

Tailor-made Energy Consulting for Private Households

The approach of the Austrian R&D project “EnBe2.0”

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Abstract: Energy consulting for private households can make a significant contribution to achieving energy efficiency targets. The extent to which these targets can be validated, however, depends to a large degree on the consideration of the individual demands of the consulted people and/or households. Not only do socioeconomic, environmental and structural factors like income, climate or living space have an impact on the effectiveness of energy consulting but also the consideration of people’s habits, needs, preferences, values, attitudes etc. Due to the fact that the common practice of energy consulting is insufficient in terms of taking into account household and end-use energy consumer related factors, energy savings gained through energy consulting for private households have, as a result, been unsatisfactory. To achieve more energy savings with the help of energy consulting the R&D-project “EnBe2.0” was launched and has been carried out by an interdisciplinary consortium in Austria. The aim of the project EnBe2.0 is to develop an energy saving tool (EnBe2.0-Toolbox) that meets the multifaceted requirements of end-use energy consumers and assists energy consultants with target-group orientated energy consulting practices for private households. This paper gives an overview of the EnBe2.0 project and highlights the project’s bottom-up and participatory approach.

Keywords: energy consulting; energy use; consulting tool; participatory research; energy related behavior, values, private household

I. INTRODUCTION

Due to the new Austrian energy efficiency law, which is based on EU directives and was implemented in Austria in January 2015, improving energy use behavior of private households – for instance through energy consulting – has become an increasingly important topic on the Austrian policy agenda. Our analysis that we obtained from both practical observations and literature reviews shows that cultural background and socio-economic factors have an impact on household energy use and consumption. This also corresponds to the level of effectiveness that energy consulting has at the household level [1, 10, 19]. Furthermore, our research has led us to pose further empirical questions: Which other factors influence the energy behavior of private households and to what extent? Which further factors have an impact? Also, how do we

measure these factors properly? How could we then frame energy consulting measures and recommendations in order to meet the various needs, preferences and expectations for both women and men? This paper provides an overview on various approaches that are stated in literature and outlines the approach of and methods used in the ongoing Austrian R&D-project “EnBe2.0 Tailor-made energy consulting for private households”. Furthermore we present preliminary results, especially concerning the concept, implementation and main elements of the EnBe2.0-Toolbox, a decision and communication support system for energy consultants.

II. BACKGROUND

A. Legal Framework

Looking at the current situation, one has to state that an unsatisfactory level of energy savings has been achieved at the private household level which might lead to a failure in achieving pre-defined energy efficiency targets. The Austrian energy efficiency law, which came into force on the 1st of January 2015, stipulated that power supply companies have to implement energy efficiency measures for end-use energy consumers, such as private households. About 40 percent of the energy savings have to be realized in private households throughout measures, such as connecting households to the district heat network, installation of smart meters or through energy consulting [7].

These circumstances lead to a major challenge for power supply companies and their energy consultants as well as for the other organizations providing energy consulting. Currently, energy advisors in Austria have the possibility to disseminate technical knowledge for energy consulting in the basic-training scheme A (A=AnfängerInnen, means beginners) and further training for scheme F (F=Fortgeschrittene, means advanced).

B. Common Practice in Energy Consulting

Within the existing trainings, neither household nor customer related factors are effectively integrated into trainings or consist of the core set of recommendations proposed within the framework of consultancy services. Aspects like current living conditions, individual preferences, behavioral patterns, perceptions of life and lifestyles, beliefs of comfort or coziness,

as well as other personal and social issues are usually underestimated. As a consequence, a set of rather unspecific, inadequate and un-personalized measures have only lead to missed opportunities for achieving potential energy savings.

