



SAVE@Work4Homes

Supporting European Housing Tenants
in Optimising Resource Consumption

WP 6: EVALUATION

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Intelligent Energy  Europe



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**Supporting European Housing Tenants
in Optimising Resource Consumption**

Intelligent Energy – Europe (IEE)

SAVE - Key action: VKA2: “Retrofitting of social housing”.

Project coordinator:
Simon ROBINSON
empirica
atwork@empirica.com

Project website: <http://save.atwork4homes.eu>

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1. General introduction

1.1 Objective of the evaluation

Positive tenant behaviour is essential if energy savings are to be made in homes. Although new housing is inherently energy efficient, the theoretical results of savings can only be achieved by a sensible use of energy in dwellings by tenants. The project SAVE@Work4Homes aims to help tenants to adapt energy efficient behaviour through innovative technologies.

The evaluation work package is an important part of the project SAVE@Work4Homes with the goal of both summative and formative evaluation of the success of the various energy awareness raising strategies and techniques. The evaluation approach has been based on a quasi-experimental design. Control groups of residents have been selected and recruited living in dwellings with characteristics matching those of the residents receiving prototype Energy Awareness Services and with equally matched socio-economic characteristics.

This evaluation methodology has evolved throughout the project. The initial evaluation criteria developed by each site early in the project were eventually consolidated for consistency and the criteria were selected. It was apparent that two types of assessment could be undertaken:

- The criteria of a sociological nature on the behaviour of tenants. Their evaluation was obtained from surveys pre and post operative. A baseline survey was carried out across both experimental and control groups to elicit relevant energy-oriented attitudes and behaviour before introduction of the Energy Awareness Services. The final survey took place towards the end of the field phase of the project.
- The criteria of a technical nature (measures). Evaluation (when possible) was made from measurements of consumption pre and post operative

Methodology of evaluation of the services:

To follow the behaviour of the tenants, we have compared the consumptions of each month during which the services were implemented to the consumption of the same month of the previous year (sometimes problems arose because the system was not operating for the complete period of 12 months in a row. In the case of heating, the measurements were corrected by degree-days (DD).

In the case of data mixing space heating and water heating (e.g. Nassauische Heimstätte), the DD correction had to be done only on the heating part. When the monthly part of heating is not known, the annual percentage of water heating is used (but this method introduces errors when the work is done only for a few months). The proportion of the water heating can also be calculated with the cubic meters of water: 100 kWh/m³ (on average) are necessary to produce one m³ of heated water at 55-60°C.

Incoherent data (more than 40% of saving and more than 100% of over consumption) had to be deleted because of measurement problems or due to important change in the life of the household.

Methodology and content of the tenant surveys

In order to identify the tenant's acceptance of the offered Energy Awareness Services and to quantify the success of these services in terms of saved energy, a survey design was conceived which included a two stage panel with control group. As shown in figure 1 the planned longitudinal design had a typical A-B-A form, that is:

- Carrying out a baseline survey - (A) *Measurement* - before implementing the tenant portal and the self-assessment tool
- Offering tenants access to the service - (B) *Treatment* - except the tenants of the control group
- Carrying out a final survey - (A) *Measurement* - after an adequate period of use of the service (e.g. after one heating period)

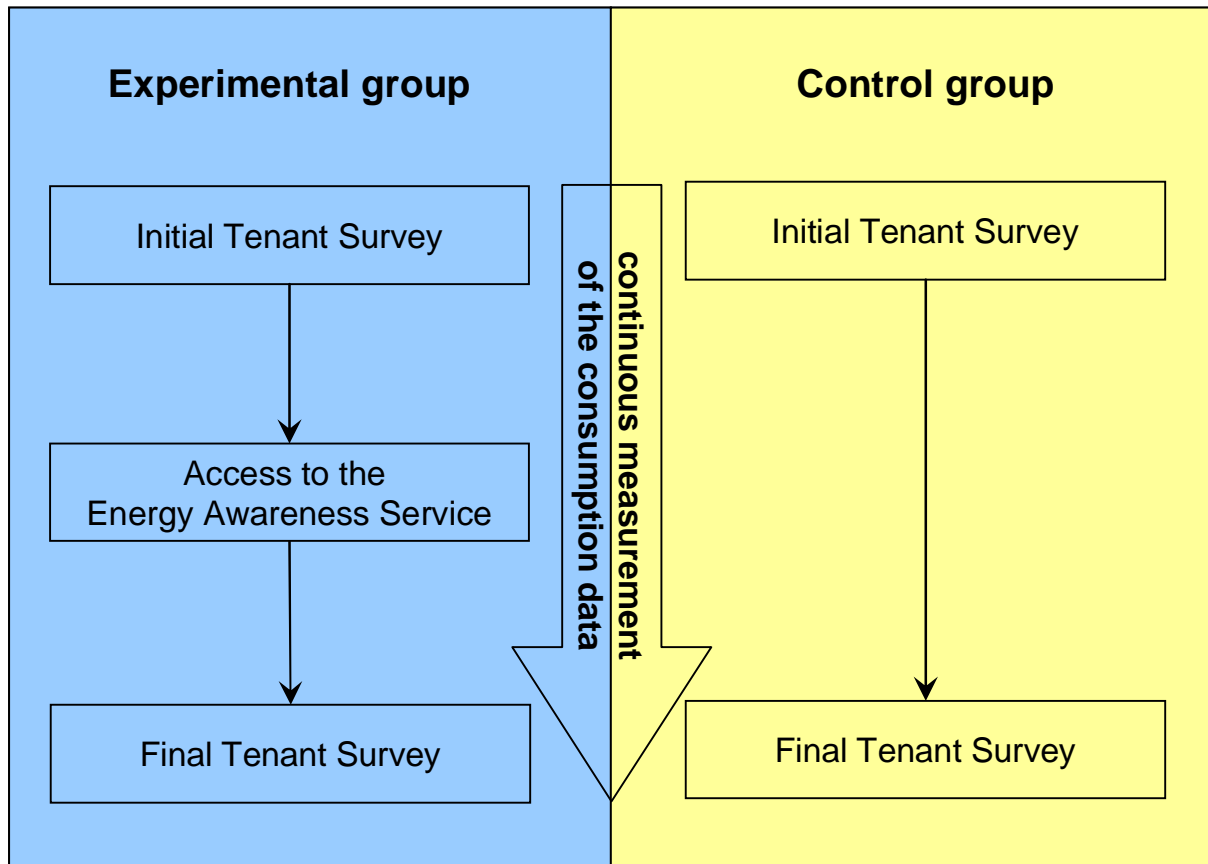


Figure 1: Design of the study

In order to guarantee comparability, the characteristics of the control group concerning the dwelling and the socio-economic conditions should match those of the experimental group. In addition to that, during the whole time period the available consumption data should be metered continuously and assigned to the survey data of both groups.

The above described survey design was addressed to the French and German sites only which mostly followed the suggested design - with one exception: For various reasons they did not carry out an initial survey to the control group. From the methodical point of view the abdication of an initial control group survey was not dramatic. In fact, in such cases an identification of potential behavioural or attitudinal changes in the variation in time is not possible. On the other hand a one-time final survey allows a comparison with the experimental group in terms of differences in attitudes or behaviour patterns. This information in combination with the knowledge about the decreases or increases of the energy consumption seemed to be sufficient in order to reach a high information content.

Due to different housing circumstances in Belfast, NIHE carried out one retrospective survey only without involvement of a control group.

Content	Longitudinal study (two-stage panel)			Retrospective survey (NIHE only)
	Initial survey	Final survey		
		experimental group	control group	
Part A	+	++	++	-
Part B	-	++	-	+
Part C	++	++	++	++
Part D	++	++	++	++

++ Fully or predominantly included + partially or similarly included - very differently or not included

Figure 2: Global structure and linking of the various surveys

All surveys normally were divided into four parts (with regard to different content):

Part A focused on global environmental attitudes and knowledge. Of interest in this context were the information levels about environmental issues in general, the consumption of energy and the possibilities of saving energy in the tenant's homes as well as the tenant's environmental awareness. Two questions were taken from the EUROBAROMETER¹ and were already used within the broad tenant survey concerning the tenant requirements, which were carried out in the context of work package 2. An analysis of these data should allow a global classification of the tenant's environmental attitudes and behaviour in comparison to the average citizen.

Part B contained questions concerning the tenant's interest and/or the user acceptance with the services provided. Within the final survey carried out to the experimental group this part covered questions with regard to the

- used channel (internet portal or brochure) and user habits (e.g. frequency of usage)
- interest in the service and the kind of information
- user satisfaction with the service in general and the offered information in detail relating to the content, the illustration, the manageability and so on
- tenant's report about the impact of the services, residual knowledge gaps and improvement suggestions

The final survey carried out to the control group primarily included questions concerning the potential interest in such a service and the level of awareness (e.g. Did you already notice this service?).

Part C dealt with the concrete consumption behaviour and attitudes of the tenants. This contained usual everyday behaviour patterns in terms of the consumption of heating energy, electricity, hot and cold water as well as the temperature choice and the ventilation behaviour. The aim of this part was to identify significant behavioural or attitudinal changes by comparing the statements of the initial and the final survey (experimental group) or the differences in behaviour of both groups. Based on this, the effect of the Energy Awareness Service can be valued.

Part D contained basic socio-demographic household characteristics like gender, age, household type, household size, predominant source of housing income and amount of the net household income per month. The knowledge about these characteristics should allow a

¹ a) Please list the five main environmental issues that you are worry about from the following list: climate change, loss in biodiversity, natural disasters...

b) How informed do you feel about environmental issues in general?

Both from: European Commission (2005). Special Eurobarometer 217. The attitudes of European Citizens towards environment

differentiated view in terms of a classification of households.² In addition, this part asked about the tenant's facilities, like access to internet and to a computer.

1.2 Potential savings

The results of the preliminary investigation conducted under this project with 2,613 tenants, (D2.1) had shown that a high proportion of residents overheated housing: 27% are heated to 21°C - 22°C, 8% were heated to 23°C-24°C, 4% were heated to 25°C. The temperature recommended in social housing is 20°C. We know also that the savings generated by a decrease of 1°C of heating is about from 6 to 7%.

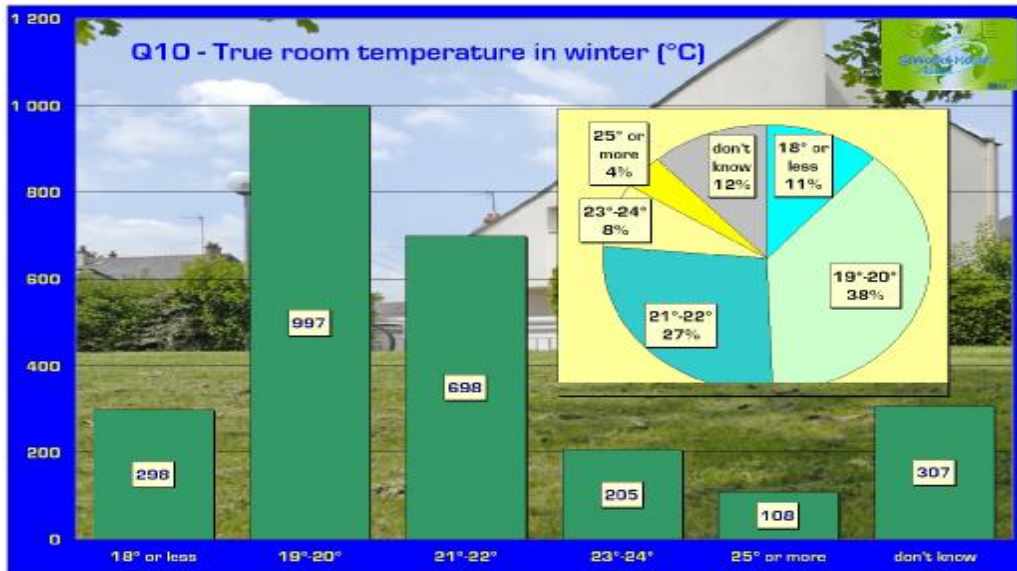


Figure 3: Temperature distribution in dwellings in winter

As an example, if all temperatures above 20°C were reduced to 20°C and by weighting with the corresponding percentage of tenants, we can calculate that a potential saving of around 7.1% can be obtained on the stock investigated.

Other examples are presented below for a goal of 19°C (10, 2% saved) and a goal of 18°C (15,7% saved).

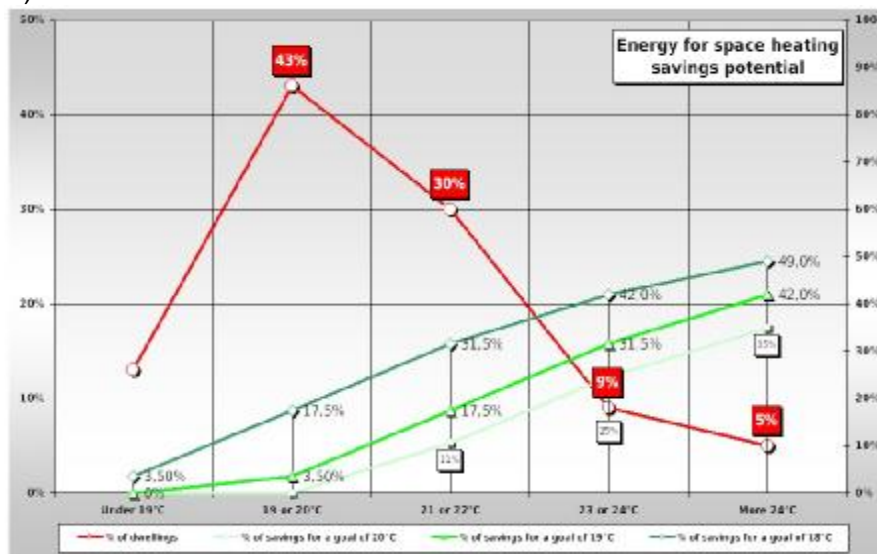


Figure 4: Energy for space heating: potential savings

² Of special interest in Germany was the question, if the rent or running costs were paid by the municipality.

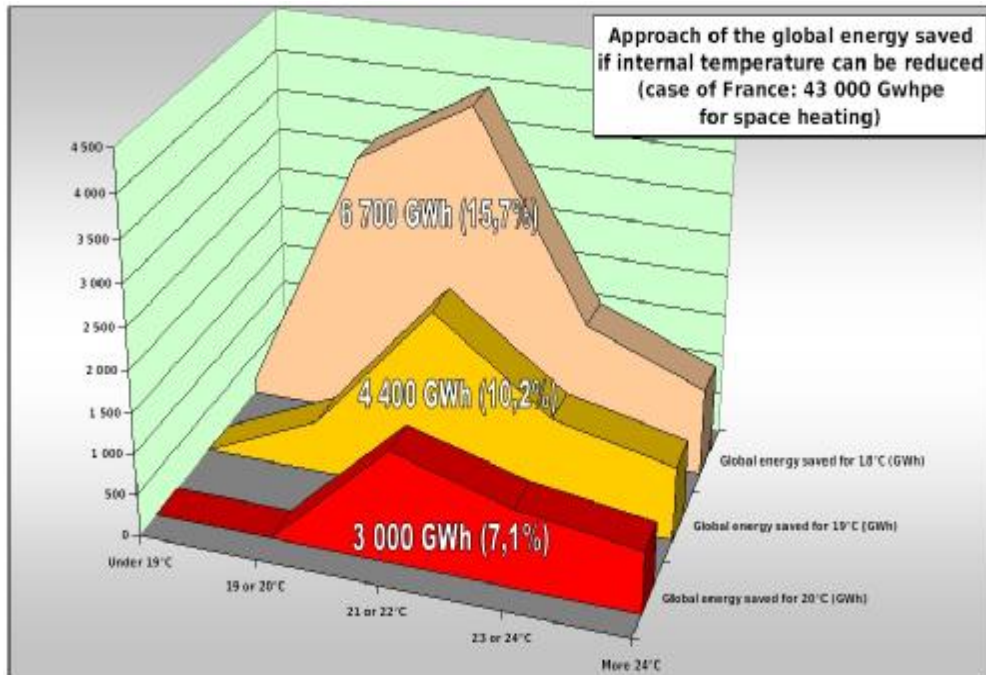


Figure 5: Approach of the global energy saved if internal temperature could be reduced

These significant savings, however, should be adjusted according to the type of tenants. It is known, for example, that older people want a temperature in their house clearly above 20°C. Similarly, a person used to heating at 23°C will not readily accept a reduction in the temperature to 20°C or less. However, this is the main future objective to be achieved with the services developed in the project.

2. Evaluation of the impact of the services on the tenant behaviour

2.1 EVALUATION: VOLKSWOHNUNG

2.1.1 Presentation of the site

VoWo has selected 4 almost identical buildings for test purposes for the new EAS “tenants’ portal”. The buildings are located at the “Rheinstrand Neighbourhood”, with a total number of 136 flats, constructed in 1967 and refurbished in 2003 (2 buildings) and 2006 (the remaining 2 buildings). The total costs of refurbishment were about 4 mill. €. The envelope including flat roofs and technical equipments, elevators, energy/electricity and sanitary installations have been renewed.



