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# kWh versus Euro – What is the most effective way to inform about efficient products?

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## Abstract

Energy efficient products often have a higher purchase price than less efficient alternatives. However, the life cycle costs are often lower due to the lower operating costs. From a purely economic point of view, efficient appliances are not only more ecological but often also more economical and, accordingly, should be purchased more frequently than less efficient appliances. However, this is not always the case. Information deficits are one of the major reasons of this discrepancy: the purchase price is visible during the purchasing process, but the follow-up costs are not, at least not in their exact amount. The EU Energy Label can be considered as a solution to close this gap. During the past decades, there has been a discussion on whether it would be better to communicate the monetary costs associated with energy consumption, since their calculation by the consumer is difficult or needs a high level of cognitive effort.

In this study, experiments and field studies on a total of 19 product groups were evaluated with regard to the question of whether the indication of costs instead of physical units affects the decision-making process of the consumer. It has been assessed under which circumstances it might positively influence the purchase decision of the customer, i.e. helping him or her to arrive at a more “energy efficient” decision. Overall, the results indicate that monetary claims possibly exceed the effect of claims on a physical basis when the costs or the differences between the alternatives available seem “relevant” to the consumer.

## Background and objective

Energy efficient products often have a higher purchase price than less efficient alternatives. However, the life cycle costs are often lower due to the lower operating costs. From a purely economic point of view, efficient appliances are not only more ecological but often also more economical for consumers and, accordingly, should actually be purchased more frequently than less efficient appliances. In reality, however, this is not always the case. For example, in Germany there has been stagnation in the market penetration of the best energy efficiency class (“A+++”) for many product groups in recent years: The market share of A+++ refrigerators stagnated at 27 %, A+++ freezers at 35 % and A+++ tumble dryers at 43 % [1]. This discrepancy between the expectation corresponding to lower life cycle costs of particularly efficient appliances and the actual consumer behavior has long been discussed in the literature [2, 3].

Information deficits are seen as one of the major reasons of this discrepancy. This can be summarized as follows: the purchase price of efficient appliances is transparent and visible during the purchasing process, but the follow-up costs for electricity or water consumption are not, at least not in their exact amount, which is why they are not usually included in the decision-making process of consumers. To close such information gaps, labels, in addition to the product price, are appropriate tools [4]. Accordingly, the EU Energy Label can also be considered as such a solution to close this information gap. The absolute energy consumption is communicated with the help of physical units and thus cost-related product properties are made transparent to the consumer. In this way, the energy consumption and possibly also the associated costs can be included in the decision-making process.

During the past decades, there has been a discussion on whether it would be better to communicate the monetary costs associated with energy consumption, since the calculation by the consumer is not possible or only possible with a high level of cognitive effort [3, 5, 6]. The monetary costs would be easy to grasp and directly comparable to the purchase price. A recent contribution to this debate was published in 2019: Andor et al (2019) investigated the purchasing behavior for lamps in an experiment [7]. They were able to show that the willingness to pay for efficient lamps was significantly higher if the test participants were given information on life cycle cost. Information on the EU-Energy Label of the alternatives, on the other hand, had no effect.

Furthermore, the focus of the EU Energy Label is on the energy *efficiency* of the products, highlighted through the graphically very appealing presentation of the energy efficiency classes [8]. The level of *absolute* energy

consumption, on the other hand, is perceived less. Due to the relative nature of the EU energy label, consumers tend to buy efficient but, e.g. in case of large appliances, still high absolute energy consumption. In addition, consumers lose reservations about product groups that typically have high absolute energy consumption when those products are classified as very efficient (e.g., freezers) [9, 10]. Communicating operating costs in monetary units is seen as a way to focus more attention on absolute consumption.

In this study, a comparative literature analysis was carried out. Experiments and field studies on a total of 19 product groups were evaluated with regard to the question of whether the indication of costs instead of physical units affects the decision-making process of the consumer. The question of whether the way costs are communicated has an influence on purchasing behavior, was also considered.

## Material and Methods

Table 1 shows publications and projects which were identified as significant. Either experiments or field studies were conducted and published on the topic in various European countries with a total of 19 product groups. Table 1 provides an overview of the time period, the method used and the geographical scope of the studies as well as of the product groups taken into account.

