Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK

Bundesamt für Energie BFE

Schlussbericht 25. April 2016

Energy-Using Durables: Driving Forces of Purchase Decisions

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Datum: 25. April 2016

Ort: Bern

Auftraggeberin:
Bundesamt für Energie BFE
Forschungsprogramm Energie-Wirtschaft-Gesellschaft
CH-3003 Bern
www.bfe.admin.ch

Auftragnehmer/in:
ETH Zürich
Chair of Economics
Clausiusstrasse 37
CH-8092 Zürich
www.econ.ethz.ch

Autor/in:
Prof. Dr. Renate Schubert, ETH Zürich, schubert@econ.gess.ethz.ch
Marcel Stadelmann, ETH Zürich, marcel.stadelmann@econ.gess.ethz.ch

BFE-Bereichs- und Programmleitung:	Dr. Anne-Kathrin Faust, Anne-Kathrin.Faust@bfe.admin.ch
BFE-Projektbegleitung:	Dr. Boris Krey, boris.krey@bfe.admin.ch
BFE-Vertragsnummer:	SI/500790-01

Für den Inhalt und die Schlussfolgerungen sind ausschliesslich die Autoren dieses Berichts verantwortlich.

Bundesamt für Energie BFE
Mühlestrasse 4, CH-3063 Ittigen; Postadresse: CH-3003 Bern
Tel. +41 58 462 56 11 · Fax +41 58 463 25 00 · contact@bfe.admin.ch · www.bfe.admin.ch

Kurzzusammenfassung

Eine Erhöhung der Energieeffizienz von Haushalts-Elektrogeräten würde finanzielle Gewinne für private Haushalte generieren und das Wachstum des Stromverbrauchs eines Landes erheblich reduzieren. Ziel dieser Studie war es, die treibenden Faktoren hinter den Kaufentscheidungen von Haushalten in der Schweiz zu identifizieren und Massnahmen zur Erhöhung der Energieeffizienz gekaufter Geräte vorzuschlagen. Bei Weisswaren ist der Verkaufsanteil energieeffizienter Geräte in der Schweiz höher als gemeinhin angenommen. Dennoch fanden wir auch Evidenz für ökonomisch nicht-rationale Kaufentscheidungen, welche zum Bespiel durch beschränkte Aufmerksamkeit oder fehlende Information zum Energieverbrauch der Geräte verursacht sein können. Der Bedeutung der Information für Kaufentscheidungen gingen wir in einem Feldexperiment nach. Wir untersuchten den Einfluss zweier verschiedener Energieetiketten auf Onlinekäufe von Haushaltsgeräten und Fernsehern. Es zeigte sich, dass die fest etablierte EU Energieetikette ebenso wie eine neue Energieetikette mit monetären und Lebenszyklus-bezogenen Informationen zum Stromverbrauch den jährlichen Stromverbrauch gekaufter Geräte unter bestimmten Voraussetzungen senken können. Bei Geräten mit hohen jährlichen Stromkosten scheinen monetäre und Lebenszyklus-bezogene Informationen auf Energieetiketten besonders erfolgversprechend zu sein.

Abstract

Increasing the energy efficiency of energy-using durables would create financial profits for private households and would considerably reduce the growth rates of private households' electricity consumption in many countries. The objective of this study was to identify the driving forces behind households' purchase decisions in Switzerland and to derive policy measures aiming to increase the energy efficiency of purchased products. For white goods in Switzerland we find that the sales proportion of energy-efficient goods is higher than commonly assumed. Nevertheless, there is evidence for economically non-rational purchase decisions, which might be caused by limited attention and incomplete information with respect to the energy consumption of products. We addressed the role of information for purchase decisions in a field experiment, examining the influence of two different energy labels on online purchases of household appliances and televisions. We found that the well-established EU Energy Label as well as a new monetary and lifetime-oriented energy label are similarly effective to reduce the mean annual electricity consumption of purchased products. The use of monetary and lifetime-oriented information on energy labels seems to be particularly promising for goods with high annual electricity costs.

Résumé

Les appareils électroménagers ayant une meilleure efficacité énergétique fournissent des économies financières aux ménages privés et réduisent la croissance de la consommation d'électricité. Notre étude avait comme objectif d'identifier les facteurs les plus importants influençant les décisions d'achats des ménages privés suisses afin qu'on puisse recommander des mesure appropriées pour augmenter l'efficacité énergétique et pour réduire la consommation d'électricité par les appareils électroménagers. En ce qui concerne les appareils ménagers, nous avons constaté qu'en Suisse les ventes des appareils énergétiquement efficaces sont plus importantes que généralement supposé. Néanmoins, les choix des ménages privés ne sont pas toujours rationnels. Ceux-ci peuvent être influencés par une attention limitée à la consommation énergétique des appareils électroménagers ou par un manque d'informations. Dans le cadre d'une expérience, nous nous sommes intéressés aux conséquences de ce manque d'informations pour les choix des consommateurs. Deux étiquettes énergies ont été aléatoirement proposées aux consommateurs souhaitant acheter des appareils électroménagers et des télévisions sur internet. Les résultats montrent que, lors de l'achat, l'affichage du label « énergétique » de l'UE ou d'une nouvelle étiquette présentant aux consommateurs les frais annuels d'électricité et les économies potentielles pendant la durée de vie des appareils peut abaisser la consommation moyenne d'électricité des appareils achetés. Fournir des informations sur les coûts à long terme d'un appareil électroménager semble être une solution prometteuse, d'autant plus pour les appareils ayant des frais annuels d'électricité importants.

Contents

Zusammenfassung

In vielen Ländern führen Produktion und Verbrauch von Energie zu negativen Externalitäten. Das heisst, es fallen Kosten wie zum Beispiel Umweltkosten an, die nicht von den Verursachern getragen werden. Die Reduktion (der Wachstumsraten) des Energieverbrauchs ist deshalb ein weit verbreitetes politisches Ziel.

In der Literatur wird vielfach darauf hingewiesen, dass energieeffiziente Haushaltsgeräte – z.B. Gefrierschränke, Waschmaschinen oder Wäschetrockner – trotz höherer Kaufpreise insgesamt zu finanziellen Einsparungen führen würden, da die laufenden Stromkosten sehr tief seien. Obwohl es also aus ökonomischer Sicht profitabel erschiene, würden die energieeffizienteren Geräte jedoch selten gekauft, was als „Energieeffizienzlücke“ interpretiert wird. Bei Käufen von Haushalts-Elektrogeräten scheinen Haushalte also freiwillig zu viel Geld auszugeben – ein scheinbar nicht rationales Verhalten, das nicht ohne Weiteres erklärt werden kann. Um dieses Verhalten besser zu verstehen und um geeignete Massnahmen zur Erhöhung der Energieeffizienz gekaufter Geräte vorzuschlagen, beschäftigt sich dieser Bericht mit den wichtigsten Faktoren beim Kauf von Elektrogeräten.

Im ersten Teil des Berichts geben wir einen Überblick über die Literatur zur Energieeffizienzlücke. Die empirische Evidenz zu den Faktoren, die die Energieeffizienzlücke verursachen, ist nicht eindeutig. Wir zeigen, dass Marktversagen und Verhaltens-Anomalien teilweise als Erklärung dafür dienen, dass Haushalte weniger energieeffiziente Geräte kaufen als es für sie ökonomisch optimal wäre. Allerdings können versteckte Kosten von energieeffizienten Geräten zu einer Überschätzung der Energieeffizienzlücke führen. Deshalb zeigen wir, wie man Faktoren, die tatsächlich eine Energieeffizienzlücke verursachen von anderen Faktoren systematisch trennen kann.

Basierend auf den Erkenntnissen des ersten Teils unseres Berichts schätzen wir die Energieeffizienzlücke für sogenannte „Weisswaren“ in der Schweiz ab. Wir identifizieren sogenannte Zwillings-Produkte, welche sich nur in ihrem Energieverbrauch und im Kaufpreis unterscheiden. Basierend auf Annahmen über den Strompreis, die individuellen Diskontraten und die Lebensdauer der Produkte vergleichen wir die diskontierten Kosten der Zwillings-Produkte für ihre gesamte Lebensdauer, um die ökonomisch vorteilhaften Produkte zu identifizieren. Eine Energieeffizienzlücke existiert dann, wenn das effizente Zwillings-Produkt den tieferen Barwert der Gesamtkosten aufweist verglichen mit seinem ineffizienten Gegenstück, Haushalte aber trotzdem das ineffiziente Produkt kaufen. Verwendet man die Listenpreise der Hersteller als Kaufpreise bei der Berechnung des Barwerts der Gesamtkosten zeigt sich, dass die effizenten Zwillings-Produkte nie die ökonomisch rationale Wahl darstellen. Verwendet man allerdings Online Shop Preise als Kaufpreise, ändert sich das Bild: Die Unterschiede der Kaufpreise zwischen effizienten und ineffizienten Zwillings-Produkten sind eher klein, wodurch der effiziente Zwilling in einigen Fällen die ökonomisch rationale Wahl darstellt. Diese Erkenntnis gilt sogar für sehr hohe Diskontraten, die die Ersparnisse bei den laufenden Stromkosten stark abwerten. Da ineffizente Zwillinge trotzdem vielfach gekauft werden, sind wir hier tatsächlich mit einer Energieeffizienzlücke konfrontiert, welche einer Erhöhung der Energieeffizienz der von Haushalten gekauften Geräte im Weg steht.

Im dritten Teil dieses Berichts präsentieren wir die Ergebnisse aus einem Feldexperiment mit Energieetiketten inklusive einer Kundenbefragung. Wir untersuchen zwei Energieetiketten: Die EU Energieetikette und eine neu entwickelte Energieetikette mit Informationen zu den jährlichen und Lebenszyklus-bezogenen Stromkosten von Produkten. Wir stellen fest, dass sich der durchschnittliche jährliche Stromverbrauch gekaufter Staubsauger und Wäschetrockner reduziert, wenn die EU Energieetikette präsentiert wird. Bei Gefrierschränken beobachten wir eine Verschiebung der Energieeffizienzklassen der gekauften Produkte in Richtung der höchsten Kategorie (A+++). Allerdings beobachten wir auch eine Erhöhung des durchschnittlichen Volumens der gekauften Geräte. In der Kombination heben sich diese beiden Effekte auf. Mit der neuen Energieetikette finden wir ähnliche Effekte wie mit der EU Energieetikette, obwohl die neue Energieetikette nicht von einer offiziellen Institution getragen wurde und für Kundinnen und Kunden komplett unbekannt war. Es scheint, als ob monetäre und Lebenszyklus-bezogene Energieetiketten ein grosses Potenzial bergen,

die Energieeffizienz privater Haushalte zu erhöhen. Dies gilt insbesondere für Warengruppen mit hohen jährlichen Stromkosten.

Aus energie-politischer Sicht deuten unsere Ergebnisse darauf hin, dass es Möglichkeiten gibt, eine nennenswerte Erhöhung der Energieeffizienz gekaufter Haushalts-Elektrogeräte zu erreichen. Mit der Verwendung von Energieetiketten können Haushalte zum Kauf eines höheren Anteils an energieeffizienten Produkten angeregt werden. Es ist dabei empfehlenswert, die Darstellung der EU Energieetikette auch in Online Shops durchzusetzen. Für Warengruppen mit hohen jährlichen Stromkosten haben monetäre und Lebenszyklus-bezogene Energieetiketten ein zusätzliches Potenzial, die Energieeffizienz gekaufter Produkte zu erhöhen. Weiterführende „nudging"-Strategien könnten ebenfalls von Interesse sein.

Executive Summary

In many countries, production and consumption of energy yields negative externalities. In other words, costs as for example environmental costs arise without being paid for by the polluters. The reduction of energy consumption and its growth rates is therefore a widespread policy goal. Increasing the energy efficiency of energy-using durables used in private households is one possibility to contribute to this goal.

A large body of literature suggests that due to low electricity running costs, purchases of more energy-efficient household appliances – e.g. freezers, washing machines or tumble dryers – would result in net monetary savings despite higher purchase prices. However, although they appear to be economically profitable, the more energy-efficient appliances often seem to be overlooked by households, leading to the discussion of the "energy efficiency gap". In their purchases of energy-using durables, households seem to leave money on the table since they buy less efficient products. This seemingly non-rational behavior has to be explained. In order to design and implement effective policy measures to increase the energy efficiency of energy-using durables that households purchase and use, this report focuses on the driving forces of households' purchase decisions with respect to energy-using durables.

In the first part of this report, we review the existing literature on the energy efficiency gap. There is no conclusive empirical evidence with respect to the factors causing an energy efficiency gap. We show that market failures and behavioral anomalies partly explain the observation that private households tend to purchase fewer energy-efficient appliances than would be optimal for them. However, hidden costs may lead to overestimations of the energy efficiency gap. We therefore show how to differentiate systematically between factors truly causal for the energy efficiency gap and other factors which are often mentioned but in fact are not causing an energy efficiency gap.

Based on the insights gained in the first part of this report, we show how to estimate the existence of an energy efficiency gap for energy-using durables in Switzerland. We identify so-called twin products with identical product attributes except for energy use and purchase price among various classes of white goods in the Swiss market. Based on assumptions for the price of electricity, individual discount rates and the products' lifetimes, we compare the discounted total lifetime costs of twin products to identify the economically rational options. An energy efficiency gap exists if the efficient twin product has a lower present value of total costs than its inefficient counterpart, but households purchase the inefficient product. Using manufacturers' list prices as purchase prices in the calculation of the present value of total costs, we find that the efficient twin products are never the economically rational choice. Yet, using online shop prices as purchase prices changes the picture: The differences in purchase prices between efficient and inefficient twins are rather small, making the efficient twin the economically rational choice in a number of cases. This even holds for very large discount rates, which considerably devaluate the running cost savings of efficient products. Since inefficient twins are still sold, we are indeed confronted with an energy efficiency gap preventing progress in increasing the energy efficiency of appliances households purchase and use.

In the third part of this report, we present the results from a field experiment using energy labels and a consumer survey to identify the driving forces of purchase decisions for energy-using durables. We examine two types of energy labels: The EU Energy Label and a newly designed energy label presenting information on annual and lifetime electricity costs. We find that the mean annual electricity consumption of purchased vacuum cleaners and tumble dryers is reduced when the EU Energy Label is presented. For freezers, we observe a shift in the energy efficiency ratings of purchased products towards the highest category (A+++). Yet, we also observe an increase in the mean volume of purchased appliances. In combination, these two effects levelled out. With the new energy label, we find similar effects as for the EU Energy Label, even though the new energy label has no "official reputation" at all and was completely unfamiliar to the customers. There seems to be a high potential for monetary and lifetime-oriented energy labels to increase energy efficiency, particularly for classes of goods with high annual electricity costs.

From a policy perspective, our results indicate that there is a considerable potential for improving the energy efficiency of purchased energy-using durables. Based on energy labels, private households may be guided to purchase a higher proportion of energy-efficient products. Enforcing the display of the EU Energy Label also in online shops is hence advisable. For classes of goods with high annual electricity costs, monetary and lifetime-oriented energy labels bear an additional potential to improve the energy efficiency of purchased products. Additional nudging strategies may also be interesting.

1 Introduction

In many countries, production and consumption of energy yields negative externalities. In other words, costs as for example environmental costs arise without being paid for by the polluters. The reduction of energy consumption is therefore a widespread policy goal. Increasing the energy efficiency of energy-using durables used in private households is one possibility to contribute to this goal.

A large body of literature suggests that due to low electricity running costs, purchases of more energy-efficient household appliances – e.g. freezers, washing machines or tumble dryers – would result in net monetary savings despite higher purchase prices. However, although they appear to be economically profitable, the more energy-efficient appliances often seem to be overlooked by households, leading to the discussion of the “energy efficiency gap”. In their purchases of energy-using durables, households seem to leave money on the table since they buy less efficient products. This seemingly non-rational behavior has to be explained.

Whether it pays or not to buy a comparatively expensive high-efficiency product with low electricity running costs depends, among other factors, on the discount rates applied to future electricity costs. If consumers' subjective discount rates are high, the present value of future cost savings generated by energy-efficient products will often not be large enough to offset their higher purchase prices. In that sense, refraining from buying energy-efficient products may be rational. In this report, we offer insights on the relevance of the discount rate based arguments to explain the energy efficiency gap.

Another key factor for purchases of energy-using products is information about the energy consumption of appliances. If consumers are hardly informed about or not attentive to electricity consumption, they may not purchase energy-efficient devices with high upfront costs. Energy labels are a popular policy instrument to increase consumers’ information and attention with respect to electricity consumption. Various types of energy labels are already in use for energy-using durables in Switzerland and in many other countries. The effectiveness of such energy labels in guiding consumers to purchase more energy-efficient household appliances will be analyzed in this report.

Overall, this report offers insights into the existence of an energy efficiency gap for energy-using durables in Switzerland. Only if an energy efficiency gap proves to be relevant, policy measures to narrow down this gap seem appropriate. In order to define such measures in an adequate way, the key driving forces of purchase decisions for energy-using durables have to be known. Our report will provide results in this context.

This report consists of three main parts. In chapter 2, we review the existing literature on the energy efficiency gap and define the “economic optimality” of purchase decisions. We illustrate the most relevant factors of households’ purchase decisions, giving particular emphasis to the role of discount rates. Based on the respective insights, in chapter 3 we present an estimate of the existence of an energy efficiency gap for energy-using durables in Switzerland. In chapter 4, we report on the results from a field study on the impacts of energy labels. The final chapter offers concluding remarks and derives some policy implications.

2 The Energy Efficiency Gap – A Literature Review

2.1. Introduction

The observation that households do not make all privately optimal investments in energy efficiency has led to the term "energy efficiency gap" (Hirst & Brown, 1990). By ignoring positive net present value investments in energy-using durables, households seem to incur unnecessarily high total costs over the product lifetime and thus enjoy lower welfare (Howarth & Sanstad, 1995). Using the terminology of Kahneman et al. (1997), households seemingly do not maximize "experienced utility".

This energy efficiency gap in households' purchases of energy-using durables is the subject of this chapter. We hereby focus on consumer decision-making and consumers' contributions to an energy efficiency gap when they purchase an energy-using durable available on the market.[1] Taking the perspective of consumers, we use private optimality of the level of energy efficiency as the reference point from which downward deviations are considered an energy efficiency gap.[2] Since the 1970s, there have been a considerable number of attempts to empirically demonstrate the apparently irrational behavior by households when purchasing energy-using durables and to identify its possible causes. The goal of this chapter is to review this literature and comment on the methods used to demonstrate the existence of an energy efficiency gap in households' purchases of energy-using durables. We additionally review the empirical evidence of the potential causes of an energy efficiency gap and associate it with the estimates of an energy efficiency gap. Identifying the causes of an energy efficiency gap is essential for policy purposes, as policy measures to close an eventual gap would have to be targeted at mitigating the particular factors causing households' underinvestment in energy efficiency.

The rest of the chapter is organized as follows. First, we introduce the term "discounting gap" before presenting the empirical findings on the existence of such a gap in purchases of energy-using durables. The next section demonstrates the differences between discounting gap and energy efficiency gap and outlines the empirical evidence for the potential causes of an energy efficiency gap. The final section concludes and provides recommendations for future research and for energy policy.

2.2. Definition of a "Discounting Gap"

The purchase decision for an energy-using durable is typically characterized by a trade-off between capital costs and operating costs. A purchase decision is economically optimal when total costs are minimized. Gerarden, Newell, & Stavins (2015) provide a simple version of a cost-minimizing energy efficiency investment decisions (p.29)[3]:

$$\underbrace{\min \text{Total Cost}}_{objective} = \underbrace{K(E)}_{equipment\ purchase\ cost} + \underbrace{O(E, P_E) \times D(r,T)}_{discounted\ operating\ costs} + \text{other costs} \tag{1}$$

The purchase cost K for any appliance is a function of annual energy use E. Since the technological progress inherent in products with higher energy efficiency is costly, K is generally decreasing in E, meaning that more energy-efficient products are characterized by larger purchase costs $K(E)$. Operating costs O are assumed as a function of energy use E and energy price P_E; they are decreasing with the degree of energy efficiency of a product. The discount factor D is a function of the discount rate r and the relevant time horizon T, i.e. the lifetime of the product.

---

[1] This perspective is in line with the majority of the literature considering an energy efficiency gap in the choice of one appliance as opposed to the choice of an alternative, more energy-efficient appliance. A different perspective of the energy efficiency gap not considered in this article would be the *timing* of the purchase decision, i.e. at what point an aging, inefficient appliance is replaced with a new, more efficient appliance.
[2] Because of the negative externalities inherent in energy production and use, the social optimum of energy efficiency would be even higher. See Jaffe et al. (2004) for a discussion of different optima of energy efficiency.
[3] This model is simplified by abstracting from any uncertainty about operating costs.

An energy efficiency gap is defined as a failure by the consumer to minimize total costs in the energy efficiency investment decision of Equation (1), which results in lower experienced utility. Such a failure can arise from different causes, which we will describe in detail in section 2.4. A popular method to determine whether consumers succeed in minimizing total costs in a energy efficiency investment decision has been to examine the trade-off between upfront capital costs and operating costs. If consumers are seeking to minimize total costs in purchase decision for energy-using durables as in Equation (1), it becomes possible to estimate implicit discount rates by applying revealed preference methods on actual purchase data (Samuelson, 1938). The rate of time discounting implicitly applied by a consumer who is indifferent between a low-efficiency product L (with low purchase cost K_L and high operating costs O_L) and a high-efficiency product H (with high purchase cost K_H and low operating costs O_H) is called the "implicit discount rate" ϑ. As we present in section 2.3, much of the literature on an energy efficiency gap has focused on estimating implicit discount rates.

We introduce the term "discounting gap" for implicit discount rates ϑ deviating from a market return available on investments with similar risks r_m:

$$\text{discounting gap} = \vartheta - r_m \tag{2}$$

A positive discounting gap exists when households' observed purchase decisions imply that they require a larger rate of return in their decision process than the typical risk-adjusted market interest rate. It is important to note that in the definition of Equation (2), objective investment risk is considered by incorporating a market return r_m on investments with similar risks. In the following section, we present the literature on empirical findings of such a discounting gap.

2.3. Findings on the Existence of a Discounting Gap

Empirical estimates of implicit discount rates in consumer choices of energy-using durables date back to the seminal publication by Hausman (1979) who estimated households' implicit discount rates in observed purchases of air conditioners. He found that individuals use a discount rate of about 20 percent in making the tradeoff decision between the higher initial costs and lower expected operating costs of the high-efficiency product. A considerable number of studies followed the approach used by Hausman (1979) and estimated the discount rates implicit in various energy efficiency investments in the residential sector. Train (1985) and DEFRA (2010) provide extensive reviews of the literature on discount rates in consumers' energy-related decisions, including details about the respective elicitation methods, which is why we refrain from repeating such elaborate information at this place. Instead, we summarize the empirical estimates of energy-related implicit discount rates in the residential sector until 2010 by product category in Table 1.