The photograph shows the building Lindenallee 31 (9 floors, 36 flats); in the background to the left and right, the buildings Kranichweg 2 and Rheinstrandallee 5; not visible: Kranichweg 4

The characteristic data of the four buildings are as follows:

Address	living space m²	flats
Lindenallee 31	2.001	36
Rheinstrandallee 5	2.593	36
Kranichweg 2	2.022	36
Kranichweg 4	2.255	28
	8.874	136

The 4 buildings have been supplied since their construction with heating energy and domestic hot water (DHW) generated by a gas-fired central heating station, which is connected to the 4 buildings by a district heating pipe line of about 180 m in length. Because of the retrofit, the energy consumption for heating and DHW, including boiler and distribution losses, has decreased in two steps, in 2004 and 2006 from a rather high initial value of > 200 kWh/m² to about 80 kWh/m² (average over all 4 buildings):

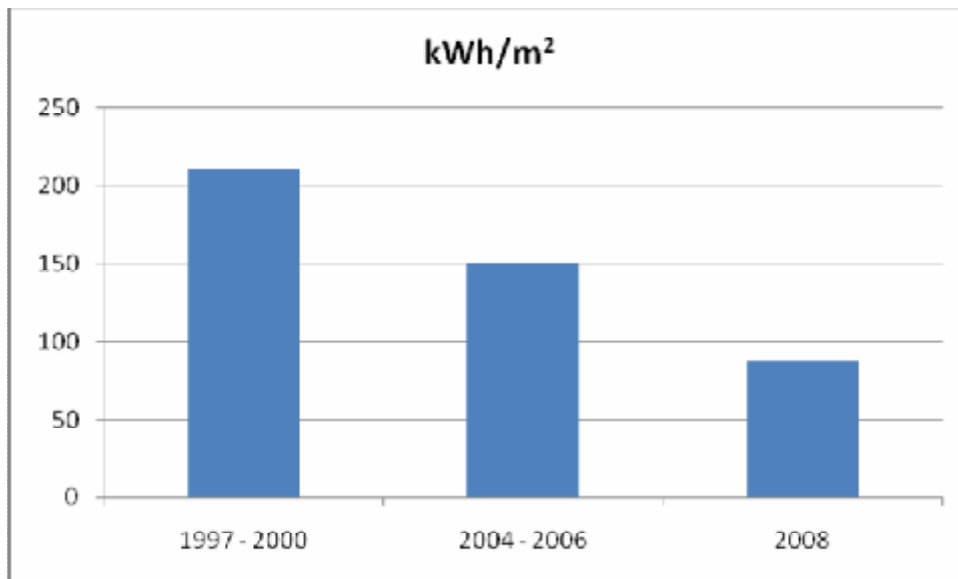


Figure 6: Average specific end energy consumption of the heating station supplying Rheinstrand neighbourhood before and after retrofit (values are average values over all 4 buildings)

The two buildings that were refurbished in 2003 serve as a reference to investigate behavioural differences. The tenants living in the two buildings, which were refurbished in 2006, Kranichweg 4 and Rheinstrandallee 5, have been informed about SAVE@Work4Homes. Residents living in Kranichweg 4 received additional information about energy consumption and energy saving opportunities through several talks with advisers from VoWo between October 2007 and May 2008.

The information to be delivered to the tenants using the tenants' portal is based on monthly measurements of heating demand and DHW consumption in every dwelling (and the total heating energy delivered to every building from the heating station). This means, as shown in the graph below, that in every flat all radiators are equipped with a wireless device, which traces the heat output of every radiator to the flat, and with a hot water meter, which measures the consumption of DHW in every flat. All those devices are polled on a monthly basis by a data collector in the building, installed outside the flats. These data, including time/data stamps, are delivered to the central server at VoWo and evaluated there for further information.

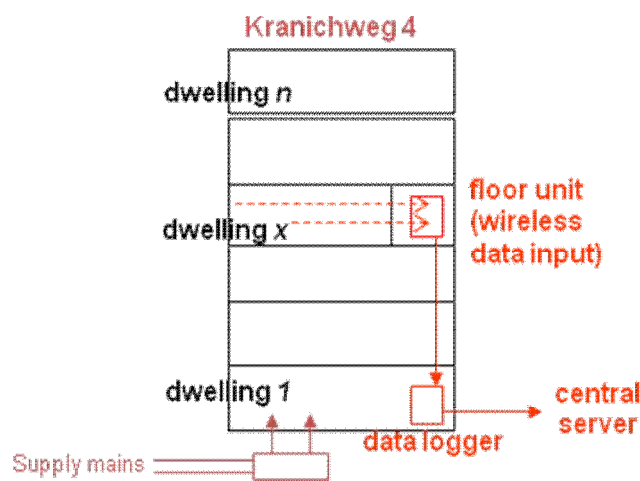


Figure 7: Measurement scheme for radiator heating output, Kranichweg 4

Originally, this system was introduced over the last 5 years in – so far – 80 % of VoWo's dwellings, to be able to log the consumption data automatically without direct access to the dwellings to calculate the annual energy costs for our tenants. Since the technical capacity of this system also allows readings on a monthly basis, it can provide much more detailed consumption data, which is needed to operate a tenant's portal.

The data received by the central server are further processed to provide understandable information for the tenants. In particular, heating demand data have to be corrected for climate differences on the basis of degree days, and comparisons with data of the preceding year and with averaged consumption values are calculated. In particular, the evaluation software has to deal with irregular events, such as tenants' moving, empty flats, failure of measurements etc., which requires precautions in programming to avoid bugs and strange results.

In the case of heating demand measurement, the measured data are "units" that are provided by measurement devices fixed on the radiators. These units have to be re-calculated using the total heating demand of the building to convert "units" into "kWh". So far, not all of our buildings are equipped with heat meters (in these cases, the *total heat energy input*, including DHW supply, is measured, or the monthly input of gas). Then, the number of kWh can be calculated and only "units" are provided by the system. The following graphics illustrates this.

The first version of the tenants portal was developed in spring and summer 2007 in co-operation with Areon/Wiesbaden, who designed the software establishing our first portal, which was provided to the tenants of Kranichweg 4 and Rheinstrandallee 5 (but not to the tenants of the other 2 buildings, Kranichweg 2 and Lindenallee 31) from September 2007 until May 2008.

Since VoWo intended to use this software under its own responsibility for the future and this first version was not satisfactory in terms of design and functionality, another software designer was engaged in August 2008 to further develop the portal design. The data base to process data received from the measurement system for the calculation of heating costs and the data needed by the portal was to be designed by VoWo's own personnel. However, the software designer who was in charge for that left VoWo in late autumn 2008. Therefore, this work also had to be outsourced to an external developer, which was – besides the additional costs – also much more time consuming. Therefore, the new version was delayed.

As explained, information about tenants' portal access and additional advices were provided to the tenants between September/October 2007 and May 2008. As a result of this timing, we have so far no clear distinction of the annual consumption based on calendar years with and without portal. This – among others things - has to be considered when comparing the development of energy consumption data. However, the 2 buildings with tenant portal can be compared with the two other buildings without tenants' portal, which are practically identical in size and insulation standard (but have, of course, different tenants).

There is also a difference between the two buildings with access to the portal, in that we have maintained a regular direct communication with the tenants in building Kranichweg 4, visiting them a few times towards the end of 2007 and spring 2008 and discussing consumption data or explaining the portal, whereas in the case of Rheinstrandallee 5 we informed the tenants only that there was a portal, how to access it and what would be its purpose.

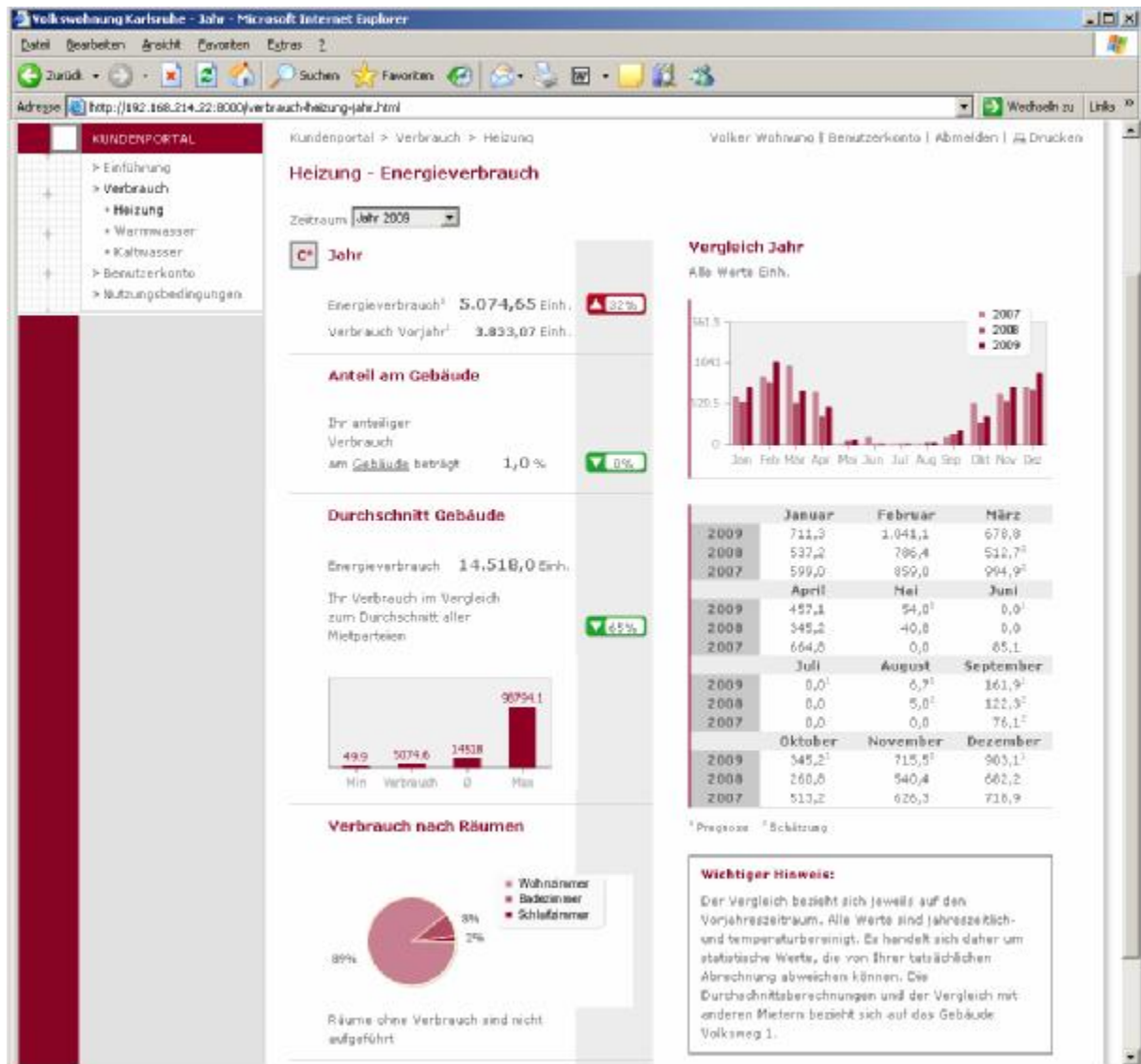


Figure 8: Tenants portal example: Screen shot of tenants portal showing heating energy consumption data of one dwelling using “units” (no real data) to compare the demand of the tenant with the preceding year and with the other tenants in his building

2.1.2 Evaluation of the services

a) Heating energy consumption

The following chart illustrates the heating demand of the four buildings in 2007 and 2008, where the 2 buildings Kranichweg 2 and Lindenallee 31 (the buildings without access to the portal) are treated as 1 building, calculating the average values for both.

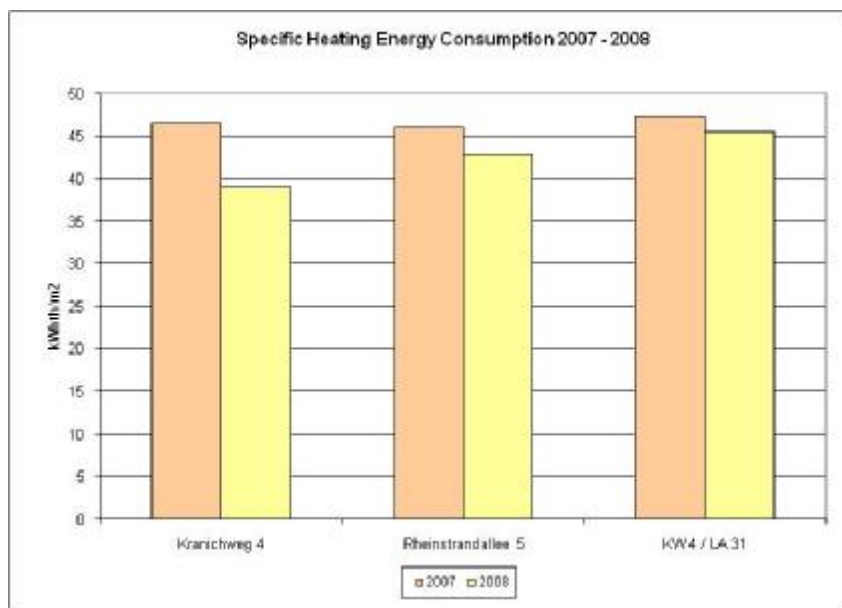


Figure 9: Specific heating energy consumption (kWh/m²) of the two “portal buildings” and the average of the two other buildings in 2007 and 2008 (data adjusted for changes in degree days).

Whereas these data provides plausible development (note also the low specific consumption of all four retrofitted buildings), they are only average data of the individual dwellings within every building, being the result of individual consumption values that vary very strongly, as shown below:

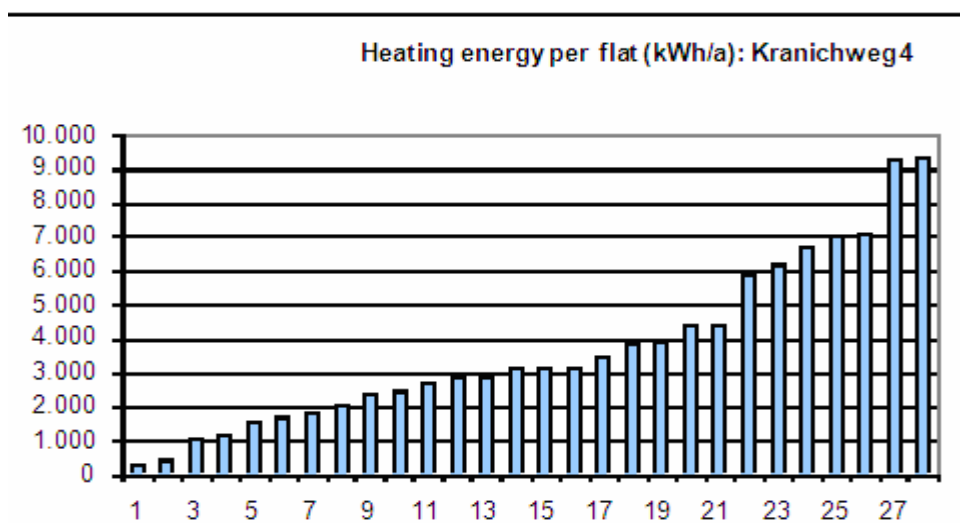


Figure 10: Measured heating energy consumption per flat (2007): 28 dwellings

Neglecting the 4 flats with very low consumption (for whatever reason), the remaining 24 flats have differences by a factor of 6! The energy conservation that we want to achieve would therefore be possible if the 7 biggest consumers (20 % of the tenants) could be influenced to reduce their demand down to the *average of all tenants* in the building (which would save almost 20 % of the total heating energy consumption of the building). This is exactly the purpose of the tenants’ portal.

One reason for increased heating demand would be a high room temperature. Two examples of a flat with normal temperature in the living room (“normal” would be considered

a temperature between 20 and 21 °C) and a flat, which is actually overheated are shown in the next chart using daily averaged data measured in January 2007:

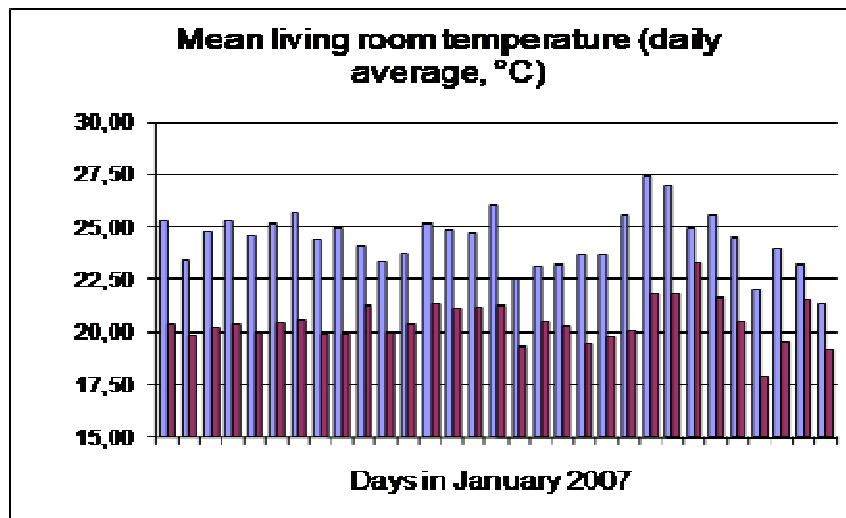


Figure 11: Mean room temperature in the living room of a flat with average consumption of heating energy and a flat on the high end of the consumers in Kranichweg 4

b) Domestic hot water consumption

As for the case of the heating energy consumption, the following chart illustrates the development of the DHW consumption in 2007 and 2008:

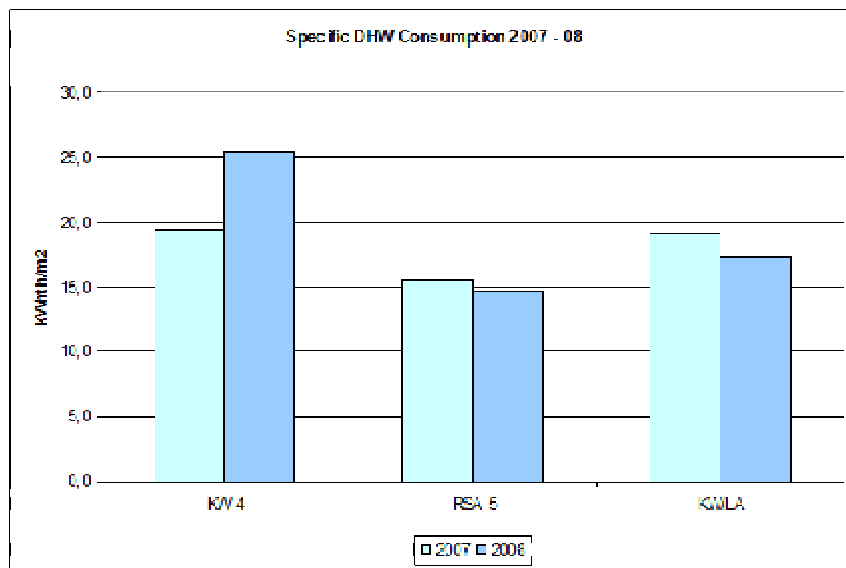


Figure 12: Specific DHW consumption (kWh/m²) of the two “portal buildings” and the two other buildings (average) in 2007 and 2008.

Unfortunately, the building where the tenants’ portal was available and where there were several direct contacts of most of the tenants with VoWo advisers, *in the average* shows an *increase* rather than the expected decrease of DHW demand, contrary to the behaviour in the case of heating.

