Innovative consumption information with social feedback regressed from household characteristics

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Keywords

awareness, customer feedback, electricity consumption benchmark

Abstract

The EU energy service directive (ESD) demands that final energy customers are provided with *"comparisons with an average normalised or benchmarked user of energy"* to better be able to understand their own consumption patterns. In accordance with the ESD, enhanced electricity consumption information was developed by the project team. This information presents high-frequency meter data, social comparisons and tips on how to save energy in a consumer friendly manner. The most innovative aspect of this information is the social comparison (social feedback) which is an individual consumption benchmark derived from regression analysis considering a certain household's characteristics and equipment. In this article, the development of this social feedback feature is described. Early results show that households that received the consumption information consider the benchmark as interesting information.

Introduction and definition

In article 13, the EU energy service directive (ESD) asks for more frequent billing[1] that accounts for actual consumption and provides historical and social comparisons. The directive assumes that such information enables "*final consumers to make better informed decisions as regards their individual energy consumption* […]".

In order to comply with the directive, electricity utilities require more frequent meter data and more detailed data of their customers. As a way to obtain such data, article 13 of the ESD also asks for the installation of "*meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use*". With the EU's 3rd energy package (directive 2009/72/EC), implementation of a broad smart metering infrastructure may become legally binding if a member state's long-term cost-benefit-analysis shows a positive net value of a smart meter roll-out. In such a case "*80 % of consumers shall be equipped with intelligent metering systems by 2020*". According assessments from each member state are due by the 3rd of September, 2012. Nevertheless, smart metering per se does not increase energy efficiency. It 'only' makes frequent metering data available. Applications of smart metering for customers are preliminary (i) innovative tariffs and (ii) enhanced energy bills and enhanced consumption feedback.

The task of our project is to identify meaningful ways to inform final customers about their electricity supply.[2] In the development of the additional consumption information, the demands of the ESD were considered. When looking at ways of designing energy consumption information, basically two types of feedback are considered: direct and indirect feedback.

1. In the directive no exact billing period is defined. In article 13, the directive demands that "*billing on the basis of actual consumption shall be performed frequently enough to enable customers to regulate their own energy consumption*".

2. We note that our focus on electricity consumption comes from the simple fact that at the moment only smart electricity meters are installed in great quantity in Austria (there are already about 40,000 installed in Upper Austria). Smart metering can also be used to meter gas, heat or water consumption. As no such devices are available at the moment in Austria we had to concentrate on electricity consumption alone.

Table 1. Working definitions.

Term	Definition
Feedback	Any direct or indirect information on household's electricity consumption which is presented to the household.
Historical feedback	Indirect feedback comparing household's present consumption to its consumption in former periods.
Social feedback	Any comparison of a household's electricity consumption with an average normalised or benchmarked household which is presented to the household.
Enhanced bill	An electricity bill with one or more of the following characteristics: frequent provision and/or temporal disaggregation of consumption data (indirect feedback), interpretation of data, recommendations on how to save energy (i.e. behaviour, investments), quick comprehensibility, clarity of denominations, transparency. Prices and currency units are included.
Consumption information	Information with one or more of the following characteristics: frequent provision and/or temporal disaggregation of consumption data (indirect feedback), interpretation of data, recommendations on how to save energy (i.e. behaviour, investments), quick comprehensibility, clarity of denominations. Prices and currency units are not included. Consumer friendliness is superior to transparency.

Direct feedback is provided in real-time (i.e. in-home displays). Indirect feedback includes i.e. standard billing, enhanced billing, web-based or SMS feedback. Many types of consumption feedback require smart metering (remote meter reading) in order to be cost-effective from the utility's point of view. Social feedback does not necessarily require frequent consumption data. Thus, social feedback is independent from smart metering though frequent data provides better and more detailed insights.

Independency of frequent metering data is an advantage only at the first glance. As advanced meter reading/management (AMR/AMM) systems will most likely be introduced in Europe by the year 2020, data will be available. Albeit, social feedback still requires or at least benefits from data on a household's equipment and characteristics – data which is normally not available to suppliers and DSOs and is not provided by smart metering alone. Thus, for future developments of social feedback in any manner, the acquirement of household data is the first task to concentrate on. The authors think that normative feedback presented to *all* customers (as it is claimed by the ESD) is hardly achievable as utilities' effort to maintain and update data on customers' characteristics does not appear affordable. However, web pages informing customers on their consumption, for example, can acquire data by allowing or obliging users to enter at least the most important data in order to compile individual benchmarks (c.f. some examples in the section on benchmark generation). Moreover, the benchmarks regressed from a certain utility's customers are rather independent of environmental conditions like climate and region as these conditions are fairly identical for the majority of customers.

