressive. Despite the instruction to choose the most energy-friendly product or to judge the energy consumption (and not the energy efficiency) of a product, participants relied on the energy efficiency rating. Although comparability was granted and they could have just compared the number of kilowatt hours per year, many participants still derived the energy-friendliness of the products based on their energy efficiency rating. This heuristic is critical because the energy consumption and the energy efficiency rating of a product can differ greatly. Furthermore, susceptibility to the energy efficiency fallacy can have a further impact on the perception of so-called energy hogs such as freezers. Results have shown that the fallacy can shift consumers' perception of the energy-friendliness of these product categories. This means that high energy efficiency ratings can mislead consumers into thinking that the energy consumption of the product is no longer an issue. As a result, consumers might choose bigger products, use them more often, or buy more than one product out of these categories.

6.2.2 The role of the energy label for energy-friendly decisions

A lot of money, time, and research have been invested in the implementation and evaluation of ecolabels, including the EU energy label. They are expected to make a significant contribution to the success of the EU's energy goals (European Council, 2012). It is therefore immanent that consumers notice the label, understand the information provided, and take it into account when making a decision. Ideally, they will choose a more energy-friendly product; however, this effect was not observed for the energy label. Although the energy label enforced the focus on energy-related information, the addition of the label as a source of information did not result in more energy-friendly decisions. This means that the mere consideration of energy information is not sufficient to enable energy-friendly decisions. There are three likely explanations for this result. First, other attributes of the products (e.g., price) were more important and overspread the considerations of the energy-related aspects and the potential motivation to make a more energy-friendly choice. For personal choices, this decision behavior seems very likely (e.g., Sammer & Wüstenhagen, 2006). Furthermore, a segmentation analysis of Swiss energy consumers found that only a small percentage of people can be classified as idealistic energy-savers who take on financial and inconvenient efforts to save energy (Sütterlin, Brunner, & Siegrist, 2011). The second explanation refers to the complexity of the information. The relevant energy-related information (i.e., kilowatt hours) was too hard to understand, as indicated by the longer mean fixation durations, and it was therefore not integrated into the decision-making process. Third, as has been pointed out before, the energy label led to a bias toward energy-efficiency information. Based on this information, it was impossible for participants to identify the most energy-friendly product (i.e., the product with the lowest energy consumption). To summarize, the energy label works as a prompt for energy-related information; however, in its current format, the energy label does not have the power to actually accelerate energy-friendly decision-making and product choices. Its responsibility for achieving energy-saving goals is therefore critical.

6.2.3 Energy-friendly decision-making is challenging for consumers

Consumers possess a wide selection of decision-making strategies. Some strategies include a careful consideration of all information, whereas other decisions happen very quickly and are based on much simpler rules (Bettman, Johnson, & Payne, 1991). The problem with the latter type of decision-making is that crucial information is potentially overlooked and might not be considered for the decision. When it comes to the purchase of a new electric good (e.g., a television), the desired choice would be a product with low energy consumption. This dissertation has pointed out that not all energy-related information is equally likely to be considered during the decision-making process. More precisely, consumers' susceptibility to the so-called energy efficiency fallacy has been suggested. This fallacy refers to the tendency to retrieve the energy-friendliness of a product from its energy efficiency rating. This energy efficiency fallacy has also been identified as one of three decision-making strategies when choosing an energy-friendly television. In particular, consumers with lower numerical skills seem to be vulnerable to this fallacy. Well-educated and high-numerated consumers are able to quickly integrate the relevant energy-related information and choose the most energy-friendly product. Therefore, it seems likely that better numeracy might help to understand and integrate information about actual energy consumption depicted in kilowatt hours. Nevertheless, this latter consumer group is not invulnerable to the energy efficiency fallacy. The most frequently identified decision-making strategy was very systematic and diligent; however, despite the careful consideration of all of the information and the longer decision time, this strategy did not guarantee the successful identification of the product with the lowest energy consumption. These results indicate that consumers might struggle with the correct interpretation of energy-related information. They also indicate that the energy efficiency fallacy can cause trade-offs for the benefit of energy efficiency. More precisely, consumers seem to trade a better energy efficiency rating for higher absolute energy consumption.

Studying energy-friendly decision-making strategies has revealed that making an energy-friendly product choice is challenging for consumers. The mere motivation to make an energy-friendly choice is not sufficient to actually choose the product with the lowest energy consumption.