Looking again at the annual DHW consumption at the level of the flats, we see a spread in demand, which is similar to the heating case:

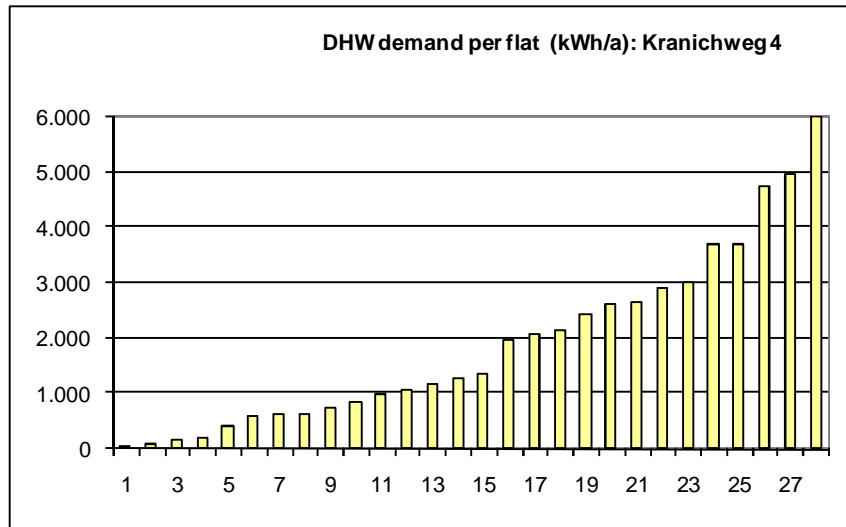


Figure 13: Measured DHW consumption per flat (2007): 28 dwellings

Are tenants, who waste heating energy, also wasting DHW? The next graph gives the answer:

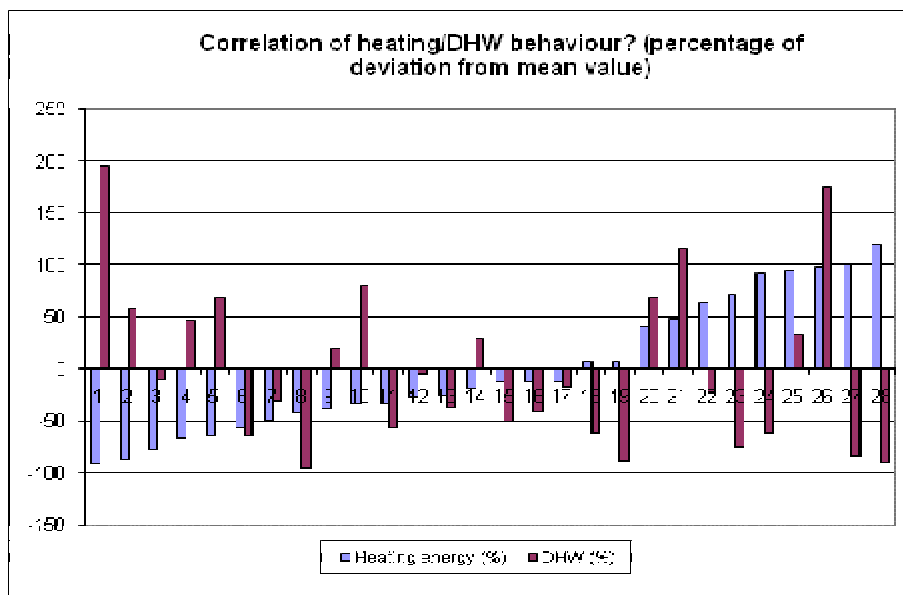


Figure 14: Deviation of annual heating energy consumption from the average consumption for 28 flats (in %) compared with the deviation (in %) of the same flat from the average DHW consumption in Kranichweg 4

The answer is obviously, that (in the case of this building) there is now a correlation between DHW consumption and the level of heating energy consumption.

Again, it should be of interest to use the available data to look in more detail and analyse the DHW consumption measured for the flats using monthly demand data:

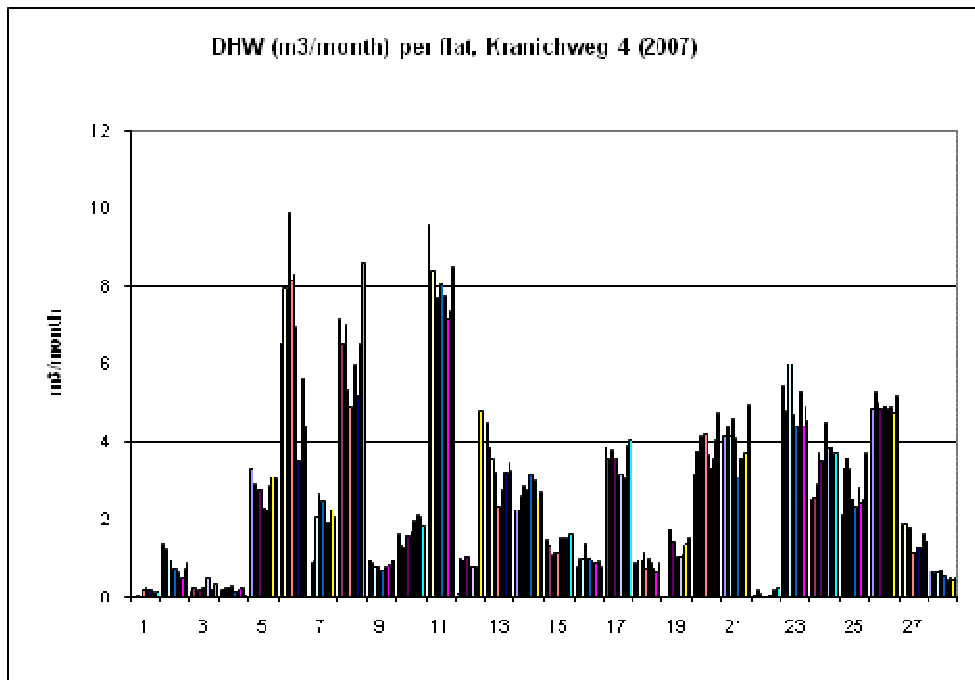


Figure 15: Monthly DHW demand in the 28 flats of Kranichweg 4 for 2007 (every flat from number 1 to 28 is characterized by 12 thin black lines representing the monthly DHW consumption in m³/month)

The graph above shows again the big variation between different flats, but it shows, on the other hand, that the behaviour of the inhabitants in one flat is rather consistent (with exceptions): in a flat, where the DHW demand is high in January, it will in general be also high, say, in September.

Then, how can an increase of DHW demand between 2007 and 2008 by more than 20 % in this building be explained? Monthly DHW consumption over 2007 and 2008 in all flats of Kranichweg 4 is shown next:

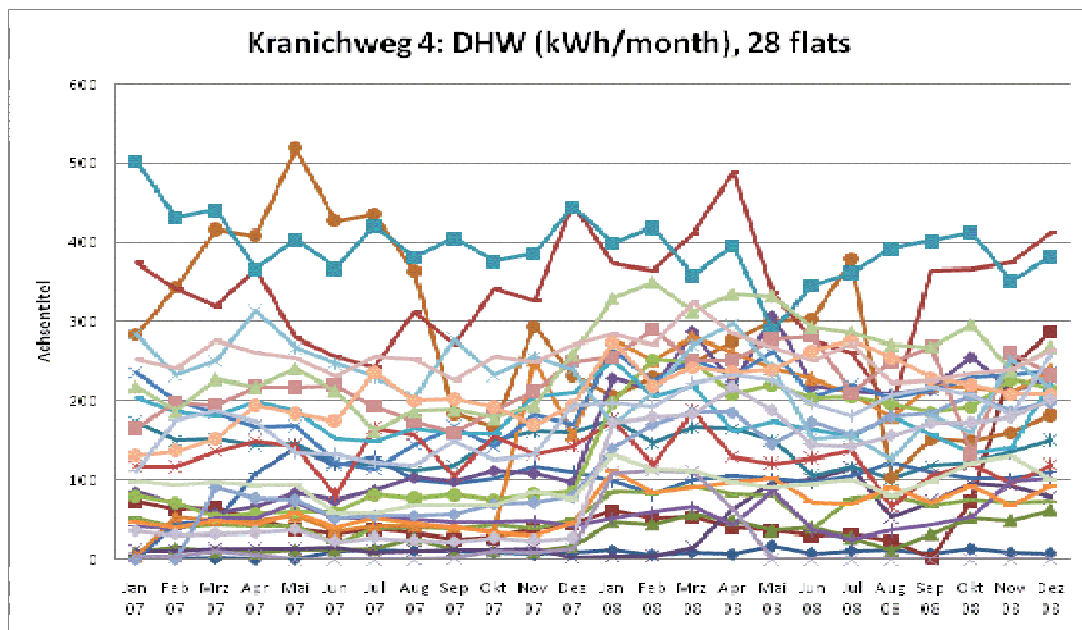


Figure 16: Monthly variations of DHW consumption, 28 flats of Kranichweg 4, from 2007 to 2008

This graph is not easily to understand. However, looking at the individual course of the demand developments and searching for the behaviour of flats with major increases from 2007 to 2008, one finds that only 7 of these 28 flats are responsible for this increase in 2008:

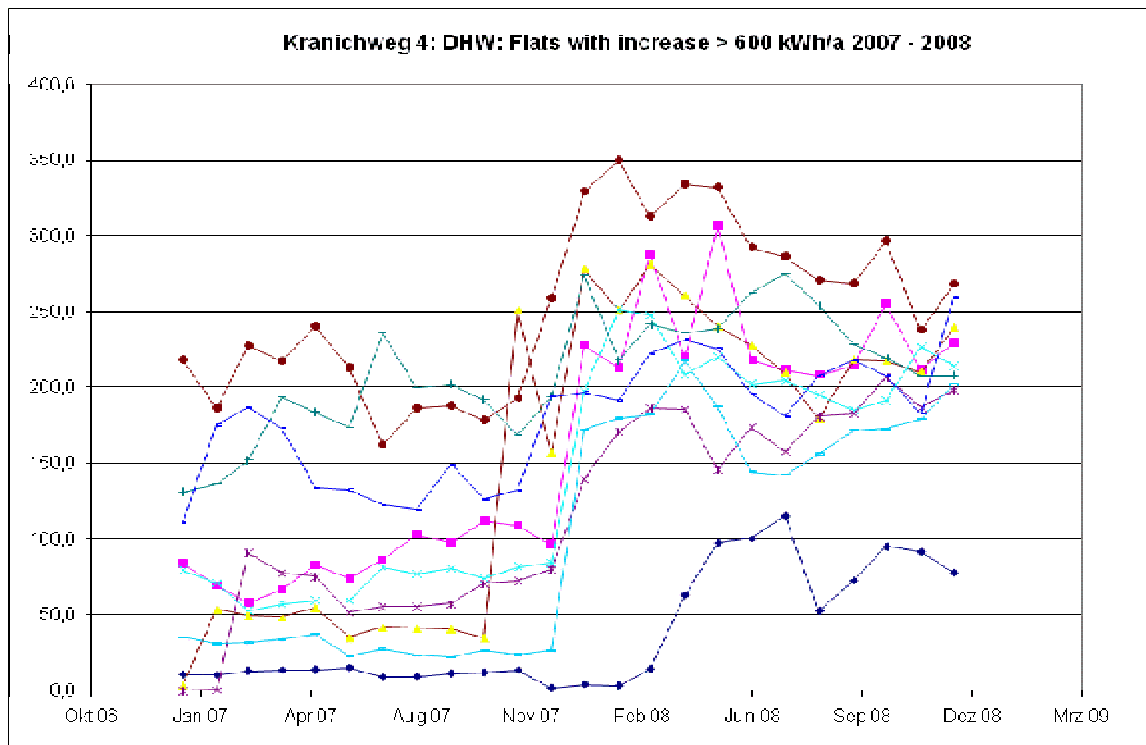


Figure 17: 7 flats with significant (> 600 kWh/a) increase of DHW consumption from 2007 to 2008

According to the graph shown above, in these 7 flats between October 07 and March 08 a step in DHW consumption occurs, from lower demand level to higher level. Investigation in VoWo's facility management department has shown, that the tenants in the corresponding flats had moved out and were replaced by other tenants, in most cases by younger ones (the average age of tenants who live in these buildings is rather high).

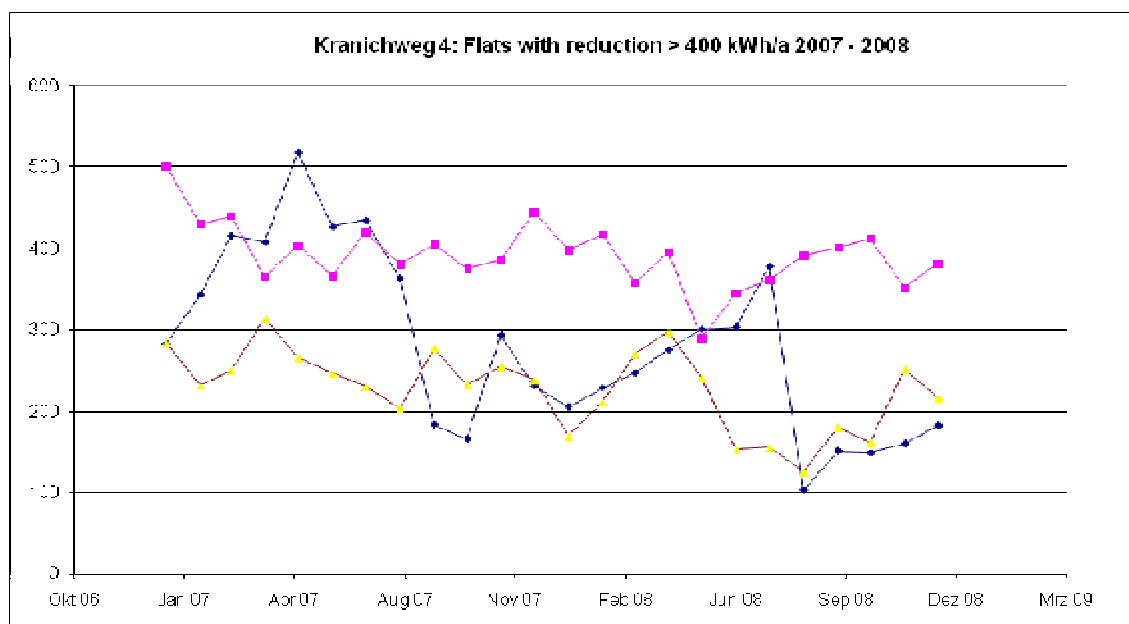


Figure 18: 3 flats with significant (> 400 kWh/a) decrease of DHW consumption from 2007 to 2008

With 7 flats showing significant increases, there are (only) 3 flats with significant decreases. In the latter, no leap is occurring, but rather a “smooth” decrease, at least for two of the three. (One is tempted to believe that this is the result of advising, either by the portal or by VoWo’s advisors.)

In the last chart, the remaining flats are presented, where no clear pattern can be recognized. In particular, the lowest line in this chart is a flat which was held empty, since it was used as an office for the local planner who controlled construction measures at the site (and obviously did not need hot water).

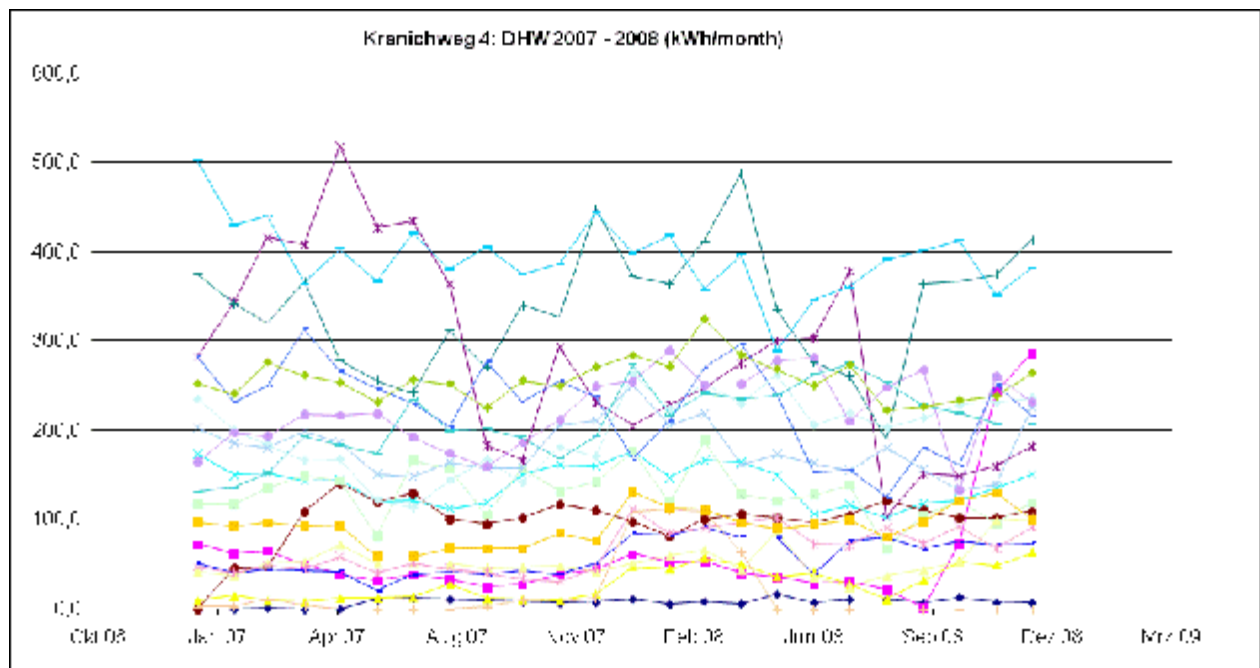


Figure 19: Remaining flats: DHW consumption from 2007 to 2008

Deleting those 7 flats from the data set, where new tenants moved in at the end of 2007 or in 2008, the remaining 21 flats show a decrease of DHW consumption by 12 % rather than an increase of over 20 %, as recognized for the full data set. So, by analysing the data and making adjustments, which may be justified according to the reasons mentioned above, the “wishful result”, a decrease of energy consumption from 2007 to 2008, can be observed – and, in addition, the decrease is larger in Kranichweg 4 than in the other buildings.

So, as a first conclusion, one might say that in Kranichweg 4 a reduction in heating energy demand by 15 % and in DHW consumption by 12 % was shown (after corrections made for changes caused by other reasons), which was larger in this building than in the other buildings.

However, in the light of the wide spread of the energy consumption per flat that was measured, and due to the influence of other changes in the building, that might outweigh behavioural changes, this conclusion seems less clear, given the fact, that the tenants portal was in operation from October 2007 until May 2008, thus mixing the two calendar years that are being compared. In addition, since the energy price increased in the same period, this might also be a reason for energy saving behaviour.