**Table 1.** Overview of investigated studies

Study	Time period	Research method	Geographical scope	Product group considered
Kallbekken et al. 2012 [11]	before 2012	Field study	Norway	Fridge-freezers Tumble dryers
Heinzle 2012 [12]	before 2012	Choice-based conjoint (CBC) analysis	Germany	Television sets
DECC 2014 [13]	2013/14	Field study	Great Britain	Washer-dryers Washing machines Tumble dryers
Incent 2016 [14]	2014	Field study	Germany	Refrigerators and freezers Washing machines Dishwashers Tumble dryers
Andor et al. 2017 [15]	2015	Discrete choice experiment	Germany	Refrigerators
Conseed 2018 [16]	2017	Discrete choice experiment	Slovenia Greece Norway	Real estate (SI) Fridge-freezers (GR) Cars (NO)
Conseed 2019 [17]	2018	Field study	Ireland Spain	Real estates Washing machines Dishwashers Fridge-freezers
Andor et al. 2019 [7]	2018 (?)	Willingness-to-pay (WTP)-experiment	Germany	Lamps (CFL, LED)

Source: Own compilation

In the following, the analysed studies are briefly described.

### **Kallbekken et al. (2012) [11]**

The aim of the field study was to test whether highlighting information on operating costs at the point of sale leads to more energy-efficient appliances being purchased on average.

The experiment was conducted in the six megastores of a Norwegian electrical appliance retail chain, selecting fridge-freezers and tumble dryers as objects of investigation. The other shops in the chain served as controls with their sales figures. Two interventions were implemented, tested both individually and in combination over a period of 5 months.

- Intervention 1: Label with lifetime operating costs (EU scheme with letters).
- Intervention 2: Training of sales staff (two-step training approach)

### **Heinzle (2012) [12]**

The aim of the experimental study was to examine three formats for indicating energy consumption (physical units (watts), annual electricity costs and lifetime electricity costs) to see how effectively they influence consumers' interpretation of this information and subsequently their decision-making behaviour.

Hypothesis 1 states that the accuracy of the estimate of potential savings in electricity costs increases significantly when monetary rather than physical information on energy consumption is provided. From this it can be deduced what the effect of providing monetary values is: if the savings are underestimated on the basis of physical data, or if they are estimated correctly, the willingness to buy an energy-efficient appliance should increase when monetary data is given. If the savings are overestimated by means of the physical data provided, the willingness to buy an energy-efficient appliance should decrease when monetary data is given.

To test the hypothesis, first 248 people were randomly assigned to three groups that received different information (group 1: electricity consumption in watts, information on electricity price; group 2: electricity consumption in watts, no information on electricity prices, group 3: electricity consumption in euros). The people were asked to estimate the difference in electricity costs in euros.

Hypothesis 2 is derived from the result of study 1, i.e. that the difference is overestimated when watt figures are given: It is assumed that the WTP for a premium for more energy-efficient products will be greater when energy consumption is given in watts (i.e. that monetary specification is counterproductive). At the same time, it is assumed that this negative effect of specifying monetary costs in euros could be offset by specifying costs over the whole lifetime and not on a yearly basis (reverse pennies-a-day effect). Thus, according to hypothesis 3, the WTP for a premium for more energy-efficient products is assumed to be greater when energy consumption is reported as "lifetime operating costs" compared to "annual operating costs" or "watts".

To test hypotheses 2 and 3, a choice-based conjoint (CBC) analysis was conducted. The subjects were divided into 3 groups (group 1: physical information on energy consumption; group 2: information on lifetime electricity costs; group 3: information on annual electricity costs).

### **DECC (2014) [13]**

The aim of the field study was to provide robust evidence on whether providing information on lifetime electricity costs at the point-of-sale changes purchasing behaviour by increasing the attractiveness of appliances with lower energy consumption. The study was conducted with washer-dryers, washing machines and tumble dryers.

Thirty-eight John Lewis shops across the UK were randomly assigned to one of the following two groups:

- Group 1, intervention (19 shops): The EU energy label also showed the cost of electricity over the lifetime of the appliance.
- Group 2, control (19 shops): Only the EU energy label was shown on the appliance, without the addition of the electricity costs.

It was ensured that the allocation of shops to the control or intervention group was similar in terms of key variables.

Training courses were conducted in July 2013 with a representative from the major electrical departments of almost all shops. Partners from control shops were given a basic overview of the study, while partners from intervention shops were provided with much more detailed information about the study and how running costs were calculated. Focus groups with shop representatives were conducted at three points in time to better understand what is happening at the point of sale.