BILLING AND FEEDBACK IN AUSTRIA

All (100 %) Austrian households receive their electricity bill annually. More frequent information about individual electricity consumption provided by electricity utilities is not available. In accordance with the ESD, Austria published its first national energy efficiency action plan (NEEAP) in June 2007 which lists the following measures to be undertaken in Austria until 2016:

1. Contemporary metering of electricity consumption including interpretation of data and recommendation on how to save energy
2. Enforcement of innovative billing.

For strengthening energy market competition, the Austrian electricity and gas market regulator (E-Control) asks for enhanced bills which are more consumer-friendly. In this context, consumer friendliness means the bills allow the customer to quickly understand the bill and identify the costs of energy (in contrast to network costs and taxes). In the end, the customer's identification and then the comparison of costs of energy should promote supplier competition. An exemplary bill was designed (E-Control 2009) using a 3x3x3-principle: it consists of three accounting parts, three billing components (energy, network, taxes), and three pages (EC2009a). Another exemplary bill was proposed by *Oesterreichs Energie* (which represents the interests of the Austrian electricity industry). According to this layout, a clear structure (page 1: overview, page 2: definitions, page 3: detailed invoice) presents essential information in a transparent and simple way. The implementation of this exemplary bill is ongoing among the member companies of *Oesterreichs Energie* (Vliet 2010). Both model bills are designed to bill once a year. They provide historical feedback (comparisons to last year's consumption); in both, social feedback is not included. Further billing innovation is to be expected as soon as frequent meter data is available. Although there are many small-scale smart meter pilot projects in Austria it is not foreseeable at which point in time the mass-rollout will be achieved. Competition-orientated billing does not aim at supporting customers in increasing their energy efficiency (EC 2009a) and are therefore of no further interest in our study.

RELATED WORK

Darby (2006) analysed 38 studies conducted between 1978 and 2006 that used various feedback methods to assess whether feedback can initiate energy savings. She subdivided the studies into those using direct feedback and those using indirect feedback methods. She subsumed that direct feedback may lead

to energy savings of 5-15 % and that indirect feedback may lead to savings between 0 and 10 %. Her numbers are supported by Faruqui et al. (2010) who find saving effects in the range of 3 to 13 percent in their meta-study of a dozen pilot projects in North America. Ehrhardt-Martinez et al. (2010) published a meta-report which looked at the impact of various types of feedback (categorised in five groups), summarising 57 studies from Europe and North America. Depending on the type of feedback savings ranged from 3.8 to 12.0 %.

Darby (2006) defines indirect feedback as "*raw data processed by the utility and sent out to customers*" who then need to read and deliberate the information given in order to decide on how to increase efficiency. In comparison to direct feedback, indirect feedback is advantageous in respect of identifying changed consumption behaviour or electricity-guzzling devices (or, on the contrary, the effect of saving measures). Darby lists the following recommendations so that energy bills may initiate energy savings:

1. more frequent billing,
2. actual meter data,
3. comparisons to former periods/years,
4. comparisons to similar households,
5. overview of average appliance consumption,
6. annual individual energy reports.

Fischer (2007) adds that there is a necessity of a clear and appealing presentation and the option to use computerised and interactive tools. Karjalainen (2011) qualitatively assessed that the most promising types of feedback are a presentation of costs, an appliance-specific consumption breakdown and historical comparisons. Moreover, Karjalainen cumulates options for presenting feedback. Regarding illustration, he summarises that "*a combination of texts, diagrams and tables was found to work more effectively than single-format presentations*". In general, text elements assist graphs. ISOE (2008) found that scales are less comprehensible than bar diagrams.

Fischer (2007) analysed ten projects applying some kind of benchmark. None of them demonstrated an effect on consumption. As a reason for this lack of reaction, Fischer considers that this can be accounted for by better-than-average households who increase their consumption as "things are going not so bad" and therefore balance the efficiency improvements of worse-than-average households.

Nevertheless, studies show that households are interested in social comparisons (see for example CSE 2004). Fischer (2007) lists two projects where either "high interest" in benchmarks is stated or normative feedback is desired by 83 % as "*it would motivate them to conserve energy if they consumed more than average*". However, when it comes to social benchmarking, CSE (2004) and ISOW (2008) furthermore find that consumers doubt the validity of average values and comparability of households (i.e. similarity, neighbours).

