



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Department of the Environment, Transport, Energy and
Communication DETEC

Swiss Federal Office of Energy SFOE
Energy Research

Annual report 2016

Underlying energy efficiency and technological change in the Swiss household sector



Centre for Energy Policy and Economics
Swiss Federal Institutes of Technology

Date: 15. January 2017

Town: Bern

Publisher:

Swiss Federal Office of Energy SFOE
Energy - Economy - Society (EES) research programme
CH-3003 Bern
www.bfe.admin.ch

Agent:

Centre for Energy Policy and Economics (CEPE)
ETH Zürich
Zürichbergstrasse 18
CH-8032 Zürich
www.eepe.ethz.ch

Author:

Prof. Dr. Massimo Filippini, CEPE, mfilippini@ethz.ch
Dr. Julia Blasch, CEPE, jblasch@ethz.ch
Dr. Nina Boogen, CEPE, nboogen@ethz.ch
Nilkanth Kumar, CEPE, nkumar@ethz.ch

SFOE head of domain: Matthias Gysler, Matthias.Gysler@bfe.admin.ch

SFOE programme manager: Anne-Kathrin Faust, Anne-Kathrin.Faust@bfe.admin.ch

SFOE contract number: SI/501106-01

The author of this report bears the entire responsibility for the content and for the conclusions drawn therefrom.

Swiss Federal Office of Energy SFOE

Mühlestrasse 4, CH-3063 Ittigen; postal address: CH-3003 Bern
Phone +41 58 462 56 11 · Fax +41 58 463 25 00 · contact@bfe.admin.ch · www.bfe.admin.ch



Contents

Project goals.....	4
Work undertaken and findings obtained.....	5
National cooperation	6
International cooperation.....	6
Evaluation 2016 and outlook for 2017.....	6
References	7



Project goals

More than 60% of the energy end-use consumption in Switzerland originates from fossil fuels. In 2014, the residential sector consumed nearly 30% of the total final energy consumption in Switzerland and about 58% of the energy end-use consumption of households was based on fossil fuels (BFE, 2015). Improving the energy efficiency in the residential sector is therefore one of the strategies to reduce total fossil energy consumption and related CO₂-emissions in Switzerland, in order to eventually meet the energy policy goals established in the Swiss 'Energy Strategy 2050'.

When thinking about reducing the energy consumption of households, four important questions arise: (1) How large are the potentials for energy savings in the Swiss residential sector for a given level of energy services? (2) How big are the differences in the levels of energy efficiency among Swiss households and to what extent are these differences driven by energy policy measures or behavioural factors? (3) What role does technological change play for the reduction of energy consumption in Swiss households? (4) What role does the level of energy and investment literacy play in the adoption of energy efficient technologies?

To answer these questions, it is important to remember that a household's energy demand is not a demand for energy per se but a derived demand for energy services, such as cooling, heating, cooking or lighting. A reduction in energy consumption for the production of a given level of energy services can be achieved either by improving the level of efficiency in the use of inputs (i.e. in the use of appliances), by adopting a new energy-saving technology (i.e. purchase of new appliances, investments in energy-saving renovations) or by both processes. Technological change can induce a reduction of energy consumption for a given level of energy services, provided that the inputs are used in an efficient way, i.e. given that the households are productively efficient. The total reduction in residential energy consumption is therefore a result of the interplay of technological change and a household's behaviour.

In this project, we estimate a household's level of energy efficiency with mathematical and statistical methods, accounting for total energy consumption and factors such as size and characteristics of the residence, household composition, number and type of appliances, number of energy-services consumed, as well as socio-economic and demographic variables and energy-related behaviour. With this approach a 'fair' benchmarking of Swiss households with respect to their energy consumption can be performed.

In order to apply the above-mentioned approach, we carried out a household survey in cooperation with nine Swiss utilities supplying major urban and suburban areas in different parts of Switzerland with electricity and gas. The survey delivers data on more than 8'000 Swiss households. In a first step, the project aims at providing a comprehensive overview of energy consumption in Swiss households. Based on descriptive statistics, information on the size and characteristics of the residences of Swiss households, on household size and composition, energy services, appliances, socio-demographics as well as energy-related attitudes and behaviours will be provided. In a next step, the level of energy efficiency in Swiss households will be estimated with the above described econometric approach. The impact of energy policy instruments and behavioural factors on the level of efficiency in the use of energy will be analysed.



Work undertaken and findings obtained

In the first intermediate report to this project (end of 2015), we provided a systematic analysis of the relation between energy demand, energy efficiency and technological change. The concepts of productive efficiency, energy efficiency, technological change and energy efficiency gap were discussed within the framework of the household production theory. Moreover, we developed a basic mathematical framework of household production theory. In addition, we provided an overview of the development and implementation of the online survey that we organized in cooperation with the nine Swiss utilities to collect data for our empirical analyses. We informed about the organization of the sampling, the process of data collection as well as the general structure of the questionnaire. Finally, we also included a sample of the questionnaire underlying the household survey. However, the descriptive statistics we provided in the first intermediate report covered, due to data availability at that time, only one of the nine utilities.

In 2016 we finished the data collection for all nine utilities. Therefore, we could **as a first part**, finish the (aggregate) descriptive statistics for all 8,378 households from nine utilities that we cooperated with for our data collection. The descriptive statistics provides information on the size and characteristics of the residences of the sampled households, energy sources used by the households, on household size, composition and characteristics, on the energy services consumed by the households, on number and age of appliances as well as socio-demographics of the survey respondents. In addition, we report energy-related attitudes and behaviours, energy literacy and the adoption of policy measures offered by the utilities (such as appliance rebates, investment support or online self-monitoring tools). In addition, we also compare the energy efficiency of the households across the participating utilities using simple efficiency indicators like electricity and gas consumption per capita or per square metre.