### **Incent 2016 [14]**

The aim of the field study was to explore the usefulness of awarding operating costs and potential effects both for consumers and for retailers.

In two electronics markets in Berlin, the operating costs over 10 years (useful life) were displayed on the device (simple and comprehensible calculation, e.g., no increase in electricity costs assumed). The experiment was conducted with fridge-freezers, washing machines, dishwashers and tumble dryers.

There were two variants:

- Label 1: Only operating costs over 10 years and
- Label 2: Operating costs and classification in scale to operating costs of appliances of the same "category".

In addition, information in the market was provided. The duration of the field study was 6 months.

### **Andor et al. 2017 [15]**

The aim of the experimental study was to identify the influence of the type and amount of information ("stimuli") in the context of the energy label on consumers' choices. Does a lot of information lead to heuristic decisions, i.e. to making a decision only on the basis of the energy efficiency class?

The households involved were divided into three groups. Households in the control group received the information on the refrigerators in the form of a simplified EU energy label which only displayed the annual electricity consumption and the energy efficiency class. Households in the *Operating Costs* group received information on annual running costs in addition to the simplified label. Households in the *Competing Stimuli* group received, in addition to the simplified label and the annual running costs, information on other, non-energy-related appliance features acting as additional stimuli and compete for attention.

Households in the three groups were faced with four choice situations, each comprising two choices (A and B). The choice situations M1 and M2 reflected realistic decision situations, while S1 and S1 did not correspond to real market situations.

### **Conseed 2018 [16]**

The aim of the experimental study was to investigate whether the provision of monetary energy information in addition to the EU energy label can convince consumers to buy more energy-efficient products as compared to the situation in which only the EU energy label was given.

Three discrete choice experiments were conducted:

- Real estate in Slovenia (two groups): control group: label only and treatment group: indication of the annual energy costs in addition to the mandatory energy label.
- Refrigerators in Greece (four groups): with label (control group), with label and indication of annual energy costs (treatment 1), without label + non-monetary information (treatment 2), without label + indication of annual energy costs (treatment 3).
- Cars in Norway (two groups): control group: label only and treatment group: monthly energy costs in addition to the mandatory energy label.

### **Conseed 2019 [17]**

The aim of the field study was to investigate whether the provision of monetary energy information, in addition to the EU energy label, can convince consumers to buy more energy-efficient products compared to the situation in which only the EU energy label was given.

Three field tests were carried out:

- Real estate in Ireland. Additional information: annual energy costs.
- Household appliances in Spain (washing machines, dishwashers, fridge-freezers). Additional indication: monetary savings over the lifetime of the appliances. There were three interventions: 1)



additional label with savings only, 2) training of sales staff only, 3) combination of label and training. Comparison of experimental and control markets.

- Cars in Norway. The treatment consisted of three elements: operating cost label (monthly operating costs), online calculation tool, training of sales staff.

### **Andor et al. 2019 [7]**

The aim of the experimental study was to determine consumers' WTP for more energy-efficient lamps based on different information.

The study comprised four steps: The test participants were first given general information about the technical properties of CFL (compact fluorescent lamps) and LED lamps. In the second step, they had to choose 15 times from a list between two different energy-efficient lamps with different prices. After a first decision run, the test participants were divided into three groups which received different information:

- Group A received information about life cycle costs (purchase and operating costs) and corresponding explanations,
- Group B was explained the energy label and saw the actual energy label of the two alternative lamps.
- Group C received information that was irrelevant for the decision (development of lamp sales in Germany); (control group)

After having informed the participants, a second round of decisions took place, in which the test participants again had to make a choice, in total 15 times, from a list between two different energy-efficient lamps with different prices.

The studies were evaluated with respect to the following criteria:

- Assessment method
- Products considered
- Temporal framing of the cost data (annually, over a longer period or the entire product lifetime)
- Was it possible to determine a positive influence of monetary claims on the purchase decision of consumers regarding particularly efficient products?

## **Results**

### **Experiments vs. field studies**

Experiments (concrete choice, willingness-to-pay, choice-based conjoint analysis) more frequently show a positive effect than field studies under real conditions.

- Of seven experiments conducted (the studies cover several experiments or variations thereof), a positive effect was found in five (83 %).
- In the 13 field studies conducted (also the field studies cover several variations or product groups each), a positive effect was found six times (46 %). This was sometimes less significant and once only visible if the sales staff were appropriately trained. In seven cases (54 %), no positive effect of monetary information was found.