6.2.4 Summary of the energy efficiency fallacy

The energy efficiency fallacy can be described as people's tendency to retrieve the energy-friendliness of a product from its energy efficiency rating. Hence, consumers seem to hold a misconception of what energy efficiency actually means and how it is implemented on the energy label. They fail to differentiate between actual consumption and energy efficiency. The concept of energy efficiency is harder to grasp than consumers tend to perceive (Egan & Brown, 2001). Furthermore, energy efficiency has become a catchphrase in policy and society for energy-friendliness and for being the solution for the successful reduction of energy consumption (Herring, 2006). As a consequence of this fallacy, consumers focus on the energy efficiency rating and neglect other crucial information—information about a product's actual consumption—to assess how energy-friendly a product actually is. The focus on energy efficiency can therefore lead to the choice of products that are highly efficient but still consume a considerable amount of energy. The fallacy can also cause consumers to make trade-offs for the benefit of a higher energy efficiency rating. Hence, although some consumers might compare the amount of kilowatt hours, they might choose the more efficient product because they erroneously assume that this is the more energy-friendly choice. Finally, the energy efficiency fallacy can even distort the perception of whole product categories. This means that product categories that used to be associated with high energy consumption are now perceived as unproblematic in terms of energy consumption due to the high energy efficiency ratings of these products. As a result, consumers might buy more products, use them more often, choose bigger products, and replace products more frequently.

6.2.5 The importance of providing transparent information to consumers

The energy label can trigger heuristic processing based on the energy efficiency rating depicted. The problem is that currently, for many product categories, most products are classified in the top classes (e.g., A^{+} to A^{+++}), and consumers tend to process the energy efficiency rating holistically (a sign of approval) instead of systematically (all of the information displayed) (Molenbroek et al., 2014). Furthermore, since the introduction of the new plus classes, the importance of energy efficiency in the purchasing process has declined (Heinzle & Wüstenhagen, 2012; Ölander & Thøgersen, 2014).

This dissertation has shown that one cause of this problematic consumer behavior is in the length of the energy efficiency scale (i.e., the distance between the worst efficiency rating and the best efficiency rating). A possible explanation for this effect is the anchor effect (Furnham & Boo, 2011; Tversky & Kahneman, 1974): the worst energy efficiency rating depicted on the energy label is the anchor (i.e., the reference point) for a subsequent judgment of another product's energy-friendliness. Consumers use this distance as an indicator for how good their choice is: if the reference point and the chosen product are far apart, the choice seems more energy-friendly relative to the best energy-efficient product. This is a problem because the scale range depicted on the energy label is not the scale range available on the market. For example, if a consumer chooses a product with an efficiency rating of B out of a scale ranging from A to G, the choice seems very energy-friendly because the distance to the worst efficiency class G is very far. However, this perception is biased because the lower efficiency classes are not available. Consequently, if the consumer chooses the same product out of a scale ranging from A to C, the choice seems considerably less energy-friendly because the distance to the worst efficiency rating C is very short. This means that the perceived gain to choose the most energy-efficient product is higher if the scale only depicts the classes actually available on the market.

6.3 Implications

6.3.1 Matching information with consumers' skills

To successfully achieve Switzerland's energy goals, it is immanent that the energy efficiency fallacy is tackled because it could impede potential energy savings. This dissertation has shown that low numerical skills can enforce the bias toward energy efficiency. Furthermore, the interpretation of the current format for absolute energy consumption is very challenging for consumers. This finding is consistent with the results of other studies showing that consumers struggle with the interpretation of technical information (Dendler, 2014; Egan & Brown, 2001) and that people often have low levels of energy literacy (i.e., understanding about qualitative and quantitative information about energy use) (DeWaters & Powers, 2011; Frederiks, Stenner, & Hobman, 2015; Sovacool & Blyth, 2015). This is an additional booster for the bias toward energy efficiency information, and as a result, for the energy efficiency fallacy. Hence, the presentation format of annual consumption in kilowatt hours per year should be revised or at least supplemented with a more accessible format. For example, the numerical information could be translated into a color scale and be put into a reference frame showing its position relevant to the lowest and the highest consumption of comparable products. Figure 6.1 presents an example of how this idea could be implemented. This could help consumers to assess whether the energy consumption depicted is high or low. Furthermore, it could help to bring information about annual consumption more to the front of consumers' minds in order to play a role in the decision-making process. This effect would especially be desirable for product categories that only feature very efficient products because within the same energy efficiency class, the absolute energy consumption can vary significantly.

A pre-test with this energy label has suggested that consumers' perceptions of the energy-friendliness of products are more accurate with the additional slider for the annual consumption compared to the original label, especially for high-consuming products. However, more studies are needed to assess consumers' understanding and use of this new graphical cue and its implementation on the energy label. The integration of graph and energy literacy could be beneficial for such a study and could help to examine individual differences (Canfield, Bruine de Bruin, & Wong-Parodi, in press; Galesic & Garcia-Retamero, 2011).