Table 1: Estimated product-specific discount rates in the residential sector p.a. (based on Epper et al., 2011, p.2; Sources: Train, 1985 and DEFRA, 2010)

Category	Implicit Discount Rate
Thermal insulation	10% - 32%
Space heating	2% - 36%
Air conditioning	3.2% - 29%
Refrigerators	39% - 300%
Lighting	7% - 17%
Automobiles	2% - 45%

With respect to these results, DEFRA (2010) makes the following observations (p.15):

1. There is a wide range of observed discount rates, from 2% to 300%;
2. Most of the observed discount rates are considerably higher than market interest rates;
3. Rates differ significantly both between and within product categories; and

4. Discount rates are lower when saving energy is the primary purpose of the investment.

The second observation indicates that many estimates of implicit discount rates suggest the existence of a discounting gap in the definition of Equation (2) – at least for some product categories. Howarth (2004) for example assumes that investments in energy efficiency have risk characteristics similar to those associated with typical private sector investments and thus favors the use of a 6% discount rate.[4] Subtracting 6% from the estimates of implicit discount rates presented in Table 1 clearly leaves a positive residual – a discounting gap – in many cases. The discounting gap seems to be particularly large for refrigerators with discount rates in the range of 39% to 300%, a range that can hardly be attributed to larger risk inherent in purchases of refrigerators as opposed to the other product categories.

From an economic perspective, it is not rational for households to require a larger rate of return for purchases of energy-using durables than they could attain for other investment opportunities of similar risk. Using an elevated discount rate in the cost-minimizing energy efficiency investment decision of Equation (1) leads to non-optimal outcomes. The observation of positive discounting gaps has thus commonly been ascribed to irrational purchase decisions by consumers – and thus as evidence of an energy efficiency gap (Train, 1985; Howarth & Stanstad, 1995). Whether this assertion is legitimate depends on the explanations for the observation of discounting gaps and whether they advert to irrational investment decisions. In other words, are the factors causing the observation of discounting gaps leading to non-optimal outcomes in the energy efficiency investment decision presented in Equation (1)? This question is discussed in the following section.

2.4. Why the Discounting Gap Is *Not* Evidence of an Energy Efficiency Gap

In this section, we assess the assertion that the measurement of a discounting gap in households' purchase decisions is evidence of an energy efficiency gap. We first provide an overview of the factors explaining the discounting gap. Then, we elaborate in detail whether these factors can lead to non-optimal decisions in Equation (1) and thus potentially explain an energy efficiency gap. Furthermore, we present the empirical evidence of the particular factors causing an energy efficiency gap to reveal the discrepancy between the claims of a sizeable energy efficiency gap – based on the estimates of large discounting gaps – and the empirical findings of specific privately inefficient behavior by households.

2.4.1. Explanations for a Discounting Gap – Overview

We can think of three feasible categories of factors potentially explaining the measurement of discounting gaps in household's purchases of energy-using durables: Objective (or external) factors that are outside the households' influence, subjective (or internal) factors representing the households' preferences and decision processes, and possibly some confounding variables that are not considered in the decision-making models or unobserved in the data used to estimate implicit discount rates. Figure 1 presents the three categories of factors potentially explaining the observed discounting gap and lists particular effects from each category that are mentioned in the literature as being the most likely to be relevant for households' purchases of energy-using durables.

As shown in Figure 1, the discounting gap observed in actual purchase decisions is likely a mix of households' rates of time preferences and other factors that make it seem as if they were part of households' time preferences. In order to assess whether the discounting gap can be interpreted as evidence of an energy efficiency gap, we raise the following questions: Are the observed choices used to estimate implicit discount rates a valid measure for the utility of outcomes? Are the factors

[4] Howarth (2004) argues that the appropriate discount rate for investments in energy efficiency is similar to returns on risky assets such as corporate stocks, which pay average real returns of 6% or more on a long-term basis. At the time of his statement in 2004, the federal funds rate was at 1% and thus almost as low as in 2016.

explaining the measurement of a discounting gap also factors explaining an energy efficiency gap? In other words, does the discounting gap only measure factors that constitute economically non-optimal (i.e. "irrational"), welfare-reducing behavior and are thus also relevant for an energy efficiency gap? We try to answer these questions in the following sections. For this discussion, we would like to extend our definition of an energy efficiency gap from the simple cost-minimization problem of Equation (1) to any choice by a household that does not maximize the utility of outcomes, i.e. experienced utility.[5]

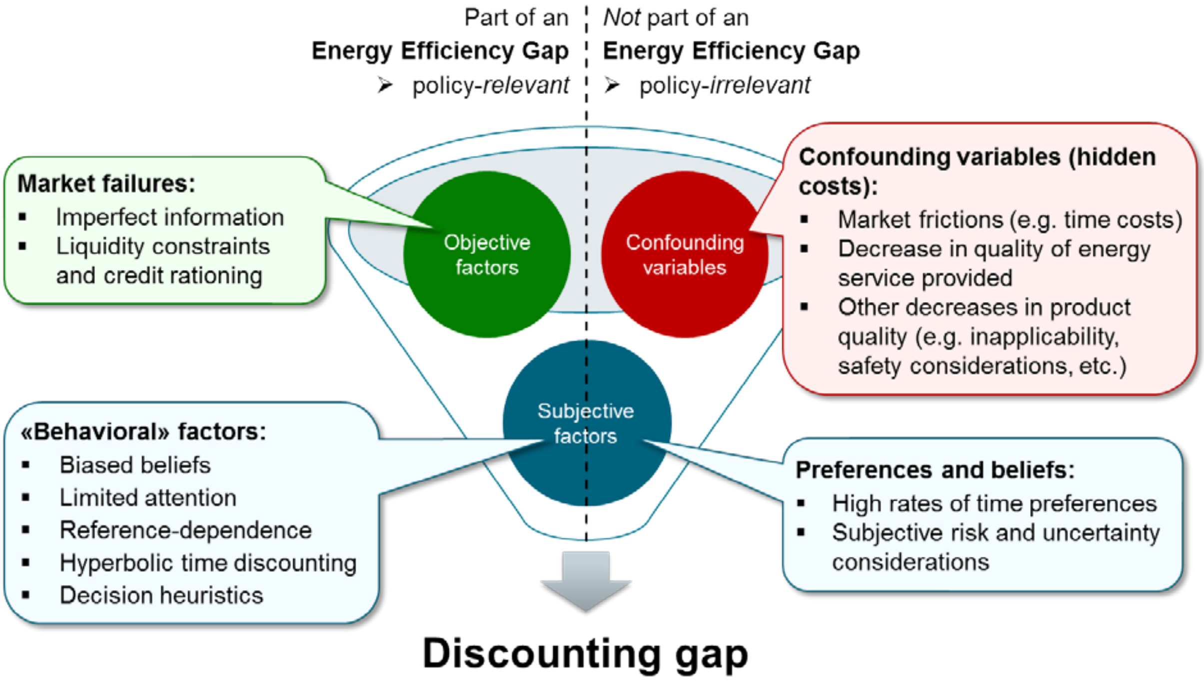


Figure 1: Factors contributing to the observed discounting gap. Own illustration.

2.4.2. Explanations for a Discounting Gap – Objective Factors

Objective factors influencing a household's decision process comprise the classical market failures that prevent the household from making privately optimal decisions. They are external to the decision problem of Equation (1) and lead to restrictions or distortions of the choice set. The presence of market failures can lead to estimates of households' discount rates that exceed their rate of time preference. We elaborate on the market failures mentioned in the literature to potentially be relevant in the context of households purchasing energy-using durables: Imperfect information and liquidity constraints.[6] As commonly accepted in economic theory, market failures can lead to economically inefficient outcomes, as they can prevent households from maximizing experienced utility. If market failures were the lone factor responsible for the measurement of a discounting gap, the discounting gap could be interpreted as evidence of an energy efficiency gap. If the market failures prove to be significant, it could be argued that policy measures are needed to correct the economically inefficient outcomes.

Imperfect Information

Information about the energy efficiency of products is often incomplete, unavailable and difficult or costly to obtain (Brown, 2004). Since energy efficiency is not visible, it is often difficult for the

---

[5] While cost-minimization remains the core of maximizing experienced utility, this extension allows including uncertainty about operating costs and a utility function shaped by risk preferences.

[6] For a broader depiction of market failures in the energy efficiency context, see Convery (2011), Jaffe et al. (2004), Brown (2004), or Levine, Koomey, Mcmahon, Sanstad, & Hirst (1995). Brown (2004) for example also mention misplaced incentives as a source of market failure, with the landlord-tenant problem as the most popular example. Since these problems occur when an "intermediary" has the authority to act on behalf of a consumer, they are of no help to explain the discounting gap in households' private purchase decisions.

consumer to obtain information about energy efficiency prior to purchasing a product. Additionally, it is also tedious to verify the performance of the product after the purchase since energy efficiency is not readily observable. Brown (2004) uses the example of the vehicle market where fuel economy is bundled with many other attributes and the consumer is unable to compare two otherwise identical offers solely on the base of different energy efficiency characteristics. In fact, fuel economy is mechanically correlated with weight and horsepower and, in consequence, even highly negatively correlated with price (Allcott & Wozny, 2014). If consumers are imperfectly informed about energy efficiency characteristics and thus the potential energy cost savings of more energy-efficient equipment, energy efficiency investment will be inefficiently low.

There are only few studies trying to disentangle the effects of information provision from other explanations of consumer behavior. In an artefactual, computer-based field experiment, Allcott & Taubinsky (2014) assess the effect of an information treatment on the purchase of compact fluorescent light bulbs as opposed to incandescent light bulbs. While they find a positive effect of the information intervention on the purchase of the energy-efficient compact fluorescent light bulbs, both of their experiments show that large shares of consumers still prefer incandescent light bulbs even after being powerfully informed.

Other studies focus on the effect of information provision provided by energy labels, which are a popular instrument for government and private labeling programs to fill the information gap. Newell & Siikamäki (2014) assess the relative importance of various elements of information labels in a stated choice experiment. They find that providing simple information on the economic value of saving energy was most effective in guiding households towards more cost-efficient investments in energy efficiency. Concerning the welfare effects of the Energy Star certification program, Houde (2014) finds that consumers rely heavily on the certification, indicating that the label indeed provides new information that influences consumers' purchase decisions. However, he also finds that some consumers over-rely on the presence of the binary Energy Star label and instead neglect other important information like the actual energy savings. With respect to the fuel economy label, Camilleri & Larrick (2014) find that preference for fuel-efficient vehicles is highest when fuel-efficiency information is communicated in terms of cost over an expanded, lifetime scale. Otherwise, empirical evidence on the impact of energy efficiency labels is sparse and the results are mixed. While some studies indicate that energy efficiency labels might have a positive impact to reduce imperfect information, other studies found no significant effect (see Rohling & Schubert, 2013 or Wiel & Mcmahon, 2005 for overviews of the literature on energy efficiency labels). This might partly be due to the fact that even when labels are available, it can still be costly to acquire information, both because labels are incomplete and sometimes biased (Sallee, 2014). If the costs to acquire information are too high, it might be rational for the household to be inattentive to energy efficiency in the purchase decision (see e.g. Sallee, 2014 or Gabaix, 2014 for models of rational inattention). Thus, in order for energy labels to reduce the effect of imperfect information, they need to be designed very carefully in order to maximize the amount of information conveyed at minimum effort costs for the households.

As presented in this subsection, the few existing empirical studies testing the effect of information provision on households' purchases of energy-using durables did not find overwhelming evidence that imperfect information is a major hindrance for households' purchases of energy-efficient appliances. Information provision seems to have some impact when delivered in the proper metric and scale, but the effect seems to be too small to explain the entire discounting gap. Nevertheless, there is some evidence of an information gap causing privately inefficient purchase decisions and thus an energy efficiency gap. Further empirical research, especially using large-scale evaluations and randomized controlled trials, is needed to provide more thorough evidence of the effect of information provision on households' purchases of energy-using durables.

Liquidity constraints and credit rationing

Investment in energy efficiency usually takes the form of an upfront cost that is recouped by future energy cost savings. If this upfront cost is large, liquidity constraints and credit rationing could prevent some consumers from undertaking profitable energy efficiency investments (Golove & Eto, 1996). Even if they intended to minimize total costs in Equation (1), the necessary amount K for the purchase of the optimal appliance could be prohibitively high. Liquidity constraints and credit rationing are thus typical examples of market failures leading to an energy efficiency gap by preventing some consumers from making privately optimal purchase decisions. This effect distorts empirical estimates of implicit discount rates, as the lack of investments in energy efficiency makes it seem as if future energy savings were extensively discounted.

Limited access to credit may be caused by credit rationing due to asymmetric information on credit risk, which impedes the distinction of borrowers with good credit risk from those with bad credit risk (Gillingham & Palmer, 2014). It will be particularly difficult for low-income consumers with large credit risk to borrow funds, even though the intended investment would most likely improve their credit risk. At the limit, a credit-constrained household faces an essentially infinite discount rate for investments in energy efficiency (Brown, 2004).

Epper et al. (2011) conducted a lab experiment to elicit data relevant for the decisions on energy-using durables and found that liquidity constraints are an important factor affecting people's behavior. They estimate that discount rates for liquidity-constrained consumers are a staggering 40% higher than for unconstrained individuals, thus explaining part of the extent of estimated discount rates. However, there is not much empirical evidence from real purchase decisions about the impact of liquidity constraints and credit rationing in the context of energy-using durables (Allcott & Greenstone, 2012). Future research could reveal if this problem transfers to real world purchases of energy-using durable goods and whether liquidity constraints and credit rationing thus pose a substantial barrier for energy efficiency investment.

While liquidity constraints are likely to hamper investment in energy efficiency, this effect will always be confined to the subgroup of households with severe liquidity constraints. For the purchases of most energy-using durables, this subgroup is rather small in industrial countries. The potential magnitude of this factor as a cause of an energy efficiency gap thus remains limited and depends on the spending capacity of households in different countries.

Objective factors:

- Information provision seems to have some impact when delivered in the proper metric and scale, but the effect does not explain the entire discounting gap.
- Liquidity constraints are likely to hamper investment in energy efficiency, but this factor is not decisive for the energy efficiency gap.

2.4.3. Explanations for a Discounting Gap – Subjective Factors

Subjective factors in our categorization include households' preferences as well as the decision-making process. Energy-using durables can be used over a relatively long period with an uncertain development of energy prices and product usage. Purchase decisions for energy-using durables are thus affected by time and risk components, which is objectively accounted for by the risk-adjusted market interest rate r_m in the definition of the discounting gap in Equation (2). In the first part of this section, we discuss the possible heterogeneity of households in subjective (stable) preferences with respect to time and risk. The second part is concerned with "behavioral" factors influencing the decision process that make households' preferences seem malleable and context-dependent.

2.4.3.1. Preferences and beliefs

Based on their preferences and beliefs, households might deliberately use discount rates that are higher than objectively risk-adjusted market interest rates. In this sense, their behavior, while contributing to the measurement of a discounting gap, maximizes their experienced utility, is not inefficient, and therefore does not explain an energy efficiency gap. Hence, these factors are located in the right half of Figure 1. Possible policy measures interfering with deliberate decisions based on households' preferences are not justifiable from an economic perspective.

High rates of time preferences

Time preferences in general capture the trade-off in valuation of current versus future consumption possibilities. Financial markets set a price for this trade-off – the market interest rate. The market interest rate determines the (higher) amount of future consumption that can be achieved by reducing current consumption. If a household prefers some amount of consumption now to the higher amount of consumption in the future as achievable with a return equal to the market interest rate, it uses a higher discount rate than the market for its privately optimal decision. The immediate costs of purchasing a product then carry relatively more weight than the discounted future energy cost savings, which decreases the demand for more energy-efficient products. This part of the discounting gap thus reflects households' pure time preferences and constitutes a "rational", private optimization of the energy efficiency investment problem presented in Equation (1).

Newell & Siikamäki (2014) elicited individual discount rates using a hypothetical choice between a $1'000 payment available in one month and a higher payment available in 12 months. They find substantial heterogeneity in individual discount rates, with a mean rate of 19 percent, a median of 11 percent, and a standard deviation of 23 percent. In an experimental study, Epper et al. (2011) find subjective discount rates of approximately 40% p.a. on average in the Swiss population, which is much higher than individual discount rates assumed in much of the literature on intertemporal choice. Even though it is unclear whether the experimental results actually carry over to real purchase decisions regarding energy-using products, it seems like individuals discount rates are generally higher than assumed in large parts of the literature. We argue that it is "rational" for households to use the discount rate at which they personally discount the future in the cost-minimizing energy efficiency investment decision of Equation (1). If households value present consumption relatively high compared to future consumption, securing a large level of present consumption maximizes their experienced utility.[7] The "irrational" aspects of discounting behavior will be discussed in section 2.4.3.2.

Subjective risk and uncertainty consideration

The outcomes of investments in energy efficiency are uncertain due to the volatility of energy prices (Howarth, 2004). Therefore, households' risk and uncertainty preferences play an important role in their purchase decisions for energy-using durables. While the objective uncertainty of energy efficiency investments is already considered in the risk-adjusted market interest rate, it is possible that the heterogeneity in households' subjective risk preferences contributes to the observations of discounting gaps. Basing purchase decisions on their subjective preferences maximizes households' experienced utility and is therefore not a possible explanation for an energy efficiency gap.[8]

The uncertainty of energy-using durables lies both in the amount of energy they will use as well as the costs of energy use based on future energy prices. For the common assumption of risk aversion, households rationally try to reduce the level of risk and uncertainty they are exposed to. In the context of energy-using durables, risk averse households' would thus generally purchase appliances of *higher* energy efficiency in order to reduce the uncertainty from future operating costs. Such behavior would lead to estimates of *lower* implicit discount rates and therefore does not contribute to a discounting gap.

Unless future research shows that a significant share of households is risk-loving in the purchase of energy-using durables, subjective risk and uncertainty considerations do not seem to be a factor explaining the observation of discounting gaps.

---

[7] We concede that it might not be realistic for "rational" discount rates to arbitrarily exceed market rates. If this was the case, households with very high rates of time preference should always exhaust their credit limit as long as the borrowing costs are lower than their time preferences and spend all their money immediately – unless risk preferences limit such behavior. While consumer credits have become much more popular in the last decades, excessive indebtedness because of consumption expenditures seems to be the exception – at least in Switzerland.

[8] The uncertainty with respect to operating costs of energy-using durables resolves only gradually over a long time period. Therefore, we argue that a household's optimal decision based on its risk preferences might also maximize experienced utility even if expected costs might not be minimized.

2.4.3.2. *“Behavioral” factors*

Due to the long product lifetime and the uncertainty in running costs, purchases of energy-using durables are complex and cognitively demanding. They present a challenge for many households, which is why the perception and processing of information plays an important role. Households have been observed to systematically deviate from neoclassical theory in their decision-making, especially when information and choice sets are complex. The different types of deviations from neoclassical theory have been compiled under the term behavioral anomalies (see e.g. Loewenstein & Thaler, 1989). Behavioral anomalies lead households to decisions that are objectively not optimal for them in their outcome, i.e. they lead to differences between the decision utility the households maximize at the time of the decision and the experienced utility they receive from the outcome (Kahneman et al., 1997). Such a difference between decision utility and experienced utility could explain both, the observation of discounting gaps as well as an energy efficiency gap. Hence, these factors are located in the left half of Figure 1. In the recent energy efficiency literature, behavioral anomalies are widely cited as a potential explanation for the existence of an energy efficiency gap (see e.g. Baddeley, 2011; Gillingham & Palmer, 2014; Gillingham et al., 2009; Greene, 2011; Helfand & Wolverton, 2011; Shogren & Taylor, 2008).

The remainder of this section introduces different behavioral factors that influence households' purchases of energy-using durables.

Biased beliefs

In an attempt to measure whether systematically biased beliefs contribute to an undervaluation of fuel economy, Allcott (2011) uses survey data to elicit consumer beliefs about future fuel savings from a higher fuel economy vehicle. He finds that consumers suffer from “MPG illusion” – they underestimate the energy cost differences among low-MPG vehicles and overestimate the cost differences among high-MPG vehicles. In a simulation eliminating this bias, Allcott (2013) ascertains that consumers would shift away from both high-MPG hybrids and low-MPG trucks and purchase more medium MPG vehicles. The aggregate effect of MPG illusion on the average MPG of vehicles sold remains ambiguous and thus does not explain a low demand for energy-efficient products (Allcott, 2011).

Tversky & Kahneman (1974) provide an extensive list of ways in which judgment diverges from rationality. One example that could be relevant in the context of purchasing energy-using durables is the “law of small numbers”, which purports that people make inferences about general probabilities from small sample sizes. The law of small numbers can take effect with respect to households' beliefs about the durability of products. Even a single bad experience with the durability of a product can induce households to generally belief that the lifetime of products is shorter than it veritably is – and much shorter than claimed by manufacturers. If households assume a shorter lifetime than adopted in the decision model to estimate the discount rates implicit in their purchase decisions, the estimated discount rates will be inflated. This effect can be extended to the general risk perception of households: A biased perception of risk associated with the purchase of energy-using durables of different energy efficiency impacts the estimated discount rates, but there is no evidence that such a tendency adversely affects high-efficiency products.

In sum, there is currently no conclusive evidence that households' biased judgment is a significant driver of an energy efficiency gap. However, one important aspect of households' beliefs – besides expectations about future energy costs – is the expected product lifetime of energy-using durables. The expected lifetime of a product is pivotal in any calculation of lifetime costs and thus for the measurement of a discounting gap. The careful elicitation of expected product lifetime in the context of households' purchases of energy-using durables is thus a promising task for future research.

Limited attention

In order to simplify complex decisions, consumers process only a subset of the available information and systematically underweight certain information. Gabaix & Laibson (2006) analyze pricing with boundedly rational consumers who do not pay attention to hidden features of product prices, which they refer to as “add-on” costs. There is a wide range of empirical findings confirming that consumers are inattentive to ancillary product costs that are less salient or obvious such as shipping and handling charges (Hossain & Morgan, 2006), sales taxes (Chetty et al., 2009), or out-of-pocket insurance costs (Abaluck & Gruber, 2011).

In the context of energy-using durables, the “shrouded” price attribute is the running energy cost while the initial purchase price is much more salient. Actual energy use is not observable since the monthly electricity bills generally provide no breakdown of individual end-uses. As a result, households tend to base their purchase decisions for energy-using durables less on energy efficiency and more on other, more visible aspects of the product, such as the initial purchase price (O’Malley, Scott, & Sorrell, 2003). When buying energy-using durables such as cars, air conditioners, and light bulbs, households might thus be more attentive to the purchase price than to the running energy costs, leading to a higher weight of the former in purchase decisions. The inattention to energy costs is especially pronounced if they are small compared to the purchase price, as is the case for household appliances like, for example, refrigerators or washing machines (Hossain & Morgan, 2006). Due to inattention, households are less likely to purchase the more energy-efficient product that commonly entails a higher purchase price and lower running energy costs than a less efficient alternative. This effect has been widely suggested in the theoretical literature as a potentially important driver of an energy efficiency gap (see e.g. Anderson & Claxton, 1982; Blumstein et al., 1980; Jaffe & Stavins, 1994; Sanstad & Howarth, 1994).

Empirically, it is very difficult to distinguish inattention from incomplete information. One possibility is to study inattention to energy efficiency with experimental manipulations of salience. In their field experiment on light bulb choice, Allcott & Taubinsky (2014) try to disentangle how much the information treatment affected choices through increased attention vs. updated beliefs. They suggest that both factors contribute to the treatment effect, maintaining that limited attention is a relevant factor in keeping households from buying compact fluorescent light bulbs. In the segment of sales tax salience, the belief survey by Chetty et al. (2009) suggests that sales tax information acts predominantly through increasing salience.

Since the effect of limited attention has been observed in other contexts, it seems likely that this could also be the case for purchases of energy-using durables, especially if the energy costs are low relative to the purchase price. Complementary use of experimental and non-experimental techniques in future research would help to isolate the effect of increasing salience of energy costs on purchase decisions for energy-using durables.