For example, advice provided to replace common household items with more energy efficient devices could well be rejected by individuals on grounds that it does not fit in with their lifestyle expectations or social identity [14]. In this regard, social identity and lifestyle may be evident through consumption habits, e.g. by looking at (individual) car choice [21]. Individual habits and practices also play a major role for the acceptance and effectiveness of energy saving measures. Due to the lack of transparency surrounding energy use [14] and especially due to the fact that people do not consume energy directly but rather use services that consume energy such as heating, light, warm water, cooking, and internet etc. [24], has meant that daily routines in which energy consuming activities are carried out within households are relevant for the analysis and adoption of energy saving measures [16, 21].

III. FOCUSING ON PRIVATE HOUSEHOLDS

Studies concerning the energy behavior of residents from various countries show that cultural factors influence the energy performance and effectiveness of energy saving measures. For instance, Norwegian households in general prefer a high number of lamps in a room to create a cozy atmosphere whereas Japanese households tend to prefer one light bulb placed in the ceiling [23]. Furthermore, through our literature review, we highlight a number of cultural differences concerning the importance of feedback about energy consumption and especially concerning the manner on how feedback is presented [9]. Studies show that citizens in the UK and Sweden have a high interest to compare their current rate of energy consumption with their own previous consumption habits. However, citizens of both countries are less interested in comparing their current habits with those of other households [12, 17]. On the contrary, Japanese citizens are much more interested in comparing themselves with each other rather than with their own previous consumption habits [18]. Finnish citizens as well desire normative comparisons [11]. Another impressive finding was gained through the testing of four different designs of energy consumption by simply focusing on just two of the samples – one sample in the US and the other in Norway. The design that ranked highest in the US attained the least approval in Norway and was characterized as “childish”, “unclear” and “difficult to interpret” [4, 22].

In many cases, cultural background and socio-economic factors have shown to have an impact on energy use and consumption and, as a result, on the level of effectiveness provided by energy consultation. When investigating decision making processes between cohabitants or family members on energy consumption, personal factors have shown to not be the only relevant criteria [2]. For example, diverse individual ambitions and beliefs concerning quality of life, household management, comfort and so forth affect the willingness to accept energy saving measures among housemates to a considerable extent [19]. Therefore, tailor-made energy consulting measures can be more acceptable as well as more effective. Energy saving measures can only be achieved by

considering a broad set of possible social, behavioral, psychological, ethnic and financial influences on household residents.

