ZEW Economic Studies 44

Klaus Rennings
Bettina Brohmann
Julia Nentwich
Joachim Schleich
Thure Traber
Rolf Wüstenhagen *Editors*


# Sustainable Energy Consumption in Residential Buildings

ZEW
Zentrum für Europäische Wirtschaftsforschung GmbH
Centre for European Economic Research

Physica-Verlag
A Springer Company

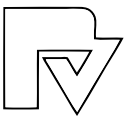
ZEW Economic Studies
Volume 44

Publication Series of the Centre for European Economic Research (ZEW), Mannheim, Germany

For further volumes:
http://www.springer.com/series/4041

Klaus Rennings • Bettina Brohmann
Julia Nentwich • Joachim Schleich
Thure Traber • Rolf Wüstenhagen
Editors

# Sustainable Energy Consumption in Residential Buildings



Physica-Verlag
A Springer Company

ZEW
Zentrum für Europäische Wirtschaftsforschung GmbH
Centre for European Economic Research

ISSN 1615-6781 ISSN 1867-2027 (electronic)
ISBN 978-3-7908-2848-1 ISBN 978-3-7908-2849-8 (eBook)
DOI 10.1007/978-3-7908-2849-8
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2012936666



Printed on acid-free paper

Physica is a brand of Springer
Springer is part of Springer Science+Business Media (www.springer.com)

# Preface: When Less is More

Climate change and energy security represent two of the most pressing problems for current and future generations. As residential buildings account for around 30 per cent of final energy demand in Germany, this sector has been receiving increasing public attention. At the moment, policy makers rely on two strategies for reducing the emission of carbon dioxide (or $CO_2$, a greenhouse gas) while meeting the energy demands of private households.

The first strategy raises the proportion of renewable energies in the production of electricity and heat for households. The second strategy seeks to make energy use in residential buildings more efficient. (Often these strategies are used in combination.) Studies have yet to be conducted on German household preferences for particular technologies or services to reduce energy consumption. And studies on households in other countries have yet to consider trade-off preferences regarding, say, heating systems and thermal insulation.

The research project Social, Ecological and Economic Dimensions of Sustainable Energy Consumption in Residential Buildings (SECO@home, Website: www.zew.de/seco) closely examined decisions on energy consumption made by private German households.

The aim of the empirical study was to answer the following questions:

- What are the determinants of the diffusion of energy-efficient household appliances and what is the impact of the energy label design?
- What factors determine investment in energy modernisation measures for heating and what role does gender play specifically?
- What are promising strategies for policy makers' and companies to help improve energy efficiency in German households?
- What is the impact of specific regulatory and company strategies to improve energy efficiency in households and reduce $CO_2$ emissions?

Several methods inform the empirical analysis. SECO@home conducted a representative survey using innovative questioning and statistical techniques to identify tenants' and property owners' preferences for specific low carbon products. Survey analysis provided insights into consumers' behaviour regarding more sustainable energy consumption, and is viewed as a substantial contribution to the field. The study also analysed survey information on observed technology choices econometrically. Furthermore, a qualitative study approached the topic of home heating from a social practices perspective, focusing on the dual role of gender and technology.

The inter- and transdisciplinary project ran from March 2008 to November 2010 and was supported by the funding initiative From Knowledge to Action -

New Paths Towards Sustainable Consumption (see the Federal Ministry of Education and Research [BMBF] at the Website: http://www.sozial-oekologische-forschung.org/de/947.php). The consortium was co-ordinated by the Centre for European Economic Research (ZEW), and included the University of St. Gallen, the Fraunhofer Institute for Systems and Innovation Research (ISI), the Öko Institut and the German Institute for Economic Research (DIW). The project team received regular and valuable feedback from an advisory board made up of leading specialists in the field of consumer behaviour and energy saving.

The members of the advisory board were:

- Bödeker, Jan Maurice, senior researcher, ifeu Institute for Energy and Environmental Research, Heidelberg GmbH
- Denkhaus, Dr. Ulrich, Germanwatch, Bonn/Berlin
- Geißler, Michael, director, Berlin Energy Agency GmbH
- Gutzwiller, Lukas, Bundesamt für Energie, Switzerland
- Helfrich, Matthias, board member, Accera Venture Partners AG, Mannheim
- Hellmer, Roland, team director, Strategy, New Products in Heating and Cooling, Vattenfall Europe Berlin AG & Co. KG, Berlin
- Jäger-Waldau, Dr. Arnulf, director, Renewable Energies Unit, European Commission, DG JRC, Institute for Energy
- Litzka, Vera, board member, Working Group for Energy and Water Savings in the Assocociation of Local Energy Suppliers
- Meixner, Dr. Horst, head, hessenENERGIE GmbH, Wiesbaden
- Münch, Dr. Wolfram, director, Department of Research, Development and Demonstration, EnBW AG, Karlsruhe
- Operto, Gianni, Good Energies Inc.
- Paradeis, Christoph, former director, Solar-Fabrik AG, Freiburg
- Peters, Dr. Aribert, director, Association of Energy Users, Rheinbreitbach
- Praetorius, Dr. Barbara, Verband Kommunaler Unternehmen e.V. VKU
- Schuele, Dr. Ralf, senior researcher, Wuppertal Institute for Climate, Environment and Energy
- Sieverding, Udo, energy director, Consumer Agerncy NRW e.V
- Weigl, Fred, Association of Energy Consulters (Bundesverband Gebäudeenergieberater, Ingenieure, Handwerker - GIH), Stuttgart