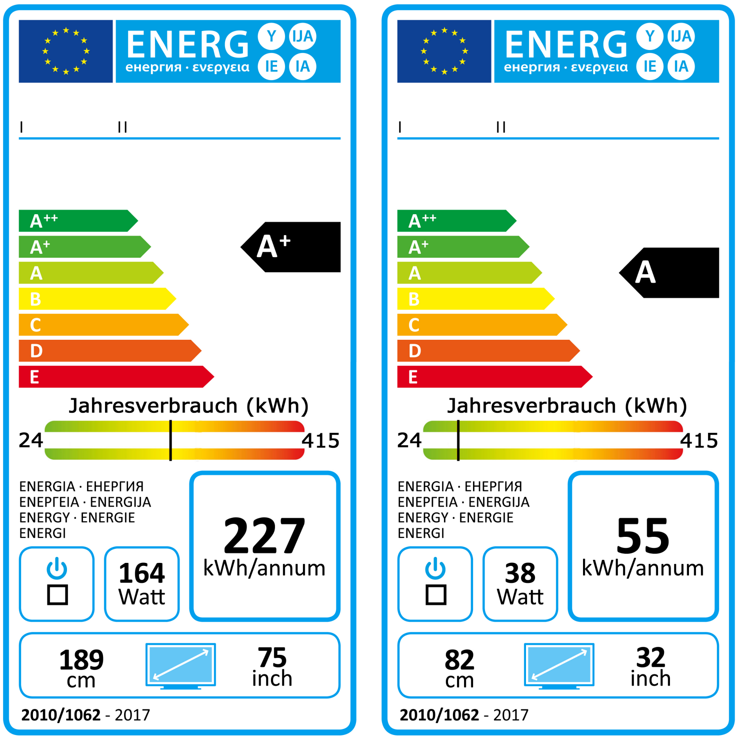


Figure 6.1. Two examples for an additional scale showing the information about annual consumption. The black line indicates how well the product performs with reference to the lowest and the highest energy consumption of televisions available on the market. The color code ranging from green (very low consumption) to red (very high consumption) provides a simple assessment of the energy consumption of the product.

6.3.2 Nudging people to make more energy-friendly product choices

How to improve and modify consumers' choices has been studied intensively in the context of food, health, and nutrition (Scheibehenne, Miesler, & Todd, 2007; Schulte-Mecklenbeck, Sohn, de Bellis, Martin, & Hertwig, 2013). This dissertation has shown that a slight change in the decision-making environment can be used to influence consumers' decisions in a desired direction, for example, toward choosing a healthier meal (Keller, Markert, & Bucher, 2015; Thaler & Sunstein, 2008). This so-called nudging strategy has also spread to environmental issues (Ölander & Thøgersen, 2014). An alteration of the energy efficiency scale on the energy label could be used as a nudge to make more energy-friendly decisions. Displaying only the energy efficiency classes available on the market could motivate consumers to choose the most energy-friendly product without prohibiting any classes. The bias toward energy efficiency could be used as a positive amplifier for choosing the most efficient product. The application of nudging strategies seems especially promising because, in this dissertation, no clear evidence was found for the role of attitudes toward energy-saving either for the choice behavior or for the susceptibility to the fallacy. This is in line with other research that suggests that the influence of values and attitudes for environmentally friendly behavior are mixed and that the correlations are often low (Bamberg & Moser, 2007; Steg & Vlek, 2009). Consequently, changing the choice architecture—in this case, changing the energy efficiency scale on the energy label—could potentially shift the behavior of all consumer groups in the desired direction of a more energy-friendly product choice.

6.3.3 Be consistent and absolute

For consumers, energy efficiency is synonymous with energy consumption. Consumers are not aware that the energy efficiency rating is in many cases relative to the size of the products or can be influenced by a certain product's attributes (e.g., the recording function on televisions). This means that a big product can be very energy-efficient (e.g., class A^{+}) but still consume more energy than a smaller product that is less efficient (e.g., class B). However, many consumers assume that a product with a high energy efficiency rating automatically has low energy consumption and vice versa. This misconception is problematic when it comes to purchasing new products. If confronted with a wide selection of differently sized products, the energy efficiency rating is not always conclusive. More precisely, for many products, the aforementioned assumption that a high efficiency rating equals low consumption does not hold. For example, for televisions and cooling units, knowing the size of the product is necessary to put the energy efficiency rating depicted on the energy label into context. It seems likely that for some product categories, the size of the product is given by certain size restrictions and less is left up to the consumer. For example, when choosing a new dishwasher, in most kitchens, there is a pre-defined space where the appliance has to fit. Consequently, for these products, the misconception and the relative energy efficiency rating scale is less problematic. However, for the choice of a new television or a new freezer, consumers might consider differently sized products because they are less restricted by space limitations. Hence, if they compare the energy efficiency rating of a big television and a smaller television, they might conclude that the bigger one is more energy-friendly and buy this product despite its higher actual energy consumption.