This effect can be attributed to various causes. On the one hand, social desirability has been discussed for a long time to be a possible contributing cause of people's survey responses regarding environmental actions. In this case, this means that the willingness to buy a particularly efficient product may be overestimated in surveys. The effects of social desirability seem to be small and subtle but may be heterogeneous across studies [18]. On the other hand, interfering effects can play a decisive role in field studies, e.g. special

promotions, a lot of competing information, delivery problems, etc. In addition, the definition of a control situation (control market or control period without intervention) is challenging, since other markets may have a different customer composition, or the general conditions may change in time [e.g. in 11]. Furthermore, compared to real-world settings, a stylized decision environment – like in a discrete-choice experiment on energy efficiency – may induce participants to focus more strongly on the energy label and increase the overall rate of opting for a more energy-efficient appliance [15].

### Share of operating costs in total costs

Monetary information is particularly effective when the share of operating costs in total costs is relatively large. For example, there is a significant increase in willingness-to-pay for monetary claims compared to energy efficiency labeling information in [7]. With total costs ranging from about 39 to 68 euros, the initial cost only accounts for about 5 euros (+/- 7 euros price difference between lamps) – correspondingly, the operating cost is about 90 % of the total cost (see figure 1). Also, in [13] there is an effect of monetary data for washer-dryers, but not for washing machines. The authors suggest that the effect was observed for washer-dryers because their lifetime electricity costs were the highest of all the product types considered, making them a salient feature for consumers.

**Figure 1.** Total costs for 15.000 hours of light



Source: [7]

### Absolute level of operating costs

Monetary claims have a positive effect on absolutely high operating costs. Both experiments [16] and a field study [17] showed, that for products with high operating costs the willingness to buy products with lower energy consumption increases when information on operating costs is provided compared to showing the physical units. For example, in [16], a discrete choice experiment was conducted for each of three product groups. For real estate and cars, there was found a significant increase in willingness-to-pay for energy-efficient alternatives: For cars (Norway), already monthly fuel costs were reported to be in the three-digit euro range per month. For real estate (Slovenia), the annual energy costs were given. For fridge-freezers, with rather low level of operating costs, no effect was visible (see following table). For real estate, also the difference between operating costs was very significant (see also the following chapter).

**Table 2.** Overview of differences in operating costs for three product types

Geographical scope	Considered products	Temporal framing	Difference in operating costs	Positive effect of monetary information?
Norway	Cars	Monthly	1.500 vs 1.125 Norwegian kroner per month, equivalent to about 150 vs. 110 € / month	Yes

			<i>Purchase prices: 400.000 vs. 450.000 kroner</i>	
Slovenia	Real estates	Annual	1640 € vs. 70 € / year  <i>Purchase prices: 88.000 vs. 96.000 Euros</i>	Yes
Greece	Fridge-freezers	Annual	44 € vs. 23 € / year  <i>Purchase prices: 550 vs. 600 €</i>	No

Source: [16]

In [17], different product groups were tested in a field study. For real estate (Ireland), providing cost information had a significant positive effect; for household appliances (Spain; washing machines, dishwashers, fridge-freezers), no or only a small effect was visible. The cost information for real estate was in the mid three- to four-digit euro range per year, while the cost information for household appliances was given over the lifetime and was in the lower three-digit range.

### **Differences between operating costs**

Monetary data have a positive effect if the differences between the operating costs are high. This can be observed, for example, in the real estate example in [16]: high annual energy costs of 1640 euros were compared to much lower energy costs of 70 euros (see table 2). Also, in [7], the differences in operating costs of the shown lamps are relatively large with about 34 vs. 63 Euros over a useful life of 15,000 hours. (see figure 1)

In the case the difference is rather small, possibly smaller than consumers estimate based on the different energy consumption or energy efficiency classes, monetary information can even have a negative impact. For example, it was shown in [12] that consumers estimate differences in operating costs to be higher than they actually are when they only have information on energy efficiency class or energy consumption available. The actual cost differences were smaller than estimated by consumers, so that the willingness-to-pay was lower with additional information on (annual) operating costs.