The project's final workshop took place at the Evangelische Akademie Loccum in late September 2010 and provided an opportunity to present the project findings to a broader audience. Numerous experts from the fields of politics, administration, business and professional associations, as well as from research and science attended the event and took part in the lively discussions. Points of debate ranged from funding instruments and energy market liberalisation to the German government's current energy plan. On the basis of the project results, all experts agreed that the road to more sustainable energy consumption in residential buildings was not hampered by a lack of will on the part of the consumers. Still, we should note the additional costs that often accrue for households when improving a building's thermal performance. Even though the building sector offers large energy saving

potentials, energy saving measures are not always associated with a positive cost-benefit-ratio, especially in the short term.

Effective policies are those that impove security for planning and investing in $CO_2$ saving measures and services in private housholds, and strengthen companies' ability to offer products (and services) that meet consumer preferences. Effective policies should also help policy makers and companies gear their strategies to consumer needs.

This book includes the core findings of the SECO@home project. Though each contribution stems from different authors and institutes, all follow the common conceptual approach described in chapter 1. This approach may be characterised as an attempt to integrate the economic, social and psychological aspects of more sustainable consumption. Chapter 2 presents findings from econometric analyses of factors driving adoption of energy-efficient household appliances based on observed behaviour data already collected in a large representative survey. Chapter 3 presents the results of the new SECO@home household survey alongside the findings of two different conjoint experiments: on TVs and on heating and insulation. On the basis of these empirical analyses, chapter 4 develops strategies for firms and policy makers to improve energy efficiency in residential buildings. Chapter 5 estimates the environmental impacts of selected strategies. Chapter 6 presents the results of a qualitative study on the gender aspects to home-heating choices.

We have just begun to understand how households make decisions about sustainable consumption; much remains to be studied at the theoretical and empirical level. A well-developed theory of sustainable energy consumption must be able to explain learning processes, habitual behaviour, lock-ins and path dependency.

Our work would not have been possible without the support of the project advisory board. We would like to thank its members for their valuable and constructive comments, and we look forward to working with them again when we elaborate the findings of SECO@home. We also would like to give special thanks to Beatrix Immig and Patrick Pilarek for assistance in the editing process and to the SECO@home research assistants Caroline Bulla, Laura Piotter and Philipp Baltes for their technical assistance and fine work in formatting this book.

The Editors
February 2012
Klaus Rennings, Bettina Brohmann, Julia Nentwich, Joachim Schleich, Thure Traber, Rolf Wüstenhagen

# Table of Contents

# 1 Introduction and Theoretical Framework



K. Rennings et al. (eds.), *Sustainable Energy Consumption in Residential Buildings*, ZEW Economic Studies 44, DOI 10.1007/978-3-7908-2849-8_1,

# 1 Introduction and Theoretical Framework

**Bettina Brohmann, Tim Clamor, Stefanie Heinzle, Klaus Rennings, Joachim Schleich and Rolf Wüstenhagen**

## 1.1 Introduction

Consumption is a key lever to achieving more sustainable development. Unsustainable consumption is a major cause of global environmental deterioration, including overexploitation of renewable resources and pollution caused by fossil fuels. The European Environmental Agency report "Household Consumption and the Environment" (EEA, 2005) identifies the need areas of food, housing, personal travel and mobility as well as tourism as the four major areas of household consumption with the highest negative environmental impacts.

The current trends are worrying. Real per capita GDP in the EU-27 member states has increased by approximately one quarter in the last fifteen years. For the period through 2020, household consumption expenditures are expected to continue to grow approximately at the same rate as GDP, or 2-3% annually. Technological innovations have reduced the energy and material used by most products, yet increasing volumes of consumed goods have offset these gains: Household energy consumption contributes to almost 30% of the total final energy consumption and its energy demand is increasing more rapidly than that of all other sectors except transportation.

This paper will focus on consumption behaviour in residential buildings. It will provide an overview of the literature on individual consumer decisions about sustainable energy consumption. We rely primarily on economic studies, in particular on those employing discrete choice models but we also include contributions from socio-economic literature. With a view to later chapters, our overview concentrates on the determinants of sustainable energy consumption with regard to household appliances, heating systems and green electricity.