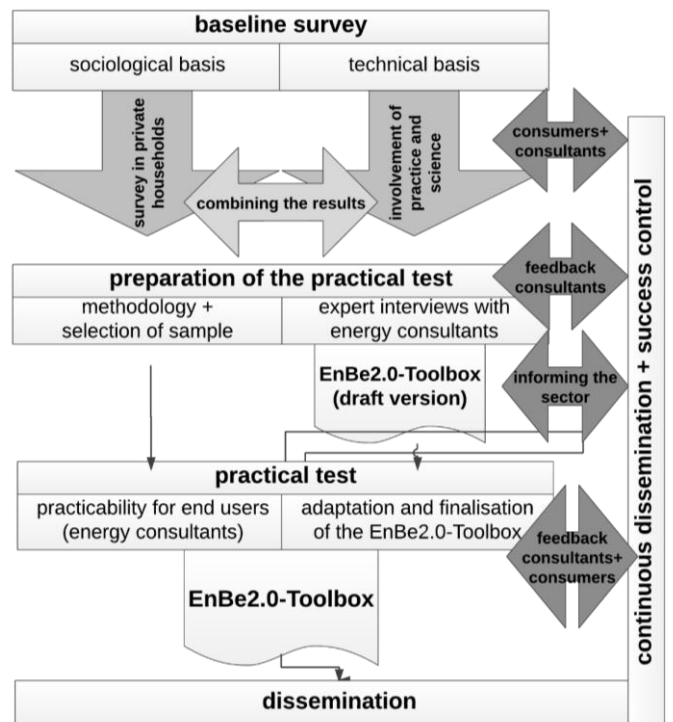
IV. THE AUSTRIAN R&D-PROJECT ENBE2.0*

Based on the hypothesis that the common practice of energy consulting in Austria is insufficient as far as taking into account household and individual factors and, hence, inadequate in terms of achieving energy saving at the private household level, the research and development project EnBe2.0 was launched by OFI Technologie & Innovation GmbH and Büro für nachhaltige Kompetenz (Consultancy for Sustainable Competence) B-NK GmbH. The interdisciplinary consortium, which combines gender expertise as well as socio-scientific and technical knowledge, has carried out this research. Through a bottom-up participation process of the both target groups, two set of beneficiaries were integrated into the research and development process: (1) end-use energy consumers in private households and (2) energy consultants. The project started in July 2014 and has a scheduled duration of 27 months.

A. The project's aims

The project's overall aim is to provide a user-friendly, gender- and diversity-sensitive consulting tool which assists energy consultants by customizing energy saving measures and recommendations to the individual characteristics and needs of end-use energy consumers, who for their part, would perceive these measures as being viable and effective for their own daily living patterns. The outcome of the project EnBe2.0 is the implementation of the research results into a practical toolbox (EnBe2.0-Toolbox). Overall, EnBe2.0 will provide a set of more effective measures that would gain higher acceptance among targeted consumers as well as among end-user consultants.

Fig.1: Scientific approach of the project EnBe2.0 (B-NK & OFI)



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Further aims of the project “EnBe2.0 Tailor-made energy consulting for private households” are:

- To survey which social and individual factors influence the acceptance and effectiveness of energy saving measures for private households in Austria;
- To develop cluster samples of households, based on a survey data about current living conditions, values, individual preferences, etc.;
- To analyze and reflect the current practical work of energy consulting for private households in Austria;
- To conduct a critical review of the well-known energy saving measuring and practical recommendations;
- To provide a user-friendly, gender- and diversity-related, tailor-made consulting tool (EnBe2.0-Toolbox) for energy consultants.

V. BASELINE SURVEY

A. Theoretical Basics

In general, energy consumption is based on activities which are embedded in cultural, social, psychological and individual contexts [1]. The routines within the members of private households, in which energy consuming services are carried out, are highly relevant for the adoption of energy saving measures [16, 21]

Focusing on the acceptance and, hence, effectiveness of energy saving measures in private households, one main distinction can be made between the individual and the household perspective [2, 19]. Both dimensions are relevant – at least for households with more than one person – since some energy saving measures can be implemented individually (e.g. duration of showering) while others may require arrangements between the household members (e.g. reducing room temperature, duration of lightning etc.). As literature review shows, behavioral change in energy-related concerns is more often investigated at the individual level than at the household level [13, 15]. To investigate the impact of household-related factors, different approaches are stated in the literature [19]. Due to page limitations we will not go into detail in this paper, but rather, we want to summarize the relevant characteristics at the household level, as follows [1, 19]:

- A household can be understood as a system which aims to fulfill a specific set of functions; specifically the fulfillment of material and non-material needs in specific situations;
- A household can be understood as an organizational system with mainly gender-biased responsibilities and gender differentiated approaches to jointly used services;
- A household can be understood as a space as well as a platform for addressing all possible discussions, feedback and participatory decision making processes;
- A household can be described based on its members’ assumptions on the quality of life that could lead to

descriptions such as: “the home as a haven”, “the home as a place for activities” etc.;

- A household can be understood as a source of material and non-material items, such as household income or knowledge.

Focusing on energy-relevant factors from an individual perspective, personal aspects gain more importance. Due to the fact that different psychological, behavioral, sociological theories are used, different approaches have been developed to categorize energy-related individual factors and therefore create various levels of classification. In regards to the energy-related household factors, as described above, we will neither discuss energy-related individual factors in detail in this paper, but rather provide an overview on some important pertaining aspects [10, 14, 19, 20]:

- Socio-demographic factors, such as gender, age, income, education etc.;
- Perceptions on life in general and the (individual) assumption on the quality of life;
- Values, tastes, needs, preferences and attitudes;
- Habits, manners, approaches and behavior ;
- Knowledge, information, awareness, interests, possibilities of choice.