Reference-dependent preferences

In their famous paper on prospect theory, Kahneman & Tversky (1979) claim that people hold reference-dependent preferences. Prospect theory accounts for several departures from expected utility theory by claiming that people evaluate outcomes based on *changes* with respect to a reference point and not with respect to the final overall wealth. The presence of a reference point for evaluating outcomes is an important characteristic of context-dependent preferences. As an additional deviation from expected utility theory, the utility function in prospect theory is steeper in the loss domain than in the gain domain. This means that a loss with respect to the reference point results in a larger decline in utility than a gain of equal size increases utility – an effect called “loss aversion” (Kahneman et al., 1991). This model of reference-dependent preferences with loss aversion has since been used by many economists and has found empirical support (see DellaVigna, 2009 for an overview).

Concerning the issue of energy-using durables, Greene (2011) asserts that loss aversion could be a factor hindering household investment in energy efficiency and thus causing part of an energy efficiency gap. Since the investment in energy efficiency bears uncertainty, as mentioned above, there is usually a chance that the investment proves not to be profitable in hindsight. The mere possibility of such a loss could prevent some loss averse households from purchasing a more efficient energy-using durable (Greene, 2011). Greene (2011) finds that the typical consumer would decline an increase in passenger car fuel economy from 28 to 35 MPG since the expected value of the investment is negative for the typical loss-averse consumer. Reference-dependent preferences with loss aversion can therefore lead to choices that fail to maximize experienced utility: The fear of the small probability of a (utility) loss with respect to the reference point hinders households from making investments with a large probability of a (utility) gain.

Because the disadvantages of changes are weighted more heavily than its advantages, loss aversion contributes to a “status quo bias” (DEFRA, 2010). The effect of reference-dependent preferences is thus expected to be particularly relevant for an energy efficiency gap with respect to the *point in time* of reaching an investment decision and less for the actual purchase decision itself.

Hyperbolic time discounting

A robust finding in the experimental literature on risk taking is the fact that people behave as if they distort objectively given probabilities in a systematic way: Broadly speaking, they tend to overweight small probabilities and extreme outcomes and underweight large probabilities and intermediate outcomes (see Fehr-Duda & Epper, 2012 for an overview on probability weighting). Epper and Fehr-Duda (2015) show that people prone to such non-linear probability weighting exhibit hyperbolic discount rates. The declining of discount rates over time often leads to time inconsistent choices (Frederick et al., 2002; Laibson, 1997; Loewenstein & Prelec, 1992).[9] Such present-biased preferences imply that the difference in purchase price (immediate costs) between products of lower and higher energy efficiency carries more weight than the difference in future energy costs (delayed benefits), which decreases the demand for energy-efficient products. Time inconsistent choices based on hyperbolic time discounting are characterized by a failure to maximize experienced utility and can thus potentially explain part of an energy efficiency gap (Kahneman & Sugden, 2005). However, other recent studies find little evidence of non-exponential discounting behavior, highlighting the need for further research of households’ discounting behavior (Andreoni & Sprenger, 2012; Andersen, Harrison, Lau, & Rutström, 2014).

Decision heuristics

When facing complex decision problems with many options, abundance of information or complex information, consumers have been found to use heuristics or so-called rules of thumb to simplify the decision-making process. DellaVigna (2009) lists the following examples, among others, where evidence in psychology suggests that individuals use simplifying heuristics (p.353):

- Preference for the familiar – choosing the option that is more familiar as can be seen for example in brand loyalty or investment in companies investors recognize from their home state
- Preference for the salient – choosing the option that is most salient as for example the first candidate on a ballot
- Choice avoidance – avoiding choice altogether, possibly in favor of the default option

In the context of energy-using durables, such decision heuristics might be applied if there are many options to choose from and/or the emotional involvement in the purchase decision is low, such as for refrigerators or washing machines. Applying decision heuristics as the ones mentioned above could lead to a systematic bias of purchase decisions towards products that are less energy-efficient: They have been around longer and are thus more familiar, they are attractive with respect to the most salient attribute purchase price and they represent the fallback option if choice is avoided altogether. However, we are not aware of any empirical evidence of the effect of decision heuristics on the diffusion of energy-efficient products.

Subjective factors:

- Choosing high discount rates based on strong preferences for current consumption may keep households from purchasing energy-efficient products, but does not constitute an energy efficiency gap.
- The empirical evidence for “behavioral” factors contributing to the energy efficiency gap is rather weak.

[9] Halevy (2015) inspects time inconsistent behavior in more detail. He distinguishes time consistency from stationarity and time invariance and finds that present-biased preferences are not necessarily the main source of time inconsistent choices.

2.4.4. Sources of a Discounting Gap – Confounding Variables

Besides the explanations presented above, we cannot exclude that model and measurement errors contribute to the discounting gap estimated in households' purchase decisions for energy-using durables. Specifically, the decision models used by Hausman (1979) and others mentioned in section 2.3 abstract from product attributes that were not observed, i.e. they infer utility of the outcomes from observed choices. Howarth (2004) provides two specific examples for unobserved product attributes in energy-using durables that lead to hidden costs: 1) Fluorescent light bulbs do not work with certain lighting fixtures and produce a different light spectrum than incandescent light bulbs that some people perceive as "cold" and aesthetically inferior; 2) Car manufacturers achieve increased fuel economy by reducing the size and weight of new vehicles, reducing their crashworthiness and thus compromising on vehicle safety. Other hidden costs not included in most decision models are market frictions (e.g. the time cost of finding or installing a more energy-efficient product), a potential decrease in the quality of the energy service provided, and other decreases in product quality concerning comfort and convenience such as aesthetical inferiority, inapplicability, or safety considerations (Gillingham & Palmer, 2014; Howarth, 2004; Jaffe et al., 2004). In our model of a cost-minimizing energy efficiency investment decision (see Equation (1)), these variables are pooled under "other costs". In order to judge the "rationality" of an energy efficiency investment decision – and to measure an energy efficiency gap – these variables need to be considered.

If highly energy-efficient products have systematically worse unobserved characteristics than products with low energy efficiency – as is the case for the aforementioned examples of fluorescent light bulbs or higher fuel economy vehicles –, they will be purchased less than expected in the households' utility maximization model. It will thus seem as if households strongly discount the future energy cost savings achievable with the highly energy-efficient products. A misspecification of households' utility functions will thus falsely lead to the interpretation that the households use a rather high discount rate. More energy-efficient cars, for example, are on average smaller and often have fewer luxury amenities than less energy-efficient models (Allcott & Greenstone, 2012). Not controlling for size and households' tastes for luxury amenities in the econometric analysis therefore leads to an upward bias in the implicit discount rate. While this effect can lead to the measurement of a discounting gap, it does not explain an energy efficiency gap.

Additionally, the discounting gap is commonly observed for the *average* consumer. However, there is often substantial heterogeneity across consumers in the utilization of the product and in unobserved costs (Allcott & Greenstone, 2012). The purchase of a more energy-efficient product might not be financially attractive for some consumers because of differences in preferences, expected use of the product, or the cost of borrowing. The investment potential for the entire population might therefore be smaller than estimated, because possible inefficiencies only exist for a segment of the population. For a population of heterogeneous consumers, the optimal share of more energy-efficient refrigerators sold will thus be lower than efficient for a population of average consumers. Bento et al. (2012) use a Monte Carlo experiment to show that heterogeneity in preferences may bias empirical studies toward finding that consumers generally undervalue savings. For example, a more energy-efficient refrigerator might be a financially profitable investment if the product is used every day over the lifetime of the product. However, a consumer purchasing a refrigerator for a summer home that is used for only a few weeks per year might prefer a less expensive, less energy-efficient refrigerator than the average consumer would purchase. In a decision-model with average usage, we would thus estimate an inflated discount rate for this consumer and falsely interpret the low-efficiency purchase as an energy efficiency gap.

The underlying issue for measuring an energy efficiency gap is to correctly quantify each variable influencing individual decision-making as suggested in Equation (1). Conventional estimates as presented in section 2.3 rarely satisfy this condition, as they measure implicit discount rates without controlling for several confounding variables that systematically bias households' purchase decisions for energy-using durables in the same direction. These hidden costs are part of the household's utility function and are thus legitimately included in a privately optimal decision. While contributing to the inflated estimates of implicit discount rates often reported in the literature, these factors do not explain an energy efficiency gap. Therefore, the conventional evidence of a discounting gap does not necessarily predict the existence of an energy efficiency gap.

Confounding variables:

- Hidden costs related to the purchase of energy-using durables explain part of the discounting gap but do not contribute to the explanation of the energy efficiency gap.

2.5. Conclusion

Since the 1970s, a large body of literature used a simple econometric approach to estimate the discount rates implicit in actual purchase decisions for energy-using durables. Estimates of discount rates considerably higher than risk-adjusted market interest rates – a discounting gap – have been interpreted as evidence of an energy efficiency gap. In this chapter we critically review this literature and challenge the assumption that high implicit discount rates estimated from observed choices are directly indicative of an energy efficiency gap. We discuss the factors possibly explaining the observed discounting gaps and whether these factors are also part of an energy efficiency gap.

The various market failures and behavioral anomalies potentially occurring in the context of households' purchases of energy-using durables explain a discounting gap as well as an energy efficiency gap. They lead households to purchase less energy-efficient appliances than privately optimal and reduce their experienced utility. On the other hand, households' (stable) preferences and beliefs as well as variables confounding the measurement of implicit discount rates in actual purchase decisions can lead to estimates of discounting gaps that are not evidence of an energy efficiency gap. The literature does not present conclusive evidence which factors are causing the observed discounting gap. Therefore, we cannot directly infer the existence of an energy efficiency gap from the observations of discounting gaps in households' purchases of energy-using durables. More sophisticated techniques are needed to estimate an energy efficiency gap and to determine which factors might be causing it.

The problem of unobserved product attributes could be eliminated by applying econometric methods such as fixed effects, as has been done in recent studies by Allcott & Wozny (2014) and Busse et al. (2013). While the results presented by Allcott & Wozny (2014) tend to suggest that some investment inefficiencies are present, Busse et al. (2013) find no significant effect. Both analyses agree that even if there are in fact some investment inefficiencies in the automobile market, the welfare losses would be relatively small (Allcott & Greenstone, 2012). More analyses using similar methods also in other markets will be necessary in order to reach a decisive conclusion about the existence and size of an energy efficiency gap. In any case, such econometric methods require an extremely rich data set of control variables, many of which would have to be ascertained in a separate economic experiment.

A more pragmatic approach to deal with hidden costs is to select a product type that presents well-measurable variables and very few unobservables relevant for the purchase decision, thus marginalizing their impact. This approach might be helpful to estimate an energy efficiency gap for that product type without the need for utterly extensive sets of panel data and is presented in chapter 3.

Concerning the causes of an eventual energy efficiency gap, much of the existing literature is based on hypothetical choice experiments. For future research, it is advisable to thoroughly test the impact of each potential factor in the field using experimental methods such as the field experiment presented in chapter 4. Identifying the causes of an eventual energy efficiency gap is essential for policy purposes in order to design policy measures targeted at mitigating these causes. In the presence of behavioral anomalies for example, policy measures could help to "nudge" households towards economically efficient purchase decisions that maximize households' experienced utilities.

3 Is There an Energy Efficiency Gap in Households' Purchases of Energy-Using Durables in Switzerland?

3.1. Introduction

Measuring an energy efficiency gap according to the definition of the previous chapter would require to correctly quantify each variable influencing individual purchase decisions concerning electric appliances. As presented, this task is not trivial since some factors that might be very relevant for the purchase decision are difficult to observe or quantify. Hence, we propose a different way to identify an energy efficiency gap. We search for product categories with as little confounds as possible to proceed with our evaluation of an energy efficiency gap in Switzerland.

We start by presenting and legitimating the chosen product category and describing the empirical method used to estimate the existence of an energy efficiency gap. After a short description of how we gathered data, we present the results of our calculations for different scenarios. The chapter is completed with a conclusion.

3.2. Product Category and Empirical Method

We identified white goods[10] as product category to estimate the existence of an energy efficiency gap because 1) they provide well-measurable product characteristics, 2) unobservable variables are less relevant in purchase decisions than for other goods, and 3) white goods cause about two thirds of households' electricity consumption and are thus relevant for energy demand (Prognos AG, Infras AG, and TEP Energy GmbH, 2015). The main advantage of analyzing white goods lies in the existence of "twin" products, i.e. two products offered by the same supplier, sharing identical characteristics except for their energy efficiency and their purchase price (Gately, 1980). Figure 5 in the appendix provides an example of two twin products.

Since twin products only differ with respect to purchase price and energy costs, they can be compared without having to worry about unobserved utility components or differences in consumers' preferences. We hence compare the total costs (TC), i.e. initial acquisition costs C plus discounted energy costs over expected product lifetime T[11], of the efficient product ($Z=1$) and the inefficient product ($Z=0$)[12]:

$$TC^Z = C^Z + \underbrace{\sum_{t=1}^{T} \frac{p_t x_t^Z}{(1+r)^t}}_{\substack{discounted\ lifetime \\ energy\ costs}} \quad ; Z \in \{0;1\} \tag{3}$$

Hereby, p_t is the private cost of energy per kWh in year $t\ (t=1,...,T)$, x_t^Z is the energy consumption in kWh resulting from using product $Z \in \{0;1\}$ in year $t\ (t=1,...,T)$, and r is the individual discount rate[13]. It is assumed that the difference in annual energy consumption x_t between the efficient product 1 and

---

[10] A white good is a large machine which accomplishes some routine housekeeping task, such as cooking, washing laundry, or food preservation.
[11] The efficient and the inefficient twin product are assumed to have the same expected product lifetime, which is in line with the claim by a large manufacturer in a private conversation.
[12] In the following, the terms "efficient" and "inefficient" are used to describe the relative difference in energy efficiency between two twin products.
[13] See chapter 2 for a discussion of individual discount rates.

the inefficient product 0 only results from different product characteristics – essentially differences in energy efficiency – and not from different usage patterns.[14]

An economically rational household i ($i=1,\ldots,I$) would choose the efficient product 1 over the inefficient product 0 if its TC are lower, i.e. if the respective difference D_i between the total costs of the efficient product (TC_i^1) and the total costs of the inefficient product (TC_i^0) is negative:

$$D_i = TC_i^1 - TC_i^0 < 0 \quad (4)$$

or

$$D_i = \underbrace{\sum_{t=1}^{T} \frac{p_{ti}(\mathrm{x}_{ti}^1 - \mathrm{x}_{ti}^0)}{(1+r_i)^t}}_{\substack{difference\ in\ discounted \\ lifetime\ energy\ costs}} + \underbrace{(C^1 - C^0)}_{\substack{incremental\ acquisition\ costs \\ for\ the\ efficient\ product\ 1}} < 0 \quad (5)$$

If conditions (4) or (5) are satisfied, any purchase of the inefficient product suggests non-rationality on the part of the consumer – and hence the existence of an energy efficiency gap. Verifying the existence of an energy efficiency gap thus requires to calculate condition (5). For this purpose, it is necessary to gather data on the annual energy consumption x_{ti}^Z and initial acquisition costs C^Z[15]. Additionally, specifications are needed for the costs of electricity p_{ti} in different time periods t ($t=1,\ldots,T$), the products' lifetimes T and households' individual discount rates r_i.

The task to choose an appropriate discount rate is nontrivial. As presented in the previous chapter of this report, there is a vast amount of literature on individual discounting behavior that lacks a clear consensus. Therefore, we opt to refrain from choosing a single value as the "appropriate" discount rate in private purchase decisions on energy-using durables. Instead, we calculate the present value of lifetime energy costs using different discount rates to highlight the sensitivity of the results on the discount rate.

3.3. Data

Based on careful online research, we detected a number of twin white goods for sale in Switzerland: 40 refrigerators, 22 fridge-freezers, 12 freezers, and 4 tumble dryers provided by the brands Bauknecht, BSH Home Appliances (Bosch & Siemens), Electrolux and V-Zug. Cooling devices seem to be particularly susceptible to be produced in twin versions by manufacturers. This may be due to the fact that options to differentiate high-end and low-end cooling devices with different functionalities hardly exists.[16] It seems to be most profitable for manufacturers to keep both product versions as similar as possible in order to minimize production costs for the individual product parts.

For the identified twin products, we collected data on product characteristics – particularly the estimated annual electricity consumption[17] – and list prices from the manufacturers' websites (for July 2015).[18] The list prices include sales taxes but exclude the antedated recycling fee. Additionally, we used the price comparison website www.toppreise.ch to collect the lowest available Swiss online shop prices for each product (Toppreise Preisvergleich GmbH, 2015).[19] An excerpt of the data we collected is provided in Table 14 in the appendix; the entire set of data is available on request.

For the calculations of the present value of lifetime energy costs, we use the average electricity price for Switzerland in January 2015 of 20 cents per kWh (Bundesamt für Energie BFE, 2015) and a product lifetime of 15 years, as used by the broadly supported Swiss information portal Topten.ch

---

[14] By defining product usage to be independent of the product, we assume that there is no *direct* rebound effect (see Greening, Greene, & Difiglio, 2000, for definitions of the rebound effect). A direct rebound effect means that gains in the efficiency of energy consumption lead to an increase in usage of this single energy service. For a refrigerator for example, a direct rebound effect would be to set the efficient product to a lower temperature than the inefficient product. Based on the results presented by Sorrell, Dimitropoulos, & Sommerville (2009), it seems reasonable to neglect such effects for white goods.

[15] We assume that the acquisition costs do not vary between individuals.

[16] This explanation has been provided by a large manufacturer in a private conversation.

[17] Based on standard testing by the manufacturers.

[18] Product information sheets for each product are available on request.

[19] We collected the prices that include shipping costs, because they represent the actual acquisition costs for households.

(2015). For simplicity, we assume that electricity prices are constant over product lifetime. The 15 years of product lifetime are rather on the longer side of the spectrum, which enhances the attractiveness of more energy-efficient products and thus increases the chances to detect an energy efficiency gap. The same reasoning leads to our choice of a uniform 0% discount rate as a starting point and various positive discount rates to demonstrate the sensitivity of the results to the discount rate.

In addition, a large Swiss online shop provided us with actual sales figures from July to December 2015 for a small sample of three of the twin product pairs. This allows us to exemplify households' actual purchase decisions and examine the existence of an energy efficiency gap. We can conclude already now that it would be helpful to have larger data sets of actual sales figures for twin products in order to measure the actual size of a potential energy efficiency gap.

3.4. Results

With our accumulated data set, we can verify whether the pre-condition (5) for the existence of an energy efficiency gap is satisfied. We first conduct this analysis using manufacturers' list prices for the initial acquisition costs and then repeat it using the lowest available prices from Swiss online shops. We terminate our analysis by presenting a small sample of actual sales figures to provide anecdotal evidence for the existence of an energy efficiency gap.

3.4.1. Manufacturers' list prices

Our first approach is to compare the TC of the twin products using list prices from manufacturers for the initial acquisition cost C in condition (5). In order to maximize the chance of satisfying condition (5), we first calculate the extreme scenario with $r = 0\%$. The results are presented in Table 2.

It is striking to see that there is not a single pair of products for which the total cost difference D between the efficient and the inefficient twin is negative (column 3). All monetary amounts in columns 4 to 7 of Table 2 are positive, meaning that the efficient twin always has higher TC than its inefficient counterpart. Therefore, pre-condition (5) for the existence of an energy efficiency gap is never satisfied. A leading manufacturer of white goods declared that this finding was not based on excessive list prices for the efficient twin products. Instead, the incremental production costs for the efficient twin are usually not fully incorporated in the incremental list price for this product.

Since using a positive discount rate would reinforce the above finding, extending the analysis by using positive discount rates is redundant. We conclude that the list prices of efficient twin products include a price premium that always exceeds the differences in discounted lifetime energy costs. If products were sold at list prices, there would thus be no monetary incentive for a rational consumer to purchase efficient twin products and hence no energy efficiency gap.

Table 2: Differences in total costs between the efficient and the inefficient twin product by class of goods, using manufacturers' list prices, a 0% discount rate, a price of electricity of 20 cents per kWh and a product lifetime of 15 years.

			Descriptive statistics for value of D (in CHF)			
Class of goods (1)	**# of product pairs (2)**	**# of pairs with $D < 0$ (3)**	**min (4)**	**max (5)**	**mean (6)**	**med (7)**
Refrigerators	20	0	73.-	476.-	232.-	243.-
Fridge-freezers	11	0	94.-	387.-	185.-	136.-
Freezers	6	0	80.-	580.-	370.-	366.-
Tumble dryers	2	0	61.-	81.-	71.-	71.-

Key results for calculations with manufacturers' list prices:

- The list prices of efficient twin products include a purchase price premium always exceeding their expected life cycle energy cost savings.
- If products are sold at list prices, there is thus no monetary incentive for a rational consumer to purchase efficient twin products and hence there is no energy efficiency gap.

3.4.2. Online shop prices

A convenient alternative to using list prices for our analysis is to use prices at which the various twin products are actually sold in online shops. Price comparison websites such as www.toppreise.ch allow households to find the cheapest offer at very low search costs. We repeat the analysis from section 3.4.1. using the lowest available online price instead of manufacturers' list prices as initial acquisition cost C for each product and present the results in Table 3.

Table 3 presents a different picture than Table 2. First of all, the number of twin pairs for which the total cost difference is negative – and for which pre-condition (5) for the existence of an energy efficiency gap is thus satisfied – is positive for all classes of goods (column 3). The efficient twin products have lower TC on average for all classes of goods (column 6). Freezers are the only class of goods for which the median twin pair entails higher total costs for the efficient product (column 7).

Under the assumptions used in Table 3, there are many cases of twin products where pre-condition (5) for the existence of an energy efficiency gap is satisfied (column 3). It therefore seems reasonable to proceed with our analysis by dropping the assumption of a 0% discount rate and using more realistic, positive discount rates. Based on the discussion of individual discount rates in section 2.4.3. we use three different discount rates: A base rate of 10%, an intermediate rate of 20%, and a high rate of 40%.[20] Table 4 presents the results for the same calculations as in Table 3 but with differing discount rates.

Within Table 4, D in columns 5-8 becomes larger with increasing discount rates. It is remarkable though that the number of twin pairs for which D is negative (column 4) does not vary with the discount rate. Comparing column 4 of Table 4 with column 3 of Table 3 reveals a large reduction of this number for discount rates between 0% (as used in Table 3) and 10%. In fact, for a discount rate of 10%, D is negative for less than half of the product pairs, i.e. the inefficient twin is the economical choice in the majority of cases. Any further increase of the discount rate up to 40% has no additional effect on the number of product pairs for which D is negative.

Table 3: Differences in total costs between the efficient and the inefficient twin product by class of goods, using lowest available online prices, a 0% discount rate, a price of electricity of 20 cents per kWh and a product lifetime of 15 years.