The descriptive statistics are meant to provide a comprehensive overview of energy consumption in Swiss households in urban and suburban areas. The surveyed households seem to represent the households in Swiss urban and suburban areas quite well in terms of household types, gross monthly household income as well as pro-environmental attitudes (captured by the share of households having donated to environmental organizations in the past year). However, the sampled households seem to be more highly educated than the general Swiss population. Weighting techniques will be used in the final data analysis to account for this fact.

As a second part, we conducted a first estimation of the level of technical efficiency in the use of electricity of Swiss households. This is based on an analysis of a Swiss household survey conducted by the association of Swiss electricity companies, the Verband der Schweizerischen Elektrizitätsunternehmen (VSE). VSE conducted two surveys. The first survey was conducted in 2005 and the second survey in 2011, both through telephone interviews. In each survey wave they collected information on around 1'200 Swiss households served by five different utility companies. Three of the companies were the same in 2005 and 2011. Data from these two survey waves were used separately to estimate a sub-vector input distance function for each year.

We find a significant inefficiency in electricity use by Swiss households. Our estimates lie at the upper end of the electricity saving potential estimated by researchers using an economic-engineering approach and suggest a considerable potential for improving the efficient use of electricity in some households. These results can be considered as explorative for the data analysis that we are going to carry out based on the data from the large household survey conducted in 2015 and 2016. As this data has a panel structure and covers electricity and gas consumption over five years, we expect to provide an even more precise analysis of the level of energy efficiency of Swiss households in our next intermediary report to this project.



National cooperation

For the organisation of the household survey we cooperate with nine Swiss utilities that operate in nine major urban areas in Switzerland, among them Aziende Municipalizzate Bellinzona (AMB), Aziende Industriali di Lugano (AIL), Services Industriels Lausanne (SiL), Energie Service Biel/Bienne (ESB), Energie Wasser Luzern (EWL), Stadtwerk Winterthur (SW), IBAarau, IWB Basel and Energie Wasser Bern (EWB). One of the criteria for the selection of these utilities was that they should operate mainly in urban areas in order to get a sample of households as homogeneous as possible in terms of environment. In addition, we predominantly approached multi-utilities that supply households not only with electricity but also with gas for heating, warm water and/or cooking, as this allows to expand the analysis to total energy consumption (at least for a subsample of the households). Furthermore, we wanted the utilities to represent all three major language areas of Switzerland. The final sample is expected to provide a good representation of Swiss households residing in urban and suburban areas of Switzerland, i.e. to be representative not on the regional but on the national level.

In addition, the project cooperates also with the Swiss Competence Center for Research in Energy, Society and Transition (SCCER CREST). For example, one part of the online survey implemented in this project (one experiment that we realised only for one of the utilities) was also implemented in another survey as part of a project collaboration with SCCER.

International cooperation

Results from this project were presented at the following international conferences:

- Annual Conference of the International Association of Energy Economics
- Annual Conference of the European Association of Environmental and Resource Economists
- Empirical Methods in Energy Economics Workshop
- European Conference on Behaviour and Energy Efficiency
- Atlantic Workshop in Energy and Environmental Economics

Evaluation 2016 and outlook for 2017

With the finalisation of this report, one important part of the project is entirely completed: the data collection is closed now and the data of eight participating utilities is ready for analysis. The data of the ninth utility, will soon be ready for analysis. The descriptive statistics for the entire sample providing a comprehensive overview of energy consumption in Swiss households in urban and suburban areas has also been concluded. In addition, first results on the level of energy-efficiency of Swiss households based on the estimation of an input distance function are available and will be used to guide our analysis of the survey data.

Furthermore, a working paper (Blasch et al., 2016) on the influence of energy literacy on the probability to purchase energy-efficient appliances has been published. This additional analysis is based on two online randomized controlled trials (RCTs) that have been included in the questionnaire of the large household survey. In this working paper, using a series of recursive bi-variate probit models and three samples of 583, 877 and 1'375 Swiss households from three participating utilities, we show how displaying information on the future energy consumption of electrical appliances in monetary terms, i.e. as an estimate of yearly energy cost (CHF) rather than in physical units (kWh),



increases the probability that an individual performs an investment analysis and hence chooses the most (cost-) efficient appliance. In addition, our econometric results suggest that individuals with a higher level of energy and, in particular, investment literacy are more likely to perform an optimization rather than relying on a decision-making heuristic and are more likely to identify the most (cost-) efficient appliance.

As a next step, we will estimate the level of energy efficiency of Swiss households based on the full sample and analyse the impact of energy literacy. As we have done so far, we will report on our progress every six months.

References

BFE: 2015, Schweizerische Gesamtenergiestatistik 2014, Bundesamt für Energie - BFE.

Blasch, J., Boogen, N., Filippini, M., and Kumar, N. (2015). Underlying energy efficiency and technological change in the Swiss household sector, Jahresbericht 2015 zu Handen des Bundesamtes für Energie - BFE.

Blasch, J., Filippini, M., and Kumar, N. (2016). Boundedly rational consumers, energy and investment literacy, and the display of information on household appliances. CER-ETH Economics Working Paper, ETH Zürich