

# ***BEYOND ENERGY EFFICIENCY: DO CONSUMERS CARE ABOUT LIFE CYCLE PROPERTIES OF HOUSEHOLD APPLIANCES?***

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## **Overview**

In the European Union (EU), environmental regulation for household appliances has focused on energy consumption during usage, such as minimum energy performance standards (Ecodesign Directive 2009/125/EC) or energy labels (Regulation (EU) 2017/1369). Recent policy efforts are broadening the scope of requirements beyond the usage phase and cover life cycle greenhouse gas (GHG) emissions. Meanwhile, socio-economic studies have mainly investigated consumer valuation of energy consumption during the usage phase (Shen and Saijo 2009, Heinzle and Wüstenhagen 2012, Davis and Metcalf 2016, Newell and Siikamäki 2014, Ward et al. 2011, Liu et al. 2016, Faure et al. 2021, Zha et al. 2020, Zhou and Bukenya 2016, Saidur et al. 2005). Little is known about consumer preferences for energy consumption during the production phase of appliances or for other life cycle characteristics such as durability, recyclability, and use of environmentally friendly material. Likewise, little is known about how these preferences are related with individual characteristics. In this paper, we empirically elicit consumer preferences for life cycle properties of large household appliances, in particular for production-related energy consumption. We also explore heterogeneity in preferences for various life cycle properties of appliances. To this end, we employ data from a demographically representative household survey among the adult population in Germany to study individual preferences for energy-related attributes of household refrigerating appliances.

## **Methods**

We examine the effects of information on production-related energy use of large household appliances through an online survey implemented in July and August 2018 in Germany. A sample of 450 participants were selected via quota sampling to be representative of the German adult population. As part of the survey, we conducted a discrete choice experiment (DCE) on refrigerator purchase in which respondents were invited to make a series of hypothetical choices between different refrigerators (two at a time). Attributes on which these refrigerators differed were size, energy class, energy consumption for production and distribution, warranty, customer rating, and purchase price. The DCE was followed by survey questions on preferences for different life cycle properties of large household appliances and questions on individual and household characteristics.

First, we use a mixed logit model to analyze the data from the DCE and elicit average preferences for the product attributes, including preferences for the energy used to manufacture the refrigerator. Second, we use latent class analysis to identify distinct groups within the household population according to their valuation of different product attributes in the DCE. Group membership is related to observable characteristics including socio-demographic characteristics such as income, preferences such as environmental identity, and capabilities such as energy literacy. Third, we elicit participants' preferences for information about the energy use related to the manufacturing of large household appliances. Fourth, we investigate to which extent participants consider different life cycle properties when purchasing such appliances. For this purpose, we asked participants to indicate how much they typically considered these criteria when making purchase decisions using a five-point rating scale ranging from 'no consideration' to 'a lot of consideration'. Finally, to explore the relation of participant preferences for these life cycle criteria, we estimate ordered logit models, which include socio-demographic information, environmental and time preferences, and an energy literacy as covariates.

## **Results**

We find that, on average, participants value the highest energy class, dislike higher energy consumption for production and distribution, and prefer refrigerators with larger volume, longer warranty periods, and high average customer ratings.

The latent class analysis suggests three household classes (based on the BIC criterion): a *price sensitive* class (35%) of households that react to price before anything else, a *green* class (40%) of households that are responsive to energy consumption during both use and manufacturing, and a *quality-oriented* class (25%) of households that stand out for valuing quality-related attributes such as warranty, user ratings, and energy consumption but ignore production-related energy consumption. People with high environmental identity and patient respondents are more likely to be in the green class than in the other classes.

Descriptive results based on survey questions further show that about 51% of participants rather (30%) or strongly (21%) agree that there should be a label for household appliances indicating the energy consumption necessary to manufacture them.

Regarding preferences for different life cycle properties, we find that more than half the participants indicate paying a lot of consideration to durability, but only around 15% indicate paying a lot of consideration to environmentally friendly materials, recyclability, and energy used to manufacture the appliance.

The ordered logit model estimations provide evidence that, for all life cycle properties, people with higher environmental identity and more patience consider life cycle properties more strongly, on average. This is consistent with the results of the latent class analysis. Furthermore, women tend to give more consideration to life cycle properties than men do, especially regarding the use of environmentally friendly materials. In addition, we find that low-income and less educated households give more consideration to life cycle criteria. Urbanites appear to care more about a product's energy footprint but not about any other life cycle property. Higher energy literacy relates to stronger consideration of product durability only. Finally, for age, high income, and homeownership, we find no statistically significant associations.

## Conclusions

Our findings suggest that there is a large segment of households (~40%) that would be attentive to life cycle information on appliance labels. Furthermore, about half of all households agree that appliance labels should show the energy used to manufacture the product. Durability is the life cycle criterion that households currently consider most.

Our findings have implications for appliance labeling policies. A label on life cycle properties should not only include information on usage and production related energy use but also on properties such as durability, recyclability, and environmental friendliness of materials used. This finding therefore supports ongoing policy initiatives which propose to make such information available to the customer (e.g., European Commission, 2022). For production-related energy use, it might be sufficient to use only a few categories to distinguish the products. Information about life cycle properties of appliances might be most effective if targeted at women, people with below average education, and urban households. Finally, improving energy literacy could lead to a higher share of the adult population to strongly consider durability when purchasing an appliance.

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