For some product categories, such as lamps or vacuum cleaners, the energy efficiency rating is based on absolute energy consumption. Hence, for these products, the energy efficiency rating can be considered on an absolute scale. However, based on the energy label, consumers cannot derive whether the energy efficiency rating has a relative or an absolute calculation base. Consequently, an absolute scale for the energy efficiency rating as a standard seems recommendable. With an absolute scale, consumers could compare differently sized products along the energy efficiency rating. This dissertation has shown that consumers are biased toward energy efficiency. If this information is misleading, or if consumers hold misperceptions about its meaning, decreasing final energy consumption is at stake.

6.4 Limitations and ideas for further research

6.4.1 Experimental design vs. representativeness

This dissertation has some limitations. One limitation that also constituted a strength of the research was that it relied on experimental designs. This was a strength because it allowed for the systematic analysis of the energy label and energy-related judgment and decision-making. However, it represented a limitation for three reasons. First, based on the experiments, the author can only speculate about how the energy efficiency fallacy is distributed in the Swiss population. The samples were not representative in terms of educational background, age, and other socio-demographic attributes. Although by randomly assigning participants to a treatment, the potential effects of these variables were minimized, they cannot be absolutely excluded as influencing variables. A survey with a representative sample would therefore provide further insights into the severity of the energy efficiency fallacy and the distribution of the different decision-making strategies in the Swiss population. Second, selection bias—that is, that people who were willing to participate were more interested in the topics than the general population—cannot be excluded and could have influenced the results. Third, the experiments only assessed hypothetical choices and not real purchase behavior. Consequently, it cannot be ruled out that consumers could behave somewhat differently in their real purchase behaviors. Future studies should focus on real purchase decisions and the impact of the energy efficiency fallacy on final choice. Further research is necessary to investigate to what extent the fallacy can actually mislead consumers to buy a bigger product due to a better energy efficiency rating. Furthermore, the proposed optimizations of the labels, such as shortening the energy efficiency scale to the number of classes available, should also be tested in a realistic shopping environment.

6.4.2 The psychology of the energy efficiency fallacy

This dissertation cannot provide a conclusive answer for what actually constitutes the energy efficiency fallacy. It has been shown that the energy label triggers the fallacy, and the affect heuristic (Slovic et al., 2007) has been suggested as a possible explanation for this effect. However, in the presented studies, affect has not been measured directly. Moreover, the affect heuristic is an oversimplification that does not explain the detailed processes of the affective responses (Kahneman & Frederick, 2002). It also seems possible that the energy efficiency fallacy is connected with the symbolic significance fallacy proposed by Sütterlin and

Siegrist (2014). This fallacy describes the human tendency to rely on the attribute with the higher symbolic meaning in a situation of conflicting information. For example, such a conflict of attributes could emerge when the energy efficiency rating of a product is very high, indicating high energy-friendliness, but its absolute energy consumption is also high, indicating low energy-friendliness. The energy efficiency rating might convey a stronger symbolic meaning than the absolute energy consumption, at least in the format currently used on the energy label. However, this does not explain why the energy efficiency fallacy did not occur in a situation without the energy label. In future work, these research questions should be tackled. An eye-tracking experiment could provide further insight into the underlying processes of the evaluation of energy-related information. For example, pupil dilation could be used as an indicator for the affect that is aroused by the different presentation formats of energy-related information (Cavanagh, Wiecki, Kochar, & Frank, 2014). This parameter could be used to improve the accessibility and ease of the information about actual energy consumption.

6.4.3 The role of numeracy, consumers' attributes, and product type for energy-friendly consumer behavior

Numeracy seemed to play a role in susceptibility to the fallacy. This finding seems plausible, as people with low numeracy perform badly in tasks involving numbers and often prefer graphical information over numerical information (Keller, Kreuzmair, Leins-Hess, & Siegrist, 2014). However, not every study detected this effect. Moreover, the influence of other consumers' attributes and other individual factors were only marginally inspected. For example, it would be worthwhile to study the influence of age, educational background, and gender on the probability of choosing the product with the lowest energy consumption. Furthermore, to keep the experiments feasible and practicable, only a selection of different product types was tested. In some studies, the results revealed differences between the different product types. For example, many more participants chose the freezer with the higher consumption than the television with the higher consumption (cf. Chapter II). On the other hand, in some studies, there were no differences between product types. For instance, the effect of the shortened energy efficiency scale was the same in all of the tested product categories (cf. Chapter V). These findings indicate the importance of product type for consumer behavior and the effect of interventions. More studies are therefore needed to assess the influence of consumers' attributes and product types for susceptibility to the energy efficiency fallacy and the promotion of energy-friendly decision-making.