Given those uncertainties, measurements over more heating periods and including more buildings/flats, say hundreds of them, will be necessary to come to a rigorous conclusion. Since the portal will be introduced on a larger scale by VoWo, beginning with the heating period 2009/10, we will have access to much better statistics in the years to come. Than it should be possible to have results that are more clear than the present measurements.

2.1.3 Evaluation of the use of the tenants' portal

The main numbers are the following:

- Technical availability of tenants' portal via internet to 28 + 36 = 64 households in 2 buildings (Kranichweg 4 and Rheinstrandallee 5) from October 2007 until May 2008.
- Access to internet (according to results of poll in April 2007): 38 % of the households --> which means, 24 households really had access during the test phase.
- VoWo has not made any statistics on user access in the first test phase (VoWo will make access statistics after launching the new portal)
- During the test phase, VoWo had direct contact with most of the tenants in Kranichweg 4 (irrespective, of internet availability or not): 20 of them at the beginning of the 1st test phase, September and October 2007, and 14 in February and March 2008 for a second feed-back (which resulted, among other things, in improvements to the portal).

2.1.4 Tenant's survey

The planned evaluation approach in Karlsruhe included a two stage panel (before and after the implementation of the tenant portal) with a control group design. The tenants of two buildings, which were refurbished in 2006, were the experimental group with an access to the Awareness service. In this context the tenants in both buildings received information about the internet portal and how to use it. In addition to this in one of these two buildings the tenants got tips about energy consumption and energy saving from the energy advisors of Volkswohnung. The tenants of two further buildings, refurbished in 2003 and almost identical, were the control group without access to the tenant portal and without any further information concerning the energy topic.

A first version of the tenant internet portal was available from October 2007 to May 2008. After that Volkswohnung (and its sub-contractors) started a broad revision of the tenant portal which necessitated an offline status. Unfortunately the new portal could not be finalised in time - with the consequence that the portal was offline since May 2008 until the end of the project. Due to this, Volkswohnung carried out the initial survey only in April 2008. The final survey, which was scheduled for spring 2009, could not be achieved. Therefore it is not possible to evaluate either the Energy Awareness Service (tenant portal) or the effect of the quality and quantity of the information provided in a statistically meaningful way.

However, there are measured consumption data of Volkswohnung over two heating periods for all four buildings, which give evidence for some changes in user behaviour. In addition to that some results of the initial survey are presented in the following - partially compared with the broad tenant survey carried out in WP2 in order to analyse the tenants' requirements in preparation for the development process of the tenant portals.

Survey results

In total 47 tenants completed the questionnaire - 26 women (53 %) and 21 men (47 %). The respondents were between 19 and 83 years old. The average age is gender-independently high - the men were on average about 61 years old, the women with about 63 years a little older. The tenants mostly lived in single- (40 %) or two-person households (44 %). In six households there were children up to 17 years old. The predominant sources of income were pensions (64 %) and income from employment or self employment (34 %). 80 % of the interviewed tenants had a net household income up to 1.500 Euro.

	Broad tenant survey (WP 2)	Initial survey
Survey period	March 2007	April 2008
Final sample	288	47
Used method	paper-based	paper-based

Figure 20: Sample size of the initial survey in comparison to the broad tenant survey in 2007

The level of information about environmental issues in general, the consumption of energy and the possibilities of saving energy in the flats is very high (see figure 21). There are between 50-70 % of tenants who feel well or very well informed. This applied also to the broad tenant survey in 2007 where the tenants' agreement was similarly high.

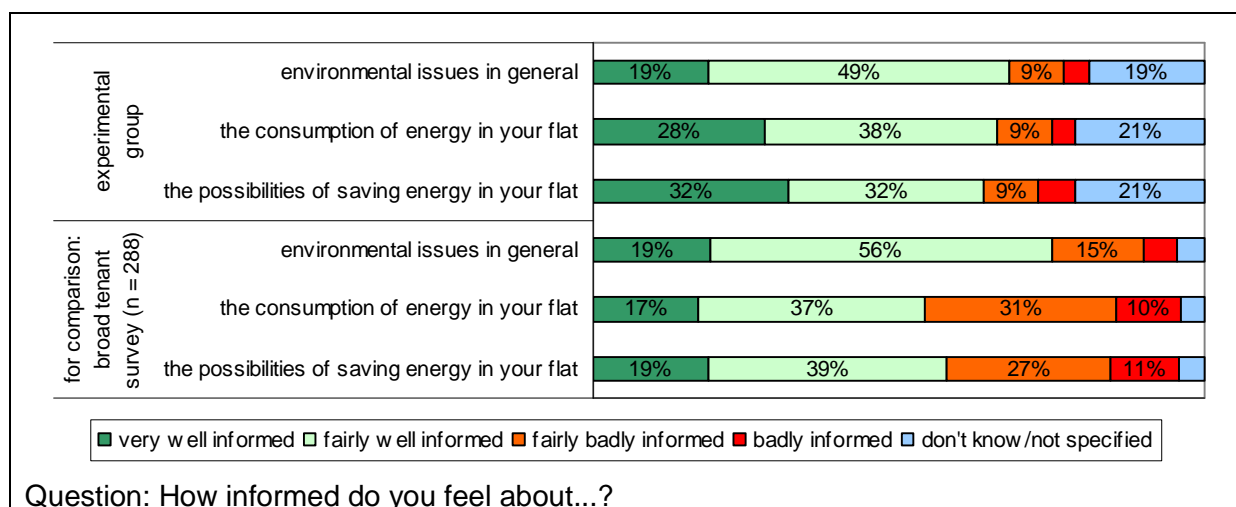
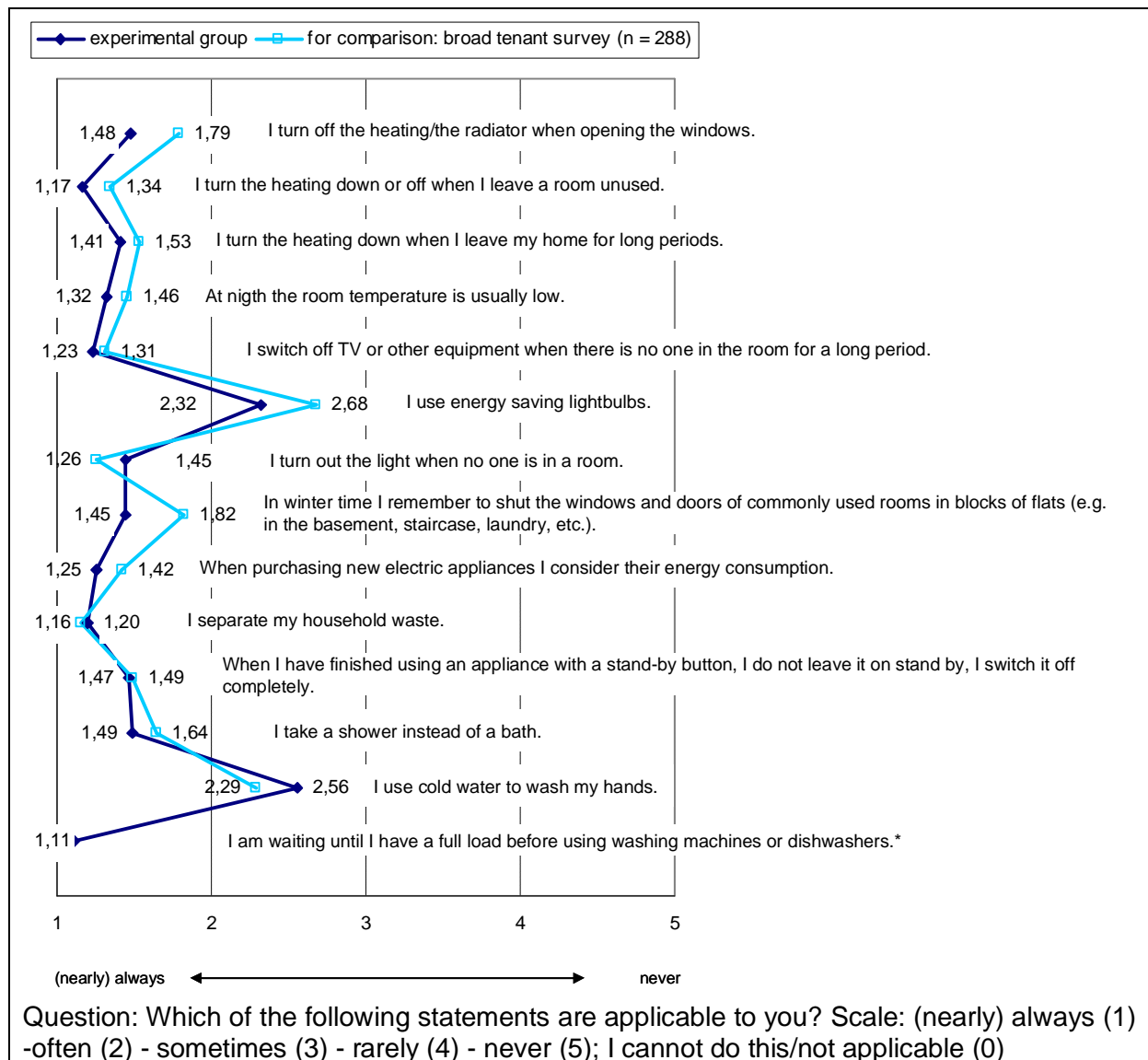


Figure 21: Information level about ...

The everyday consumption behaviour of the tenants in both surveys is very similar too. Mostly the tenants are very environmentally conscious - concerning their heating behaviour and the use of washing machines or dishwashers.

Two behaviour patterns are quite different to the others. The use of energy saving lamps and the use of cold water in order to wash their hands are still not common. In the near future the use of conventional incandescent bulbs will not be a problem anymore because the European Parliament will prohibit the sale of such bulbs lamps - beginning with a size of 100 W from the 1st of September 2009 and extending this ban to smaller bulbs in further consecutive steps until the year 2013.



* The last item wasn't part of the broad tenant survey in 2007.

Figure 22: Behaviour pattern, mean values

About 46 % of the tenants prefer a room temperature of 20 °C in their home (mean value 20.6 °C with a range from 17 to 22 degree). Nearly all tenants (98 %) feel comfortable with the temperatures in their home – due to the option to control and regulate the heating system by themselves.

Within the retrofitting the tenements were equipped with a mechanical ventilation system which is sufficient for ventilating the rooms for most tenants. Only three households preferred ventilating their rooms by opening the windows widely at times. Approximately two thirds of the tenants feel comfortable with the ventilation system.

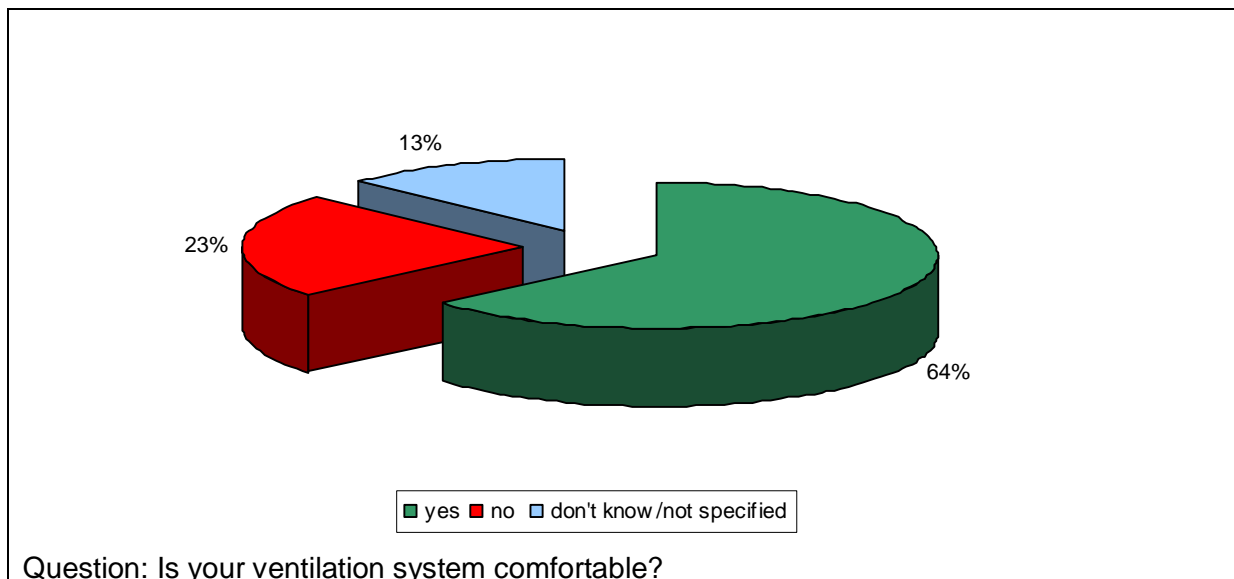


Figure 23: Comfort of the ventilation system

Half of the tenants estimated their own energy consumption as “medium”, about 25 % as low or very low.

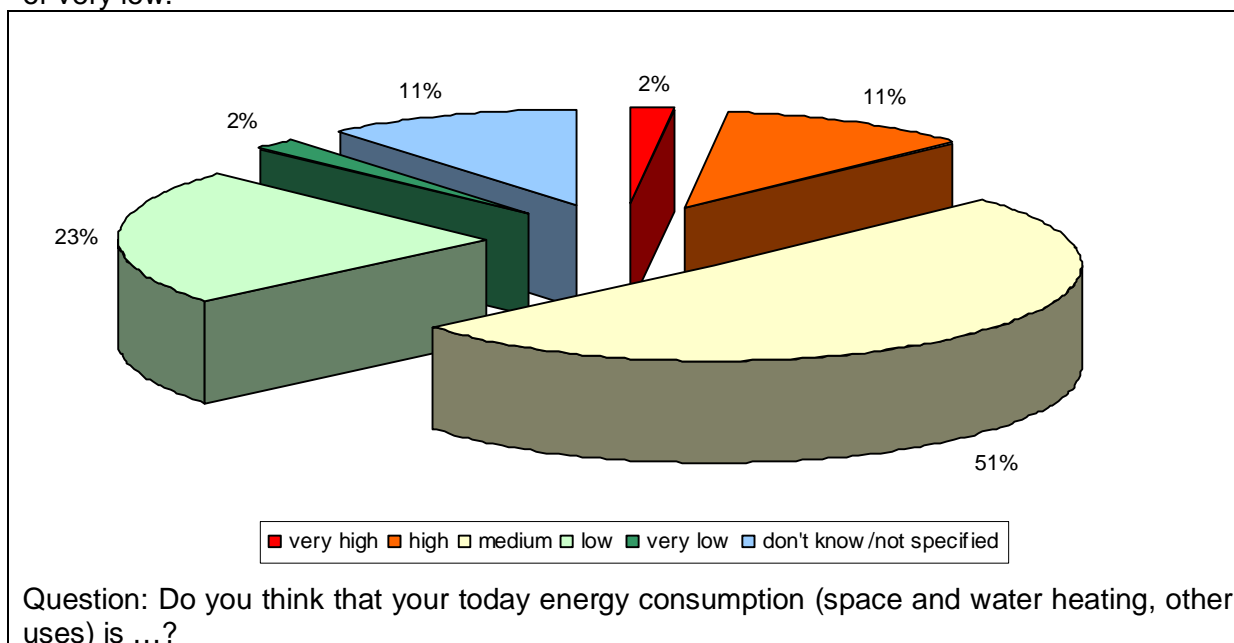


Figure 24: Self-assessment of the energy consumption

Most tenants of Volkswohnung in Karlsruhe already act in an environmentally friendly way. Although they mostly estimate their energy consumption as medium or low, there are still possibilities utilise save energy and increase the ecological awareness of the residents. Many tenants are more than 60 years old. The access to internet is rather low (37 %) as well as the access to a private personal computer or notebook (36 %). It will be important to choose the right information channels in order to provide the tenants with such information they need.

2.2 EVALUATION: NOTHERN IRLAND HOUSING EXECUTIVE (NIHE)

2.2.1 Evaluation of the service

In Northern Ireland, it was not appropriate to provide the same services as the other sites. This is because there is no collective heating in NIHE stock, the landlord does not get access to individual tenants' bills which are a private matter between them and the energy supplier and there is a low level of internet access among tenants. The Housing Executive therefore decided to use Personal Digital Assessors (PDAs) to bring the Self Assessment Tool (SAT) into tenants' homes during routine housing visits by Neighbourhood Wardens. The Housing Executive also provided more in-depth advice to 38 tenants who stated they were unable to use their heating controls properly.

Housing Executive staff brought the SAT to some 160 households. The use of PDAs was successful on this project prior to its withdrawal due to IT security issues unrelated to this scheme.

More in-depth advice on the use of heating controls was provided to the tenants that requested it. The local gas supplier made available consumption records for 25 of these tenants. However, only 10 of these covered the period of the project. In three households the consumption was nearly the same in both viewed periods. In another three households the gas consumption was higher than before (between +7 and +22 %). In four households the gas consumption was lower after the energy-related advisory service (between -6 and -20 %).

The provision of direct face to face advice was very effective for some tenants in enabling them to use their heating controls properly to manage their gas consumption.

2.2.2 Tenant survey

In deviation from the French and German sites NIHE carried out one retrospective evaluation survey only. This survey was addressed to those 38 tenants whose former coal or electric heating was replaced with gas or oil heating systems and who indicated a need for a more in-depth advice on heating controls via an earlier survey. Also a self-assessment tool brought to the tenants - through a PDA-Service³ delivered by three Neighbourhood Wardens who called on a total of 160 tenants. The self assessment tool contains relevant, suitable and up to date energy saving hints. This tool was made available on the NIHE website too, but internet access among the NIHE tenants is on an extremely low level. Also within the SAVE@Work4Homes project the broad tenant survey conducted in 2007 showed that about 70 % did not have an access to internet.

Due to the incomparableness of the former and current heating systems a longitudinal study was inappropriate. In addition to that NIHE was not able to assign the actual consumption data to the survey data because NIHE takes no role in metering and billing. All tenants using gas heating systems are responsible for paying their bills to the gas supplier directly⁴. Data protection reasons only allowed the provision of anonymous consumption data which are not linked to names or addresses of tenants. A separate analysis of the consumption data is to be found in the chapter 2.

³ PDA = Personal Digital Assistant = handheld

⁴ Oil is a non metered fuel.

Survey results

27 tenants took part in the retrospective survey - 20 women and 7 men, most of all aged more than 60 years (93 %).