We are well aware that institutional setting partly determines individual energy consumption. Consider tenants. They may have landlords who are uninterested in energy-saving investments or for whom energy costs are unimportant. Still, all forms of energy consumption require individual decisions, be they conscious or unconscious.

Our objective is to analyse individual decision making so as to make it more transparent.

The paper begins with a definition of sustainable consumption. We then review the general economic, social science and psychological literature on individual decisions about energy demand and the general factors that influence sustainable energy use. Section 3 will present methodological contributions on the subject. A review of the literature on household appliances, heating systems and green electricity will follow. Finally we draw some conclusions and present some hypotheses regarding the three applications, and briefly discuss research needs.

## 1.2 Definitions of Sustainable Consumption

"Over the last decade or so, there has been a wealth of social and natural scientific debate about the environmental consequences of contemporary consumption and there is, by now, something of a consensus. It is clear that lifestyles, especially in the West, will have to change if there is to be any chance of averting the long-term consequences of resource depletion, global warming, the loss of biodiversity, the production of waste or the pollution and destruction of valued 'natural' environments" (Shove, 2003, p. 1).

The Brundtland Report (WCED, 1987, p. 43) provides the classic definition of sustainable consumption: "[T]he use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the lifecycle, so as not to jeopardise the needs of future generations" (OECD, 2002, p. 16)

Sustainable consumption is seen as a process involving negotiation and consensus-building; in some cases this process competes with conventional market operations. For new consumption strategies to be established, all actors must be willing to engage in discourse. Hansen and Schrader (1997, p. 455) point out that the normative judgment of sustainable development and sustainable consumption "has to be given additional legitimacy by […] societal discourse" and *practice*.

Sustainable consumption has to be understood as a societal field of action. It can be characterised by three interacting areas:

- the individual area of action (divided into two sub-areas): a demand-side area, which includes consumption activities in the context of households and professional procurement activities (of both large-scale private-sector companies and the public sector); and an informal area, in which private consumers undertake informal activities (e.g. unpaid household work) not oriented to the market and thus not visible ba demand levels;
- the supply-side and structural area of action, which includes the activities of companies and also governmental bodies to provide sustainable products, services and information;
- the socio-political area of action, which includes the activities of governmental bodies, organisations and associations to form the general framework for governance in both the individual and supply-side (or structural) area of action. Societal factors of consumption behaviour such as visions and moral concepts are formed in this area of action.

The three areas are interrelated: Consumer behaviour is based on individual decisions, while individual behavior largely depends on supply-side measures, appropriate infrastructure (e.g. the availability of energy-efficient household equipment) and socio-political factors (e.g. the existence of energy taxation, emissions trading systems or eco-labels).

Eberle, Brohmann and Graulich (2004) look at sustainable consumption as a more ecological but also socially responsible way of buying and using goods and services. Individual and societal consumption behaviour is influenced by a variety of contextual factors: specific lifestyles, social environment (neighbourhood, favoured peer groups), infrastructure, habits and routines (Shove and Warde, 1998; Empacher, 2003; Shove, 2003).

There is consensus among experts that the implementation of more sustainable consumption practice requires not only awareness among consumers but also changes in social and economic structures. Consumption is a "socially constructed historically changing process" (Bocock, 1993, p. 45). Several authors (e.g. Fichter, 2005; van Vliet, 2002) stress the need for new product policies and the important role played by consumers: "People are not simply end-consumers entirely isolated from the production process" (van Vliet, Chapells and Shove 2005, p. 17). "They participate in the organisation of production-consumption cycles" (van Vliet, 2002, p. 53).

On the one hand, every purchase is a vote for or against certain production conditions (including environmental effects as well as social conditions); on the other, "the existence of a suitable supply" (Hansen and Schrader, 1997, p. 463) is crucial for the transition to more sustainable consumption. "The creation of an awareness that an ignorant 'business as usual' attitude does not only promote inaction but constitutes an active immoral act is hence a necessary prerequisite for a change towards sustainable consumption" (Hansen and Schrader, 1997, p. 459). Empirical data show that this awareness already exists in some Western societies. For instance, 75% of German consumers believe that users are able to put considerable pressure on producers.

In this sense, every consumer also serves as a "co-producer" (Hansen and Hennig, 1995). The widespread debates in the early 2000s on consumption as utility production – as in the field of behavioural economics (Belz and Egger, 2001; Belz, 2001; Scherhorn, 1994) – reveals numerous factors to be considered in a strategy for change. As noted by Jackson (2005) (quoted in Kaenzig and Wüstenhagen, 2006, p. 295), sustainable behaviour is "a function of partly attitudes and intentions, partly of habitual responses, and partly of the situational constraints and conditions under which people operate." A variety of models and theories address decision making in the consumption sector. They originate from three disciplines in particular: (Behavioural) economics, social psychology (environmental psychology) and sociology (cultural anthropology, sociology of technology). Their contributions will be briefly described in the next section.