6.4.4 What happens after the consumer has left the store?

The focus of this dissertation relied on consumer behavior in the context of the energy label and energy-related judgment and decision-making. This means that consumer behavior after the purchase was not investigated. Potential spillover effects and moral licensing effects after the purchase of a highly efficient product have yet to be studied. For example, it is necessary to investigate whether the purchase of a television with a high energy efficiency rating affects watching behavior (e.g., leaving the television on in the background) or enhances its usage. Such rebound effects based on moral licensing could concern several energy-consuming durables. For instance, one could forgo turning off the lights because the lamps are very energy-efficient. However, it also seems possible that the purchase of a new highly efficient appliance could lead to positive spillover effects, for example, by fostering the replacement of other inefficient household appliances. Lanzini and Thogersen (2014) observed the positive spillover effects of green purchase behavior on other environmentally friendly behavior; however, this was mostly on behavior that requested little effort (recycling, use of public transport, etc.). While systematic analyses of the relevance of household characteristics and opinion leaders for the diffusion of energy-efficient household appliances exist (Mills & Schleich, 2013; Yamamoto, 2015), very little is known about the possible positive spillover effects after the purchase of such appliances (Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014). More detailed knowledge on this topic is important for the further development and assessment of the effectiveness of existing policy tools and energy strategies.

6.5 Conclusion

The goal of this dissertation was to model consumers' judgment and decision-making processes in the context of energy-consuming durables and to understand the effect of energy-related information, such as the energy label, on consumer behavior. The research questions arose from a very applied and politically prevailing background: the energy strategy for 2050. Therefore, the challenge was to implement the research questions in academic research, to combine them with more fundamental research questions, and to convey the practical implications. This was done by using a mixture of different methodologies. In the first step, qualitative interviews with consumers were conducted at the point of sale. The benefit of this method was that it allowed for interactions between the researcher and the interviewee—no a priori hypotheses were required. Based on the qualitative results, specific research objectives were generated and, in the next step, they were tested with experiments. Adding the eye tracker for the next experiment was very useful because it is an objective measurement that is less susceptible to psychologically confounding variables such as social desirability. Finally, based on the results of the previous studies, a possible optimization of the energy label was tested.

One could assume that choosing an energy-friendly household appliance is only a matter of comparing information. The energy label provides all the information that is needed to make an optimal choice in terms of energy-friendliness; however, for consumers, the task is more challenging than this. This dissertation has shown that information can be ambiguous for consumers, and they might hold misconceptions about certain information that can substantially influence the choices they make. Furthermore, presentation designs and formats can be of different saliencies and accessibilities, thereby biasing the decision-making process. Finally, individual characteristics seem to play a role when it comes to making an energy-friendly product choice. For the promotion of energy-friendly behavior, these results constitute a challenge but also an opportunity. The results revealed misconceptions that might impede energy savings. Furthermore, possible leverage points on the energy label that could be used to ensure its success have been identified. To conclude, this dissertation has shown that to achieve the energy-saving goals, various factors must be accounted for. A sustainable society can only be achieved with a fruitful interaction between policy makers, the economy, and the consumers.

References

Bamberg, S., & Moser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14-25. doi:10.1016/j.jenvp.2006.12.002

Bettman, J. R., Johnson, E. J., & Payne, J. W. (1991). Consumer decision making. *Handbook of consumer behavior, 44*(2), 50-84.

BFE. (2015). *Swiss energy statistics 2014 [Schweizerische Gesamtenergiestatistik 2012]*. Retrieved from Bern:

Bundesrat. (2011). *Federal Council decides to gradually phase out nuclear energy [Bundesrat beschliesst im Rahmen der neuen energiestrategie schrittweisen Ausstieg aus der Kernenergie]*. online: Bundesamt für Energie (BFE) Retrieved from http://www.admin.ch/aktuell/00089/index.html?lang=de&msg-id=39337 (accessed: 25.12.2013).

Bundesrat. (2013). *Federal Council communicates the energy-strategy 2050 [Bundesrat verabschiedet Botschaft zur Energiestrategie 2050]*. Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK) Retrieved from http://www.uvek.admin.ch/dokumentation/00474/00492/index.html?lang=de&msg-id=50123 (accessed: 25.12.2013).

Canfield, C., Bruine de Bruin, W., & Wong-Parodi, G. (in press). Perceptions of electricity use communications: effects of information, format, and individual differences. *Journal of Risk Research*.

Cavanagh, J. F., Wiecki, T. V., Kochar, A., & Frank, M. J. (2014). Eye tracking and pupillometry are indicators of dissociable latent decision processes. *Journal of*