Another innovative example for feedback methods is the social feedback presented for the U.S. city of Gainesville, Florida, which is accessible at a webpage (http://gainesville-green.com/). A map is presented in which houses are coloured according to their energy consumption, starting with dark green for low and red for high consumption. The house with the least energy consumption is marked with a green tree symbol. The house with the highest consumption is marked with a red star. Obviously, household characteristics are not accounted for. No results of this project concerning energy savings are known to the authors.

Normative feedback presents an average consumption value for various kinds of consumer categories. CSE (2004) mentions average consumption values of households lived-in by varying numbers of persons. Six houses with one to six persons in it are pictured. Underneath, each of the average values is displayed. Inhabitant-related average consumption can further be differentiated by other parameters, in example Stadtwerke Heidelberg, Germany, enclosed tabular information which showed categories of consumption which additionally account for hot water generation. These normative feedbacks require the customers to find their characteristics in a table or graph and compare it to their own consumption. In Austria, local utilities Linz AG and Salzburg AG ask for some household data when consumers register on their websites. This data includes the number of inhabitants, type of building, living space, main heating fuel, main hot water generation fuel, etc. For the case of Linz AG, feedback is given by a bar which is green on the left and red on the right side and a smiley that points on the bar in relation to the consumption. Salzburg AG's feedback is a drawing which shows a biologically more or less intact landscape scenery depending on the household's consumption. In these latter approaches, benchmarks are calculated individually. Impact evaluations of stand-alone normative feedback are not available.

Methodology

This paper describes the development of the consumption information applied in the research project "E-Motivation". Methodology includes the layout of the information and the denominations used in it, the selection of the field test sample and the generation of the benchmark regressed from household characteristics. The impact of the consumption information on the energy consumption of the households cannot be considered as the one-year field test is still running at the finalisation of this paper.

After completion of the field test, it is feasible to control for the total impact of the information presented to the customers. However, it is not possible to control for the impact of its individual design elements which include social feedback. Questionnaires and focus groups yet to be conducted will allow for drawing conclusions on social feedback.

DEVELOPMENT OF CONSUMPTION INFORMATION

In the field test, which started in April 2010, a CI is sent to the experimental group in intervals of one month. A CI prototype was developed by the project team (work package leader *EnCT GmbH*) based on existing literature and stakeholders' statements (e.g. EC 2009).

For electricity bills, there is a "*need to strike a balance between providing enough and all the essential information to customers and having easily understandable and readable bills*" (Vliet 2010). Concerning our CI, two general aspects need to be considered: firstly, the CI is sent to the customers in addi-