### **Temporal framing of operating costs**

Reporting lifetime operating costs tends to be more effective than reporting annual costs. For example, it was shown in [12] that indicating the annual electricity costs of televisions is even counterproductive (cf. previous chapter), i.e., it leads to a lower willingness to pay than information in watts. However, specifying the electricity costs over the entire lifetime of the appliances leads to a higher willingness to pay, both compared to specifications in watts and compared to specifying the annual electricity costs (see figure 2). Adding up the annual costs over a longer period of time increases the amount of operating costs, both in absolute terms and in comparison to the purchase price. In some cases, the annual operating costs are too low, and subjectively do not matter ("pennies-a-day effect", see [19]). In the field studies with data on service life, nevertheless, no or only a small effect is visible. This can have various causes, e.g. competing information, special promotions or difficulties in defining the comparison group (cf. chapter "Experiments vs. field studies" above).

**Figure 2:** Comparison of willingness-to-pay with different specifications of energy consumption / operating costs (in

	Group 1 ("watts")	Group 2 ("lifetime energy operating costs")	Group 3 ("annual energy operating costs")
Energy consumption/energy operating costs	60 W	€180	€18
	115 W	€340	€34
	170 W	€500	€50
	225 W	€660	€66
WTP:	480 €	640 €	350 €

"watts", lifetime or annual energy operating costs)

Source: Own compilation with data from [12]

### Competing information reduces the effect of monetary disclosure

In [15], the effect of competing information on the effectiveness of cost information was investigated. When energy costs were shown in addition to the EU Energy Label in a simplified setting, households were significantly more likely to choose the more energy-efficient appliance. If, on the other hand, additional information on other, non-energy-related appliance features acting as additional stimuli and competing for attention, was displayed, there was no effect or even a negative effect of energy costs compared to information in kilowatt hours.

### Further findings

Besides the above-described results there were some further findings which are of interest:

- When there is an effect of monetary claims for household appliances, it is usually rather small [13, 17]. The large effect in [7] is likely due to a combination of effects: it is an experiment (not a field study), the operating costs are a large proportion of the total costs and the differences between the operating costs of the alternatives are relatively large. In addition, the informative value of the efficiency classes shown is rather low: A vs. A+ on a scale from A++ to E.
- In contrast, the effect of monetary information for real estate and cars is rather large [16, 17].
- Training of sales staff only partially increases the effect of the label (positive effect in [13], no effect visible in [17]),
- Reporting savings might have a stronger impact than reporting (absolute) costs [17],
- Women seem to be more responsive to energy-use information and also cost information [16].
- 

### Discussion and conclusions

The results indicate that monetary claims are effective, and possibly exceed the effect of claims on a physical basis, especially in those cases in which costs or the differences between the alternatives available reach such a high level that it is substantial enough to be "relevant" to the consumer: this can be caused by a high share of operating costs in total costs, by a large absolute level of operating costs, or by large differences between alternatives. Depending on how high the operating costs are in absolute or relative terms compared to the acquisition costs, sometimes information on a monthly or annual basis is sufficient for this (e.g. for real estate or cars) – sometimes, however, only information over a longer period of time leads to the perception that the operating costs are of a relevant order of magnitude (e.g. for televisions). These results are in good agreement with the conclusions in [20], where requirements for the communication of life cycle or operating costs were derived, taking into account behavioural economics.

If the absolute values or the differences, especially in comparison to purchase prices, are rather small, monetary information can even be counterproductive: because it decreases the relevance of operating costs

estimated by consumers with the help of energy efficiency classes and the indication of energy consumption. Communicating the costs objectifies the decision-making process here – but since the differences were previously overestimated, the effect works in the other (wrong) direction.

Overall, the results tend to suggest that monetary information should not generally replace information in watts or kilowatt-hours on the energy label, since a potentially small advantage is counterbalanced by the risk that the information will not influence behavior in the desired direction. There are also practical limitations: for example, electricity prices in different Member States range from around 30 ct/kWh in Germany to just under 10 ct/kWh in Bulgaria [21]. Thus, a uniform value for all member states would be poorly representative.

However, targeted use in specific applications and situations can be useful: for example, national communication activities could certainly draw attention to operating costs and differences if the conditions are right. In [22] retailers saw an increase in sales of efficient appliances (A++ and A+++ ) due to the indication of annual operating costs. In addition to real estate and cars, for which the studies did indeed find a significant effect, there are also household appliances for which the differences in operating costs are (still) high, for example tumble dryers [23]. It can be assumed that the operating costs for heating systems are also large enough to argue with.

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