			Descriptive statistics for value of D (in CHF)			
Class of goods (1)	**# of product pairs (2)**	**# of pairs with $D < 0$ (3)**	**min (4)**	**max (5)**	**mean (6)**	**med (7)**
Refrigerators	20	16	-213.-	151.-	-68.-	-53.-
Fridge-freezers	11	8	-301.-	90.-	-109.-	-99.-
Freezers	6	3	-279.-	186.-	-50.-	-13.-
Tumble dryers	2	2	-344.-	-1.-	-172.-	-172.-

[20] These numbers represent individual, risk-adjusted discount rates and are therefore justifiably higher than market rates, as demonstrated e.g. by Hassett and Metcalf (1993) and Jaffe et al. (2004). Using the same method to elicit individual discount rates, Coller & Williams (1999) estimate a median discount rate of 17%-20% while Newell & Siikamäki (2014) estimate a mean rate of 19% and a median of 11%, leading to our use of a base rate of 10% and an intermediate rate of 20%. Epper et al. (2011) find subjective discount rates of approximately 40% p.a. on average in the Swiss population, leading to our high rate of 40%.

Table 4: Differences in total costs between the efficient and the inefficient twin product by class of goods, using lowest available online prices, a price of electricity of 20 cents per kWh, a product lifetime of 15 years, and different discount rates.

				Descriptive statistics for value of D (in CHF)			
Discount rate (1)	**Class of goods (2)**	**# of product pairs (3)**	**# of pairs with $D < 0$ (4)**	**min (5)**	**max (6)**	**mean (7)**	**med (8)**
10%	Refrigerators	20	7	-144.-	241.-	9.-	34.-
	Fridge-freezers	11	4	-197.-	195.-	-8.-	3.-
	Freezers	6	2	-150.-	280.-	53.-	81.-
	Tumble dryers	2	1	-267.-	61.-	-103.-	-103.-
20%	Refrigerators	20	7	-115.-	279.-	41.-	68.-
	Fridge-freezers	11	4	-154.-	240.-	33.-	46.-
	Freezers	6	2	-98.-	319.-	96.-	119.-
	Tumble dryers	2	1	-235.-	87.-	-74.-	-74.-
40%	Refrigerators	20	7	-93.-	308.-	66.-	95.-
	Fridge-freezers	11	4	-121.-	274.-	66.-	78.-
	Freezers	6	2	-58.-	350.-	129.-	148.-
	Tumble dryers	2	1	-210.-	107.-	-52.-	-52.-

The product pairs for which D is negative in Table 4 can be divided into two categories: 1) The price premium for the efficient product is small and the difference in the consumption of electricity is sufficiently large, so that even if future energy costs are discounted with a high rate of 40%, the efficient product remains the option with lower TC; 2) The purchase price of the efficient product is *lower* than the price of the inefficient product. For product pairs belonging to the second category, D will always be negative, i.e. pre-condition (5) for the existence of an energy efficiency gap will always be satisfied, irrespective of the assumptions about the discount rate, the price of electricity and the lifetime of the product.[21] We find that 6 refrigerator twin pairs (see Table 14 in the appendix), 3 fridge-freezer twin pairs, and 1 tumble dryer twin pair belong to this second category. There were even seven cases where the efficient twin product was offered at a lower purchase price than the inefficient twin product by a single online shop. It is a relevant topic for future research to investigate into the online price structures of efficient and inefficient twin products and the reasons behind these structures.

A further question we analyzed is the relevance of the electricity price for the lifetime cost differences of twin products. Electricity prices typically fluctuate and their future development is uncertain. Therefore, we would like to show how changes in electricity prices today would – ceteris paribus – affect the discounted total cost differences of twin products. For simplicity, we keep electricity prices constant over product lifetime. The respective results are presented in Table 5.

Table 5 shows D for the twin pairs with the smallest, the median and the largest D per class of goods in the base case of a 0% discount rate, a price of electricity of 20 cents per kWh and a product lifetime of 15 years (column 3). Columns 4-7 depict the price of electricity per kWh for which each twin product pair has identical TC, i.e. $D=0$, at various discount rates. The results in Table 5 show that for the minimum D pair of refrigerators, fridge-freezers, and tumble dryers, there is no positive electricity price for which a balancing of TC ($D=0$) is achievable. This means that in these cases, as long as electricity prices are positive, the efficient twin product will never have larger TC than its inefficient counterpart, because even its purchase price is lower. Hence, for these cases, pre-condition (5) is always fulfilled.

[21] Except for negative electricity prices.

Table 5: Price of electricity for which each twin product pair has identical TC at various discount rates, presented for twin products with minimum, median, and maximum difference in TC by class of goods, using lowest available online prices.

			Price of electricity that leads to $D = 0$ for different discount rates (in Rappen/kWh)			
Class of goods (1)	**Ranking (2)**	**D for r = 0% (in CHF) (3)**	**r = 0% (4)**	**r = 10% (5)**	**r = 20% (6)**	**r = 40% (7)**
Refrigerators	min	-213.-	-7.3	-13.1	-19.5	-31.5
	med	-53.-	14.2	25.4	37.9	61.1
	max	151.-	34.8	62.4	93.1	150.2
Fridge-freezers	min	-301.-	-5.7	-10.2	-15.2	-24.6
	med	-99.-	11.4	20.9	30.6	49.3
	max	90.-	27.5	49.2	73.4	118.4
Freezers	min	-279.-	1.4	2.6	3.8	6.2
	med	-13.-	18.9	33.8	50.4	81.4
	max	186.-	37.5	67.2	100.2	161.6
Tumble dryers	min	-344.-	-19.5	-34.9	-52.1	-84.0
	max	-1.-	19.9	35.7	53.5	86.0

For a discount rate of 10%, TC for the median pair of fridge-freezers are practically balanced between the efficient and the inefficient product at the current average Swiss electricity price of 20 Rappen/kWh. For refrigerators, TC for the median twin pair would be balanced with a 25% increase in electricity prices, which is already quite substantial. If we assume a discount rate of 20% or higher, current electricity prices would have to be raised by 50% (fridge-freezers) to 250% (freezers) in order to make the majority of the efficient twin products economically attractive for households. Such a scenario seems rather unrealistic for the next decade. At current prices in online shops, the inefficient twin product thus likely remains the economically optimal choice for a rational consumer in the majority of purchase decisions.

Key results for calculations with online shop prices:

- There are cases of twin products offered in online shops where pre-condition (5) for the existence of an energy efficiency gap is satisfied, even for very large discount rates.
- For the majority of twin products, the inefficient product is the more economical choice at reasonable discount rates and electricity prices at the current level or slightly higher.
- Only if electricity prices go up substantially would the majority of efficient twin products become economically attractive for households.

3.4.3. Sample of actual sales figures

A large Swiss online shop provided us with sales figures of June to December 2015 for three of our twin product pairs of freezers. The figures are presented for three different time periods in columns 3-8 of Table 6. The three time periods vary in their length since they are chosen based on the price development of the products, i.e. a major price change in one of the products initiated a new time period. In columns 3, 5, and 7, we mark the product with lower TC during the respective time period with an “x”. The inspection of actual sales figures helps to get an idea of the magnitude of the energy efficiency gap for white goods in Switzerland.

Table 6: Sales figures for three examples of twin freezers for June to December 2015, including information about the relative TC of each product pair.

		June 17 – Sep 10		Sep 11 – Nov 25		Nov 26 – Dec 11	
Product name (1)	**Energy Efficiency (2)**	**Lower TC[a] (3)**	**Sales # (4)**	**Lower TC[a] (5)**	**Sales # (6)**	**Lower TC[a] (7)**	**Sales # (8)**
Bosch GSV29VW30	A++	x	1	x	1	x	0
Bosch GSV29VW40	A+++		2		2		0
Bosch GSN58AW30	A++		3		5		0
Bosch GSN58AW41	A+++	x	32	x[b]	46	x[b]	10
Siemens GS58NAW30	A++		1		3		0
Siemens GS58NAW41	A+++	x	3	x	7	x[b]	2

[a]For all discount rates up to 40%

[b]Even purchase price is lower for the efficient product during these time periods

We discuss each twin pair presented in Table 6 separately:

- Bosch GSV29...: The inefficient twin always has lower TC, therefore we do not have an energy efficiency gap. Nevertheless, the efficient twin with higher TC is actually sold more often, which could be explained by imperfect information or strong preferences (ecological preferences) for the purchase of an A+++ product.
- Bosch GSN58...: The efficient twin always has lower TC than its inefficient counterpart. After September 11, the efficient twin even has the lower purchase price and is thus the more economical choice irrespective of the assumed discount rate, product lifetime, and electricity price. Nevertheless, the inefficient twin is also sold in the first two periods, indicating the existence of an energy efficiency gap for this product pair.
- Siemens GS58...: The efficient twin always has lower TC than its inefficient counterpart. After November 26, the efficient twin even has the lower purchase price and is thus the more economical choice irrespective of the assumed discount rate, product lifetime, and electricity price. Nevertheless, the inefficient twin has a sales share of 25% – 30% in the first two periods, indicating the existence of an energy efficiency gap for this product pair.

Searching for more anecdotal evidence of sales shares of efficient versus inefficient twin products, we interviewed a large manufacturer of white goods. The key statement was that the sales share of efficient versions of twin products steadily increased in the last years up to a distribution of 70% to 30% in favor of the efficient product. This tendency can also be observed in the general Swiss sales statistics for white goods. For washing machines for example, the market share of products rated in the highest energy efficiency category A+++ had already reached 68% in 2014 (Schweizerische Agentur für Energieeffizienz S.A.F.E., 2015).

It turns out that overall, there seems to be a tendency for sales of efficient products even if they are more costly than the inefficient ones. In some cases, however, inefficient products are bought despite being more costly than the efficient ones, which constitutes an energy efficiency gap. Hence, even for products that only vary in the energy efficiency and in their price, other factors than just the economic preferability seem to play a role. Therefore, it seems to be worthwhile to investigate more into this phenomenon.

Key results for actual online sales figures:

- A high share of efficient products is sold even if they are more costly than the inefficient ones.
- In some cases, inefficient products are bought despite being more costly than the efficient ones. This constitutes an energy efficiency gap.

3.5. Conclusion

The existence of an energy efficiency gap remains a controversial issue, despite various attempts to provide evidence for an energy efficiency gap since the 1970s. In this chapter, we introduced a new method to estimate empirically the existence of an energy efficiency gap. We identified so-called twin products among various classes of white goods in the Swiss market. For each twin product, we calculated total lifetime costs by adding the purchase price to the sum of discounted running energy costs over the expected lifetime of the product. Based on assumptions for the price of electricity, the individual discount rate, and the product's lifetime, we compared the discounted total lifetime costs of twin products to identify the economically rational option. An energy efficiency gap exists if the efficient twin product has a lower present value of total costs than its inefficient counterpart, but households purchase the inefficient product.

Using manufacturers' list prices, we found that the efficient twin product was never the economically rational choice, even if all other parameter assumptions were favoring the efficient product. The reason behind this phenomenon is that according to the list prices, the efficient twin is so much more expensive than the inefficient one that the lower discounted running costs can never make up for this difference. It would be interesting to further examine the formation of manufacturers' list prices and whether the price span between efficient and inefficient products are justified by production cost differences.

When using online shop prices for comparing present values of total costs of the twin products, the picture changed. The difference in purchase prices between efficient and inefficient twins was generally smaller, making the efficient twin the economically rational choice in a number of cases, especially if the assumptions on the other parameters like electricity prices or discount rates favored the efficient products. Increasing discount rates reduce the relative economic attractiveness of the efficient twins. However, there were cases in which the efficient twin was the economically rational choice even for very large discount rates. Hence, if the inefficient twins are still sold, as presented in anecdotal evidence, we are confronted with an energy efficiency gap. In these cases, encouraging the purchase of efficient appliances could provide a double dividend: Financial profits for private households can be expected as well as higher social welfare due to the reduction of negative externalities from the consumption of energy. The following chapter will provide some insights into the purchase motivation of households to explain the likely causes of the respective purchase decisions.

4 The influence of energy labels on private purchase decisions for household appliances: A field experiment

4.1. Introduction

As presented in section 2.4.2., there is evidence of an information gap causing privately inefficient purchase decisions and thus an energy efficiency gap. In the context of household appliances, for many countries energy labels are an established instrument to provide information about energy consumption and energy efficiency of appliances. In their review of the literature on energy labels for household appliances, Rohling & Schubert (2013) show that most studies are hypothetical and the evidence is inconclusive. Therefore, we chose to run a field experiment with real purchase decisions in order to assess the impact of energy labels on the purchase decisions for household appliances. In particular, we are interested in whether the presence of energy labels guides households to purchase products with higher energy efficiency and lower annual electricity consumption.

We first describe the general framework for energy labels in Switzerland before explaining the study design. After presenting our hypotheses, we inform about the collected data and our results. The chapter ends with a discussion of limitations of our field experiment and a conclusion.

4.2. Energy Labels in Switzerland

In Switzerland, energy labels exist for household appliances, lamps, televisions, automobiles and other goods (see Bundesamt für Energie BFE, 2016 for a complete overview). For many goods, presenting the energy label on or next to the physical products in stores is required by law. Swiss policy makers have decided to adopt the energy label created by the European Union. Figure 2 presents examples of the EU energy label for different classes of goods.

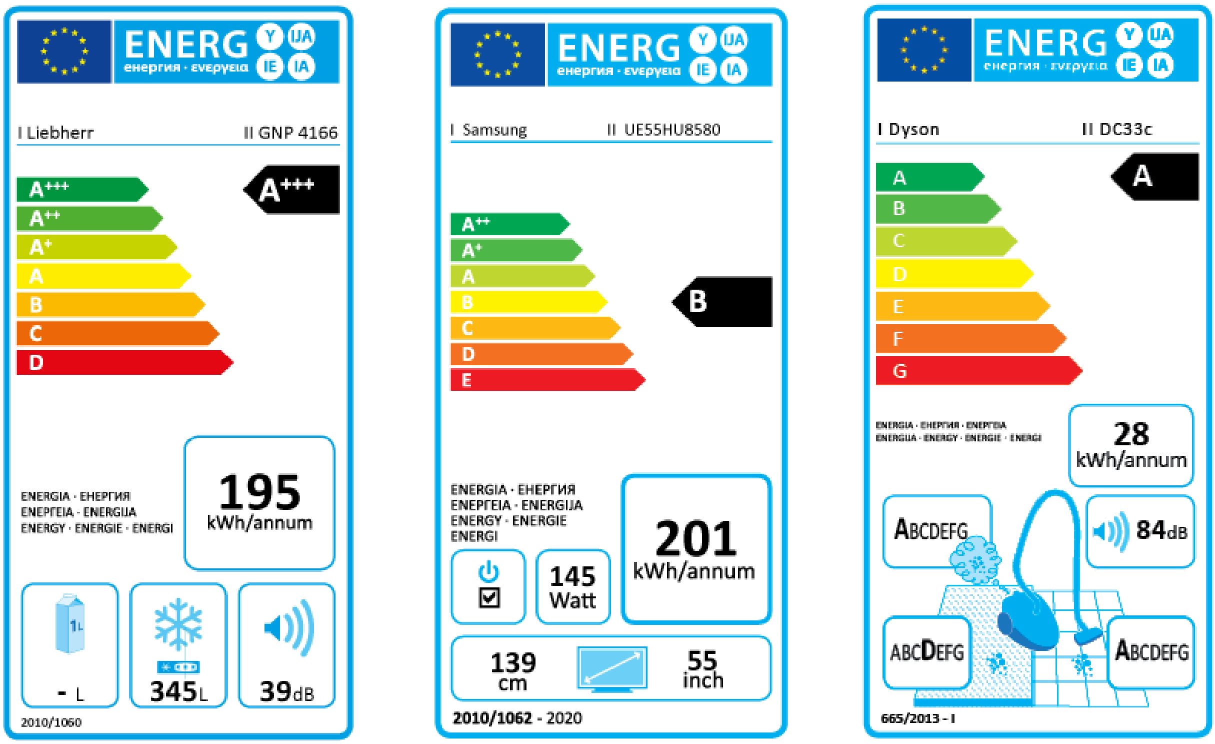


Figure 2: Example of the EU energy label for cooling devices (left), televisions (middle) and vacuum cleaners (right) with varying information about product characteristics.

Comparing the different labels presented in Figure 2, the following features pop up:

- The EU Energy Label contains a categorical, alphabetical rating scale for the energy efficiency class of appliances. This scale covers a large part of the label and gains additional salience through a color code from green to red. The range of the scale varies for different classes of goods (e.g. A+++ to D for cooling devices or A to G for vacuum cleaners), but always covers 7 categories.
- The EU Energy Label indicates the declaration of expected annual electricity use in kilowatt hours (kWh), based on standard testing by the manufacturers. The size of this information element varies between the different classes of goods.
- The EU Energy Label contains additional information specific for the respective class of goods (for instance on water consumption, size or noise).

The energy efficiency rating is based on an energy efficiency index that is calculated separately for each class of goods. For freezers for example, the index takes into account primarily energy consumption, the volume and the lowest temperature of different compartments (European Committee of Domestic Equipment Manufacturers CECED, 2015). The size of the appliance is also considered in the energy efficiency index for televisions (screen size) and for tumble dryers (filling quantity). For these classes of goods, the energy efficiency rating is a relative measure, relating energy consumption to the size of the product. Lower annual electricity use does not always lead to a higher energy efficiency rating: e.g. a freezer with 360l volume and an annual electricity use of 201 kWh receives an A+++-rating while a freezer with 212l volume and only 190 kWh annual electricity use receives an A++-rating. For vacuum cleaners on the other hand, the energy efficiency rating is only based on the absolute electricity consumption and thus simply puts the information of kWh/year in a categorical scale.

In recent years, Switzerland introduced minimum energy efficiency standards. Such standards are a policy tool used to force low-efficiency products out of the market (Harrington & Waide, 2004). They require that only appliances that meet the minimum energy efficiency standards are allowed to be sold. Switzerland currently applies minimum energy efficiency standards for cooling devices (minimum A++, see Bundesamt für Energie BFE, 2014), tumble dryers (minimum A+, see Bundesamt für Energie BFE, 2014b) and washing machines (minimum A, see Bundesamt für Energie BFE, 2014c).

The European Commission (2014) introduced a special regulation for the presentation of the EU Energy Label in online shops. This regulation has not (yet) been strictly enforced in Switzerland.

4.3. Study Design

4.3.1. General framework and choice of products

In our field experiment, we focused on an online shop in Switzerland to examine the influence of energy labels on private purchase decisions. We used the following criteria to select classes of goods for which we studied the effect of energy labels:

- Considerable annual use of electricity as stated on the EU Energy Label
- High variability in electricity consumption and energy efficiency class between different products in one class
- Relatively high sales figures

Based on these criteria, we chose the following products for our field experiment: 30 tumble dryers with 7 kg volume, 44 vacuum cleaners, and 56 freezers with volumes between 160l and 370l. A new series of televisions was introduced shortly before the start of our experiment. From this series, we chose 45 televisions with screen size 55-65 inches for “wave 1” of televisions and 45 televisions with screen size 27-65 inches for "wave 2".[22] Since there were no pre-study sales figures available for these televisions, they were not included in all parts of our data analysis.

4.3.2. Creation of a new energy label

The EU Energy label displays, as mentioned above, essentially physical and yearly information on products' energy consumption. In their review of the literature on energy labels for household appliances, Rohling & Schubert (2013) show that the impact of energy labeling proves to be stronger when the information on energy consumption is accumulated over a product's expected lifetime. In a recent study, Camilleri & Larrick (2014) find that both the metric (monetary instead of physical units are more powerful) and the scale (larger numbers are more powerful) of the information matter. We thus created a new energy label displaying monetary as well as lifetime-oriented information.

Figure 3 presents two examples of our new energy label. The *first piece* of information in both of them is a continuous scale of annual electricity costs of similar appliances in a color code from green (lowest electricity costs) to red (highest electricity costs). Both ends of the scale are given by the appliance using the least or the most electricity among similar products. The similarity of appliances is judged by their size.[23] For freezers, we use three size categories: 160l-230l volume, 230l-300l volume, and 300l-370l volume. For televisions, we use two size categories (55" screens and 60" to 65" screens) in the first wave and one size category (27" to 65" screens) in the second wave. Tumble dryers and vacuum cleaners are presented in one single category.[24] For each size category, the monetary values at the left end and right end of the annual electricity cost range are different, i.e. they are higher for larger size categories. The annual electricity costs are calculated by multiplying the annual electricity use in kWh stated on the EU Energy Label with the Swiss average electricity price of 20 cents per kWh (Bundesamt für Energie BFE, 2015).

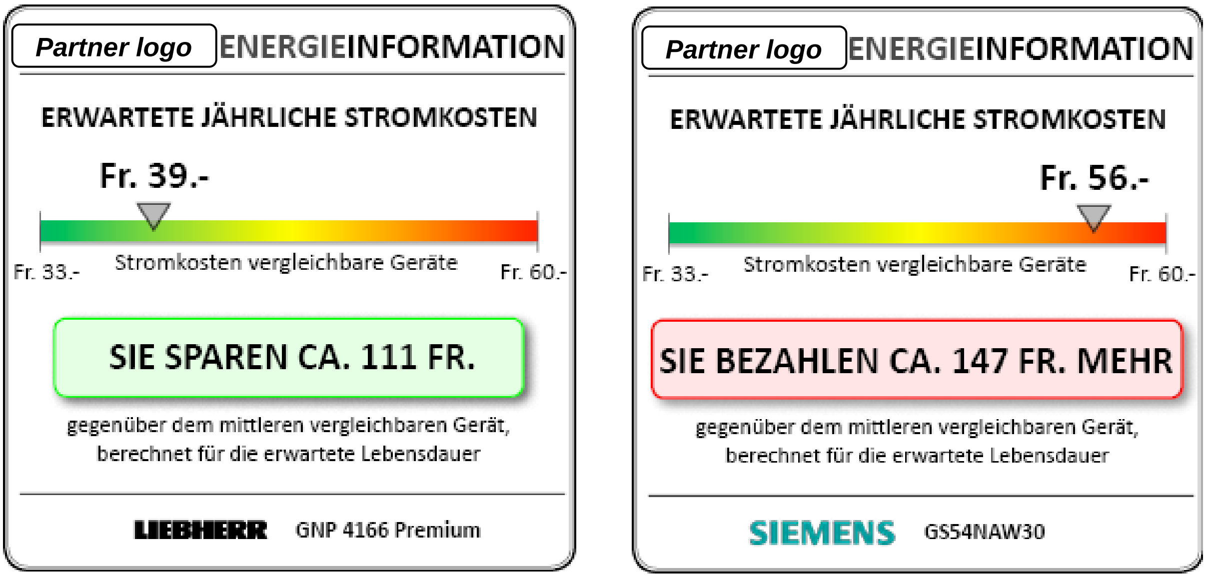


Figure 3: Newly created energy label for cooling devices with a focus on monetary information and a positive "gain" frame (left figure) or negative "loss" frame (right figure); placeholder displayed instead of the logo of the online shop to guarantee anonymity.

[22] See section 4.3.3. for more details on the first and second wave of televisions.
[23] We chose to compare products of similar sizes because the energy efficiency rating of the EU Energy Label also considers the size of a product. Additionally, we expect the majority of consumers to pre-select an appropriate size range based on their needs and then make the purchase decision among products within this selection. To examine this hypothesis, we used the second wave of televisions and included two questions regarding this issue in the online questionnaire.
[24] For vacuum cleaners, size is not a specific driver of energy use. For tumble dryers, we only considered appliances of one size (7 kg volume).