Furthermore, these personal or individual factors are also influenced by societal processes, located on a micro-level dimension (household members, family etc.), on a meso-level dimension (neighbors, peers etc.) as well as on a macro-level dimension (cultural, ethnical, societal aspects etc.).

A broad variety of energy-relevant aspects in private households has to be considered regarding energy consulting that meets the individual demands of end-use energy consumers. Our literature review shows that some aspects may influence groups of people differently [19]. Therefore, it is necessary to identify the influences and their coherences to create tailor-made energy consulting. With this approach, we assume some advantages: on one hand to deliver highly acceptable and therefore effective energy saving measures and, on the other hand, to not overwhelm nor overemphasize end-use energy consumers with already known or inappropriate measures.

B. Measuring individual and societal energy-relevant factors within the quantitative EnBe2.0-survey

To investigate and characterize different types of households and their approach towards energy issues in general and to energy saving measures in particular, a quantitative online based survey among private household has been carried out (n = 541).

Based on a literature review, the quantitative survey with an online questionnaire was developed in order to investigate and characterize different types of households and/or individuals and their approach towards energy issues in general and to energy saving measures in particular. The survey addresses end-use energy consumers in private households in Austria.

The questionnaire consists of two main parts:

The first part of the questionnaire focuses on appropriate energy saving measures and to what extent each measure is feasible to the respondent. Therefore seven different energy saving measures were selected, as shown in the following table:

TABLE 1: OVERVIEW AND CHARACTERISATION OF ENERGY SAVING MEASURES INQUIRED IN THE ONLINE QUESTIONNAIRE FOR THE ENBE2.0 PROJECT. ABBREVIATIONS SEE TABLE 2. (B-NK 2014)

Energy saving measures and their characteristics			
Energy saving measure	A	C	L
Replacement of light bulbs by LED lamps	E	€	-
Replacement of a refrigerator by a more efficient refrigerator	E	€€	-
Arrange rooms in a way that radiators can emit heat freely into the room	B	-	-
Apply flow-restrictors (or flow regulators) on water faucets or shower head	E	€	-
Avoid devices' standby mode by using specific switches	B	-	-
Use a matching lid when cooking	B	-	-
Replace windows by thermally insulated windows	E	€€€	§

Due to usability reasons regarding the time the user spends filling out the questionnaire, we could not inquire more on energy saving measures than those listed above. In order to enable a certain comparison with other energy saving measures, we developed a scheme to characterize different types of measures. For characterizing the energy-saving measures, the three following criterion-groups were developed of which at least one measure from each group was implemented into the questionnaire:

- (1) Energy saving approach [A];
- (2) Expenditures to realize the measure [C];
- (3) Legal permission [L].

As shown in Table 2, each of the three criteria has multiple characteristics. For the energy saving approach [A] we distinguish between measures which primarily require behavioral change (B) and measures that primarily deal with changes in equipment and infrastructure in general, such as the replacement of devices through more efficient devices (E). Concerning the expenditures for realizing the measure [C] we distinguish between four levels of costs. The criterion legal permission [L] addresses the fact that some measures such as changes made to a building require obtaining permission. In most cases these measures are related to the fact whether one is possessing or renting one's own residential property. For example, a person renting a flat might replace standard windows with thermally insulated windows as an appropriate measure in terms of saving energy, but the person will not have control over the implementation of this measure.

TABLE 2: CRITERIA FOR THE CHARACTERISATION OF THE ENERGY SAVING MEASURES INQUIRED IN THE ENBE2.0 ONLINE QUESTIONNAIRE. (B-NK 2014)

Criteria for characterization of energy saving measures		
Criterion	Characteristics	Code
Energy saving approach [A]	Replacement of equipment, facilities, infrastructure	E
	Behavioral change	B
Expenditures [C]	No costs occur	-
	Low costs occur	€
	Medium costs occur	€€
	High costs occur	€€€
Legal Permission [L]	Unnecessary	-
	Necessary	§

The second part of the questionnaire deals with individual and social factors that – as literature has shown – do have an impact on energy consumption in private households. Therefore questions out of the following topics were developed and implemented in the online questionnaire.