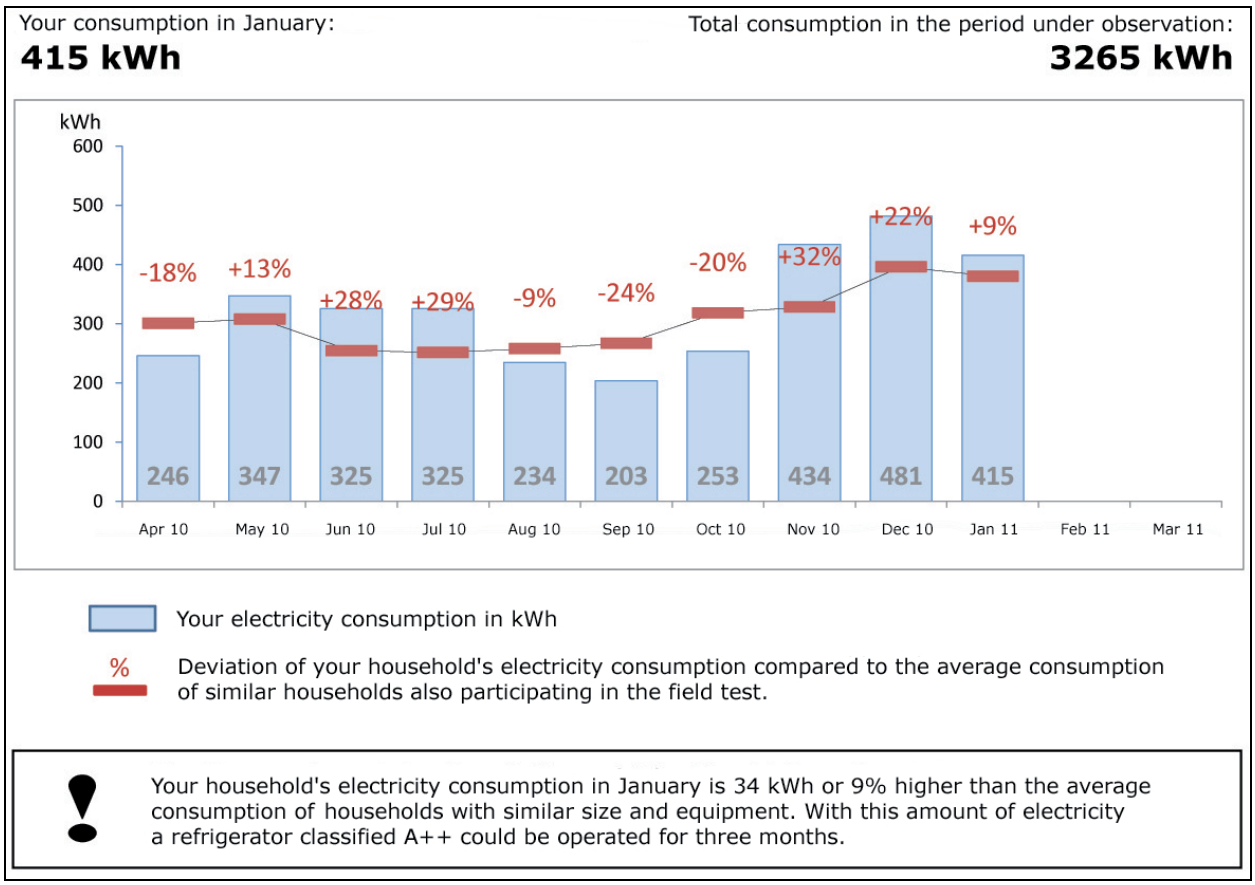


Figure 1. First page of the consumption information. *In its upper part, it mentions the consumption in the last month and the total consumption since the beginning of the field test. Monthly historical feedback is given in a bar diagram. Stripes illustrate the "average consumption of similar households" which actually is an expected value derived from regressing participating households' consumption on their characteristics. Design developer: EnCT GmbH (http://www.enct.de).*

tion to the annual bill. It therefore does not need to comply with any legal provisions. Secondly, the CI was developed to be as readable and comprehensible as possible. Achieving an easy-to-read CI was difficult due to some unique complexities of Austria's electricity billing practices. In Austria the electricity price consists of three components and some of them may change once or even more often throughout a billing period. This is one of the major reasons why existing bills are difficult to understand for laymen. Therefore, the CI does not include monetary values. Furthermore, the graphs and denomination used are easily understandable and straightforward.[3] The layout also enables the indication of data when the household possesses more than one meter. Initial testing of the prototype involved the use of two focus groups and was conducted in the field test region (Upper Austria). Valuable inputs especially concerning the use of graphs and denominations were derived from the focus groups. The proposed alternatives received varying approval concerning comprehensibility and interestingness. For example, a bar diagram was understood immediately. On the contrary, a disc diagram was considered by far more interesting. However, for the latter, it took focus groups longer to understand this rather unconventional type of diagram. For the final version, graphs and denominations considered most understandable were chosen.

For clarity and fast comprehensibility, designers chose a two-page format. The CI specifies last month's electricity consumption. In a diagram, the consumption of the current month is shown and can be compared to recent months (in the timeframe of the field test). The diagram also depicts social feedback as the consumption of "similar households participating in the field test" (below: "benchmark"). The benchmark is pictured as a horizontal line above or below the end of the bar which shows the household's monthly consumption. Proportional deviation is denoted in percent. Beneath the diagram, the household's residual consumption is illustrated as the gain or loss in an appliance's work cycles, e.g. if a household consumes 20 kWh more than its benchmark this deviation is illustrated by noting that with this amount of electricity it could operate an appliance for 20 work cycles. A check mark and an exclamation mark symbolise low and high consumption, respectively, compared to the benchmark.

On the second page the daily consumption is presented. The households' average consumption in the month under consideration is included. The day on which consumption reached this month's maximum is highlighted. Clearly arranged tips to save energy by behavioural changes and by investment in energy efficient appliances are given. These tips go in line with the utilities' actual promotion of energy efficient behaviour

3. In Austria, denominations of the various billing components are given in the respective law. Again, we do not have to follow these as the CI does not include monetary values.