The *second piece* of information in the new energy label is a colored box with information on expected lifetime energy costs of the appliance. Instead of displaying the absolute value of lifetime energy costs, we provide a relative statement comparing an appliance's costs with the mean similar appliance (the middle of the electricity cost range mentioned above) as reference point. Lower costs compared to the reference appliance – a "gain" – are formulated as cost savings in a green box (see Figure 3, left-hand side). Higher costs than the reference appliance – a "loss" – are formulated as additional costs in a red box (see Figure 3, right-hand side). The separation of a gain frame (for efficient appliances) and a loss frame (for inefficient appliances) aims at triggering differential psychological effects. Especially the loss frame may trigger loss aversion among consumers, hence raising the (psychological) bar for purchasing an inefficient appliance (Kahneman et al., 1991). Lifetime electricity costs are calculated for an electricity cost of 20 cents per kWh and common lifetime expectancies of 15 years for freezers and tumble dryers and 10 years for televisions and vacuum cleaners (Topten.ch, 2015).[25]

As can be seen in Figure 3, the new energy label does not include any additional information specific to the class of goods. It is kept simple and looks identical for all classes of goods in order to facilitate comparisons for consumers. The label was created in German and French for each product in our study.

4.3.3. Field experiment

Starting in mid-June 2015, the EU Energy Labels were placed next to the product pictures in the German and the French version of the online shop of our cooperation partner and remained there for four weeks. After these four weeks, the EU Energy Labels were replaced by the new energy labels.[26] After another four weeks, we switched back to the EU Energy Labels and continued to switch back and forth between the two labels in four-week spans for a total of 6 months. Thus, both labels were displayed for 3x4 weeks, i.e. for a total of 12 weeks. This allows us to control for seasonal effects during the study period.

For televisions, we had a "wave 1" for 55" to 65" screens lasting for 2x4 weeks per energy label. In "wave 2" we included televisions with screen size 27" to 65" for the remaining 8 weeks.[27] Again, we presented the EU Energy Label for the first 4 weeks and switched to the new energy label for the final 4 weeks. We pooled all products into one size category for the new energy label in "wave 2". This allowed us to investigate whether comparisons of electricity costs for products of very different sizes have an effect on households' purchase decisions.

4.3.4. Online questionnaire

We gathered information about households' purchase decisions with an online questionnaire that customers of the online shop voluntarily filled out after having purchased a labeled product. The link to the online questionnaire was included in the order confirmation and was also sent out by e-mail. The questionnaire was available in German and French and included, among others, questions on purchase motives, expectations on product lifetime, perception of energy labels, environmental attitudes and energy literacy. The entire questionnaire in German and French is provided in the appendix. To incentivize customers to fill out the questionnaire, they were awarded a 40 Fr. gift card for the online shop when entering their order number at the end of the questionnaire. With the help of the order number, we were able to retrieve data on the product purchased and the purchase price. The implementation of the online questionnaire was approved by the ethics commission of ETH Zurich.

[25] In order to keep the label simple, these assumptions are not displayed. This is in line with labels currently in use, as for example the EU energy label is not transparent on the label itself on the assumptions made to calculate annual electricity use.
[26] In order to guarantee the anonymity of the online shop, we are unable to present illustrations of the placement of the energy labels in the online shop.
[27] 20 televisions from the first wave were included in the second wave.

4.4. Hypotheses

The main focus of our analysis lies on differential effects between the EU Energy Label and the new energy label. Our assumption is that customers visit an online shop with the intention to purchase a new product and that at least some of them consult the information on the energy label prior to their purchase decision. Energy labels could help to reduce the energy efficiency gap.

Let’s start with two hypotheses on the EU Energy Label. Using choice experiments and randomized information treatments, Newell & Siikamäki (2014) find that the energy efficiency letter grade from the EU Energy Label has a powerful effect in guding households’ energy efficiency decisions. Furthermore, Waechter, Sütterlin, & Siegrist (2015) illustrate that consumers tend to base their estimates of a product's electricity consumption mainly on the energy efficiency class (e.g., A) communicated on the EU Energy Label. Based on these insights, our first two hypotheses are the following:

H_1: Compared to the status quo without energy label, the presentation of the EU Energy Label guides consumers to purchase a higher proportion of energy-efficient products.

H_2: Compared to the status quo without energy label, the presentation of the EU Energy Label leads to a reduction in mean annual electricity consumption of purchased products.

Instead of an energy efficiency rating and information on annual electricity consumption in kWh, our new energy label provides monetary information on annual and lifetime electricity costs compared to other products of similar size. Newell & Siikamäki (2014) and Heinzle (2012) both find that disclosing monetary information on electricity costs is the most important element guiding consumers towards more energy-efficient purchase decisions, paticularly if the costs are presented for product lifetime. On these grounds our next two hypotheses are as follows:

H_3: Compared to the status quo without energy label, the presentation of the new energy label guides consumers to purchase a higher proportion of energy-efficient products.

H_4: Compared to the status quo without energy label, the presentation of the new energy label leads to a reduction in mean annual electricity consumption of purchased products.

Besides examining the impact of the two energy labels compared to the status quo without energy label separately, it is of interest to compare the effectiveness of the two energy labels. As mentioned above, the core features of the new energy label are: 1) A continuous scale with monetary information on annual electricity costs from lowest available cost (green color) to highest available cost (red color) and 2) lifetime information on electricity costs in a gain/loss-frame with the mean similar appliance as reference point. Based on the results by Newell & Siikamäki (2014) and Heinzle (2012), we would expect the information provided by the new energy label to be more effective than the EU Energy Label in guiding consumers towards more energy-friendly purchase decisions. On the other hand, the EU Energy Label has the advantage that it is an official and well-established label, whereas the new label is unfamiliar to the consumers and lacks reputation. Hence, we hypothesize as follows:

H_5: There is no difference in the mean annual electricity consumption of purchased products between the EU Energy Label and the new energy label.

Waechter, Sütterlin, & Siegrist (2015) show that consumers are subject to an “energy efficiency fallacy”, as they judge the energy-friendliness of products based on the relative energy efficiency rating of the EU Energy Label and not on the absolute electricity consumption of their devices. This means that with the EU Energy Label being displayed, larger products with higher energy efficiency ratings seem to be preferred over smaller products with lower energy efficiency ratings. This effect seems to be essentially caused by the dominant salience of the energy efficiency rating on the EU Energy Label. We presume that this effect disappears in our new energy label if there is only one size category:

H_6: Compared to the EU Energy Label, the new energy label leads on average to purchases of smaller products with lower annual electricity consumption.

With the information on household characteristics gathered in the online questionnaire, we are able to further investigate the driving forces of purchase decisions for the different appliances. Some interesting insights allowing to find additional explanations for the findings for H_1 – H_6 will be presented in section 4.6.4.

4.5. Data

4.5.1. Sales figures

For the study period from June to December 2015, the online shop provided us with daily sales figures for each labeled product. Table 7 presents the number of products sold during the time periods in which the respective energy labels were shown. The sales figures in Table 7 reveal that televisions were sold the most while only few tumble dryers were sold. Total sales were not always balanced between the two energy labels. This can partly be explained by seasonal effects. For example, the time period when the new energy label was shown for televisions of wave 2 partially coincided with the Christmas shopping period. When analyzing the data, we controlled for such seasonal effects.

We were also provided with sales figures for the selected products for the 12 weeks before our study period (end of March 2015 to mid-June 2015).[28] So we could compare purchases during our study period with a baseline period when no energy labels were displayed in the online shop.

Table 7: Number of products sold by class of goods during the time periods between June and December 2015 when each energy label was presented in the online shop.

	Freezers		Vacuum cleaners		Tumble dryers		Televisions	
	EU label	Own label	EU label	Own label	EU label	Own label	EU label	Own label
June 17 – July 14	78	-	106	-	19	-	106	-
July 15 – Aug 11	-	51	-	112	-	23	-	81
Aug 12 – Sep 8	58	-	168	-	24	-	112	-
Sep 9 – Oct 6	-	43	-	142	-	15	-	106
Oct 7 – Nov 3	60	-	154	-	27	-	*wave 1 ended*	
Nov 4 – Dec 1	-	40	-	176	-	20		
Total	**196**	**134**	**430**	**435**	**70**	**58**	**218**	**187**

Televisions wave 2:

Oct 16 – Nov 15	396	-
Nov 16 – Dec 14	-	615

4.5.2. Control variables

In order to identify the true label-effect, we have to control for other potential influences like changes in price and availability of a product during baseline and study period. If for example the price of energy-efficient products dropped while it remained constant for energy-inefficient products, it is likely that the share of energy-efficient products sold increases. If this price drop coincides with the introduction of the EU Energy Label, the change in the types of products sold could falsely be attributed to the presence of the energy label. We manually recorded the sales prices and the availability[29] of each product twice a week and used the respective information to control for the influence of price and availability on purchase decisions.

[28] As mentioned before, these sales figures are not available for televisions which were mostly launched in late May 2015. For televisions, comparisons to a baseline period without energy label are thus not possible.
[29] Based on whether a scheduled delivery date was designated.

Similarly, we gathered information of the inclusion of our selected products in special advertisment campaigns of the online shop and controlled for the respective impact on sales figures.

4.5.3. Online questionnaire

We received a total number of N=469 completed online questionnaires, which amounts to a response rate of about 27%[30]. The high response rate may be attributed to the incentive of the 40 Fr. gift card. 74% of the responders filled out the questionnaire in German, 26% in French. 19% of the responders were female. The age distribution of responders is presented in Figure 4. As could be expected for an online questionnaire conducted with customers of an online shop, the age group above 66 is underrepresented while younger adults between 26 and 45 are overrepresented compared to the Swiss population (Schweizerische Eidgenossenschaft, 2016).

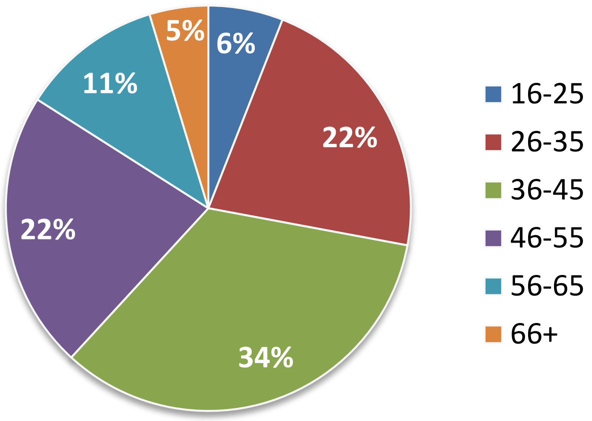


Figure 4: Age distribution of responders to the online questionnaire, N=469.

Table 8 presents the number of completed questionnaires by class of goods and by the type of energy label presented at the time of purchase. While in total, the representation of both energy labels is quite balanced, there is some disparity within the classes of goods. The sample for tumble dryers is very small, reflecting the low total sales figures for this class of goods.

Table 8: Number of completed questionnaires by class of goods and type of energy label shown.

Class of goods	EU Energy Label	Own Energy Label	Total
Televisions	152	118	270
Freezers	26	49	73
Vacuum cleaners	58	42	100
Tumble dryers	13	11	24
Total	249	220	469

4.6. Results

In this section, we describe the methods of analysis used to test the hypotheses presented in section 4.4. and the subsequent results. Since the four classes of goods selected for our study are rather diverse, their results are generally presented seperately. The section follows the order of the hypotheses from section 4.4

[30] In total, there were 2'092 products sold, but the 330 purchases of vacuum cleaners in the last 8 weeks were exempt from participation, as the number of completed questionnaires for vacuum cleaners was deemed sufficient. From the remaining 1'762 purchases, 469 customers completed the questionnaire, which amounts to 27%.

4.6.1. Hypotheses 1 and 2

H_1 and H_2 focus on the influence of the EU Energy Label on purchase decisions. As described in section 4.2., Swiss online shops are currently required to declare the energy efficiency rating of the product in the product description, but the established label itself is not displayed. In order to test H_1 and H_2, we compare the sales figures from the 12 week baseline period without energy label to the sales figures of the 3x4 weeks when the EU Energy Label was displayed.[31]

We examined all products for exceptional price changes, significant periods of unavailability or exceptional advertisement effects. Due to such effects, 13 freezers, 11 vacuum cleaners and 1 tumble dryer were excluded from our analysis of H_1 and H_2.

Hypothesis 1

H_1 concerns the energy efficiency of the purchased products, expressed by the EU energy efficiency rating. In order to examine whether the distribution of energy efficiency ratings among the products purchased is different when the EU Energy Label is shown compared to the baseline period without energy label, we perform chi-square tests of the goodness of fit. The results for the three applicable classes of goods are presented in Table 9.

Table 9: Number of products sold by class of goods and by energy efficiency rating in the baseline period without energy label and in the study period with the EU Energy Label, including chi-square tests for the goodness of fit.

Class of goods	Energy efficiency class	No energy label	EU Energy Label	Total
Vacuum cleaners:	**A**	227	269	496
	B	20	8	28
	C	0	0	0
	D	29	5	54
	E	135	65	200
	F	0	1	1
	G	12	10	22
	Total	423	378	801
	Pearson chi2(5) = 32.2511, $p < 0.001$			
Tumble dryers:	**A+++**	4	3	7
	A++	39	53	92
	A+	23	14	37
	Total	66	70	136
	Pearson chi2(2) = 4.3486, $p = 0.114$			
Freezers:	**A+++**	51	88	139
	A++	86	90	176
	Total	137	178	315
	Pearson chi2(1) = 4.6827, $p = 0.03$			

[31] As mentioned in section 4.3.1., there are no baseline sales figures for our selection of televisions, which is why this class of goods is exempt from this analysis.

For *vacuum cleaners*, we observe a highly significant (at the 1%-level) shift in the distribution of energy efficiency classes of purchased products when the EU Energy Label is displayed, particularly from E- and B-ratings towards A-ratings. Since the EU Energy Label had been introduced for vacuum cleaners in Switzerland only in 2015, some households may not yet be sensitized to considering energy efficiency in their purchases of vacuum cleaners. Presenting the EU Energy Label in the online shop might therefore have drawn the attention of some households towards the issue of energy efficiency, resulting in a strong increase of purchasing A-rated products.

For *tumble dryers*, the hypothesis that the EU Energy Label influences the purchase behavior has to be rejected given the results in Table 9. However, if the categories A+++ and A++ are pooled, the difference in energy efficiency ratings of the products purchased between the period without label and the period with the EU Energy Label is significant at the 10%-level (Pearson chi2(1) = 3.7819, p =0.05); the share of A+-rated products purchased is lower when the EU Energy Label is shown. As for freezers, this could be explained by the higher salience of the electricity consumption of the products. Additionally, there might be a lack of knowledge by some households that products more energy-efficient than A+ are available.

For *freezers*, we observe a significant (at the 5%-level) shift in purchases towards the highest energy efficiency rating A+++ when the EU Energy Label is displayed. It seems as if the presence of the EU Energy Label increased the salience of the energy characteristics of the product and thereby influenced the purchase decision. Additionally, without the information of the EU Energy Label, some customers might not have been aware that an energy efficiency class above A++ existed.

In sum, the presence of the EU Energy Label seems to guide consumers to purchase a higher proportion of energy-efficient products. H_1 thus cannot be rejected. Statements in the online questionnaire suggest that the energy efficiency rating is the key information element from the EU Energy Label for most households. 60% of the responders who purchased a product when the EU Energy Label was shown declared that the label influenced their purchase decision. Among this group, 73% of the households stated that the energy efficiency rating was the piece of information that mostly affected their purchase decision.

Hypothesis 2

With H_2 we address the mean annual electricity consumption of the purchased products. We assume the annual electricity consumption of a product as indicated by the manufacturers. The label-effect with respect to the mean annual electricity consumption can only deviate from the results presented for H_1 if the size of the products varies. We use two sample t-tests with equal variances to examine whether the mean annual electricity consumption of the purchased products increases or decreases when the EU Energy Label is presented (cf. Table 10).

Table 10: Mean annual electricity consumption of the purchased products by class of goods without and with EU Energy Label, including t-tests for differences in mean.

	No energy label		EU Energy Label		Difference	
Class of goods	**# obs**	**mean annual electricity use (in kWh)**	**# obs**	**mean annual electricity use (in kWh)**	**mean EU label – mean without label (in kWh)**	**Δ%**
Vacuum cleaners	423	37.8 (0.6)	378	34.0 (0.5)	-3.8*** (0.8)	-10.2%***
Tumble dryers	66	241.7 (7.5)	70	222.3 (5.8)	-19.4** (9.5)	-8.0%**
Freezers	137	202.6 (1.6)	178	201.9 (1.1)	-0.7 (1.9)	-0.3%

Standard errors in parentheses.

*,**,***: Significant at the 10%, 5%, and 1% levels, respectively.

Table 10 shows that the mean annual electricity consumption of purchased *freezers* does not significantly differ for periods with EU Energy Label and periods without energy label. This result seems to be contradicting the finding in Table 9 that proportionately more A+++-rated appliances are purchased when the EU Energy Label is presented. The contradiction is resolved, however, if we consider the volumes of the purchased freezers. A two-sample t-test shows a significant increase in the mean volume of purchased freezers for the EU Energy Label (M=277 l, SD=71.4) compared to the baseline without energy label (M=259 l, SD=67.9), $t(313) = 2.29$, p=0.012. Since smaller freezers are predominantly A++-rated and larger freezers are predominantly A+++-rated in our selection of products, it is possible that the presence of the EU Energy Label guided some households to purchase a larger appliance with the highest energy efficiency rating. This result would support the finding by Waechter, Sütterlin, & Siegrist (2015) that consumers judge the energy-friendlyness of a product based on the relative energy efficiency rating of the EU Energy Label and not based on the absolute electricity consumption of the device. In sum, given that there is no change in the mean annual electricity consumption for purchased freezers, H_2 has to be rejected for this class of goods.

Since the size of the product is not an issue for *vacuum cleaners* and for our selection of *tumble dryers*[32], the results presented in Table 10 are in line with the findings for H_1 for these classes of goods. The presence of the EU Energy Label significantly reduces the mean annual electricity consumption of purchased vacuum cleaners and tumble dryers. The reductions are rather large and amount to 10.2% for vacuum cleaners (significant at the 1%-level) and 8% for tumble dryers (significant at the 5%-level). H_2 thus cannot be rejected for these two classes of goods.

Key results for hypotheses 1 and 2:

- The EU Energy Label guides households to purchase a higher proportion of energy-efficient vacuum cleaners, tumble dryers, and freezers.
- The mean annual electricity consumption of purchased vacuum cleaners and tumble dryers is lower when the EU Energy Label is presented.
- The mean annual electricity consumption of purchased freezers remains unchanged when the EU Energy Label is presented, as a higher proportion of energy-efficient appliances with a higher volume is purchased.

4.6.2. Hypotheses 3 and 4

In order to test H_3 and H_4, we compare the sales figures from the 3x4 weeks in which the new energy label was displayed and the 12 weeks without an energy label.[33]

We controlled again for exceptional price changes, significant periods of unavailability or exceptional advertisement effects. We hence excluded 15 freezers[34], 11 vacuum cleaners, and 1 tumble dryer from our analysis of H_3 and H_4.

Hypothesis 3

H_3 concerns the energy efficiency of the purchased products. In order to examine whether the distribution of energy efficiency ratings among the products purchased is different when the new energy label is shown as compared to the baseline period without energy label, we perform chi-square tests of the goodness of fit. The results are presented in Table 11.

For *vaccum cleaners*, we observe a significant (at the 10%-level) shift from E- and D-rated products towards A-rated products when the new energy label is presented. This observation may be explained by the fact that A-rated appliances are always in the green section of the range of annual electricity costs. Furthermore, A-rated appliances are typically represented in a gain frame over product lifetime, while E- and D-rated appliances are typically in the red section of the range of annual electricity costs

---

[32] See section 4.3.2. for an explanation why size is not an issue for these classes of goods.
[33] As mentioned in section 4.3.1., there are no baseline sales figures for our selection of televisions, which is why this class of goods is exempt from this analysis.
[34] Two more freezers than in 4.6.1 are excluded because they were not available at the end of the study any more when the new energy label was displayed.

and represented in a loss frame over product lifetime. This information might trigger loss aversion and cause households to shy away from the purchase of less energy-efficient products.

For *tumble dryers*, Table 11 presents significantly (at the 10%-level) lower purchases of A+-rated products in the presence of the new energy label. This result is in line with the explanations stated above that the new energy label might lead some households away from purchasing inefficient products inducing an expected loss from lifetime electricity expenditures.

For *freezers*, we observe a significant (at the 10%-level) shift in purchases from A++-ratings to A+++-ratings. As for vacuum cleaners, this observation may be explained by the fact that A+++-rated appliances are always in the green section of the range of annual electricity costs and represented in a gain frame while A++-rated appliances are typically in the red section of the range of annual electricity costs and represented in a loss frame.

In sum, the new energy label with monetary information on electricity consumption seems to guide households to purchase products with higher energy efficiency ratings for all classes of goods. H_3 cannot be rejected.

Table 11: Number of products sold by class of goods and by energy efficiency class in the baseline period without energy label and in the study period with the new energy label, including chi-square tests for the goodness of fit.

Class of goods	Energy efficiency class	No energy label	New energy label	Total
Vacuum cleaners:	**A**	227	236	463
	B	20	17	37
	C	0	0	0
	D	29	12	41
	E	135	107	242
	F	0	0	0
	G	12	9	21
	Total	423	381	804
	Pearson chi2(4) = 8.9656, p = 0.062			
Tumble dryers:	**A+++**	4	3	7
	A++	39	45	84
	A+	23	10	33
	Total	66	58	124
	Pearson chi2(2) = 5.1981, p = 0.074			
Freezers:	**A+++**	51	70	121
	A++	49	40	89
	Total	100[35]	110	210
	Pearson chi2(1) = 3.4252, p = 0.064			

Hypothesis 4

H_4 addresses the mean annual electricity consumption of the purchased products, referring to the manufacturers' indications. We use two sample t-tests with equal variances to examine differences in

[35] Sales figures for freezers without energy label are different in Table 5 than in Table 3 because two additional freezers, which were not available at the end of the study period when the new energy label was shown, were excluded from the analysis.

mean annual electricity consumption of the purchased products when the new energy label is displayed. The results are presented in Table 12.

Table 12: Mean annual electricity consumption of the purchased products by class of goods without and with the new energy label, including t-tests for differences in mean.

	No energy label		New energy label		Difference	
Class of goods	**# obs**	**mean annual electricity use (in kWh)**	**# obs**	**mean annual electricity use (in kWh)**	**mean new label – mean no label (in kWh)**	**Δ%**
Vacuum cleaners	423	37.8 (0.6)	381	36.0 (0.6)	-1.7** (0.8)	-4.5%**
Tumble dryers	66	241.7 (7.5)	58	218.4 (6.2)	-23.3** (9.9)	-9.6%**
Freezers	100	199.5 (2.1)	110	200.1 (1.9)	+0.6 (2.8)	+0.3%

Standard errors in parentheses.

*,**,***: Significant at the 10%, 5%, and 1% levels, respectively.

The results from Table 12 are similar to those from Table 10: The effect of the new energy label on purchases of *freezers* disappears when annual electricity consumption is considered. This may be ascribed to the fact that smaller, A++-rated freezers in our sample have higher annual electricity consumption than larger, A+++-rated freezers, i.e. the volume has less impact on annual electricity consumption than the energy efficiency rating.[36] Moving from a high consumption product (A++-rated) in the red section of the electricity cost range to a low consumption product (A+++-rated) in the green section of the range is often accompanied by an increase in product volume. We observe an increase in mean volume of the purchased freezers when the new energy label is presented (M =298 l, SD =61.8) compared to the baseline without an energy label (M =282 l, SD =65.2), $t(208) = 1.76$, p =0.04. The fact that in spite of the presentation of the new energy label the annual electricity consumption remains unchanged suggests that the shift from the red section to the green section of the annual electricity cost range was often not within, but *between* the size categories.[37] In sum, we find no change in mean annual electricity consumption of purchased freezers when the new energy label is displayed; H_4 has to be rejected.