- Attitudes towards energy, such as awareness on energy saving, being interested in energy consumption benchmarks, favoring renewable energy;
- Knowledge about energy, such as the ability to estimate the energy consumption of appliances, knowledge about the costs of energy units like cost for one kWh electricity;
- Consumer behavior and preferences, such as individual media usage, importance of design of products;
- Household demands and standards towards tidiness or coziness, perceptions towards the utilization of the household space;
- Values, lifestyle and beliefs towards quality of life, also such as ecological awareness, risk disposition;
- Sphere of life and importance of e.g. health, family, wealth;
- Socio-demographic items, such as gender, age, income, education.

The quantitative EnBe2.0-survey has been carried out with the online-tool "Lime Survey". The time-period to fill out the questionnaire started at the end of October 2014 and ended in the middle of March, 2015.

C. Analysing the data

We analyzed the data with the help of statistical methods like principal components analysis, factor analysis and linear regression. Based on the statistical analysis, we developed five types of end-use energy consumers. Each of the five types is

characterized with the help of statistically significant combinations of elements out of the survey categories, such as sphere of life, values, household demands, consumer behavior, and knowledge about energy as well as attitudes toward energy. For instance, one of the types is characterized as follows: education, knowledge, independence, autonomy, gainful employment and independence are important spheres of life. People of this type tend to be considerate, generous, environmentally and health-conscious, interested in technology and new media; they want their household primarily to be practical and clear as well as an area where people stay and to receive guests; concerning consumption environmental labels and energy efficiency classes are considered; implementing energy-saving measures is rather seen as troublesome.

Although the correlations are statistically significant, it is clear that the descriptions for each type are only tendencies and that overlaps occur. Nonetheless the five types can be differentiated well. In the En.Be2.0-Toolbox the types serve as a basis for target-group oriented communication of energy saving measures. Therefore, we compiled five sets of terms, concepts and arguments (one set for each type), which provide potential connecting points for target-group oriented communication and the presentation of energy saving measures. The five seats are compiled out of the statistical analysis as well as of the results from the qualitative research.

D. Qualitative research with the help of face-to-face in-depth interviews

Additionally to the quantitative survey, a qualitative survey was conducted (n=14), to gain in-depth information on energy-relevant factors on the households' and their members' level. In particular the lead questions focused for instance:

- Responsibilities about household sectors such as monitoring energy consumption and processing energy bills;
- Needs, habits, practices towards household activities (regarding energy consumption);
- Energy saving approaches (save money, normative values);
- Dependencies between the individual and the household level regarding energy consumption patterns, if several residents are living together;
- Dependencies between the individual and the societal level regarding energy consumption patterns.

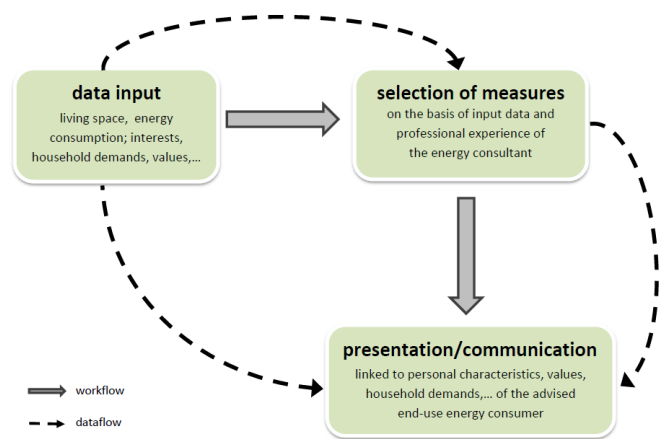
The results of the qualitative survey enriched the outcomes of the statistical analysis of the quantitative data from the online survey. Especially concerning enhanced and widened connecting points for target-group oriented communication of energy saving measures.