Experimental Psychology: General, 143(4), 1476-1488. doi:http://dx.doi.org/10.1037/a0035813
Dendler, L. (2014). Sustainability meta labelling: an effective measure to facilitate more sustainable consumption and production? *Journal of Cleaner Production, 63*(0), 74-83. doi:/10.1016/j.jclepro.2013.04.037
DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy, 39*(3), 1699-1710. doi:10.1016/j.enpol.2010.12.049
Egan, C., & Brown, E. (2001). *An analysis of public opinion and communication campaign research on energy efficiency and related topics.* Retrieved from http://aceee.org/sites/default/files/publications/researchreports/a013.pdf
Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (2012).
Evans, J. B. T. (2006). The heuristic-analytic theory of reasoning: Extension and evaluation. *Psychonomic Bulletin & Review, 13*(3), 378-395. doi:10.3758/BF03193858
Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews, 41*(0), 1385-1394. doi:http://dx.doi.org/10.1016/j.rser.2014.09.026
Furnham, A., & Boo, H. C. (2011). A literature review of the anchoring effect. *The Journal of Socio-Economics, 40*(1), 35-42. doi:http://dx.doi.org/10.1016/j.socec.2010.10.008
Galesic, M., & Garcia-Retamero, R. (2011). Graph Literacy: A Cross-Cultural Comparison. *Medical Decision Making, 31*(3), 444-457. doi:10.1177/0272989x10373805
Heinzle, S., & Wüstenhagen, R. (2012). Dynamic Adjustment of Eco-labeling Schemes and Consumer Choice – the Revision of the EU Energy Label as a Missed Opportunity? *Business Strategy and the Environment, 21*(1), 60-70. doi:10.1002/bse.722
Herring, H. (2006). Energy efficiency - a critical view. *Energy, 31*(1), 10-20. doi:10.1016/j.energy.2004.04.055
Holland, R. W., Hendriks, M., & Aarts, H. (2005). Smells like clean spirit. *Psychological Science, 16*(9), 689-693. doi:DOI 10.1111/j.1467-9280.2005.01597.x
Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: the psychology of intuitive judgment*. Cambridge: Cambridge University Press.
Keller, C., Kreuzmair, C., Leins-Hess, R., & Siegrist, M. (2014). Numeric and graphic risk information processing of high and low numerates in the intuitive and deliberative decision modes: An eye-tracker study. *Judgment and Decision Making, 9*(5), 420-432.
Keller, C., Markert, F., & Bucher, T. (2015). Nudging product choices: The effect of position change on snack bar choice. *Food Quality and Preference, 41*, 41-43. doi:10.1016/j.foodqual.2014.11.005
Lanzini, P., & Thogersen, J. (2014). Behavioural spillover in the environmental domain: An intervention study. *Journal of Environmental Psychology, 40*, 381-390. doi:10.1016/j.jenvp.2014.09.006
Mills, B., & Schleich, J. (2013). Analysis of Existing Data: Determinants for the Adoption of Energy-Efficient Household Appliances in Germany. In K. Rennings, B. Brohmann, J. Nentwich, J. Schleich, T. Traber, & R. Wüstenhagen (Eds.), *Sustainable Energy Consumption in Residential Buildings* (Vol. 44, pp. 39-67): Physica-Verlag HD.
Molenbroek, E., Smith, M., Groenenberg, H., Waide, P., Attali, S., Fischer, C., . . . Fong, J. (2014). *Final technical report. Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive ENER/C3/2012-523*. Retrieved from

https://ec.europa.eu/energy/sites/ener/files/documents/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

North, A. C., Hargreaves, D. J., & McKendrick, J. (1999). The influence of in-store music on wine selections. *Journal of Applied Psychology, 84*(2), 271-276. doi:10.1037/0021-9010.84.2.271

Ölander, F., & Thøgersen, J. (2014). Informing Versus Nudging in Environmental Policy. *Journal of Consumer Policy*, 1-16. doi:10.1007/s10603-014-9256-2

Prognos. (2014). *Energy consumption of households 2000 - 2013 [Der Energieverbrauch der privaten Haushalte 2000 - 2013]*. Retrieved from Basel:

Sammer, K., & Wüstenhagen, R. (2006). The influence of eco-labelling on consumer behaviour – results of a discrete choice analysis for washing machines. *Business Strategy and the Environment, 15*(3), 185-199. doi:10.1002/bse.522

Schaub, A. (2014). *Univox Environment 2013 [Univox Umwelt 2013]*. Retrieved from online: http://gfs-zh.ch/wp-content/uploads/2015/02/Univox-Umwelt-2013.pdf

Scheibehenne, B., Miesler, L., & Todd, P. M. (2007). Fast and frugal food choices: Uncovering individual decision heuristic. *Appetite, 49*, 578-589.

Schulte-Mecklenbeck, M., Sohn, M., de Bellis, E., Martin, N., & Hertwig, R. (2013). A lack of appetite for information and computation. Simple heuristics in food choice. *Appetite, 71*(0), 242-251. doi:http://dx.doi.org/10.1016/j.appet.2013.08.008

Siegrist, M., & Visschers, V. H. M. (2013). Acceptance of nuclear power: The Fukushima effect. *Energy Policy, 59*, 112-119. doi:10.1016/j.enpol.2012.07.051

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Sovacool, B. K., & Blyth, P. L. (2015). Energy and environmental attitudes in the green state of Denmark: Implications for energy democracy, low carbon transitions, and energy literacy. *Environmental Science & Policy, 54*, 304-315. doi:10.1016/j.envsci.2015.07.011

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309-317. doi:http://dx.doi.org/10.1016/j.jenvp.2008.10.004

Sütterlin, B., Brunner, T. A., & Siegrist, M. (2011). Who puts the most energy into energy conservation? A segmentation of energy consumers based on energy-related behavioral characteristics. *Energy Policy, 39*(12), 8137-8152. doi:10.1016/j.enpol.2011.10.008

Sütterlin, B., & Siegrist, M. (2014). The reliance on symbolically significant behavioral attributes when judging energy consumption behaviors. *Journal of Environmental Psychology, 40*(0), 259-272. doi:http://dx.doi.org/10.1016/j.jenvp.2014.07.005

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge. Improving decisions about health, wealth and happiness*. London, UK: Penguin.

Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Global Environmental Change-Human and Policy Dimensions, 29*, 127-138. doi:10.1016/j.gloenvcha.2014.09.004

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131. doi:10.2307/1738360

Yamamoto, Y. (2015). Opinion leadership and willingness to pay for residential photovoltaic systems. *Energy Policy, 83*, 185-192. doi:10.1016/j.enpol.2015.04.014

SUMMARY

The energy goals of many countries include reducing final energy consumption. Households are responsible for approximately 30% of the total energy demand. Within households, a great deal of electricity is needed for household appliances, such as refrigerators and washing machines, as well as other consumer goods such as televisions and personal computers. In order to accelerate the transition of energy-efficient and low-consuming products, the EU implemented an energy label. Switzerland adopted the labeling system and made it mandatory for various products. However, the energy demand is not decreasing as much as desired in order to reach Switzerland's target energy goals.

This dissertation therefore tackled the research questions of how consumers perceive the energy label and energy-related information, what constitutes energy-friendly judgment and decision-making, and what might be impeding it. Further, the goal of this dissertation was to provide practical implications for policy makers.

Chapter I provided an overview of different aspects of consumer behavior, judgment and decision-making, and energy-friendly behavior. Based on the insights of qualitative interviews with consumers who had just bought an electric good, several experiments were designed. In Chapter II, a series of experiments examined the so-called energy efficiency fallacy that refers to consumers' tendency to focus on energy efficiency information to assess a product's energy-friendliness. Furthermore, it was shown that this focus on energy efficiency information could decrease the perceived energy problem of product categories usually associated with high energy consumption. Using an eye-tracking study, further explanations for the occurrence of this fallacy were provided in Chapter III. The study has revealed that due to the salient and accessible format of energy efficiency information, the energy label could be the cause for the detected energy efficiency fallacy. Furthermore, by investigating energy-friendly decision-making strategies in Chapter IV, potential barriers and drivers for energy savings were identified. The results suggested that energy-friendly decision-making is challenging for consumers—the mere motivation to make an energy-friendly choice is not sufficient. Consumers' might lack the required skills to successfully integrate the relevant energy-related information. Finally, a new energy efficiency scale was tested in Chapter V; it only included the number of energy efficiency classes actually available on the market. By shifting the reference point for energy-friendliness evaluations, the motivation to choose the most energy-efficient product could be increased. Finally, in Chapter VI, the main findings of this disserta-

tion were integrated and several implications were provided in order to achieve Switzerland's target energy goals.

ZUSAMMENFASSUNG

Die Energieziele vieler Länder beinhalten die Reduktion des Energieverbrauchs. Haushalte sind für etwa 30% des benötigten Energiebedarfs verantwortlich. Innerhalb der Haushalte wird viel Strom für Haushaltsgeräte wie Kühlschränke und Waschmaschinen verwendet, aber auch für Konsumgüter wie Fernseher und Computer. Um den Energieverbrauch von elektrischen Geräten zu reduzieren, hat die Europäische Union eine Energieetikette für diverse Geräte eingeführt. Das Ziel der Energieetikette ist es, die Verbreitung von energieeffizienten, sparsamen Geräten zu fördern. Die Schweiz hat dieses System übernommen und eine Kennzeichnungspflicht für eine Vielzahl von Produkten eingeführt. Der absolute Energieverbrauch sinkt jedoch nicht genügend, um die geplanten Energieziele zu erreichen.

In dieser Dissertation wurde untersucht, wie Konsumenten die Energieetikette sowie weitere energierelevante Informationen verarbeiten, was energiefreundliches Urteilen und Entscheiden ausmacht und welche Hindernisse für energiefreundliches Konsumentenverhalten existieren. Ein weiteres Ziel dieser Dissertation bestand in der Ausarbeitung von konkreten Implikationen für politische Entscheidungsträger.