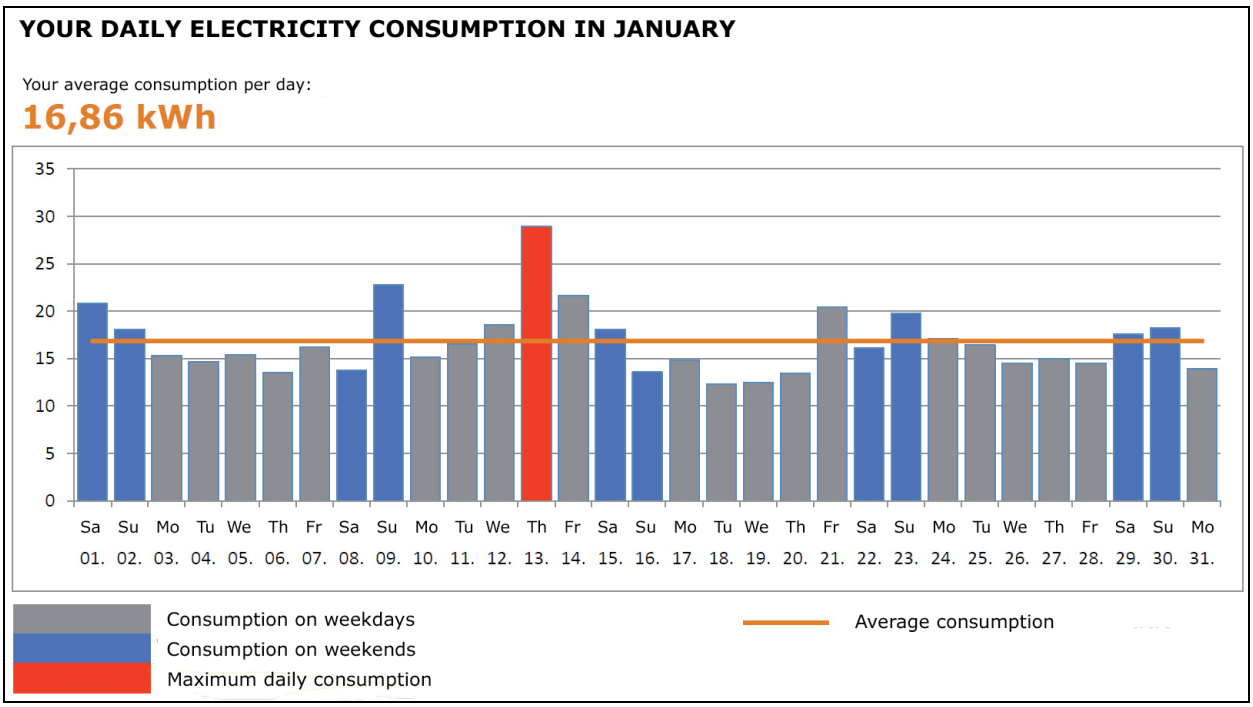


Figure 2. Upper part of the second page of the consumption information. *It shows daily consumption values in a bar diagram. Weekends are highlighted in blue. The average daily consumption is depicted by an orange stripe. The day with the highest consumption is highlighted in red colour. Design developer: EnCT GmbH (http://www.enct.de).*

and investment. They are presented in a general manner i.e. are not specified to the characteristics of households because detailed data on household characteristics is not available. The tips show an animal called and illustrated as a "pig dog". In German, a "pig dog" is not an animal; it is an expression describing the inner temptation which one has to overcome to achieve a higher target (energy efficiency in this case). In the drawings, the cutely illustrated "pig dog" demonstrates excessively inefficient behaviour and a text explains how to use electricity (and also heat) in an efficient way. Supplier's promotion (no advertisement) is positioned on the bottom of the second page.

FIELD TEST SAMPLE

Beginning in January 2010, Upper Austrian household customers were recruited for the field test. Participants are customers of regional electricity suppliers Linz AG and Energie AG. Eligibility of private participants required annual electricity consumption of less than 100,000 kWh and the installation of a smart meter. Information on individual consumption is provided to customers of the Linz AG via the web portal E.I.S. Customers of the Energie AG receive the two-sided postal CI. In this work we will only concentrate on the latter group which constitutes of 876 participants.