VI. FIRST DRAFT OF THE EN.BE2.0-TOOLBOX

The En.Be2.0 toolbox is a decision and communication support system for energy consultants who advice end-use energy consumers in private households.

The toolbox consists of three main elements: 1) data input, 2) selection of measures and 3) presentation and communication of the measures. As shown in Fig. 2, the information recorded (data input) through the energy consultant has an effect both on the selection of measures and on the proposed connecting points for target-group oriented communication of the selected energy saving measures.

Fig.2: Main elements of the En.Be2.0-Toolbox (B-NK & OFI)



The first draft of the En.Be2.0-Toolbox was implemented with Microsoft Excel. The software provides adequate functionality for the algorithms used. In the first spreadsheet information concerning the household (e.g. living space, number of residents, heating system, power consumption) as well as information concerning the advised person (=end-use energy consumer) is gathered. Additionally to input fields for household data, we developed five questions which shall be asked by the energy consultant and which allow a quick characterization and classification of the advised person in terms of the five types from the statistical analysis. Due to the fact that reality differs from statistically significant ideal types, the advised person is not classified to only one type, but rather the five types are ranked in accordance to the importance for the description of the advised person. To compute a ranking order, the answer options from the questions in the data input sheet are assigned with different scores for each type. The type which ranks highest (in sum) is presented first to the energy consultant, then the second highest, and so on. The rank-score of each type is also presented, to show how distinct the ranking order is.

According to the input data also energy-saving measures are selected and get displayed as 'more suitable' for the advised person. For instance regarding technical equipment of the household, considered expenses for measures or concerning the competence to implement measures from a legal permissions' view (ownership, rent, community issues etc.). The energy consultant has the possibility to adapt the selection, e.g. when the selection differs compared to his/her professional experience or compared to his/her estimated suitability of certain measures. Actually more than 160 energy saving measures are included in the En.Be2.0-Toolbox. Furthermore, the energy consultant has

the possibility to add other measures and adapt already included measures.

Both the selected measures and the connecting points for target-group oriented communication are displayed to the energy consultant simultaneously, in a second spreadsheet. This facilitates to communicate selected measures in a way that directly addresses the advised person and hence leads to higher actual energy savings.

VII. PRACTICAL TESTING

At the moment, the project team is working on the further development of the first draft of the En.Be2.0-Toolbox. Throughout the project cycle feedback from energy consultants has been implemented and the toolbox has been adapted accordingly. We have gained much positive feedback from energy consultants of various organizations for the first draft of the toolbox, as well as we detected concrete starting points to extend, adapt and further develop the tool. As a next step, the En.Be2.0-Toolbox will be proof-tested by energy consultants in real life energy consulting situations with end-use energy consumers. This will create the possibility for further feedback and ensure the user-friendliness and the usability of the toolbox. Therefore we collaborate with energy consultants from both, major power supply companies in Austria and NGOs. All these experiences will be monitored, reflected and processed for the ongoing development of the En.Be2.0-toolbox.

Based on an evaluation of the process, the final version of the toolbox will be developed. Finally, the EnBe2.0-Toolbox as a tailor-made energy consulting tool will be a result of a bottom-up process that will be achieved by integrating multiple feedback loops from various perspectives – stakeholders, energy consultants as well as end-use energy consumers.

VIII. OUTLOOK

At the conference in September 2015 we want to present the project EnBe2.0, its approach and the first preliminary results.

- Overview on the common energy consulting practice in Austria, its actors and their professional background
- Results based on the quantitative online survey as well as on the qualitative survey
- First Draft of the EnBe2.0 Toolbox
- Reflection on the up-to-date participatory approach

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