As could be expected, the results for *vacuum cleaners* and *tumble dryers* presented in Table 12 are in line with the findings for H_3. The presence of the new energy label reduces significantly the mean annual electricity consumption of purchased vacuum cleaners and tumble dryers. With 9.6% (significant at the 5%-level), reductions are particularly large for tumble dryers, while they amount to 4.5% (significant at the 5%-level) for vacuum cleaners. H_4 thus cannot be rejected for these two classes of goods.

Key results for hypotheses 3 and 4:

- The new energy label guides households to purchase a higher proportion of energy-efficient vacuum cleaners, tumble dryers, and freezers.
- The mean annual electricity consumption of purchased vacuum cleaners and tumble dryers is lower when the new energy label is presented.
- The mean annual electricity consumption of purchased freezers remains unchanged when the new energy label is presented, as the higher proportion of energy-efficient appliances goes along with an increase in the mean volume of purchased freezers.

[36] In fact, only the two smallest A++-rated freezers of our selection have lower energy consumption than the largest A+++-rated freezer.

[37] See section 4.3.2. for explanations of the three size categories. Since the range of annual electricity consumption has different endpoints for each size category, it is possible that the same monetary amount is in the red section of one size category while it is in the green section of the next larger size category.

4.6.3. Hypotheses 5 and 6

After having evaluated the effects of each energy label individually, we compare them now with each other. H_5 concerns all classes of goods during the entire study period while H_6 is specifically examined for the second wave of televisions. We controlled again for exceptional price changes, significant periods of unavailability or exceptional advertisement effects. Hence, we excluded 13 freezers, 1 vacuum cleaner, and 10 televisions of wave 1 from our analysis of H_5 and 6 televisions of wave 2 from our analysis of H_6.

Hypothesis 5

In order to test H_5, we compare the sales figures from the 3x4 weeks when the EU Energy Label was shown to the 3x4 weeks when the new energy label was presented in the online shop.[38] Our main interest lies in the mean annual electricity consumption of the purchased products. We use two sample t-tests with equal variances to examine whether the mean annual electricity consumption of the purchased products is different for the two energy labels. The results are presented in Table 13.

Table 13 shows a significant difference between the two energy labels only for *vacuum cleaners*. The EU Energy Label leads to a lower mean of annual electricity consumption of purchased vacuum cleaners than the new energy label, which means that H_5 has to be rejected. This rejection may be explained as follows:

- Answers from the online questionnaire show that the majority of households prefers the EU Energy Label because it is an established label: After seeing both energy labels, 59% of responders select the EU Energy label as being more informative, with 54% of them stating as the main reason that this label was already known and more comprehensible.
- The amounts of annual electricity costs for vacuum cleaners are at a very low level.[39] The mean annual electricity costs of the vacuum cleaners included in our study amount to 7.20 Swiss Francs. In the questionnaire, we observe that responders on average overestimate monthly electricity costs of vacuum cleaners by a factor of eight, which is by far the most extreme result of all classes of goods studied. The new energy label makes the (lower than expected) electricity costs salient, which might induce some households to neglect the electricity consumption of the product in their purchase decision and hence buy less efficient products.

Table 13: Mean annual electricity consumption of purchased products by class of goods when the EU Energy Label or the new energy label was displayed in the online shop, including t-tests for differences in mean.

	EU Energy Label		New energy label		Difference	
Class of goods	**# obs**	**mean annual electricity use (in kWh)**	**# obs**	**mean annual electricity use (in kWh)**	**mean new label – mean EU label (in kWh)**	**Δ%**
Vacuum cleaners	424	33.8 (0.5)	430	35.3 (0.5)	+1.5** (0.7)	+4.4%**
Tumble dryers	70	222.3 (5.8)	58	218.4 (6.2)	-3.9 (8.6)	-1.8%
Freezers	148	204.3 (2.2)	115	204.5 (2.6)	+0.2 (3.4)	+0.1%
TVs wave 1	129	131.0 (2.4)	146	130.2 (2.3)	-0.8 (3.3)	-0.6%
TVs wave 2	315	83.7 (2.5)	339	85.7 (2.3)	2.1 (3.4)	+2.5%

Standard errors in parentheses.

*,**,***: Significant at the 10%, 5%, and 1% levels, respectively.

[38] For televisions, we separately analyze the 2x4 weeks per energy label of the first wave and the four weeks per energy label of the second wave.

[39] While absolute amounts of electricity costs are low for vacuum cleaners, the proportion of electricity costs to purchase price is similar as for the other classes of goods.

For all other classes of goods, no significant differences in the mean annual electricity consumption can be observed and the effects of the EU Energy Label and the new energy label are more or less equivalent. Considering the fact that the new energy label could not profit from recognition and reputation effects strengthens its importance for households' purchase decisions. It can be argued that once established and well-reputed, the new energy label can be expected to have an even stronger effect than the EU Energy Label. This conjecture applies to those classes of goods for which annual electricity costs are at least in the double digit range in Swiss Francs. For vacuum cleaners with very low annual electricity costs, we observe a reduced effect of the new energy label compared to the EU Energy Label. The reason for this is the emphasis on the low electricity costs.

Hypothesis 6

H_6 addresses differences in the effects of the two energy labels when the new energy label compares televisions of a broad range of different sizes (27" to 65") within one new label comparing all of their annual electricity costs. We compare the four weeks of wave 2 when the EU Energy Label was displayed to the four weeks with the new energy label presented. [40]

The results for televisions of wave 2 presented in Table 13 lead to a rejection of H_6: The mean annual electricity consumption of the purchased products does not differ significantly for the two energy labels. A two-sample t-test also shows no significant difference in the mean screen size of purchased televisions for the EU Energy Label (M=42.9, SD=11.8) compared to the new energy label (M=43.6, SD=11.7), $t(652) = 0.684$, p=0.247. This means that for televisions, the "energy efficiency fallacy" does not seem to materialize in households' purchase decisions. The mean annual electricity consumption of purchased televisions seems to be unaffected by the way in which information on the electricity consumption is displayed (relative to the size of the product as for the energy efficiency rating of the EU Energy Label or in absolute monetary costs as for the new energy label).

A possible explanation for this result comes from the questionnaire: Only 26% of customers report that they approached their purchase decision without a clear conception of the size of television they would like to purchase. The majority of households had a clear conception of their preferred size of television and will therefore only compare products within their pre-selcted size range. For comparisons *within a size category*, there is no difference between relative and absolute information on electricity consumption and consequently no difference between the EU Energy Label and the new energy label.

Key results for hypotheses 5 and 6:

- The effects of the EU Energy Label and the new energy label are very similar.
- If the new energy label would have the same reputation as the EU Energy Label, it would most likely have a stronger effect to reduce mean annual electricity consumption of purchased products than the EU Energy Label.
- Vacuum cleaners are the exception: Because of low annual electricity costs, the new energy label has a weaker effect than the EU Energy Label.
- The "energy efficiency fallacy", i.e. the change from smaller less energy-efficient appliances to bigger more energy-efficient appliances, seems to be absent in the case of television purchases.

4.6.4. Additional insights from the questionnaire

In this subsection, we present additional insights gained from the online questionnaire on households' driving forces in purchase decisions.

[40] The energy efficiency rating from the EU Energy Label takes the screen size into account: a television with 55" screen size and an electricity use of 115 kWh/year receives an A+ rating while a television with 32" screen size and an electricity use of 51 kWh/year is only rated A. The new energy label of wave 2 compares televisions of all sizes with respect to their annual electricity use. Comparing the impact of the two energy labels on purchase decisions thus allows testing for the "energy efficiency fallacy".

Trust in energy labels

For consumers who lack trust in the information of energy labels, it can be expected that the presence of an energy label has little or no impact. In the questionnaire, customers expressed a high degree of confidence in the correctness of information provided by energy labels. In fact, only 4% of responders state that they distrust the information on energy labels (choice of “d” or “e” in item 15 in the questionnaire; see appendix). A lack of trust in the energy label hence does not seem to be an issue in keeping households from purchasing products with lower annual electricity consumption.

Expected product lifetime

The longer a product is expected to last, the more likely an “investment” in a more energy-efficient product with a higher purchase price pays off over the product’s lifetime.[41] For shorter expected product lifetimes, accumulated running electricity costs are less relevant. The inefficient products with higher annual electricity consumption might then be the economically rational option more often (see Equation (5) in section 3.2). Households’ expected product lifetimes are on average only slightly shorter than the values used for our lifetime cost calculation on the new energy label (15 years for freezers and tumble dryers, 10 years for vacuum cleaners and televisions): 13.4 years (SD=5.1) for freezers, 12.3 years (SD=4.3) for tumble dryers, 8.9 years (SD=3.5) for vacuum cleaners, and 8.4 years (SD=3.7) for televisions. Hence, mean expected product lifetimes are sufficiently long to make purchases of products with low annual electricity consumption economically attractive.

Financial literacy

Households wanting to make an economically optimal choice when buying electric appliances need the cognitive abilities to make financial calculations with respect to the lifetime costs of a product. We tested the financial literacy of households (see items 21-24 in the questionnaire in the appendix) and examined its impact on households’ purchase decisions. We found that over all classes of goods the financial literacy score (0=lowest score, 4=highest score) is negatively correlated with annual electricity consumption of the purchased products, but the effects are not significant ($r(438) = -0.07$, $p = 0.13$). There seems to be weak evidence that households with better financial literacy tend to purchase products with lower annual electricity consumption.

Liquidity constraints

Due to liquidity constraints, some households may not have the financial means to purchase more energy-efficient products with higher upfront costs.[40] Instead, they buy less energy-efficient products at cheaper prices, even if the expected total lifetime costs of these products are higher. We asked households to self-report their liquidity constraints (see item 16 in the questionnaire in the appendix). It turned out that with respect to the purchase costs of the appliances in our sample only very few customers considered themselves as liquidity-constrained. Liquidity constraints thus do not seem to be an issue in keeping households from purchasing products with lower annual electricity consumption.

Environmental attitudes

Households with more environmentally friendly attitudes may purchase products with lower annual electricity consumption in order to prevent further environmental damage. From the items in our questionnaire (see items 25 and 26 in the questionnaire in the appendix) we derived proxies to measure the *awareness* for the societal importance of saving energy and the *willingness* to personally save energy. The reliability of these scales can be expressed in values of Cronbach’s α with 0.78 and 0.85 respectively. There seems to be no significant correlation between the awareness and willingness-to-save scales on the one hand and the annual electricity consumption or the energy efficiency ratings of the purchased products on the other hand.

---

[41] This perspective applies to freezers and tumble dryers, for which the energy efficiency of the product is a valuable aspect, leading to a negative correlation of purchase price and electricity consumption. For vacuum cleaners and televisions on the other hand, purchase price and electricity consumption are positively correlated, as high-end products tend to offer more performance accompanied by higher electricity consumption.

Key results from the questionnaire:

- A lack of trust in the energy label, short expected product lifetimes, or liquidity constraints seem to be no major issue in keeping households from purchasing products with lower annual electricity consumption.
- Households with better financial literacy tend to purchase products with lower annual electricity consumption.
- There seems to be no correlation between reported environmentally friendly attitudes on the one hand and environmental friendliness of purchased products on the other hand.

4.7. Limitations

Our field experiment studying the effects of energy labels on households' purchase decisions has various limitations. Most of them are due to practical reasons within the general framework of this study.

First of all, we only had a one shot chance to present an alternative label to the EU Energy Label. The low sales figures for products like freezers and tumble dryers together with time restrictions for the duration of the experiment prevented us from testing different treatments with different types of energy labels. The new energy label considered two main pieces of information: the range of annual electricity costs over a variety of similar products and the monetary amount to be saved or lost over the product's lifetime. In principle, these two pieces of information should be studied separately to disentangle the effects of both variations. Furthermore, variations in energy label design or in the reference point set for the calculation of electricity cost savings or losses should be examined. A lab study on energy labels by Newell & Siikamäki (2014) analyzes the design of energy labels by changing only one aspect at a time – in the field, this would require more treatments and thus larger sales figures to which we had no access.

Additionally, due to technical restrictions, we were unable to randomly assign the type of energy label presented to a customer of the online shop. Therefore, we presented the two energy labels in temporal sequences. Our approach encompasses the risk of external influences which we tried to control for by eliminating products with external "shocks" from the analysis. It would be desirable, however, to randomize the type of energy label shown to a customer e.g. by network IP address. This approach would be particularly helpful if several different types of energy labels are to be tested.

Furthermore, when comparing the EU Energy Label with the new energy label, it is difficult to distinguish the effects of information from the effects of trust and reputation. The EU Energy Label is well-established in Switzerland, has been attached to products in stores for several years, and is presented in the name of the European Union. The new energy label on the other hand is presented in the name of the online shop and is otherwise completely new and unknown. Disentangling the effects of reputation and trust from the effects of information is a promising task for future research. However, given the fact that the new energy label did not perform worse than the EU Energy Label although it had no reputation at all highlights the potential that monetary and lifetime-oriented energy labels may have. Hence, it seems worthwile to push such labels forward via the regulator and to give them more "official importance". A further increase of the energy efficiency of households' purchases, i.e. a further narrowing down of the energy efficiency gap, can be expected.

4.8. Conclusion

Energy labels are an established instrument to provide information about the energy consumption and energy efficiency of an appliance. Policy makers usually promote energy labels in order to call households' attention to the energy consumption of a product and guide them to more energy-efficient products. Yet, it is not clear whether and which energy labels are effective. Literature generally states that energy labels are effective, yet there is no clear consensus on the optimal design of energy labels.

In our field experiment, we found that the mean annual electricity consumption of purchased vacuum cleaners and tumble dryers was lower when the EU Energy Label was presented. For freezers, we observed a shift in the energy efficiency ratings of purchased products towards the highest category (A+++). Yet, we also observed an increase in the mean volume of purchased appliances. In combination, these two effects caused the mean annual electricity consumption of purchased freezers to remain unchanged when the EU Energy Label was presented.

Since the EU Energy Label only displays physical information of electricity consumption and literature suggests the importance of monetary and lifetime information for purchase decisions, we designed a new energy label. The new energy label presented a range of annual electricity costs for products of similar size, color-coded from green (product with lowest costs) to red (product with highest costs). Additionally, the new energy label illustrated expected lifetime electricity cost savings or losses if the appliance uses less or more electricity than the mean product in its category.

Compared to the baseline period without energy label, we found similar effects for the new energy label as for the EU Energy Label. The only difference between the two labels was observed for vacuum cleaners, where the EU Energy Label led to a larger reduction of the mean annual electricity consumption of purchased products. A possible explanation for this effect is that annual electricity costs for vacuum cleaners are low in absolute terms and massively overestimated by households. Making these small amounts salient might lead some households to neglect the electricity consumption for their purchase decision when they see the new energy label.

Comparing the effects of the EU Energy Label with the effects of the new energy label brings up the issue of trust in labels and familiarity with labels. Even though the new energy label had – compared to the EU Energy Label – no “official reputation” at all and was completely unfamiliar to the customers, the new label’s impacts were similar to those of the EU Energy Label. Hence, there seems to be a high potential for monetary and lifetime-oriented energy labels, particularly for classes of goods with large amounts of annual electricity costs.

5 Conclusions and Policy Implications

In this project, we were interested in the analysis of driving forces of households' purchase decisions with respect to energy-using durables. We wanted to assess the relevance and causes of an energy efficiency gap in Switzerland. We showed that market failures and behavioral anomalies partly explain the observation that private households tend to purchase less energy-efficient appliances than privately optimal. However, hidden costs may lead to an overestimation of the energy efficiency gap.

Our analysis of the Swiss energy efficiency gap focused on white goods and other electric appliances including televisions. For white goods, we investigated into so-called twin products which only vary in purchase prices and electricity consumption. We found that the efficient products are never the economically optimal choice when manufacturers' list prices are used by the decision-makers. According to manufacturers, the large sales price differences between efficient and inefficient products are not even covering the substantially higher production costs of the efficient products. This implies that the economic incentives for manufacturers to improve the energy efficiency of their products are not particularly large. From a policy perspective, it might therefore be appropriate to encourage or even force manufacturers to further improve their products' energy efficiency. This might be done either with economic incentives or with bans in the form of dynamically adjusting minimum efficiency standards.

Using online shop prices in the comparison of present values of total costs, we found a considerable number of cases in which the efficient twin products represent the economically optimal choices, which customers are interested to buy. Nevertheless, there were also cases in which inefficient products were purchased even though they were not the economically optimal choice, i.e. where we have an energy efficiency gap. This means that there is potential to increase private and social welfare by guiding consumers to purchase more energy-efficient appliances.

Energy labels are a suitable policy instrument to guide consumers' purchase decisions towards higher energy efficiency. We studied the effectiveness of energy labels in a field experiment in an online shop. We found that both, the EU Energy Label as well as a newly designed energy label with a monetary and lifetime-oriented focus were generally effective in guiding households to purchase a higher proportion of energy-efficient products. For policy makers, enforcing the EU Energy Label to be presented in online shops could thus be a first step to increase the energy efficiency of purchased products. There is additional potential by improving the energy efficiency rating scale of the EU Energy Label. We recommend to complement the EU Energy Label by information on the efficiency rating categories that are allowed to be sold in Switzerland. The information may raise the attractiveness of highly rated products and thus increase the energy efficiency of purchased products.

For freezers, we found a "volume-effect" for both energy labels: While both energy labels guided consumers to purchase a higher proportion of energy-efficient freezers, the mean volume of purchased appliances also increased. An approach to eliminate the volume-effect could be to rate products only based on their absolute electricity consumption and not on electricity consumption relative to the size of the product (as done for the EU Energy Label). For the newly designed energy label, the volume-effect might be eliminated by arranging products of all sizes on one single range of annual electricity costs, as done for televisions of wave 2 in our field experiment.

For both energy label types, one might also think of defaults or nudges. Nudges, for example, could be relevant if in online shops one first has to make a size-decision with a default on smaller appliances or if highly energy-efficient products and smaller products are always the first appliances the customers are presented with.

Given the fact that the new energy label generally did not perform worse than the EU Energy Label although it had no reputation at all highlights the potential that monetary and lifetime-oriented energy labels may have. Hence, it seems worthwile to push such labels via the regulator and to give them more "official importance". A further increase of the energy efficiency of households' purchases, i.e. a further narrowing down of the energy efficiency gap, can be expected. This is particularly the case for classes of goods with high annual electricity costs like white goods or air conditioners. For classes of goods with a high rate of annual electricity costs compared to the purchase price but with low absolute amounts of annual electricity costs, grading scales like the EU energy efficiency rating seem to be more promising than electricity cost information. In these cases, measures that do *not* highlight the fact that electricity costs are hardly relevant appear more appropriate.

Overall, it turns out that a well-designed mixture of energy efficiency ratings and monetary labels with annual and lifetime information could help to narrow down the energy efficiency gap. Minimum standards for producers and volume nudges for households are suitable measures to reinforce a reduction in energy consumption.

References

Abaluck, B. J., & Gruber, J. (2011). Choice Inconsistencies among the Elderly: Evidence from Plan Choice in the Medicare Part D Program. *American Economic Review*, *101*(June), 1180–1210.

Allcott, H. (2011). Consumers ' Perceptions and Misperceptions of Energy Costs. *American Economic Review*, *101*(3), 98–104.

Allcott, H. (2013). The Welfare Effects of Misperceived Product Costs: Data and Calibrations from the Automobile Market. *America Economic Journal*, *5*(3), 30–66.

Allcott, H., & Greenstone, M. (2012). Is There an Energy Efficiency Gap? *Journal of Economic Perspectives*, *26*(1), 3–28.

Allcott, H., & Taubinsky, D. (2014). The Lightbulb Paradox: Evidence from Two Randomized Experiments.

Allcott, H., & Wozny, N. (2014). Gasoline Prices, Fuel Economicy, and the Energy Paradox. *The Review of Economics and Statistics*, *96*(5), 779–795. doi:10.1162/REST

Andersen, S., Harrison, G. W., Lau, M. I., & Rutström, E. E. (2014). Discounting behavior: A reconsideration. *European Economic Review*, *71*, 15–33. doi:10.1016/j.euroecorev.2014.06.009

Anderson, C. D., & Claxton, J. D. (1982). Barriers to Consumer Choice of Energy Efficient Products. *Journal of Consumer Research*, *9*(2), 163–170.

Andreoni, J., & Sprenger, C. (2012). Estimating Time Preferences from Convex Budgets. *American Economic Review*, *102*(7), 3333–3356.

Baddeley, M. (2011). Energy, the Environment and Behaviour Change: A survey of insights from behavioural economics.

Bento, A. M., Li, S., & Roth, K. (2012). Is there an energy paradox in fuel economy? A note on the role of consumer heterogeneity and sorting bias. *Economics Letters*, *115*(1), 44–48. doi:10.1016/j.econlet.2011.09.034

Blumstein, C., Krieg, B., Schipper, L. E. E., & York, C. (1980). Overcoming Social and Institutional Barriers to Energy Conservation. *Energy*, *5*, 355–371.

Brown, M. A. (2004). Obstacles to Energy Efficiency. *Encyclopedia of Energy*, *4*, 465–475.

Bundesamt für Energie BFE. (2014a). Energieetikette für Kühl- und Gefriergeräte. Retrieved from http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_535522878.pdf

Bundesamt für Energie BFE. (2014b). Energieetikette für Wäschetrockner. Retrieved from http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_744148314.pdf

Bundesamt für Energie BFE. (2014c). Energieetikette für Waschmaschinen. Bern. Retrieved from http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_527817332.pdf

Bundesamt für Energie BFE. (2015). Energieeffizienz im Haushalt. Retrieved December 01, 2015, from http://off-fr.ch/Portals/0/Images/Brochure/EnergieSchweiz_Broschuere.pdf

Bundesamt für Energie BFE. (2016). Bundesamt für Energie BFE - Die Energieetikette.

Busse, M. R., Knittel, C. R., & Zettelmeyer, F. (2013). Are Consumers Myopic ? Evidence from New and Used Car Purchases and Florian Zettelmeyer Evidence from New and Used Car Purchases.

Camilleri, A. R., & Larrick, R. P. (2014). Metric and Scale Design as Choice Architecture Tools. *Journal of Public Policy & Marketing*, *33*(1), 108–125. doi:10.1509/jppm.12.151

Chetty, R., Looney, A., & Kroft, K. (2009). Salience and Taxation: Theory and Evidence. *American Economic Review*, *99*(4), 1145–1177. doi:10.1257/aer.99.4.1145

Coller, M., & Williams, M. B. (1999). Eliciting Individual Discount Rates. *Experim*, *2*, 107–127.

Convery, F. J. (2011). Reflections-Energy Efficiency Literature for Those in the Policy Process. *Review of Environmental Economics and Policy*, *5*(1), 172–191. doi:10.1093/reep/req026

DEFRA. (2010). *Behavioural economics & energy using products: scoping research on discounting behaviour and consumer reference points*.

DellaVigna, S. (2009). Psychology and Economics: Evidence from the Field. *Journal of Economic Literature*, *47*(2), 315–372. doi:10.1257/jel.47.2.315

Epper, T., & Fehr-Duda, H. (2015). THE MISSING LINK: Unifying Risk Taking and Time Discounting.