Das erste Kapitel gibt einen Überblick zu unterschiedlichen Aspekten des Konsumentenverhaltens im Allgemeinen, zu Urteilungs- und Entscheidungsfindungsprozessen sowie zu energiefreundlichem Verhalten. Basierend auf den Erkenntnissen von qualitativen Interviews mit Konsumentinnen und Konsumenten, die soeben ein elektrisches Gerät gekauft hatten, wurden verschiedene Experimente entwickelt. Im zweiten Kapitel dieser Dissertation wurde der Fehlschluss zur Energieeffizienz untersucht. Dieser beschreibt die Tendenz, sich bei der Beurteilung der Energiefreundlichkeit eines Gerätes in erster Linie auf die Energieeffizienzklassifizierung zu stützen. Viele Konsumenten setzen Energieeffizienz mit Stromverbrauch gleich und nehmen an, dass eine hohe Effizienz automatisch einen tiefen Stromverbrauch impliziert. Zusätzlich konnte gezeigt werden, dass diese Fehlwahrnehmung von Energieeffizienz dazu führen kann, dass die wahrgenommene Energieproblematik von Stromfressern (z.B. Gefriergeräte) abgeschwächt wird. Mithilfe einer Eye Tracking Studie konnten weitere Erklärungen für das Auftreten dieser Energieeffizienz-Fehlvorstellung in Kapitel III aufgeführt werden. Die Studie zeigte, dass die Energieetikette den Fokus auf Energieeffizienz auslösen kann, aufgrund des auffälligen und leicht zugänglichen Darstellungsformats der Energieeffizienzinformation. Die Untersuchung von energiefreundlichen Entscheidungsstrategien in Kapitel IV ermöglichte die Umreissung möglicher Hindernissen und Antreiber von Energieeinsparungen im Entscheidungsprozess. Die Resultate verdeutlichten, dass energiefreundliches

Entscheidungsverhalten eine Herausforderung darstellt und die Motivation, eine energiefreundliche Wahl zu treffen, alleine nicht ausreichend ist. Den Konsumenten fehlt möglicherweise essentielles Wissen und die Fähigkeit relevante Informationen erfolgreich zu verarbeiten. Zum Schluss wurde eine neue Version der Energieeffizienzskala getestet, welche lediglich die Klassen darstellte, die effektiv auf dem Markt erhältlich sind. Dadurch wurde der Referenzpunkt für die Evaluierung der Energiefreundlichkeit eines Produktes verändert. Dies könnte die Motivation, das energieeffizienteste Gerät zu wählen, verstärken. Im letzten Kapitel (Kapitel VI) werden die wichtigsten Erkenntnisse dieser Dissertation diskutiert und Empfehlungen für die erfolgreiche Erreichung der Energieziele aufgeführt.

ACKNOWLEDGMENTS

This thesis is the result of three challenging years, during which I was fortunate enough to be supported by many people. I cannot thank them enough.

I would like to thank Prof. Dr. Michael Siegrist for making this thesis possible. I am deeply grateful for his invaluable feedback, his sympathy, and his assistance throughout the whole process. I thank Dr. Bernadette Sütterlin for her advice on my research—her door was always open. A special thanks goes to Dr. Boris Krey for his interest in my research and for being my co-examiner.

I would like to express my gratitude to all of my colleagues at the CB who enlightened many working situations. I thank all of them for their scientific input, for pre-testing the studies, and for asking critical questions in the colloquia. A very big thanks goes to Angela Bearth, Christina Hartmann, and Angelina Gmür for cordially receiving me as their “Bürogspändli” and for becoming much more than that. My very warmest thanks goes to Christina Kreuzmair for sharing her experiences, for her assistance in many tricky situations, and for being my friend. My special gratitude goes to Sonja Mötteli for so many jogging hours on the Züriberg and for her invaluable support and encouragement during our shared time as PhD candidates.

This work was only possible thanks to many volunteers and participants. I thank all of the people who donated their time and contributed to my research.

My very deepest gratitude goes to my beloved sisters, my father, and my godmother—I could not have done it without you! My deepest thanks to all of my friends and to the royal “Kochkompanie” for all the laughter and down-to-earth conversations. Last, but not least, I thank Marco Ghelfi—the love of my life and my best friend. Thank you for your unconditional support, for always being there for me, and for being yourself.

CURRICULUM VITAE

Signe Maria Waechter, lic. phil

Born 18th February 1984 in Zurich

Educational Background

2013 – 2016:	PhD Candidate, ETH Zurich (Consumer Behavior)
2004 – 2011:	Master of Science in Psychology, University of Zurich
	Thesis: Participation – Identification of the success factors
	Minor subject: Popular Cultural Studies
	Secondary subject: Medieval History
2004:	Language Stay in South America (6 months)
1999 – 2003:	Matura at Kantonsschule Riesbach, Zurich
	Main focus: modern languages

Professional Background

2013 – 2016:	PhD Candidate, ETH Zurich (Consumer Behavior)
2011 – 2013:	Market researcher at the Insight Institute AG, Zurich
2007 – 2010:	Tutor at the Faculty of Social Psychology, University of Zurich
2008 – 2010:	Research assistant, ETH Zurich (Centre for International Studies)