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Switching from Fossil Fuel to Renewables in Residential Heating Systems: An Empirical Study of Homeowners' Decisions in Germany

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Overview

This research investigates key drivers and barriers behind homeowners' decisions to switch from a fossil fuel to a renewable residential heating system. So far, academic research has mainly focused on energy appliance and fuel choice while replacement purchases and fuel switch decisions have been less investigated. The focus of previous studies on energy appliance and fuel switching behavior is to a large extent on stoves and fuels for cooking in developing countries, applying the so-called energy ladder model (e.g. Van der Kroon et al., 2013). For the case of the non-adoption decision, the literature mainly focuses on the energy efficiency gap (e.g. Jaffe and Stavins, 1994; Sorrell et al., 2004; Allcott and Greenstone, 2012) and the consumers' resistance to innovations (e.g. Kleijnen et al., 2009). While the number of empirical studies on the determinants of positive RHS adoption decisions has been increasing over the past years, empirical research that explicitly studies the reasons for not adopting a certain RHS is still scarce (e.g. Claudy, 2011 or Sopha et al., 2011). Thus, the two research questions of this study are as follows: What are the drivers behind homeowners' decisions to switch to a renewable RHS (*replacement decision*)? What are the barriers that prevent homeowners to convert their fossil fuel into a renewable RHS (*non-adoption decision*)?

Methods

The data analyzed in this paper stem from survey responses of owners of existing 1-family or 2-family homes in Germany who replaced their old oil- or gas-fired RHS between January 2009 and August 2010 either by a new gas- or oil-fired condensing boiler with solar thermal support, a heat pump, or a wood pellet-fired boiler. It represents a subsample of a representative mail survey conducted in 2010 among owners of newly built and existing 1-family or 2-family homes that received a capital grant by BAFA for the installation of a new RHS (for details of the survey, see Michelsen and Madlener, 2012, 2013). In order to explore the RHS replacement behavior, we apply logistic regression techniques (ordered logit, multinomial logit) on the survey data. In our logistic regression models, there are four categories of variables including (i) socio-economic characteristics (e.g. homeowners' income, age, gender, education), (ii) attributes of the home (e.g. vintage class, size, type, energy standard), (iii) locational variables (e.g. rural area, South or East Germany) and, (iv) motivational aspects (e.g. perceived relative costs, capital grant, attitude, external threats, comfort issues, influence of peers or RHS-related knowledge). Moreover, we analyze the determinants of the decision to generate a certain share of heat by means of solar thermal collectors. This includes solar thermal support for (i) hot water generation only or (ii) both hot water generation and heating support.

Results

Above all, the findings for the *replacement decision* show that the motivation to deal with external challenges (i.e. environmental protection and independence from fossil fuels) and a higher degree of RHS-related knowledge are key drivers to switch to a renewable RHS. In contrast, socio-demographic characteristics and attributes of the home seem to be relatively less relevant. The analyzed barriers can be grouped into "perceived economic and non-economic barriers" and "evaluation of RHS-related attributes". The results for the *non-adoption decision* show that the barriers vary by RHS. In particular, for the reference case of a fossil fuel RHS, the strong reliance on pricey oil or natural gas (which is the case in Germany) is found to be the main hurdle to adoption. For the heat pump, it is shown that the perceived difficulty of getting used to the system and a misunderstanding of its basic functioning are important obstacles to adoption. Finally, for the wood pellet-fired boiler, the results imply that non-adopters perceive the low user-friendliness, the labor-intensive operation, and the systems' high susceptibility to faults to be important barriers.

Conclusions

In general, the results on drivers and barriers to adopting renewable RHS show that homeowners often fear major changes to their status quo (e.g. replacement of the entire existing heating infrastructure, earth moving operations in the garden, major energy retrofit of the home) and, thus, tend to opt for only minor and thus quick adjustments to the RHS (e.g. exchange of the boiler). Likewise, a higher replacement rate of fossil fuel by renewable RHS requires the homeowners' willingness to relinquish old habits and perceptions of how an RHS works and operates. Consequently, a key towards an increased replacement of fossil fuel by renewable RHS seem to be homeowners that are well informed about alternative RHS. This includes a basic understanding of the technical principles and functioning as well as the

awareness of possible consequences linked to the usage of different RHS. This research sheds some important new light on the households' energy appliance and fuel-switching behavior in the context of an industrialized country. Moreover, the findings contribute to a better understanding of the likely future transition dynamics of the energy system in the residential heating sector. Implications for policy-makers include that policy instruments such as capital grants may better be combined with information and awareness campaigns on renewable RHS in order to increase their effectiveness. Likewise, marketing strategies of RHS manufactures should also aim at explaining basic technical principles and how to operate the system to possible adopters.

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