European Commission. Delegierte Verordnung (EU) Nr. 518/2014 der Kommission (2014). Bruss: European Commission. Retrieved from http://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32014R0518&from=DE

European Committee of Domestic Equipment Manufacturers CECED. (2015). New EU Energy Label. Retrieved from http://www.newenergylabel.com/index.php/download_file/17/

Fehr-Duda, H., & Epper, T. (2012). Probability and Risk: Foundations and Economic Implications of Probability-Dependent Risk Preferences. *Annual Review of Economics*, *4*(1), 567–593. doi:10.1146/annurev-economics-080511-110950

Frederick, S., Loewenstein, G., & Donoghue, T. O. (2002). Time Discounting and Preference: A Critical Time Review. *Journal of Economic Literature*, *40*(2), 351–401.

Gabaix, X., & Laibson, D. (2006). Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets. *The Quarterly Journal of Economics*, (May), 505–540.

Gately, D. (1980). Idividual discount rates and the purchase and utilization of energy-using durables: comment. *The Bell Journal of Economics*, *11*(1), 373–374.

Gerarden, T. D., Newell, R. G., & Stavins, R. N. (2015). Assessing the Energy-Efficiency Gap. Cambridge, MA.

Gillingham, K., Newell, R. G., & Palmer, K. (2009). Energy Efficiency Economics and Policy. *Annual Review of Resource Economics*, *1*, 597–620.

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

Golove, W. H., & Eto, J. H. (1996). Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency.

Greening, L. A., Greene, D. L., & Difiglio, C. (2000). Energy efficiency and consumption - the rebound effect - a survey. *Energy Policy*, *28*, 389–401.

Halevy, Y. (2015). Time Consistency: Stationarity and Time Invariance. *Econometrica*, *83*(1), 335–352. doi:10.3982/ECTA10872

Harrington, L., & Waide, P. (2004). Labels and Standards for Energy. *Encyclopedia of Energy*, *3*, 599–611.

Hausman, J. A. (1979). Individual discount rates and the purchase and utilization of energy-using durables. *The Bell Journal of Economics*, *10*(1), 33–54.

Heinzle, S. L. (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

Helfand, G., & Wolverton, A. (2011). Evaluating the Consumer Response to Fuel Economy: A Review of the Literature. *International Review of Environmental and Resource Economics*, *5*(2), 103–146.

Hirst, E., & Brown, M. (1990). Closing the efficiency gap: barriers to the efficient use of energy. *Resources, Conservation and Recycling*, *3*(4), 267–281. doi:10.1016/0921-3449(90)90023-W

Hossain, T., & Morgan, J. (2006). ... Plus Shipping and Handling: Revenue (Non) Equivalence in Field Experiments on eBay. *Advances in Economic Analysis & Policy*, *6*(2), 1–27.

Houde, S. (2014). How Consumers Respond to Environmental Certification and the Value of Energy Information.

Howarth, R. B. (2004). Discount Rates and Energy Efficiency Gap. *Encyclopedia of Energy*, *1*, 817–822.

Howarth, R. B., & Sanstad, A. H. (1995). Discount Rates and Energy Efficiency. *Contemporary Economic Policy*, *13*(3), 101–109.

Jaffe, A. B., Newell, R. G., & Stavins, R. N. (2004). Economics of Energy Efficiency. *Encyclopedia of Energy*, *2*, 79–90.

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., Knetsch, J. L., & Thaler, R. H. (1991). Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias. *The Journal of Economic Perspectives*, *5*(1), 193–206.

Kahneman, D., & Sugden, R. (2005). Experienced Utility as a Standard of Policy Evaluation. *Environmental and Resource Economics*, *32*(1), 161–181. doi:10.1007/s10640-005-6032-4

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

Kahneman, D., Wakker, P. P., & Sarin, R. (1997). Back to Bentham? Explorations of Experienced Utility. *The Quarterly Journal of Economics*, *112*(2), 375–405.

Laibson, D. (1997). Golden eggs and hyperbolic discounting. *The Quarterly Journal of Economics*, (May), 443–477.

Levine, M. D., Koomey, J. G., Mcmahon, J. E., Sanstad, A. H., & Hirst, E. (1995). Energy efficiency policy and market failures. *Annual Review of Energy and the Environment*, *20*, 535–555.

Loewenstein, G. F., & Prelec, D. (1992). Anomalies in Intertemporal Choice: Evidence and an Interpretation. *The Quarterly Journal of Economics*, *107*(2), 573–597.

Loewenstein, G., & Thaler, R. H. (1989). Anomalies: Intertemporal Choice. *The Journal of Economic Perspectives*, *3*(4), 181–193.

Newell, R. G., & Siikamäki, J. (2014). Nudging Energy Efficiency Behavior: The Role of Information Labels. *Journal of the Association of Environmental and Resource Economists*, *1*(4), 555–598.

O'Malley, E., Scott, S., & Sorrell, S. (2003). Barriers to Energy Efficiency: Evidence from Selected Sectors. *Policy Research Series*, *47*(18269).

Prognos AG, Infras AG, & TEP Energy GmbH. (2015). *Analyse des schweizerischen Energieverbrauchs 2000 - 2014 nach Verwendungszwecken*.

Rohling, M., & Schubert, R. (2013). Energy labels for household appliances and their disclosure format: A literature review Energy labels for household appliances - Overview.

Sanstad, A. H., & Howarth, R. B. (1994). "Normal" markets, market imperfections and energy efficiency. *Energy Policy*, *22*(10), 811–818. doi:10.1016/0301-4215(94)90139-2

Schweizerische Agentur für Energieeffizienz S.A.F.E. (2015). *Schweizer Verkaufsstatistik Geräte 2004 – 2014* (pp. 1–10). Retrieved from http://www.topten.ch/uploads/images/download-files/FEA-Geraetestatistik-2004-2014.pdf

Schweizerische Eidgenossenschaft. (2016). Bevölkerung nach Alter. Retrieved March 31, 2016, from http://www.bfs.admin.ch/bfs/portal/de/index/themen/01/02/blank/key/alter/gesamt.html

Shogren, J. F., & Taylor, L. O. (2008). On Behavioral-Environmental Economics. *Review of Environmental Economics and Policy*, *2*(1), 26–44. doi:10.1093/reep/rem027

Sorrell, S., Dimitropoulos, J., & Sommerville, M. (2009). Empirical estimates of the direct rebound effect: A review. *Energy Policy*, *37*(4), 1356–1371. doi:10.1016/j.enpol.2008.11.026

Toppreise Preisvergleich GmbH. (2015). Toppreise.ch - Preisvergleich Schweiz. Retrieved October 21, 2015, from http://www.toppreise.ch/

Topten.ch. (2015). Ratgeber Gefriergeräte. Retrieved December 01, 2015, from http://www.topten.ch/deutsch/ratgeber/ratgeber_gefrierschranke.html&fromid

Train, K. (1985). Discount Rates in Consumers' Energy-related Decisions: A Review of the Literature. *Energy*, *10*(12), 1243–1253.

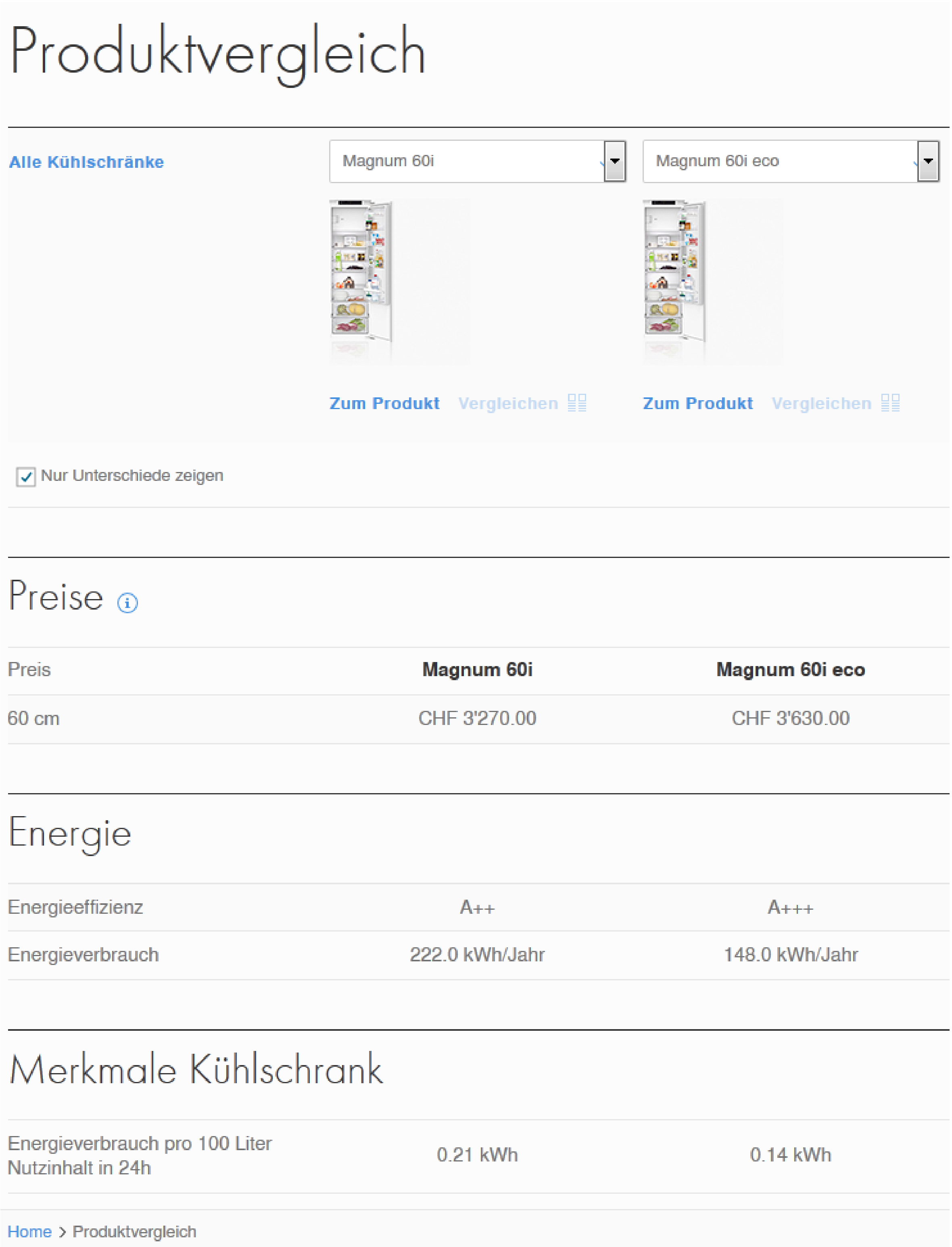
Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124–1131.

V-Zug. (2015). Produktvergleich. Retrieved December 22, 2015, from http://www.vzug.com/ch/de/compare_products?p=5103000005&bp=baseproduct_51030-_Kuehlschrank_Magnum_eco&cat=refrigerator&p=5102400005&bp=baseproduct_51024-_Kuehlschrank_Magnum&cat=refrigerator

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*, 193–202. doi:10.1016/j.jclepro.2015.01.011

Wiel, S., & Mcmahon, J. E. (2005). *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting - 2nd Edition*.

Appendix



Produktvergleich

Alle Kühlschränke | Magnum 60i | Magnum 60i eco

Zum Produkt Vergleichen | Zum Produkt Vergleichen

Nur Unterschiede zeigen

Preise

Preis	Magnum 60i	Magnum 60i eco
60 cm	CHF 3'270.00	CHF 3'630.00

Energie

Energieeffizienz	A++	A+++
Energieverbrauch	222.0 kWh/Jahr	148.0 kWh/Jahr

Merkmale Kühlschrank

Energieverbrauch pro 100 Liter Nutzinhalt in 24h	0.21 kWh	0.14 kWh

Home > Produktvergleich

Figure 5: Product comparison of two refrigerators using the option “only show differences”, which demonstrates that the two refrigerators are twin products, only differing in energy use and purchase price. Source: V-Zug (2015).

Brand	Model	Vol (l)	kWh	Efficiency	Op cost/a (Fr.)	LCC (Fr.)	List price (Fr.)	Total cost list price (Fr.)	Cost difference (Fr.)	Lowest online price (Fr.)	Total cost online price (Fr.)	Cost difference (Fr.)
Bauknecht	KVEE 3161	224	127	A+++	25.40	381.00	2555.00	2936.00	73.00	1300.90	1681.90	24.50
Bauknecht	KVEE 3160	224	191	A++	38.20	573.00	2290.00	2863.00		1084.40	1657.40	
Bauknecht	KVI 2951	135	104	A+++	20.80	312.00	1785.00	2097.00	76.00	891.05	1203.05	-25.10
Bauknecht	KVI 2950	135	152	A++	30.40	456.00	1565.00	2021.00		772.15	1228.15	
Bauknecht	KVIE 3161	224	127	A+++	25.40	381.00	2555.00	2936.00	73.00	1229.50	1610.50	-37.30
Bauknecht	KVIE 3160	224	191	A++	38.20	573.00	2290.00	2863.00		1074.80	1647.80	
Bauknecht	KVIE 3261 CH	257	135	A+++	27.00	405.00	3345.00	3750.00	476.00	1468.00	1873.00	-11.30
Bauknecht	KVIE 3260 CH	257	203	A++	40.60	609.00	2665.00	3274.00		1275.30	1884.30	
Bauknecht	KVIE 3261 EU	257	135	A+++	27.00	405.00	3345.00	3750.00	476.00	1630.00	2035.00	151.10
Bauknecht	KVIE 3260 EU	257	203	A++	40.60	609.00	2665.00	3274.00		1274.90	1883.90	
Electrolux	IK2070SR	181	115	A+++	23.00	345.00	2350.00	2695.00	244.00	1179.00	1524.00	19.00
Electrolux	IK2065SL	181	172	A++	34.40	516.00	1935.00	2451.00		989.00	1505.00	
Electrolux	IK227SL	219	127	A+++	25.40	381.00	2640.00	3021.00	114.00	1343.00	1724.00	-46.00
Electrolux	IK225SR	219	189	A++	37.80	567.00	2340.00	2907.00		1203.00	1770.00	
Electrolux	IK3029SR	286	143	A+++	28.60	429.00	3395.00	3824.00	129.00	1679.00	2108.00	-36.00
Electrolux	IK3026SR	286	215	A++	43.00	645.00	3050.00	3695.00		1499.00	2144.00	
Siemens	KI21RAD40	144	65	A+++	13.00	195.00	2030.00	2225.00	344.00	667.00	862.00	-139.00
Siemens	KI21RAD30	144	97	A++	19.40	291.00	1590.00	1881.00		710.00	1001.00	
Siemens	KI22LAD40	124	98	A+++	19.60	294.00	2030.00	2324.00	287.00	667.00	961.00	-196.00
Siemens	KI22LAD30H	127	149	A++	29.80	447.00	1590.00	2037.00		710.00	1157.00	
Siemens	KI31RAD40	172	67	A+++	13.40	201.00	2130.00	2331.00	351.00	740.00	941.00	9.00
Siemens	KI31RAD30	172	100	A++	20.00	300.00	1680.00	1980.00		632.00	932.00	
Siemens	KI32LAD40	154	105	A+++	21.00	315.00	2130.00	2445.00	294.00	740.00	1055.00	-213.00
Siemens	KI32LAD30	154	157	A++	31.40	471.00	1680.00	2151.00		797.00	1268.00	
Siemens	KI41RAD40	214	69	A+++	13.80	207.00	2240.00	2447.00	342.00	802.00	1009.00	-106.65
Siemens	KI41RAD30H	214	105	A++	21.00	315.00	1790.00	2105.00		800.65	1115.65	
Siemens	KI42LAD40	195	114	A+++	22.80	342.00	2240.00	2582.00	273.00	802.00	1144.00	-170.00
Siemens	KI42LAD30H	196	173	A++	34.60	519.00	1790.00	2309.00		795.00	1314.00	
Siemens	KI72LAD40H	249	132	A+++	26.40	396.00	2830.00	3226.00	242.00	1021.00	1417.00	-196.95
Siemens	KI72LAD30H	249	198	A++	39.60	594.00	2390.00	2984.00		1019.95	1613.95	
Siemens	KI82LAD40H	285	146	A+++	29.20	438.00	3220.00	3658.00	255.00	1320.00	1758.00	-44.90
Siemens	KI82LAD30H	287	211	A++	42.20	633.00	2770.00	3403.00		1169.90	1802.90	
V-ZUG	Magnum 60i eco	296	148	A+++	29.60	444.00	3630.00	4074.00	138.00	1676.40	2120.40	-66.65
V-ZUG	Magnum 60i	296	222	A++	44.40	666.00	3270.00	3936.00		1521.05	2187.05	
V-ZUG	Magnum eco	296	148	A+++	29.60	444.00	3680.00	4124.00	138.00	1678.90	2122.90	-77.00
V-ZUG	Magnum	296	222	A++	44.40	666.00	3320.00	3986.00		1533.90	2199.90	
V-ZUG	Perfect 60i eco	191	118	A+++	23.60	354.00	2380.00	2734.00	183.00	1130.00	1484.00	-59.90
V-ZUG	Perfect 60i	191	177	A++	35.40	531.00	2020.00	2551.00		1012.90	1543.90	
V-ZUG	Perfect eco	241	133	A+++	26.60	399.00	2690.00	3089.00	126.00	1129.55	1528.55	-137.95
V-ZUG	Perfect	241	191	A++	38.20	573.00	2390.00	2963.00		1093.50	1666.50	

Table 14: Descriptive data and calculated energy consumption for the 20 twin product pairs of refrigerators. Operating costs are calculated with a price of 20 cents per kWh, life cycle costs for a product lifetime of 15 years and a 0% discount rate. Cost differences are calculated as efficient – inefficient.

Online Questionnaire: German

Sehr geehrte Teilnehmerin, sehr geehrter Teilnehmer

Vielen Dank, dass Sie sich zur Teilnahme an einer Studie der ETH Zürich in Kooperation mit _________ entschieden haben. Die Studie beschäftigt sich mit Kaufentscheidungen für Haushaltsgeräte von Schweizerinnen und Schweizern und wird vom Schweizerischen Bundesamt für Energie (BfE) finanziert.

Für das vollständige Ausfüllen des Fragebogens werden Sie etwa 10-15 Minuten benötigen. Bitte füllen Sie den Fragebogen ohne Unterbrechung aus. Es ist leider nicht möglich, die Antworten zwischenzuspeichern und den Fragebogen zu einem späteren Zeitpunkt zu beenden.

Wir garantieren Ihnen, dass alle Ihre Angaben anonym und vertraulich behandelt werden. Die Daten dienen ausschliesslich wissenschaftlichen Zwecken.

Als Dank für das Ausfüllen des Fragebogens erhalten Sie von uns einen Gutschein für _________ im Wert von 40 Franken. Ihr Gutschein wird nach vollständigem Ausfüllen des Fragebogens innerhalb einer Woche direkt von _________ per E-Mail versandt.

Besten Dank für Ihre Teilnahme an dieser Studie!

Die Daten werden an der ETH Zürich aufbewahrt und nicht an _________ oder Dritte weitergegeben. Voraussetzung für die Teilnahme an der Studie ist der Kauf eines Produktes auf _________. Die Teilnahme ist freiwillig und Sie können den Fragebogen jederzeit abbrechen. Ihre Daten werden in diesem Falle gelöscht und Ihr Anspruch auf den Gutschein erlischt. Allfällige Fragen zur Studie können Sie an marcel.stadelmann@econ.gess.ethz.ch vom Projektteam der ETH Zürich richten. Das Gesuch zur Durchführung dieser Studie wurde durch die Ethikkommission der ETH Zürich bewilligt.

Sind Sie mit den <u>Teilnahmebedingungen</u> einverstanden?

☐ Ja ich bin eiverstanden.

Welches Produkt haben Sie soeben gekauft?

a. TV
b. Tiefkühlgerät
c. Staubsauger
d. Anderes: ________

Was war der Grund für die Anschaffung dieses Gerätes?

a. Ersatzkauf für defektes Gerät
    i. *Wie lange nutzten Sie das vorherige Gerät? Bitte antworten Sie in Anzahl Jahren.* ________
b. Ersatzkauf für veraltetes Gerät
c. Neukauf, erstes Gerät im Haushalt
d. Neukauf, zusätzliches Gerät
e. Anderer: ________

„Was erwarten Sie, wie lange das neu gekaufte Gerät bei durchschnittlichem Gebrauch typischerweise funktionieren wird?“
Bitte antworten Sie in Anzahl Jahren.

______ Jahre

Unter Annahme, dass das Gerät einwandfrei funktioniert, wie lange werden Sie es voraussichtlich nutzen, bevor Sie ein neues Gerät kaufen?

a. 1-5 Jahre
b. 6-10 Jahre
c. 11-15 Jahre
d. 16-20 Jahre
e. Bis es nicht mehr funktioniert

Ordnen Sie die folgenden Faktoren nach der Wichtigkeit bei Ihrer Kaufentscheidung, vom Wichtigsten zuoberst zum Unwichtigsten ganz unten in der Liste.
Klicken Sie auf einen Faktor auf der linken Seite und ziehen Sie diesen bei gedrückter Maustaste nach rechts. Sie können die Reihenfolge der sechs Faktoren auf der rechten Seite jederzeit ändern, indem Sie einen bereits platzierten Faktor an die gewünschte Position verschieben.
Auf einem mobilen Endgerät klicken Sie die Faktoren in der Reihenfolge ihrer Wichtigkeit an.

a. Aussehen/Design
b. Marke
c. Preis
d. Umweltbelastung
e. Betriebskosten (Strom- und ggf. Wasserkosten)
f. Funktionen des Gerätes

Haben Sie beim Kauf Ihres Gerätes auf dessen Stromverbrauch geachtet?

a. Ja, der Stromverbrauch hatte einen Einfluss auf meine Kaufentscheidung
    i. *Weshalb achteten Sie auf den Stromverbrauch? Mehrfachauswahl möglich.*
        1. Der Umwelt zu liebe
        2. Um Geld zu sparen
        3. Aus technischem Interesse
        4. Anderer Grund: __________
b. Ja, der Stromverbrauch hatte aber keinen Einfluss auf meine Kaufentscheidung
    i. *Weshalb hatte der Stromverbrauch keinen Einfluss auf Ihre Kaufentscheidung?* __________
c. Nein, ich habe nicht auf den Stromverbrauch des Gerätes geachtet.

Inwiefern trifft folgende Aussage auf Ihre Kaufentscheidung zu?

„Um den Stromverbrauch zu minimieren, habe ich auf den Kauf eines möglichst kleinen Gerätes geachtet." → 5-Point Likert Skala (trifft völlig zu – trifft überhaupt nicht zu)

Inwiefern trifft folgende Aussage auf Ihre Kaufentscheidung zu?

„Ich hatte vor dem Kauf eine klare Vorstellung zur gewünschten Grösse des Gerätes und habe den Stromverbrauch lediglich zwischen ähnlich grossen Geräten verglichen."
→ 5-Point Likert Skala (trifft völlig zu – trifft überhaupt nicht zu)

Wie hoch schätzen Sie die monatlichen Stromkosten des gekauften Gerätes bei einer normalen Nutzung?
Bitte geben Sie den ungefähren Betrag in Franken an.