	Broad tenant survey	Retrospective survey
Survey period	May - June 2007	September - October 2008
Initial sample	1.400	38
Final sample	541	27
Response rate	39 %	71 %
Used method	postal survey followed up by face to face interviews	face to face interviews

Figure 25: Sample size of the retrospective survey in comparison to the broad tenant survey in 2007

Most tenants were satisfied with the service provided (41 % very satisfied; 52 % satisfied). After the more in-depth advice they felt (very) well informed about the use of the heating system and the heating controls.

Compared with the results of the broad tenant survey in 2007 the respondents of the retrospective survey described to a lesser extent knowledge gaps concerning the consumption of energy and the possibilities of saving energy in their homes. 93 % did not notice any topics they need to know more about in order to save energy.

33 % of the respondents are now more interested in saving energy. Two thirds are now more likely to save energy during the next winter period.

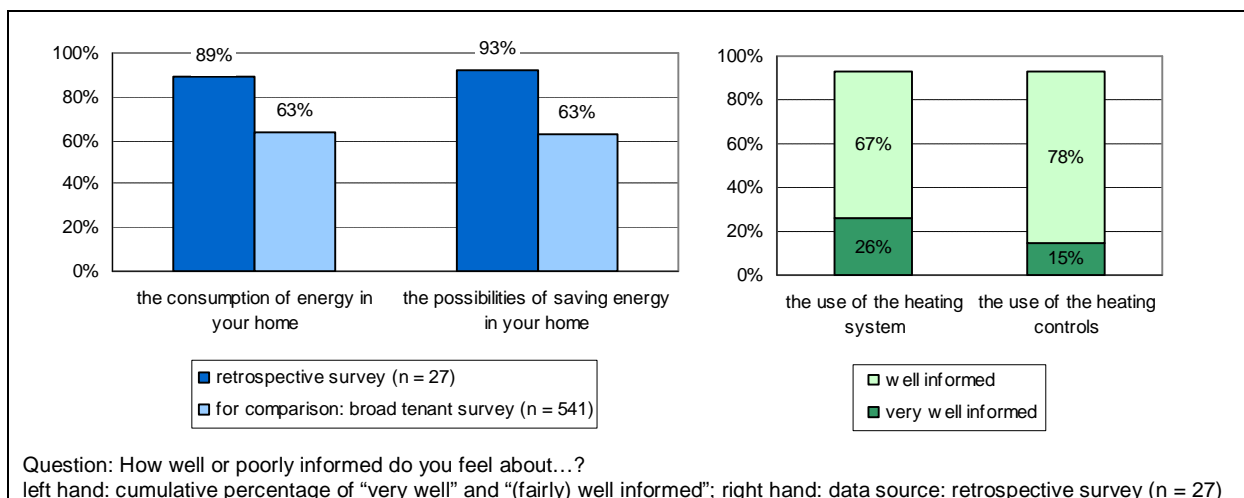


Figure 26: Information level about...

Nevertheless, in comparison to the broad tenant survey the actual behaviour patterns are very similar. Even the possibilities of saving heating energy are less common. The respondents attach more importance to power saving (Turn out the light when no one is in a room, switch off electrical appliances completely after use) and to separating the household waste.

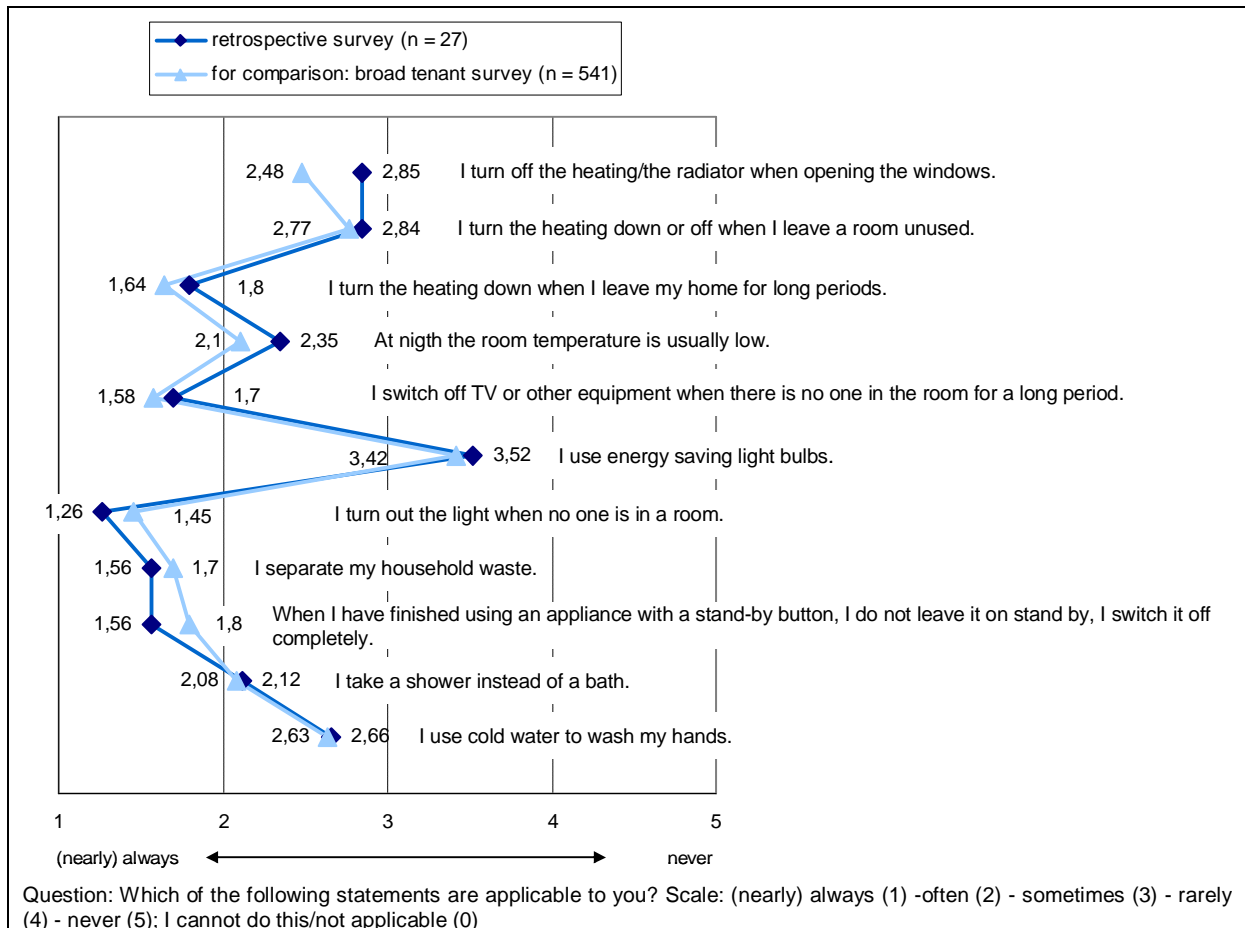


Figure 27: Behaviour pattern, mean values

The same applies to the ventilation behaviour in winter or on colder days. Independently from the usage of the several rooms more than half of the tenants in the broad tenant survey as well as the respondents of the retrospective survey specified that they usually ventilate their home by leaving the windows ajar at times. The more energy saving and healthy method of opening the windows widely sometimes is predominantly unusual.

Although all tenants affirmed that they can regulate or change the overall temperature in their home and most of them have a programmer and timer (96 %) or a room thermostat (70 %), the tenants often did not know the temperature which they approximately set their heating (44-48 %, percentages vary between several rooms). All the rest set their heating at an average of 22 degrees Celsius. The comfortable room temperatures range from 20 to 25 degrees. This finding reconfirmed the result of the broad tenant survey that old people often wanted higher room temperatures.

The effect of the programme by analysing the gas consumption

As mentioned above, the gas supplier made available the gas consumption data to analyse. The delivered data covered a total of 44 households - among them 24 households, who took part in the programme, and 20 households living in similar houses but without taking part in the programme as a control group. Figure 28 shows the anonymised mode in which the consumption data were delivered.

1	26.06.2008	1702	Actual
	07.07.2007	813	Actual
	28.06.2009	0	Actual
2	18.02.2008	629	Actual
	30.01.2007	596	Actual
	15.08.2003	0	Actual
3	24.06.2008	4422	Actual
	13.04.2005	999	Actual
4	05.06.2008	3600	Actual
	14.09.2007	2278	Actual
	07.07.2007	2081	Actual
	25.05.2007	1956	Actual
	25.05.2007	16512	Actual
	02.04.2007	16306	Actual
	16.01.2007	15796	Actual
	04.10.2006	15130	Actual
	12.06.2006	14863	Actual
5	21.03.2008	7069	Actual
	03.05.2007	5978	Actual
	01.02.2007	5541	Actual
	25.10.2005	3681	Actual

Figure 28: Billing periods of five several households (in that case data of the control group)

The data analysis was afflicted with several problems:

- For data protection reasons, the gas supplier delivered completely anonymous consumption data without any further information on household characteristics (e.g. household size). Therefore a combined analysis of the subjective survey data and the objective consumption data of the experimental group was not possible.
- Another problem became apparent because of the precondition that both experimental and control group needed to have at least two meter readings⁵ which covered similar billing periods in order to get comparable consumption figures. As can be seen from Figure 29 the provided billing data covered a broad range of various time periods. As a consequence there were no household in the control group with nearly comparable meter reading periods to the experimental group.
- Unfortunately the gas supplier also partially operated with estimated instead of actual consumption data.

				m ³ per day (mean)	kwh per day (mean)	number of days
10	05.09.2008	11174	Actual	1,54	17,7	83
	12.06.2008	11046	Actual	3,65	42,0	92
	10.03.2008	10710	Actual	5,70	65,6	88
	12.12.2007	10208	Estimate	4,17	48,0	88
	14.09.2007	9841	Actual	2,13	24,5	92
	12.06.2007	9645	Actual	4,37	50,2	90
	12.03.2007	9252	Estimate	6,23	71,7	90
	12.12.2006	8691	Estimate	4,17	48,0	82
	20.09.2006	8349	Actual			

Figure 29: Billing periods of five several households (in that case data of the experimental group)

Finally for ten households of the experimental group the changes in gas consumption⁶ could be calculated for a comparable time period in 2007 and 2008. All ten households together had savings of about 8 % after the advisory service.

⁵ before and after the implementation

⁶ actual consumption in cubic meter per day, temperature adjusted

(The degree days were taken from the website of the Oxford University (<http://www.eci.ox.ac.uk/research/energy/degreedays.php#degreedays>).

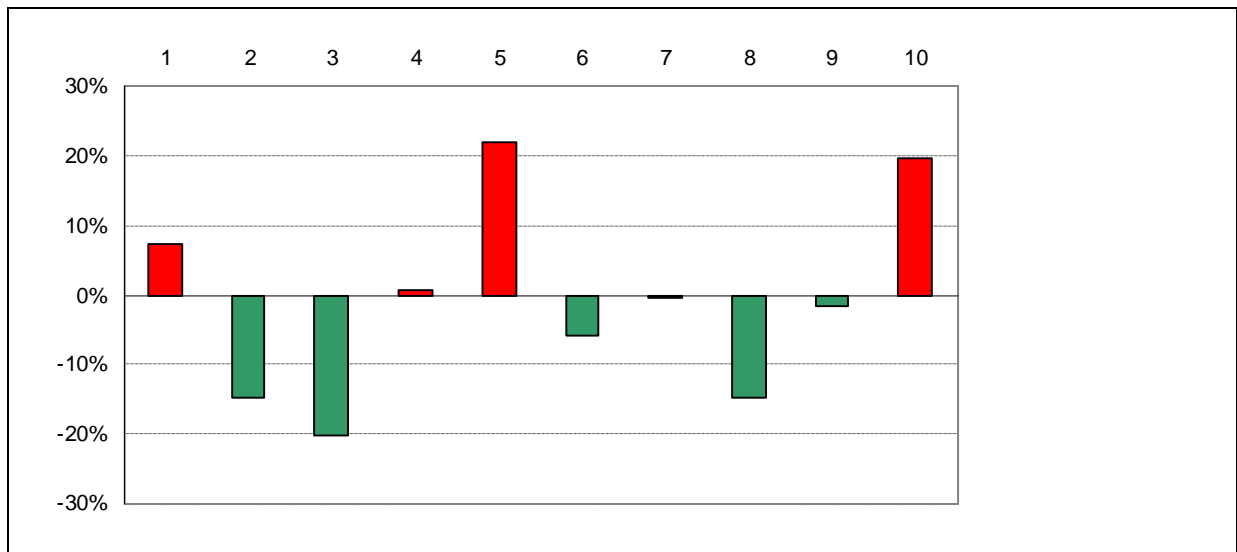


Figure 30: Gas consumption development (Decreases in green colour, increases in red colour)

In three households the consumption was nearly the same in both viewed periods. In another three households the gas consumption was higher than before (between +7 and +22 %). In four households the gas consumption was lower after the energy-related advisory service (between -6 and -20 %).

2.3 EVALUATION: NASSAUISCHE HEIMSTÄTTE

2.3.1 Evaluation of the services

During the project period, data collection of monthly consumption data was made available for 284 tenants in the period from April 2007 until June 2009. For the analysis, the heating season November 2007 until April 2008 is compared with the months November 2008 until April 2009.

Out of the group of 284 tenants, 15 tenants agreed to get personalised information with the tenant portal and/or paper based information. These tenants have been informed about their monthly consumption from February 2009 onwards and they received general information before (November 2008).

During the project period, the validation of the measured data showed in a couple of cases "no-recordings" or wrong values. The metering companies in charge explained that this was due to technical problems in transmitting the data from the meters in the dwellings to the data collectors in the basements and/or during the transfer from the collector to the data processing centre. In addition the meter itself could be the reason. This can only be changed once a year, as at this point in time the billing has to be done only on a yearly basis. In cases where the measured values seem to be wrong, the measuring company simply estimates consumption from previous periods for the billing. If the data collection could be done in shorter periods like during the project and including a validated software algorithm, these errors would be detected more quickly and could be corrected.

For these technical reasons, several dwellings needed to be excluded from the analysis. Other dwellings had a tenant change including a period of vacancy. All of these need to be excluded to get more realistic results. For the "user group" in total the consumption data of eight dwellings can be analysed and for the "control group" 188 dwellings show reasonable consumption data.

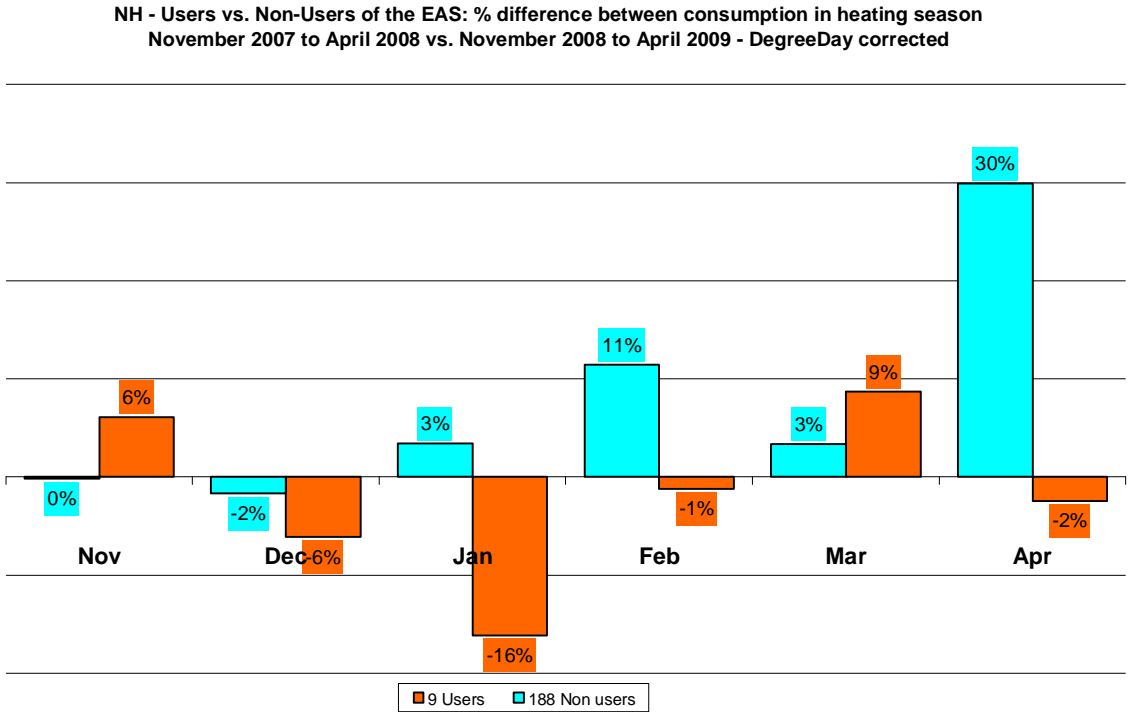


Figure 31: Consumption of service users vs. non-users

Comparing the results from the first heating season, the total change in consumption of the user group is 2% whereas the control group has no significant change. However, the chart

above shows that the user group sees a decreasing consumption in four months whereas the control group had saved energy only in December compared to the previous year.