The project team attempted to avoid selection biases. Nevertheless, a signed permit to frequently read the meter was required from both, the experimental and the control group. Thus, a letter was sent out including a reply card. The letter's wording focused on the availability of the consumption information and only secondarily mentioned the potential to save energy. Therewith the authors intended to attract not only those who are interested in saving energy but generally in their consumption. In order to avoid group-specific selection biases, the wording of the two letters was chosen very similar to each other. Thus, the experimental group was offered to be sent a CI free of charge every month. The control group was offered to be sent a CI on a monthly basis. This means they will receive one CI depicting the consumption of the previous 12 months after the completion of meter reading. As participants had to return the signed reply card, it also included questions on basic household and contact data. Recording started on April 1st, 2010. The first information was posted to the experimental group in May 2010. The field test sample according to the data provided by the reply cards has the following characteristics: Nineteen percent of the households are single-person households, 44 % consist of two people, 17 % consist of three people, 14 % of four people, 6 % of five or more people (with a maximum of seven). On average, 2.47 people live in a household in our sample. In 2009, *Statistik Austria* calculated an average of 2.39 people per household for Upper Austria. In 2009, *Statistik Austria* calculated an average of 104.6 square meters *usable* area per household. In our sample, a household's average living space is 116 square meters. Fifty-eight percent of the households live in one- or two-family houses. Thirty-eight percent live in flats which are assumed to be situated in blocks with more than two flats. The residual 34 % live in row houses. In family houses, an average of 2.70 people constitutes a household. An average of 2.14 people live in a flat and 2.36 people live in a row house.

BENCHMARK GENERATION

It is the purpose of the subsequent regression analysis to develop a monthly electricity consumption benchmark for each household participating in the field test taking into consideration the individual household's characteristics. The final benchmark displayed on the consumption information is the

Table 2. Number of persons in household and living space.

# of persons in household	Share (%)	Average "living space" (m²)	Average additional living space
1	19	81	81
2	44	107	26
3	17	136	29
4	14	148	12
5+	6	153	5
Sample average	2.47	116	
Upper Austrian average (*Statistik Austria*)	2.39	105 "usable space"	

sum of two components. The first component is the benchmark derived from the households' main ("first") electricity meter. 52.5 % of the households in our sample have only one meter. 47.5 % have two or three electricity meters. In Austria, the second and third meters are usually used to meter electricity consumption for space heating and hot water generation (like heating pumps and boilers). If there is only one meter, the second component is equal to zero and the final benchmark is determined by the main meter's benchmark only.

We used an ordinary least squares (OLS) regression to test the relationship between variables. Variables include the electricity consumption metered continuously and the household characteristics communicated on the reply card. As the intention is to provide social feedback, the dependent variable is the households' electricity consumption in the respective month. We identified eight variables for our benchmark model plus a constant. The application of a more comprehensive econometric model, accounting for the longitudinal structure of the monthly data, was not possible since benchmarks are sent to the households directly after the month of their origination. Therefore, we start with estimation with only one value for electricity consumption, and the longitudinal structure evolves with the progress of the field test only. Since benchmarks are calculated from the incoming data of each month, the benchmark automatically accounts for seasonal effects even in the OLS specification. Thus, each coefficient in Table 3 gives the coefficients (average electricity consumption) as well as their statistical significance for the respective type of household characteristic in our sample. We now take a look at each variable in turn:

- Living space (number of m²) is used as a proxy for all minor electricity consuming goods that vary with the space of a household, such as light bulbs and general plug load. The variable is highly significant throughout all months of our field test. It varies between 1.4 kWh/m² in April and 1.9 kWh/m² in November. The coefficient declined throughout the summer months and rose again in autumn. It is expected that there's a close connection between space heating and electricity consumption (e.g. circulating pump, radiant heaters). The connection between consumption and size of living area seems straightforward. On the contrary, air conditioning is not very common in Austrian households; only 2 % use air conditioning (Wegscheider-Pichler 2009). According to Statistik Austria, an average Austrian household consumes 33 kWh (0.75 %) per year for ventilation (which is by far more common), air (de)humidification and space cooling. In 2010, the hottest month was June with twelve days with more than 30 degrees Celsius in the Upper Austrian capitol city.
- Swimming pool, waterbed, home cinema (dummy variables): We identified these three appliances in the households to be important influences on overall electricity consumption. The coefficient for the swimming pool considerably increases in summer time. In August, the coefficient is double the coefficient for April or November. However, the swimming pool coefficient is also highly significant in all the other months. Whether or not to include the variables waterbed and home cinema was a major point of discussion. Summed up, these two variables considerably contribute to households' overall electricity consumption which is the main reason we included them in the final model.
- Size of municipality < 5,000 (dummy variable): 780 households in our model live in municipalities with less than 5,000 inhabitants. These coefficients are not significant, which means that the differences in the electricity consumption between inhabitants of cities and people living in the countryside are captured well by the other variables. Nevertheless, for theoretical reasons we included the size of municipality dummy in our benchmark, as people living in rural areas usually have, for example, gardens and garages and require some additional electricity for these amenities. Since information regarding these two or similar variables is not available, we used the size of municipality as a proxy for them.
- Persons in households (number of persons): As expected, this coefficient is highly significant in each month. They slightly fall in summertime but stay in a range of 39 to 55 kWh per person.
- Electric space heating and hot water generation (dummies): These two variables depict whether space or water heating are done using electricity. For households having more than one meter both dummy variables are always zero, since we would account for electric space heating and hot water generation twice in households with a second meter. (Remember the usual usage of a further meter for space and water heating described above. See below for the inclusion of electric heating and hot water generation for households with a second meter.) Electric heating is significant in all periods except for July and August in which heating is normally not necessary in Austria. Coefficients for electrically generated hot water are significant throughout all months under con-

Table 3. Benchmark variables: coefficients and probabilities of error (* p < 0.1, ** p < 0.05).

	April	May	June	July	August	September	October	November
Consumption of main meter								
Constant	-32.8	-32.2	-15.7	6.4	4.7	-22.0	-64.9	-81.4
							**	**
Living space	1.4	1.4	1.0	0.9	0.9	0.9	1.7	1.9
in # of m²	**	**	**	**	**	**	**	**
Swimming pool *dummy*	102.5	150.0	181.6	202.6	192.3	142.4	100.1	92.1
	**	**	**	**	**	**	**	**
Waterbed *dummy*	60.9	50.6	61.7	57.2	48.8	38.6	13.7	74.2
			**		*			
Home cinema *dummy*	38.3	35.0	22.6	27.2	32.4	21.5	57.4	-7.8
				*	*			
Size of municipality < 5.000 *dummy*	21.8	30.6	19.5	14.1	13.6	19.4	20.7	23.4
Persons in household	45.7	44.7	46.8	39.5	43.1	54.9	50.9	48.6
in # of persons	**	**	**	**	**	**	**	**
Electric heating *dummy*	112.3	63.2	57.2	16.1	14.0	98.7	302.2	422.0
	**	**	**			**	**	**
Electric hot water *dummy*	44.6	49.3	93.1	78.6	82.7	95.1	122.4	128.3
	**	**	**	**	**	**	**	**
Consumption of second and third meter								
Electric heating x	2.6	1.2	0.4	0.0	0.1	0.7	2.6	3.7
square meters	**	**	**			**	**	**
Electric hot water x	47.3	44.2	38.7	35.3	36.7	41.9	44.7	39.5
persons in household	**	**	**	**	**	**	**	**

sideration. The inclusion of these two variables is essential to account for the higher electricity consumption households necessarily have if they provide space heating and hot water with electricity in comparison to households who use other energy sources (e.g. gas, heating oil or biomass).

The second component of the final benchmark is the estimation derived for the residual meters. As space heating primarily depends on the number of square meters and hot water generation primarily depends on the number of people living in a household, the following variables were used:

- Electric heating multiplied by square meters: We see that the electricity consumption per square meter is highly significant in the heating period. This means that electric heating adds up to 4 kWh per square meter to the monthly electricity bill in the cold season.
- Electric hot water generation multiplied by the number of persons: We see that the demand for hot water per person is about 41 kWh per month. Consumption slightly varies seasonally.

Table 4 gives an overview of the electricity consumption from April to November 2010. Most notable, the standard deviation is very high, which was to be expected given the heterogeneity of households. The mean value of consumption declines in summer and rises again in autumn.

Findings

In June 2010, when participants had received three CIs, a questionnaire was sent to them. Only a fraction of the participants originally provided an e-mail address on their reply cards. The URL to the online form was mailed to them. The remaining majority received the questionnaire per postal service. The total rate of return was 18 %. The questionnaire asked for five areas of interest: household and housing characteristics and appliances, decision making processes within the household,

Table 4. Summary on sample electricity consumption April - November 2010.