Welche Informationsquellen – neben __________ – haben Sie vor Ihrer Kaufentscheidung genutzt? (→ Mehrfachauswahl möglich)

a. Preisvergleichsseiten im Internet
b. Andere Webshops
c. Internet-Seite der Hersteller der Geräte
d. Unabhängige Informationsportale (z.B. topten.ch, compareco Haushaltsgerätefinder, etc.)
e. Prospekte von Herstellern
f. Beratung im Geschäft
g. Andere: __________
h. Keine

Haben Sie während dem Einkauf auf __________ (mindestens) eine Energieetikette gesehen?

a. Ja
    i. *Hatte die Energieetikette einen Einfluss auf Ihre Kaufentscheidung?*
        1. Ja
            a. *Welche Informationen der Energieetikette hatten einen Einfluss auf Ihre Kaufentscheidung? (→ Textfeld)*
            b. *Weshalb haben Sie sich dank diesen Informationen für Ihr gekauftes Gerät entschieden? (→ Textfeld)*
        2. Nein
b. Nein

Unten sehen Sie zwei beispielhafte Energieetiketten für Kühlgeräte. Welche Etikette finden Sie informativer?
Bitte klicken Sie auf das Bild der Etikette, welche Sie als informativer wahrnehmen. Durch den Klick wird diese heller. Bitte beachten Sie, dass am Schluss nur ein Bild hell sein sollte.

a. Eigenes Label (Bild) (Reihenfolge randomisiert; positiv/negativ randomisiert)
b. EU-Label (Bild)

Weshalb finden Sie diese Energieetikette informativer?
Bitte begründen Sie kurz stichwortartig oder in ganzen Sätzen.

Ist Ihnen während dem Besuch des Webshops von ___________ eine der oberhalb abgebildeten Energieetiketten (respektive in ähnlichem Design) begegnet?
Bitte beschränken Sie Ihre Antwort auf das, was Sie auf ___________ gesehen haben.

a. Ja, die „___________“-Etikette mit den Informationen zu den Stromkosten des Gerätes
b. Ja, die „EU“-Etikette mit dem Rating von A+++ bis D für die Energieeffizienz des Gerätes
c. Ja, ich habe sowohl die die „___________“-Etikette als auch die „EU“-Etikette gesehen
d. Nein, ich habe keine dieser Energieetiketten gesehen

Bitte beurteilen Sie folgende Aussage: „Ich gehe davon aus, dass die Angaben von Energieetiketten korrekt sind.“

a. Trifft völlig zu
b. Trifft eher zu
c. Neutral
d. Trifft eher nicht zu
e. Trifft überhaupt nicht zu

Bitte beurteilen Sie folgende Aussage: "Wenn ich gewollt hätte, hätte ich mir ein teureres Gerät leisten können, ohne mein monatliches Budget zu gefährden."

a. Trifft völlig zu
b. Trifft eher zu
c. Neutral
d. Trifft eher nicht zu
e. Trifft überhaupt nicht zu

Was schätzen Sie, was kostet 1 Kilowattstunde (kWh) Strom in der Schweiz im Durchschnitt? Bitte geben Sie den ungefähren Betrag in Rappen an.

________ Rp.

Was schätzen Sie, wie hoch ist die jährliche Stromrechnung eines typischen Schweizer Haushalts (4.5-Zimmer-Wohnung, vier Personen)? Bitte geben Sie den ungefähren Betrag in Franken an.

_________ Fr.

Nehmen Sie an, dass eine Glühbirne jedes Jahr etwa 1000 Stunden brennt und eine Kilowattstunde (kWh) Strom im Durchschnitt 20 Rappen kostet. Wie hoch sind die jährlichen Stromkosten für eine Sparlampe mit 7 Watt?

a. 1.40 Fr.
b. 2.80 Fr.
c. 5.40 Fr.
d. 7.20 Fr.
e. Weiss nicht

Was schätzen Sie, wie sich der Strompreis in den nächsten 10 Jahren entwickeln wird?

a. Starker Rückgang
b. Leichter Rückgang
c. Bleibt etwa gleich
d. Leichter Anstieg
e. Starker Anstieg

Nehmen Sie an, dass Sie 100 Franken auf Ihrem Bankkonto haben und die Bank bietet Ihnen eine Verzinsung von 2% pro Jahr an. Wie hoch ist der Betrag auf dem Konto nach 1 Jahr, sofern Sie das Geld darauf belassen?

a. Weniger als 102 Franken
b. Exakt 102 Franken
c. Mehr als 102 Franken
d. Weiss ich nicht.

Nehmen Sie an, dass Sie 100 Franken auf Ihrem Bankkonto haben und die Bank bietet Ihnen eine Verzinsung von 2% pro Jahr an. Wie hoch ist der Betrag auf dem Konto nach 5 Jahren, sofern Sie das Geld und die Zinserträge darauf belassen?

a. Weniger als 110 Franken
b. Exakt 110 Franken
c. Mehr als 110 Franken
d. Weiss ich nicht.

Nehmen Sie an, dass die Verzinsung auf Ihrem Sparkonto 1% pro Jahr beträgt und die Inflationsrate bei 2% liegt. Was können Sie sich mit dem Betrag nach einem Jahr leisten?

a. Ich kann mir weniger leisten.
b. Ich kann mir genau gleich viel leisten.
c. Ich kann mir mehr leisten.
d. Weiss ich nicht.

Nehmen Sie an, dass im Jahr 2016 sich sowohl Ihr Einkommen, als auch die Preise für Waren und Güter verdoppelt haben. Wieviel können Sie sich im Jahr 2016 dann leisten?

a. Ich kann mir weniger leisten.
b. Ich kann mir gleich viel leisten.
c. Ich kann mir mehr leisten.
d. Weiss ich nicht.

Es folgt nun eine Reihe von Aussagen. Bitte beurteilen Sie jeweils, inwiefern Sie diesen zustimmen.

- „Jede Bürgerin und jeder Bürger muss für die Umwelt Verantwortung übernehmen."
- „Jeder einzelne Beitrag zum Umweltschutz ist wichtig."
- „Der steigende Energiebedarf ist ein ernsthaftes Problem für unsere Gesellschaft."
- „Die globale Erwärmung ist ein ernsthaftes Problem für unsere Gesellschaft."

Alle Aussagen werden mit einer 5-Point Likert Skala evaluiert (stimme völlig zu – stimme überhaupt nicht zu)

Es folgen einige weitere Aussagen. Bitte beurteilen Sie jeweils, inwiefern diese auf Sie persönlich zutreffen.

- „Energiesparen ist mir sehr wichtig."
- „Ich beabsichtige, in Zukunft meinen Energieverbrauch (noch stärker) zu reduzieren."
- „Ich gebe Acht auf meinen Energieverbrauch, weil ich mich um das Wohl der nächsten Generation sorge."
- „Ich fühle mich moralisch dazu verpflichtet, die Umwelt zu schützen."

Alle Aussagen werden mit einer 5-Point Likert Skala evaluiert (trifft völlig zu – trifft überhaupt nicht zu)

Wie gut beschreiben die folgenden Aussagen Ihre Persönlichkeit?

- „Ich verzichte heute auf etwas, damit ich mir morgen mehr leisten kann."
- „Ich neige dazu, Dinge auf später zu verschieben, auch wenn es besser wäre, diese sofort zu erledigen."
- „Ich bin ein sehr geduldiger Mensch."
- „Ich handle oft impulsiv."

Alle Aussagen werden mit einer 5-Point Likert Skala evaluiert (trifft völlig zu – trifft überhaupt nicht zu)

Bitte machen Sie eine Angabe zu Ihrem Geschlecht.

a. Weiblich
b. Männlich

Geben Sie bitte Ihr Alter an.

Offenes Textfeld

Geben Sie bitte die Postleitzahl Ihres Hauptwohnortes an.

Offenes Textfeld

Welche aktuelle Erwerbssituation trifft auf Sie zu?

Selbständig; Arbeitnehmer/-in; Lehrling; In Ausbildung; Hausfrau/-mann; Rentner/-in; Erwerbslos; Ich möchte keine Angabe machen.

Welches monatliche Nettoeinkommen steht Ihnen zur Verfügung?

0-1000 Fr.; 1001-2000 Fr.; 2001-3000 Fr.; 3001-4000 Fr.; 4001-5000 Fr.; 5001-6000 Fr.; 6001-7000 Fr.; 7001-8000 Fr.; 8000+ Fr.; Ich möchte keine Angabe machen.

Welche ist Ihre höchste abgeschlossene Ausbildung?

a. Erfüllen der obligatorischen Schulpflicht
b. Sekundarstufe II: Berufliche Grundbildung (Lehre)
c. Sekundarstufe II: Allgemeinbildung (Matura, Fachmatura)
d. Abschluss einer höheren Fachschule (eidg. Diplom, eidg. Fachausweis)
e. Abschluss einer Fachhochschule (Bachelor, Master)
f. Abschluss einer universitären Hochschule inkl. ETH (Bachelor, Master/ Diplom, Doktorat)
g. Ich möchte keine Angabe machen.

Vielen Dank für Ihre Angaben. Für den letzten Schritt zu Ihrem Gutschein klicken Sie bitte auf „Weiter".

Um Ihnen den Gutschein zustellen zu können, benötigen wir die Bestellnummer Ihres letzten Einkaufs auf _________. Sie finden diese entweder unter den Bestellungen in Ihrem _________ Benutzer-Konto oder in der Bestellbestätigung per E-Mail, die Sie von _________ erhalten haben.

Sie erhalten Ihren Gutschein innerhalb maximal einer Woche per E-Mail von _________. Sollten Sie nach 7 Tagen noch keinen Gutschein erhalten haben, melden Sie sich bitte bei uns unter marcel.stadelmann@econ.gess.ethz.ch.

Alle anderen Informationen in diesem Fragebogen werden, wie eingangs erwähnt, anonym und vertraulich behandelt und nicht an _________ weitergegeben.
Wenn Sie Ihre Bestellnummer nicht angeben möchten, können wir Ihnen leider keinen Gutschein zusenden. Ihre Antworten gehen dadurch aber nicht verloren und stellen einen wertvollen Beitrag für unsere wissenschaftliche Studie dar.

Bestellnummer (10-stellig): _______________

Der Fragebogen ist beendet. Herzlichen Dank für Ihre Unterstützung. Sie können das Fenster nun schliessen.

Online Questionnaire: French

Chères participantes, chers participants,

Nous vous remercions d'avoir pris la décision de participer à cette étude de l'EPF de Zurich en collaboration avec _________. Cette étude s'occupe des décisions d'achats d'appareils ménagers et est financée du Office fédéral de l'énergie (OFEN).

Pour remplir complètement le questionnaire, il vous faudra environ **10 à 15 minutes**. Veuillez remplir le questionnaire dans les prochaines 24 heures sans interruption prolongée.

Nous vous garantissons que toutes vos données soient traitées de manière anonyme et confidentielle. Elles servent uniquement à des fins scientifiques.

En remerciement d'avoir rempli le questionnaire, nous vous offrons un bon d'achat **d'une valeur de 40 francs** à utiliser sur _________. Après avoir complété entièrement le questionnaire, votre bon d'achat vous sera envoyé sous une semaine directement par courrier électronique de _________.

Merci de participer à cette étude!

Les données sont conservées à l'EPF de Zurich et ne sont pas transmises à _________ ou à des tiers. La condition de participation au sondage est l'achat d'un produit sur _________. La participation est facultative et le questionnaire peut être annulé à tout moment. Dans ce cas, vos données sont effacées et votre droit à recevoir le bon d'achat s'éteint. Vous pouvez adresser d'éventuelles questions au sujet de l'étude à marcel.stadelmann@econ.gess.ethz.ch, membre de l'équipe de projet de l'EPF de Zurich. La demande pour la réalisation de cette étude a été autorisée par la Commission d'éthique de l'EPF de Zurich.

Consentez-vous aux <u>conditions de participation</u>?

☐ Oui, je suis d'accord.

Quel produit venez-vous d'acheter?

a. TV
b. congélateur
c. aspirateur
d. autre: ________

Quelle était la raison pour l'acquisition de cet appareil ?

a. achat de remplacement pour un appareil défectueux
   i. *Pendant combien de temps avez-vous utilisé l'appareil précédent? Répondez s'il vous plaît en nombres d'années.* ________ans
b. achat de remplacement pour un appareil obsolète
c. nouvel achat, premier appareil dans le ménage
d. nouvel achat, appareil supplémentaire
e. autres: ________

Quant au fonctionnement de l'appareil nouvellement acheté, à quelle durée de vie typique vous attendez-vous lors d'un usage moyen?

Répondez s'il vous plaît en nombres d'années.

______ ans

En supposant que l'appareil fonctionne de manière irréprochable, combien de temps l'utiliserez-vous probablement avant d'acheter un nouvel appareil?

a. 1 à 5 ans
b. 6 à 10 ans
c. 11 à 15 ans
d. 16 à 20 ans
e. jusqu'à ce qu'il ne fonctionne plus

Classez les facteurs suivants selon leur importance pour la décision d'achat du plus important en tête de liste jusqu'au moins important en fin de liste.

Cliquez sur un facteur sur le côté gauche et tirez-le vers la droite en maintenant le bouton de la souris enfoncé. Vous pouvez changer l'ordre des facteurs à tout moment en déplaçant un facteur déjà placé vers la position souhaitée.

a. apparence/Design
b. marque
c. prix
d. effet sur l'environnement
e. frais d'exploitation (coûts d'électricité et évtl. d'eau)
f. fonctions de l'appareil

Avez-vous fait attention à la consommation d'énergie lors de l'achat de votre appareil?

a. oui, et la consommation d'énergie a influencé ma décision d'achat
   i. Pourquoi avez-vous fait attention à la consommation d'énergie?
      1. pour le bien de l'environnement
      2. pour économiser de l'argent
      3. par intérêt technique
      4. autre raison: __________
b. oui, mais la consommation d'énergie n'avait pas d'influence sur ma décision d'achat
   ii. Pourquoi la consommation d'énergie n'avait pas d'influence sur votre décision d'achat? __________
c. Non, je n'avais pas fait attention à la consommation d'énergie

Dans quelle mesure l'énoncé suivant correspond à votre décision d'achat ?
« Pour minimiser la consommation d'énergie, j'ai veillé à acheter l'appareil le petit possible. »

a. absolument faux
b. plutôt faux
c. neutre
d. plutôt vrai
e. absolument vrai

Dans quelle mesure l'énoncé suivant correspond à votre décision d'achat ?
« J'avais déjà une idée précise de la taille souhaitée de l'appareil avant l'achat et j'ai donc comparé la consommation d'énergie seulement entre appareils de taille similaire. »

a. absolument faux
b. plutôt faux
c. neutre
d. plutôt vrai
e. absolument vrai

À combien estimez-vous les coûtes d'électricités mensuel de l'appareil acheté à l'emploi normal? Veuillez indiquer le montant approximatif en francs.

Quelles sources d'infomations – autres que _________ – avez-vous utilisé avant de prendre votre décision d'achat? Plusieurs réponses possibles.

a. sites de comparaison de prix sur internet
b. autres magasins de vente en ligne
c. site internet des fabricants des appareils
d. portails d'informations indépendants (par ex. topten.ch, compareco guide électroménager, etc.)
e. prospectus des fabricants
f. conseils d'achat dans le magasin
g. autres: __________
h. aucune

Avez-vous vu (au moins) une étiquette-énergie pendant l'achat sur _________?

a. oui
    iii. L'étiquette-énergie avait-elle influencé votre décision d'achat?
        1. oui
            a. Quelles informations de l'étiquette-énergie ont eu une influence sur votre décision d'achat?
            b. Pourquoi avez-vous opté pour l'appareil acheté grâce à ces informations?
        2. non
b. non

Ci-dessous vous voyez deux différents exemples d'étiquettes-énergie. Quelle étiquette vous semble plus informative?
Cliquez s'il vous plaît sur l'image de l'étiquette que vous trouvez plus informative. Avec le click celle-ci apparaît plus claire. Veuillez noter qu'à la fin une seule image doit être mise en évidence.

Pourquoi cette étiquette-énergie vous semble plus informative?
Veuillez justifier brièvement par mots-clés ou par phrases entières.

Pendant votre visite du webshop de _________, avez-vous vu une des étiquette-énergie (ou en design similaire pour votre appareil) montré au-dessus?

a. Oui, l'étiquette «_________ » avec les renseignements sur les coûts d'électricités de l'appareil
b. Oui, l'étiquette « EU » avec l'évaluation du l'efficacité énergétique de l'appareil du A+++ à D
c. Oui, j'ai vu l'étiquette «_________ » autant que l'étiquette « EU »
d. Non, je n'ai vu aucune de ces étiquettes-énergies

Veuillez évaluer les déclarations suivantes:« Je présume que les indications des étiquettes-énergie sont correctes. »

a. absolument faux
b. plutôt faux
c. neutre
d. plutôt vrai
e. absolument vrai

Veuillez évaluer la déclaration suivante: « Si j'avais voulu, j'aurais pu m'offrir un appareil plus cher, sans pour autant mettre en péril mon budget mensuel. »

a. absolument faux
b. plutôt faux
c. neutre
d. plutôt vrai
e. absolument vrai

Essayez s'il vous plaît de répondre aux questions suivantes le mieux possible.

Combien estimez-vous coûte un kilowattheure (kWh) d'électricité en moyenne en Suisse?
Veuillez indiquer le montant approximatif en centimes.

________ ct.

À combien estimez-vous la facture d'électricité annuelle d'un ménage Suisse typique (appartement 4.5 pièces, 4 personnes)?

Veuillez indiquer le montant approximatif en francs.
_________ fr.

Supposez qu'une ampoule est allumée pendant environ 1000 heures par année et qu'un kilowattheure (kWh) d'électricité coûte en moyenne 20 centimes. À combien reviennent les frais d'électricité annuels pour une lampe économique de 7 watts?

a. 1.40 fr.
b. 2.80 fr.
c. 5.40 fr.
d. 7.20 fr.
e. Je ne sais pas.

Comment estimez-vous que le coût d'électricité va évaluer dans les prochaines 10 années?

a. baisse considérable
b. légère baisse
c. reste environ constant
d. légère augmntation
e. augmentation considérable

Supposez que vous disposez de 100 francs sur votre compte bancaire et que la banque vous offre un taux d'intérêt de 2% par an. Quel est le montant sur le compte après 1 an, si vous y laissez l'argent ?

a. moins que 102 fr.
b. éxactement 102 fr.
c. plus de 102 fr.
d. Je ne sais pas.

Supposez que vous disposez de 100 francs sur votre compte bancaire et que la banque vous offre un taux d'intéret de 2% par an. Quel est le montant sur le compte après 5 ans, si vous y laissez l'argent ainsi que le produit des intérêts?

a. moins que 110 fr.
b. éxactement 110 fr.
c. plus de 110 fr.
d. Je ne sais pas.

Supposez que le taux d'intérêt sur votre compte d'épargne est de 1% par an et que le taux d'inflation s'élève à 2%. Combien pouvez-vous vous offrir avec le montant après un an?

a. Je peux m'offrir moins.
b. Je peux m'offrir autant qu'avant.
c. Je peux m'offrir plus.
d. Je ne sais pas.

Supposez qu'en 2016 autant votre salaire que le prix pour les produits et marchandises ont doublé. Combien pouvez-vous vous offrir en 2016?

a. Je peux m'offrir moins.
b. Je peux m'offrir autant qu'avant.
c. Je peux m'offrir plus.
d. Je ne sais pas.

Voici une série de déclarations. Veuillez indiquer pour chacune dans quelle mesure vous l'approuvez. → je n'approuve pas du tout / je n'approuve plutôt pas / j'approuve plutôt / j'approuve absolument

- « Chaque citoyenne et citoyen doit assumer sa responsabilité pour l'environnement.»
- « Chaque contribution individuelle à la protection de l'environnement est importante. »
- « Le besoin croissant en énergie est un problème sérieux pour notre société. »
- « Le réchauffement de la planète est un problème sérieux pour notre société. »

Voici une autre série de déclarations. Veuillez indiquer dans quelle mesure celle-ci vous correspondent personnellement.
→ absolument faux / plutôt faux / neutre / plutôt vrai / absolument vrai

- « Économiser de l'énergie est pour moi d'une grande importance. »
- « J'ai l'intention de réduir davantage ma consommation d'énergie dans le futur. »
- « Je fais attention à ma consommation d'énergie, parce que je me soucie du bien de la prochaine génération. »
- « Je me sens moralement obligé à protéger l'environnement. »

Dans quelle mesure les déclarations suivantes correspondent-elles à votre personnalité?
→ absolument faux / plutôt faux / neutre / plutôt vrai / absolument vrai

- « Je me passe de quelque chose aujourd'hui pour que je puisse m'offrir plus demain. »
- « J'ai tendance à reporter des choses à plus tard alors qu'il serait mieux de les régler tout de suite. »
- « Je suis une personne très patiente. »
- « J'agis souvent de manière impulsive. »

Veuillez indiquer votre sexe.

a. féminin
b. masculin

Veuillez indiquer votre âge.

Veuillez indiquer le code postal de votre lieu de domicile principal.

Quelle situation professionnelle correspond à la vôtre?

Indépandant(e); Salarié(e); Apprentis; En formation; Femme/homme au foyer; Rentier/rentière; Chômeur; Je préfère ne rien indiquer

De quel revenu net mensuel disposez-vous?

0-1000 fr.; 1001-2000 fr.; 2001-3000 fr.; 3001-4000 fr.; 4001-5000 fr.; 5001-6000 fr.; 6001-7000 fr.; 7001-8000 fr.; 8000+ fr.; Je préfère ne rien indiquer.

Quel est votre niveau de formation achevée le plus élevé?

a. aucune formation après la scolarité obligatoire.
b. niveau secondaire II: formation professionelle de base (apprentissage)
c. niveau secondaire II: formation générale (maturité, maturité professionnelle)
d. diplôme d'une école supérieure (diplôme fédéral, brevet fédéral)
e. diplôme d'une école supérieure spécialisée (bachelor, master)
f. diplôme d'une haute école universitaire y compris l'EPF (bachelor, master/diplôme, doctorat)
g. Je préfère ne rien indiquer.

Merci beaucoup pour vos indications. Pour parvenir à la dernière étape qui vous permettra de recevoir votre bon d'achat, veuillez cliquer sur « Suivant ».

Afin de pouvoir vous faire parvenir le bon d'achat nous avons besoin du numéro de commande de votre dernier achat sur _________. Vous trouverez celui-ci soit sous la rubrique des commandes dans votre compte d'utilisateur sur _________ ou alors dans la confirmation de commande que vous avez reçu par courrier électronique de _________.

Vous recevrez votre bon d'achat au plus tard sous une semaine par courrier électronique de _________. Si après 7 jours vous n'avez pas encore reçu de bon d'achat, veuillez nous contacter à l'adresse suivante: marcel.stadelmann@econ.gess.ethz.ch.

Toutes les autres informations dans ce questionnaire, comme mentionné au début, sont traîtées de manière anonyme et confidentielle et ne vont pas être transmises à _________.
Si vous ne souhaitez pas indiquer votre numéro de commande, nous ne pouvons malheureusement pas vous faire parvenir de bon d'achat. Toutefois vos réponses ne sont pas perdues dans ce cas et font l'objet d'une précieuse contribution pour notre étude scientifique.

numéro de commande (10 chiffres): ________________

Veuillez cliquer sur « Suivant ».

Le questionnaire est terminé. Un grand merci pour vos efforts. Vous pouvez maintenant fermer la fenêtre.