NH - EAS users: consumption in heating season November 2007 to April 2008 vs. November 2008 to April 2009 - DegreeDay corrected

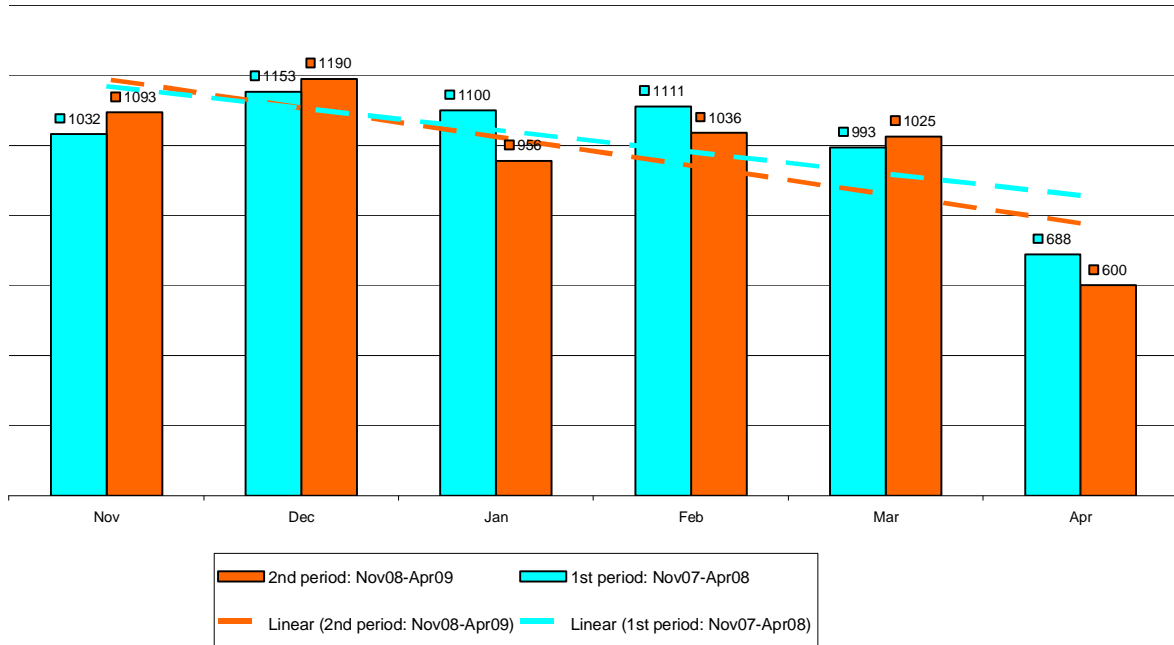


Figure 32: Consumption of Service users

Nevertheless, due to the small number of tenants in the user group, it is hard to draw overall conclusions about the efficiency of the service. Half of the tenants in the user group reduced their consumption whereas the other half increased their consumption.

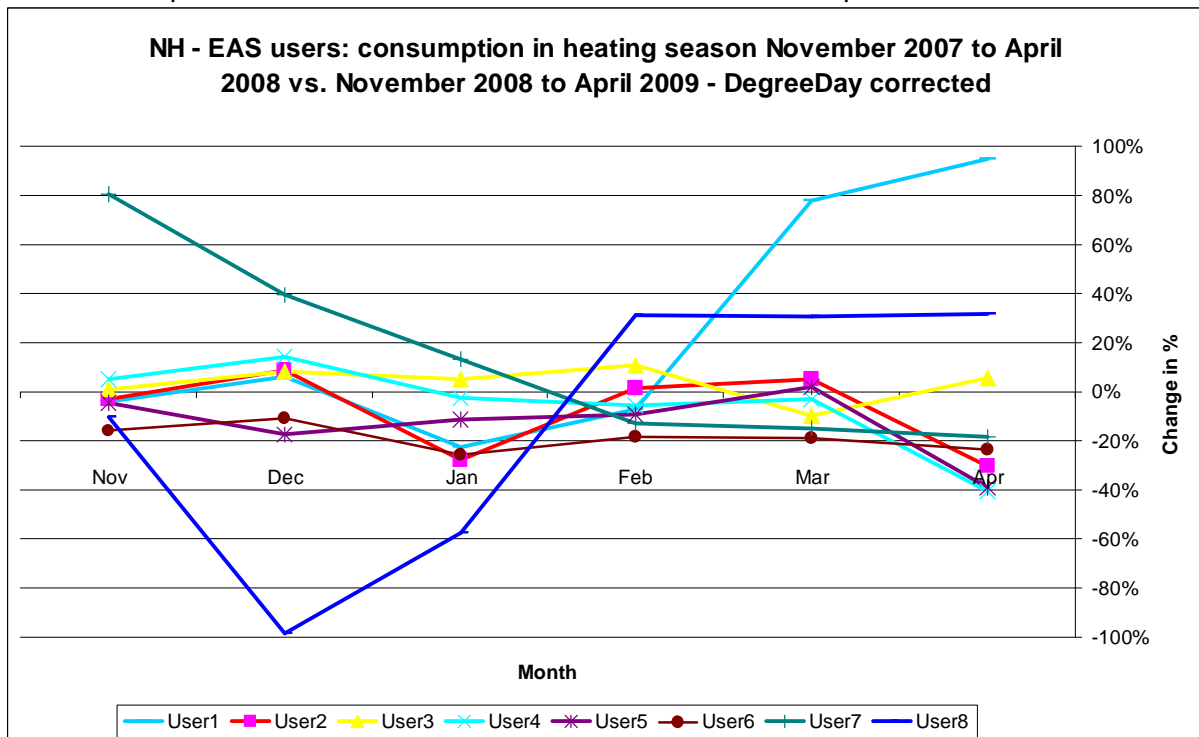


Figure 33: Detailed consumption of Service users

During the period outlined above, the users 4, 7 and 8 show high deviations up to a change of nearly 100% whereas for the other users minor changes can be seen. Analysing the data without Degree Day correction shows even higher differences up to 364% between the months of the two heating seasons. Varieties in consumption for users 3,4 and 7 might be explained by longer holiday trips, a baby being born or other life changes and not by a change in behaviour.

2.3.2 Tenant's survey

Nassauische Heimstätte carried out a longitudinal evaluation study with two survey stages - before and after the implementation of the service. Within the context of the offered service the tenants could choose from the use of a password protected tenant internet portal or a monthly delivered printout of the relevant consumption figures, which is very similar to the layout of the tenant portal.

The two stage panel took place in Stadtallendorf near Marburg in the State of Hessen where mainly people from a Turkish background live in the housing stock owned by Nassauische Heimstätte. The willingness to use the services offered was very small - with consequences for the participation in the surveys. Only a few tenants were motivated to take part. This problem could be observed at other sites too. The assumed reasons for that will be discussed in the conclusion of this report.

9 tenants took part in both stages of the panel - 2 women and 7 men, aged between 33 and 61 years. Two respondents lived alone, the rest stayed with their partners. In three households there were children. 7 of the 9 households used the monthly delivered pamphlet, one household the password protected internet portal and one household used both offers.

	Initial survey	Final survey
Survey period		Mai 2009
Initial sample		11
Final sample	11	9
Response rate		82 %
Used method		paper and pencil

Figure 34: Sizes and characteristics of the longitudinal study

Tenants mostly read the offered information carefully once a month. Three households kept the figures safe in order to compare it monthly with the previous month or to control the annual bill.

Three respondents were satisfied with the service in general, while the rest of tenants were still undecided⁷. The satisfaction with details of the offered services is shown in figure 35 Accordingly the highest tenants' satisfaction consists of the clarity and illustration of the provided data and the adequacy of the provided data.

Thinking of the provided service, all tenants now know much (2 answers) or little more (7) than before about the consumption of energy in their home. 8 tenants described the same with regard to the possibilities of saving energy in their home. Two tenants are now more interested in energy saving issues than before. The remainder's interest was the same as before the implementation of the service.

⁷ Question: How satisfied are you with the service in general? Scale: see fig. 3.2

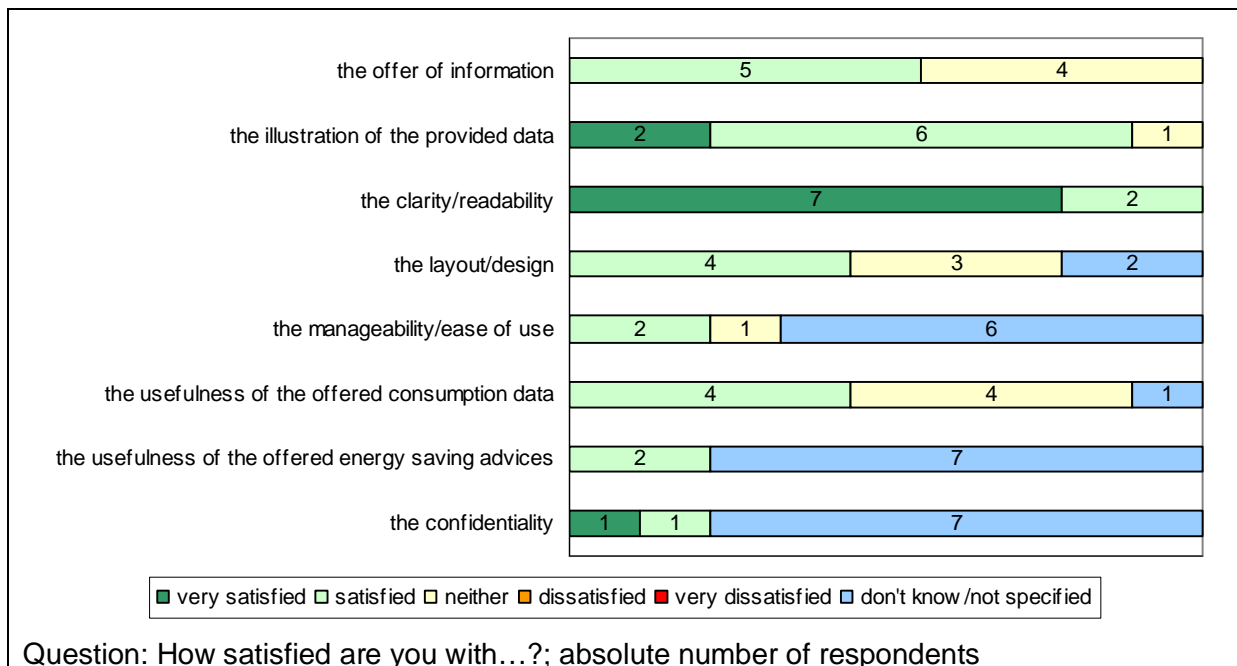


Figure 35: Satisfaction with details of the Awareness Service

The extent to which the tenants were interested in the provided data and information is presented in figure 36. Primarily the tenants are interested in tips for energy saving behaviour.

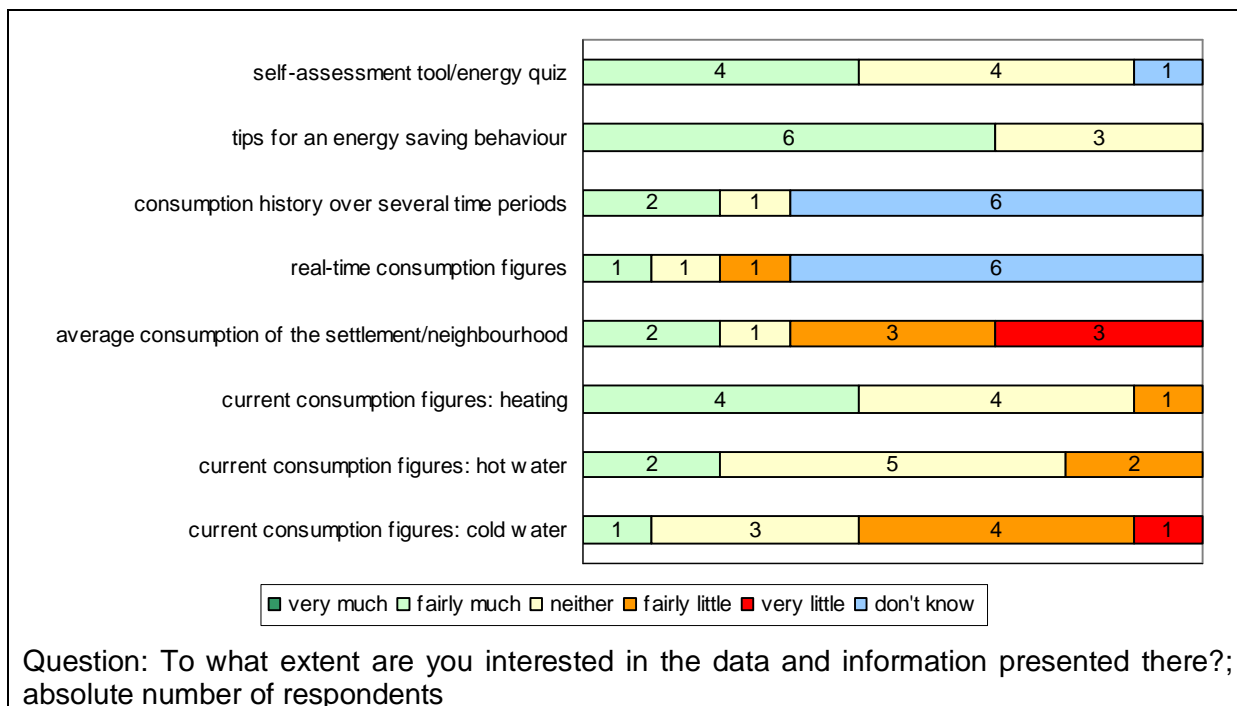


Figure 36: Interest in the data and information presented in the tenants' portal resp. printouts

In comparison to the initial tenant survey the finally metered behaviour patterns are very similar. This statement corresponds with the finding that only one tenant described changes in behaviour pattern as a result of the usage of the provided service.⁸

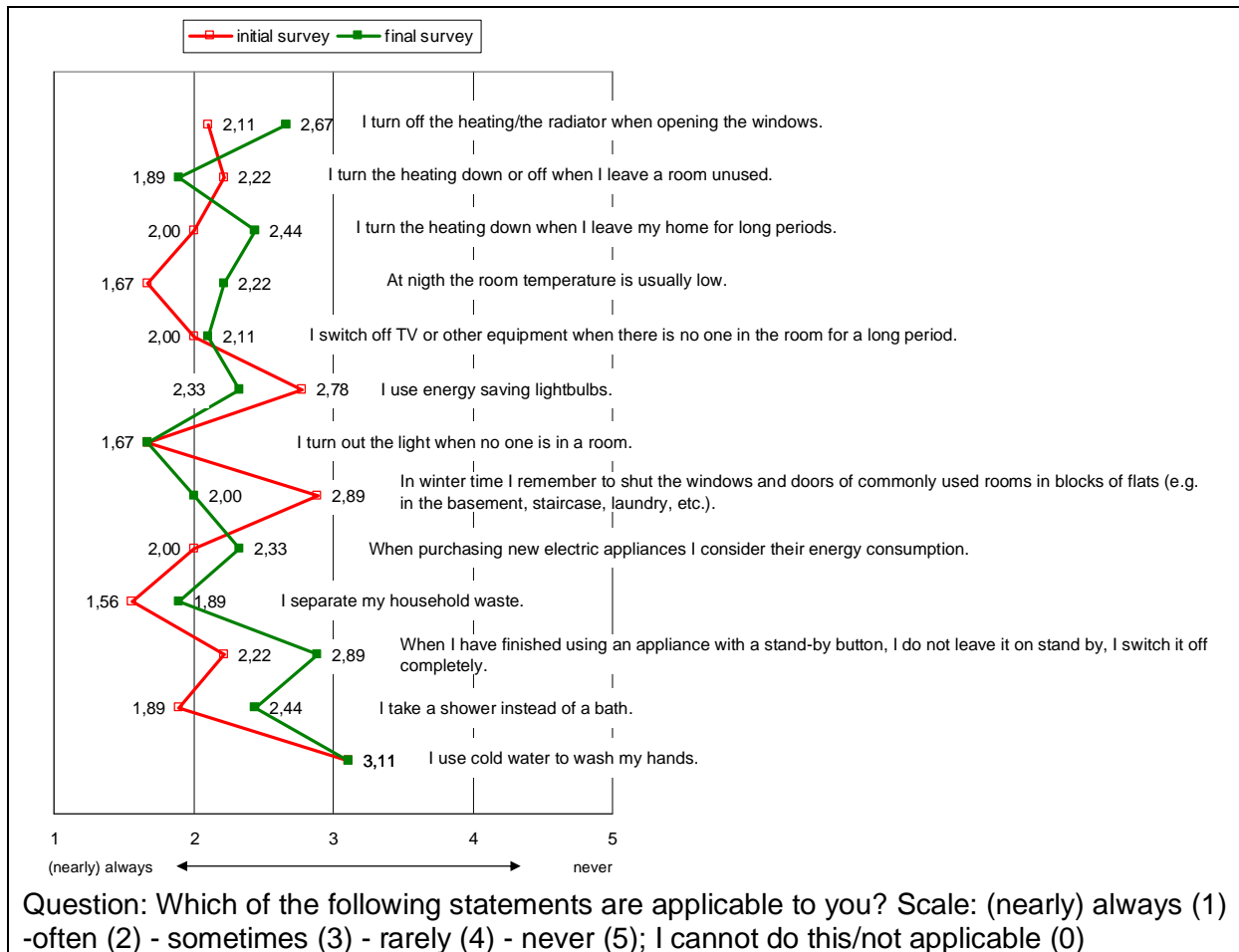


Figure 37: Behaviour pattern, mean values

Nevertheless, the reported behaviour approximately corresponds to an energy saving mode. As the mean values in figure 38 show, tenants often acted ecologically. This more conscious behaviour tenants have learnt during the two panel stages as some further findings show:

- Especially the ventilation behaviour changed: Now all nine respondent tenants ventilate their living room in winter time or on colder days by opening the windows widely at times. For comparison, in the initial survey six households described that they leave the windows ajar at times or at all times. Today only one household usually ventilates the bedroom, kitchen and bathroom by leaving the windows ajar often or all the times.⁹
- In winter time tenants had, in little used rooms, lower room temperatures than in much used rooms.
- In little used or unused rooms the tenants had an average room temperature of 18 °C (range from 15 to 20 °C). In much used rooms mostly 21 °C (range from 20 to 22 °C)

⁸ Question: Did you change any of these behaviour patterns as a result of your usage of the provided service? Possible answers: Yes – no – don't know.

Following open question: If yes, which behaviour pattern did you change?

⁹ Question: How do you usually ventilate your home in winter time or on colder days? (classification into several room types)

could be metered.¹⁰ For seven respondents it was easy to regulate the room temperature.¹¹

- In addition to that, more respondents reported that they feel better informed about the possibilities of saving energy and the consumption of energy in their flats.