Electricity consumption	# observations	Median	Mean	Standard deviation	Minimum	Maximum
April 2010	876	311.7	381.9	270.0	.00	2243.0
May 2010	876	315.1	371.6	258.8	.00	3893.0
June 2010	876	272.2	312.6	176.6	.00	1273.5
July 2010	876	258.7	295.4	162.1	.00	1122.0
August 2010	876	272.6	304.5	164.2	.01	1115.8
September 2010	876	286.0	328.3	207.9	.55	2906.1
October 2010	876	335.1	414.2	295.3	1.62	2539.3
November 2010	876	348.8	443.6	351.6	.23	2919.9

the opinion on the field test itself and personal interests/behavioural patterns.

General results show that the CI is regarded positive. The average respondent says that the CI is simple and easy to understand (1.6 with 1 = easy to understand and 5 = not understandable) and the configuration of design elements is rather good (3.9 with 1 = bad and 5 = good). Being asked about the extent of the CI (1 = too little, 5 = too much) most respondents chose category 3, however, an average of 2.8 indicates support for more information (note that only three CIs were posted at that time and the CI is probably more interesting in the short run).

Social feedback was discussed controversially in the focus groups. Initial denominations (i.e. "neighbour") were rejected. Indeed, the wording finally chosen ("similar household") was not commonly accepted as well, as participants thought that their supplier does not know their actual equipment. However, as field test participants initially transmitted their basic household characteristics this negative point was neglected and social feedback with the wording "in comparison to a similar household" was included in the CI. Although there was an intensive discussion on this type of feedback in the focus groups, results from the questionnaire show that social feedback is accepted. Participants could weight their interest in listed components of the CI by marking numbers 1 = very interesting to 6 = not interesting at all. All components were rated with an average ranging between 1 and 2, the modus and thus the median being 1. (Actually, the median was 2 for the interest in the supplier's promotion.) Participants' interest in the social feedback reached an average of 1.50. 69 % marked 1 for "very interesting" and only 5 % marked the ratings 4, 5, or 6. The number of working cycles of a specific appliance illustrates the deviation to the benchmark. Except for the tips on energy-saving behaviour/investments and the supplier's promotion, this illustration scored the lowest results on the participants' interest. Nevertheless, with an average of 1.61 and 86 % marking best ratings 1 or 2, the illustration can still be considered "interesting".

Participants were asked to list every modification in the CI they would propose. 16 % of respondents answered the question but supported the layout or did not propose any change. 4 % made varying remarks partially not related to the question. Supporting Karjalainen (2011), 5 % demanded more detailed information with regard to time-of-use (e.g. "split forenoon, afternoon, evening") or appliances (e.g. "of great interest: values of individual consuming devices"). No response concerned the benchmark pictured.

The questionnaire asked for a self-evaluation of participants. As the following were separate questions, percentages do not sum up to 100 %: 61 % did not change their consumption behaviour, 27 % said they have consumed less electricity since the beginning of the field test and 16 % indicated they shifted consumption to on another time of day.

Conclusion

As explained in the section on its development, the benchmark information is part of each CI. Literature does not provide a system for the calculation of benchmarks for household electricity consumption on a monthly basis. The purpose of the benchmarking information is allowing the consumer to decide whether his or her electricity consumption is adequate, or if improvements (reduction of consumption) are possible.

A straightforward approach for developing such a benchmarking system would be defining the maximum adequate electricity consumption for an individual person and obtaining the benchmark from this consumption times the number of household members. From the perspective of the equality of all consumers, this proceeding represents a fair approach since the same maximum adequate electricity consumption is assigned to each individual, disregarding their income or other social variables. Nevertheless, neglecting the individual circumstances of a person and the equipment and appliances the monitored household has in use, will lead to extremely high deviations in the benchmarks for households in an environment different to the average. We saw a high risk that these households would then consider the benchmark as unrealistic and not applicable for them, with the result that they would not react to it.

Therefore we decided to use an individualised benchmark for each household, accounting for the equipment and appliances of each household. Thus, the household's benchmark represents the average electricity consumption of a household with almost exactly the same amenities. Exceeding the benchmark means that the household could reduce its electricity consumption at least to the benchmark without any reduction of his comfort or

wealth. Surely, we could not account for all factors influencing electricity consumption, but the most important characteristics related to consumption were surveyed while recruiting the participants.

Results of the questionnaire indicate that households accept the social feedback given and are, on average, equally or more interested in it compared to other components of the CI.

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