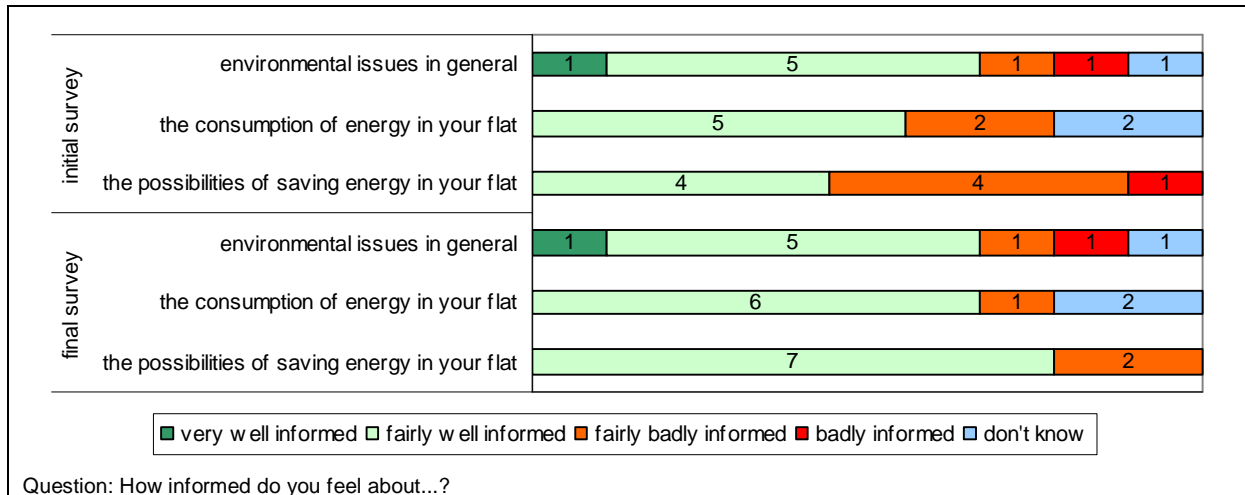


Figure 38: Information about environmental issues, initial and final survey in comparison

¹⁰ Question: Which room temperature does your home has in winter? (classification into much used and little used/unused rooms)

¹¹ Question: It is easy for you to regulate the room temperature? Yes – no – don't know.

2.4 EVALUATION: STADT UND LAND

2.4.1 Evaluation of the services

102 tenants in two different buildings are equipped with a radio metering system – which is the precondition for participation in the project. All of them were contacted to participate in the test and 13 decided to do so. Thereafter, six tenants decided to receive the information by letter and seven via the new tenant internet portal.

It is not easy to explain why only a few tenants participated in the trial as it was an additional cost-free service and we even gave small presents as an incentive to participants. The survey that we conducted at the beginning of the project among the tenants showed a high interest in environmental issues in general and detailed information on energy consumption in particular.

On the other hand we registered an increased interest compared to the previous heating period (release 1) when only one tenant was willing to use an earlier version of the tenant portal. This increase was due to the option of a paper version for tenants without internet access, a better communication of the service and the high energy prices at the moment of the introduction.

For a further increase of the number of participants, continuous communication with the tenants seems to be the most promising method. But there are limits defined by the socio-economic structure of the tenants. In any case, the assumption that younger and better educated tenants would participate more - as one would suppose - cannot be proved as the two buildings are the only ones where this test is technically possible.

As for the usage, there is quantitative data available only for the seven participants who chose to use the internet portal. Analysing the connection statistics we realized that only three of them really used the portal. The other four did not connect at all, despite having received all the necessary information by letter and some reminders by email (in three of four cases).

Tenant	Connection	Date	Time (min)	Heating	Water	Benchmarking	Energy Quiz	Others
Tenant 1	1	28/01/2009	44	x	x	x	x	x
	2	04/02/2009	1	x				
	3	27/02/2009	4	x	x	x		
	4	02/04/2009	1	x				
	5	04/05/2009	6	x	x	x	x	x
	6	19/05/2009	19	x	x	x	x	x
Tenant 2	1	27/01/2009	8	x	x	x	x	x
	2	28/01/2009	7	x				x
	3	29/01/2009	3	x	x			x
	4	30/01/2009	1	x				x
	5	31/01/2009	8	x	x			x
	6	05/02/2009	1	x				
	7	22/02/2009	1	x				
	8	26/02/2009	1	x				
	9	28/02/2009	1					
	10	29/03/2009	1	x				
	11	02/04/2009	1					
	12	28/04/2009	2					x
	13	16/05/2009	5	x	x			x
Tenant 3	1	03/02/2009	32	x	x			x
	2	03/02/2009	5	x	x			
	3	26/02/2009	16	x	x	x	x	x
				19	11	6	5	12

Figure 39: Service users

In their usage the three participants focussed basically on the simple presentation of their consumption data (heating as well as hot and cold water). The benchmarking tool, which was developed in this project to set the heating consumption data in relation to the outside temperature and prior consumption patterns, did not get quite as much attention. The third important component of the tenant portal - the self assessment tool - was mostly ignored by

the tenants. Only one tenant took the survey completely. The other tenants hit the page as well but stayed there so little time that it was impossible to complete the survey. When evaluating the data we compare the consumption in the test phase with the consumption of the year before. The heating consumption data is qualified with degree days. In one case the participant is a new tenant and therefore there is no prior year's data to compare with. So we just evaluated the results of the other twelve participants. The services developed in this project aim at a change of the tenant's energy consumption behaviour. But there are other parameters that influence the energy consumption, too, such as the climate and the tenant's life style. While the outside temperature can be measured easily we do not know if a tenant spends more time at home - i.e. because of an illness - if he goes on a long vacation or if there are visitors. These incidents might have an even stronger effect on energy consumption than a change in behaviour. But this can be neglected if the sample is big enough so that particular incidents even out. But having only 12 results from our participants, this is not the case. So we have to be careful when analysing the data and apply common sense.

	Version	Connections	Warm Water	Cold Water	Heating
Tenant 1	Internet	6	----- <i>New tenant</i> -----		
Tenant 2	Internet	13	-	-	-54,64%
Tenant 3	Internet	3	15,56%	3,97%	-19,76%
Tenant 4	Internet	0	-10,32%	-2,74%	-10,00%
Tenant 5	Internet	0	-13,50%	-17,66%	-11,03%
Tenant 6	Internet	0	120,69%	38,49%	-38,30%
Tenant 7	Internet	0	-	-	-20,63%
Tenant 8	Paper		-4,52%	-14,46%	352,23%
Tenant 9	Paper		-21,38%	-22,06%	27,87%
Tenant 10	Paper		-17,36%	-33,49%	2,37%
Tenant 11	Paper		30,32%	45,09%	168,64%
Tenant 12	Paper		-18,60%	-21,34%	-4,27%
Tenant 13	Paper		-	-	-75,41%
Total			-4,17%	-7,85%	-9,31%
Control Group			-4,77%	?	-8,24%

Figure 40: Service users by version used

Heating

As can be seen in the chart above, the heating consumption behaviour of the participants is slightly better than of the control group which consists of the 82 tenants of the same two buildings who did not subscribe to the service. The figures even get a little better when we take out the two highest and two lowest values in order to eliminate the extremes of tenant 8 and 11.

Nevertheless, due to the small number of participants and the little differences to the control group we cannot statistically prove the efficiency of our service. In the case of warm water consumption the figures of our participants are even slightly worse than the ones of the control group.

One positive result of this evaluation is the improvement of the heating consumption of our active tenant portal users. Also 1 resident is a new tenant who has no previous history of the project but shows very low consumption figures.

Cold Water

The interpretation of the results can be improved by rejecting the incoherent data. In the case of cold water consumption, the 2 initial group of 81 and 9 tenants have been reduce to 65 and 7 tenants. Indeed, an important change of consumption is not related to the EAS but due to a change in the composition of the family or to an absence (hospital, holidays...).

The same criterion has been applied to the two samples: deletion of tenants who changed more than 25% (+ or -) their consumption between the first and second year.

Assessment:

- The users group consumed 18% less than the control group during the first year.
- The users group consumed 23% less than the control group during the second year.
- The non users group has saved 0.5% between the 2 years (Fig II.4.1.3)
- The users group has saved 7.0% between the 2 years (Fig II.4.1.4).
- The users group has saved 6.5% more than the non users group between the 2 years.

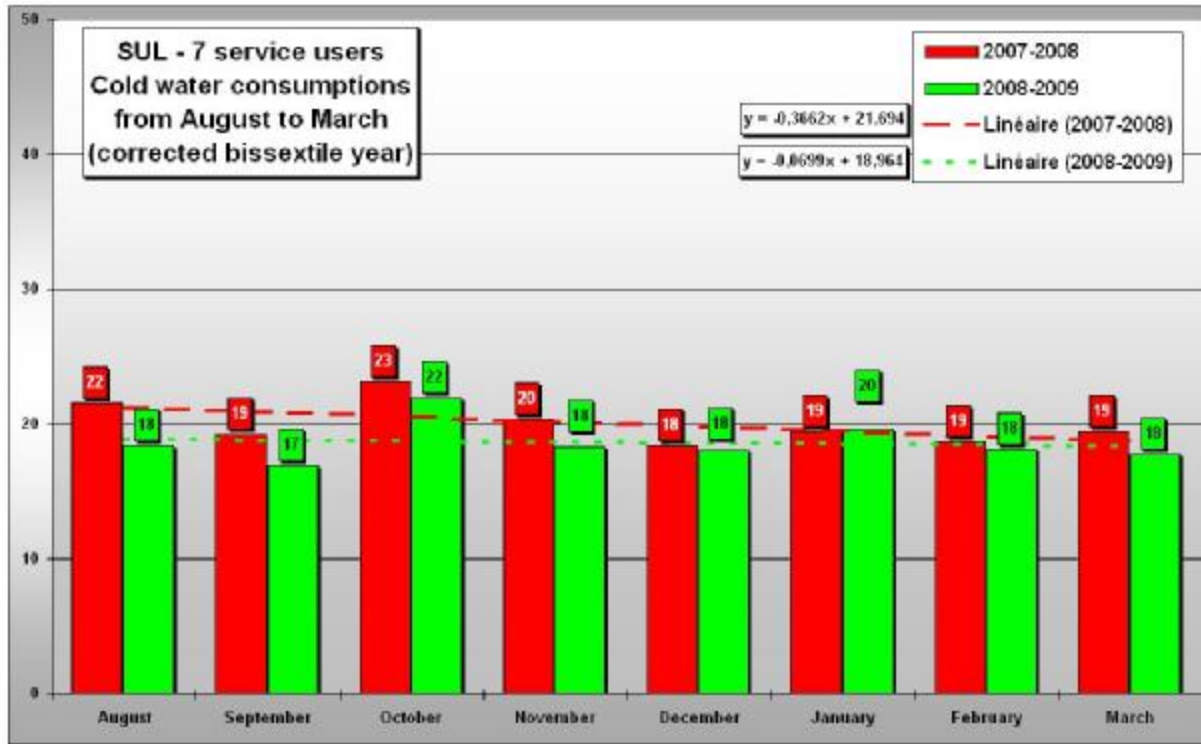


Figure 41: Cold Water consumptions of the users

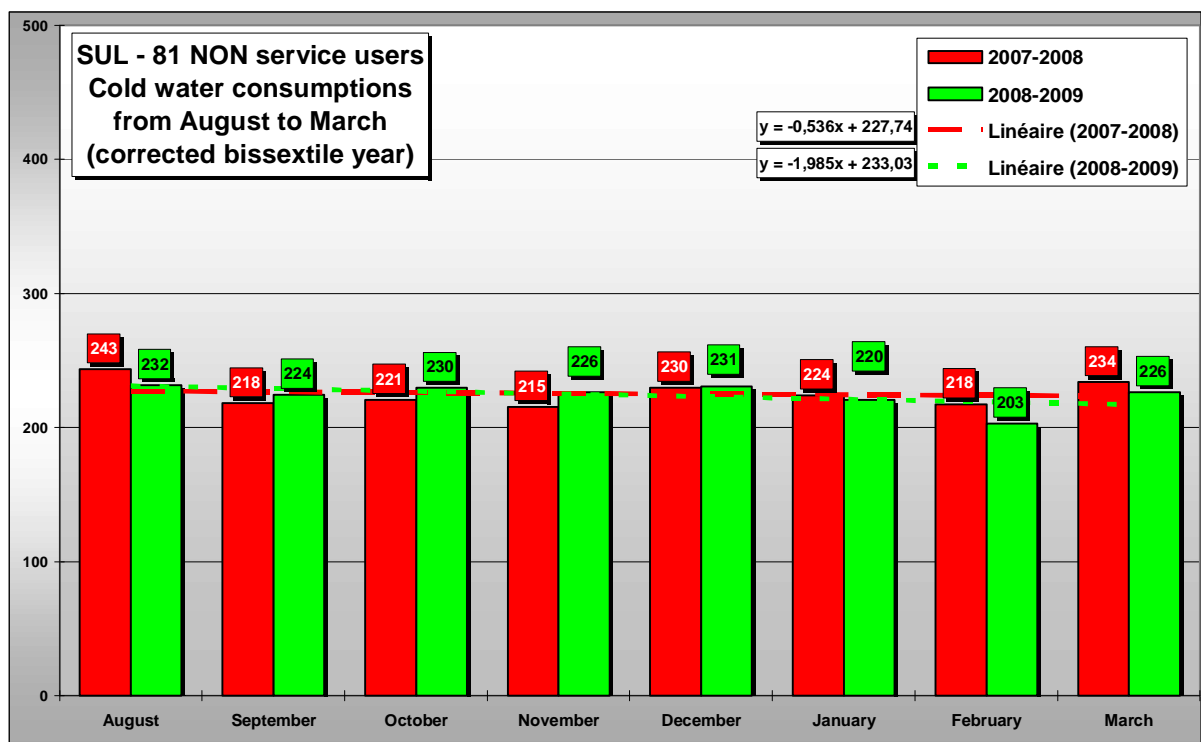


Figure 42: Cold Water consumptions of the non users

2.4.2 Tenant's survey

The Stadt und Land evaluation approach is very similar to the Frankfurt approach. SuL also carried out a longitudinal evaluation study with two survey stages - before and after the implementation of the service. Tenants could also choose from the usage of a password protected tenant internet portal or a monthly delivered printout of the relevant consumption figures, which is very similar to the layout of the tenant portal. The participation was also very low. In contrast to the Frankfurt approach in Berlin a control group design was set up.

Survey results: longitudinal comparison

In total 8 tenants took part in the final survey, but only five of these households already participated in the initial survey of the two stage panel. The average age of these two women and three men was 44 years. One of these five households used the tenant internet portal. The rest preferred the brochure.

	Initial survey	Final survey	
	Experimental group	Experimental group	control group
Survey period	January 2009	May 2009	June 2009
Initial sample	13	7	84
Final sample	7	5 (+3)*	13
Response rate	54 %	71 %	16 %
Used method	paper and pencil	paper and pencil	paper and pencil

Figure 43: Sizes and characteristics of the longitudinal study

* The final survey included three tenants who didn't take part in the initial survey.

The tenants read the information offered once a month. Two households kept the monthly pamphlets in order to control the annual bill. Four of five respondents were (very) satisfied with the service in general. The details are shown in figure 44.

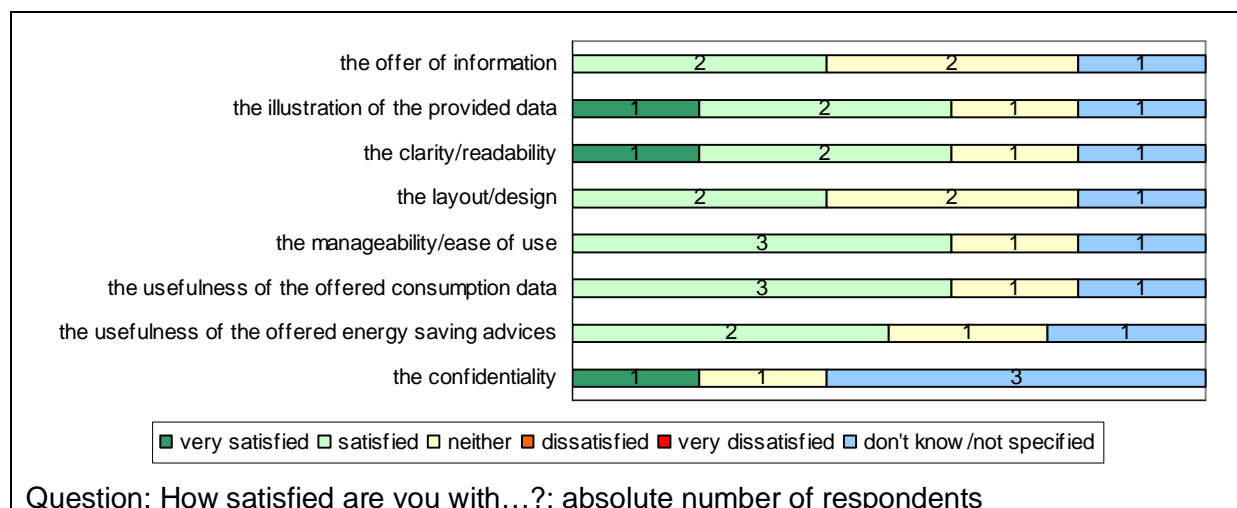


Figure 44: Satisfaction with details of the Awareness Service

Based on the provided service three tenants now know more about the consumption of energy and the possibilities of saving energy in their homes. One tenant is now more interested in energy saving issues than before.

To what extent the tenants were interested in the provided data and information is presented in figure 45. Primarily the tenants are interested in tips for energy saving behaviour and the current consumption figures of domestic hot water and heating.

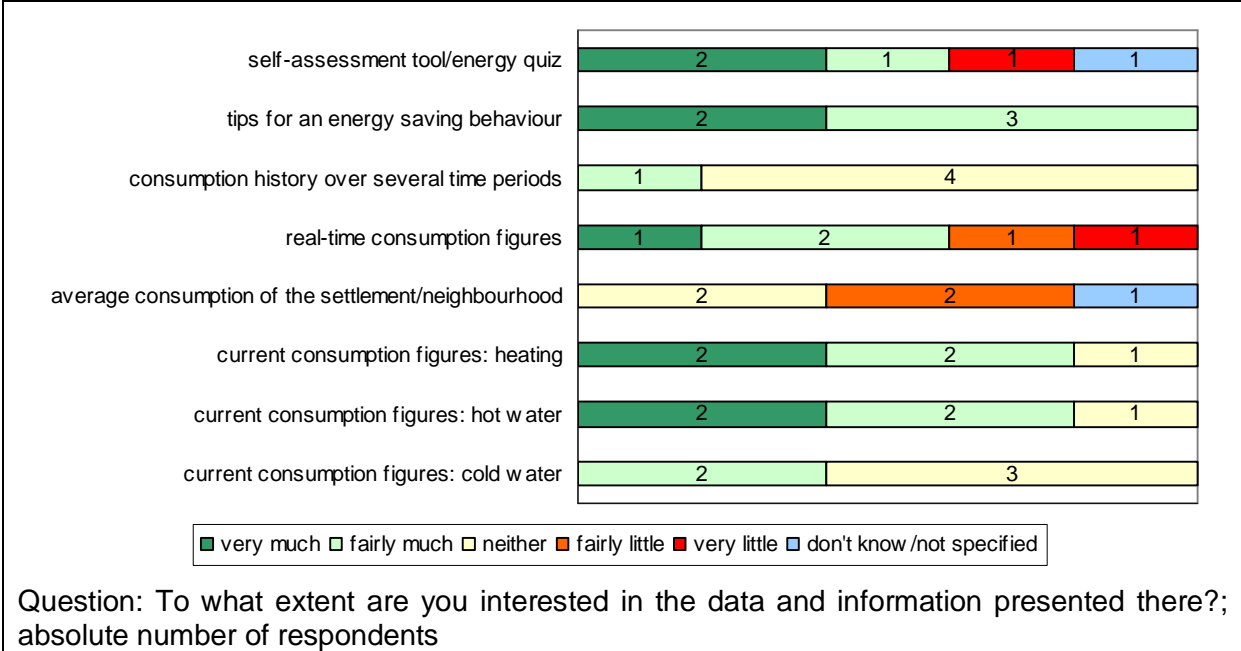


Figure 45: Interest in the data and information presented in the tenants’ portal resp. printouts

The behaviour patterns - as shown in figure 46 - are close to ecologically oriented consumption behaviour. Apart from two cases concerning the heating behaviour which clearly developed in a worse way, the everyday behaviour changed in a positive way. In particular the consumption of electricity and hot water is now more important. Furthermore the ventilation behaviour is exemplary. Four from five tenants ventilate their living room in winter time or on colder days by opening the windows widely at times. This finding could already be observed in the initial survey. In relation to the living room, the bedroom, the kitchen or the bathroom nobody leaves the windows ajar often or all the times now.

In winter times tenants have lower room temperatures in little used rooms than in much used rooms. The average room temperature in little used or unused rooms was 18 °C, in much used rooms 21 °C. Nevertheless, broad temperature ranges could be observed – in much used rooms temperatures between 18 and 25 °C, in little used rooms from 15 till 20 °C.

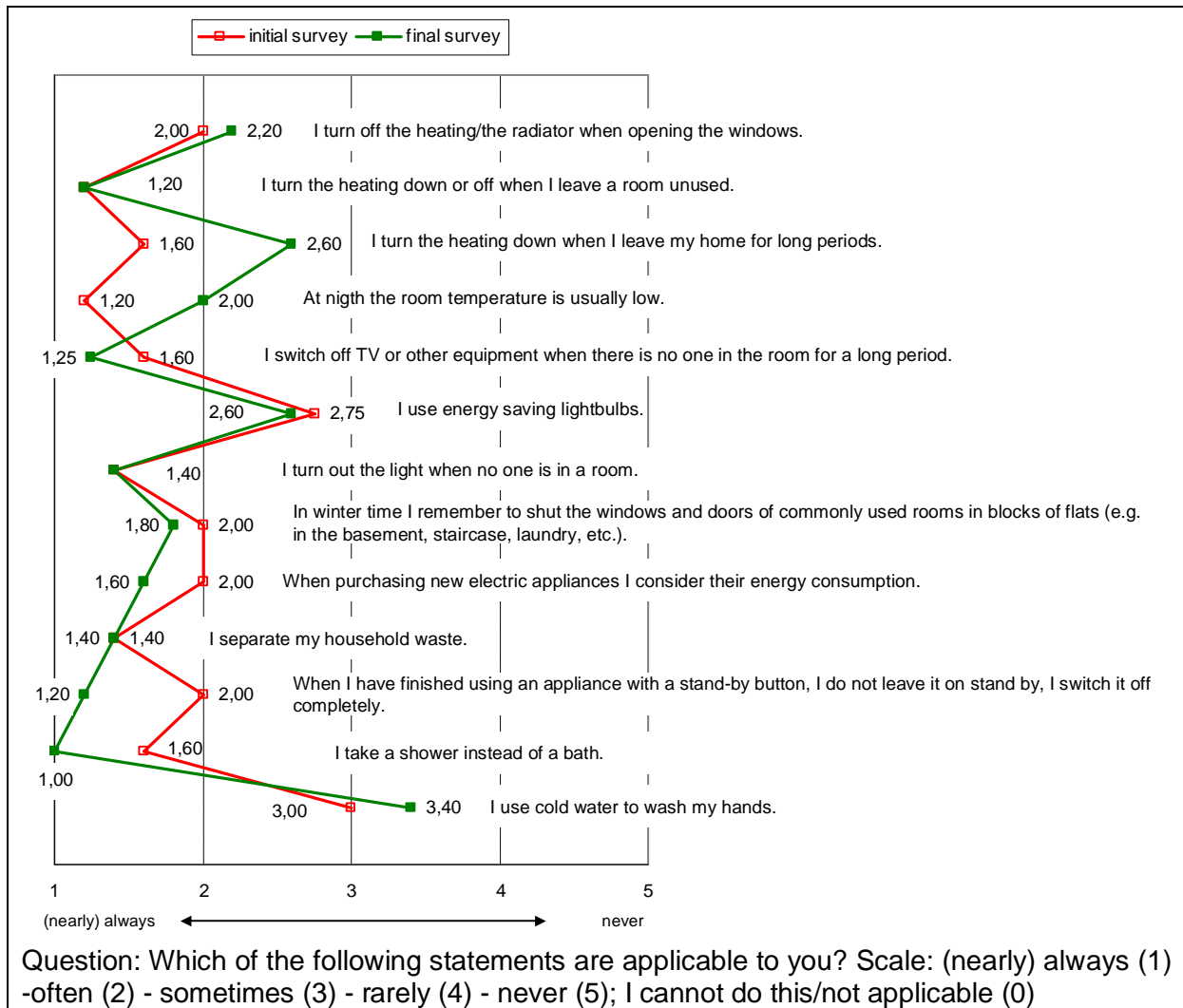


Figure 46: Behaviour pattern, mean values

With regard to the knowledge about the consumption of energy and the possibilities of saving energy in their flats, tenants were better informed after the implementation of the service.

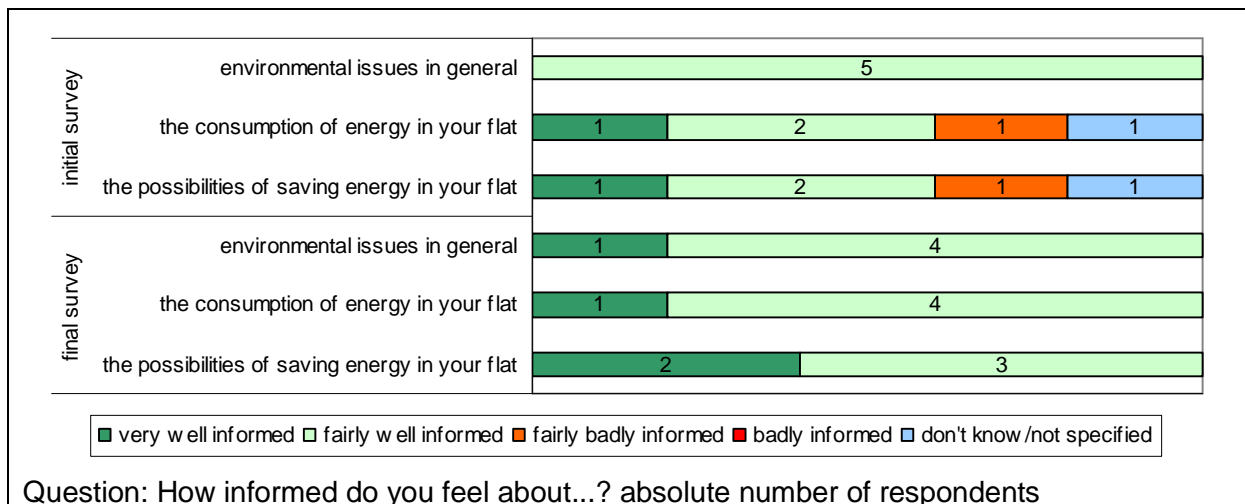


Figure 47: Information about environmental issues, initial and final survey in comparison

Comparing the years 2008 and 2009 the consumption of heating decreased in two cases by 10 and 11 percent. One households' consumption nearly stayed the same (+ 2 %). One

household is an exception with a strong heating consumption increase of 168 % which seems to be a metering error or the like. For the fifth tenant involved, no comparative values were available because he/she only moved into the dwelling in 2009.

Noticeable characteristics which can explain those differences could not be observed or analysed by quantitative methods.

Survey results: comparison of experimental and control group

The following data analysis includes these eight tenants with access to the Stadt und Land awareness service (experimental group) and thirteen households without any information for the purpose of such services (control group). The control group solely was informed about the existence of a password protected internet portal in the tenants' newspaper and in a letter from the housing provider. The following table (Figure 48) contains some socio-demographic characteristics known from both groups. Some differences are obvious: The participants in the experimental group are noticeably younger and have relatively more often a permanent access to the internet at home and a private access to a computer. In general the tenants in both groups live on low income levels.

	Experimental group	Control group
Gender	3 men, 5 women	8 men, 5 women
Average age	45,2 years	64,5 years
Household size/household type	mostly single-person households, one household with children	mostly single-person households, no household with children
Access to internet	5 respondents with permanent access to internet at home	4 respondents with permanent access to internet at home
Access to a computer	6 respondents with private access	4 respondents with private access

Figure 48: Selective socio-demographic characteristics of the experimental and the control group

The tenants in both groups described themselves as being quite or somewhat aware of environmental issues.¹² Predominantly both groups felt fairly well informed about such topics in general. Concerning the consumption of energy and the possibilities of saving energy in their flat the tenants of the control group more often assessed themselves as being very well informed. The experimental group in both cases appeared a little less informed (see figure 49).

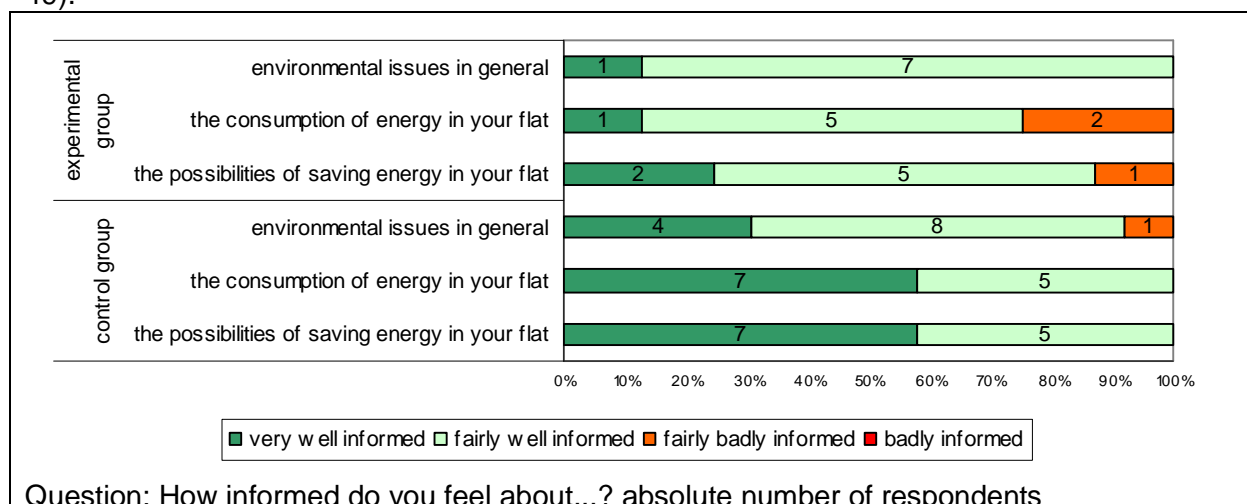


Figure 49: Information about environmental issues, experimental and control group in comparison

¹² To what extent would you describe yourself as being aware of environmental issues? Scale: very much aware - quite aware - somewhat aware - not very aware - not at all aware

Laying the focus on concrete consumption behaviour patterns the following results are of interest:

- In winter times all tenants in little used rooms have lower room temperatures than in much used rooms. The tenants of the experimental group have an average temperature in little used or unused rooms of 17,4 °C, the tenants of the control group of 18,5 °C. The reported room temperatures in much used rooms are very similar in both groups - about 21 °C. Tenants mostly feel comfortable with the temperature in their flats.
- The ventilation behaviour of the experimental group is ideal. The living room, the bedroom and the kitchen are predominantly ventilated by opening the windows widely at times. In the bathrooms they more often leave the windows ajar at times. Only in two cases did they leave the windows ajar often or all the times. Within the control group¹³ such cases were reported more often - especially concerning the living room.
- As shown in figure 50 the tenants of the experimental group act more positively on heating issues. They always or often turn off the heating/radiator when opening the windows or when they leave a room unused. The last mentioned aspect explains the above mentioned lower average temperature of the experimental group in little used or unused rooms.
- In addition, the experimental group more often pay attention to switching off the TV or other appliances when there is no one in the room for a long period. The same applies to completely switching off when the tenants have finished using an appliance with a stand-by button.
- Furthermore the experimental group attach more importance to the proper separating of the household waste.
- Concerning the consumption of hot and cold water the control group acts slightly more ecologically - except with regard to the use of washing machines or dishwashers where both groups act exemplarily.
- In terms of the remaining everyday behaviour patterns, shown in figure 50, the statements of both experimental group and control group are very similar.

¹³ Compared are the statements of 9 tenants only who do not have a ventilation system.

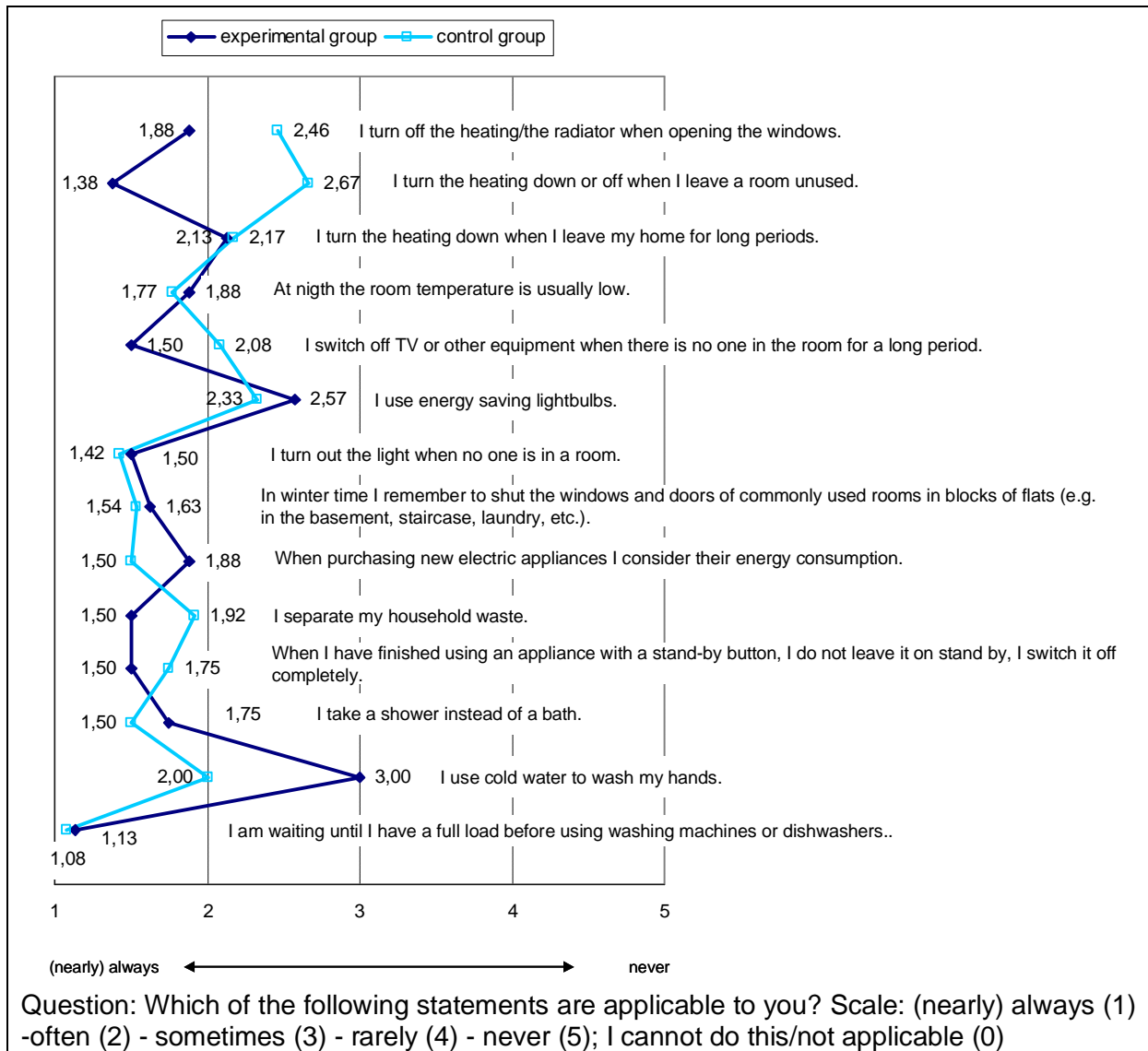


Figure 50: Behaviour pattern, mean values

2.5 EVALUATION: MOULINS HABITAT

2.5.1 Evaluation of the services

For the record, the project of Moulins Habitat aimed to offer tenants a tool to examine follow-their water and energy consumptions. With the timeframe of the project SAVE@Work4Homes and on the basis of the answers obtained during the first survey, it was decided to limit the experiment to 80 flats distributed on Moulins-South and the down-town of Moulins.

Although the Internet portal and the follow-up of water consumptions are operational, it is today impossible to estimate the results obtained thanks to the implementation and to the deployment of this service. Indeed, Moulins Habitat met numerous difficulties throughout the progress of the project, the difficulties having caused such a delay such that a relevant evaluation of consumption data is not possible (cf. D5.1 for further descriptions).

2.5.2 Tenant's survey

Moulins Habitat originally also planned an evaluation approach which included a longitudinal study. Because of contracting problems with the energy provider, metering and data protection difficulties, the landlord was not able to carry out the final survey before the end of the project. Based on an initial survey only, a comprehensive evaluation of the tenants' acceptance concerning the offered services is not possible. Therefore the following results focus the requirement to save energy by using a tenant portal. Partially the findings will be compared with the broad tenant survey (WP 2) which was completed at the beginning of the project.

Survey results

In total 23 tenants - living in the residential areas Nomazy, llot Thonier, City Centre and Champmilan - participated in the initial survey, among them 13 women and 10 men.

	Broad tenant survey (WP 2)	Initial survey
Survey period	March-April 2007	July 2008
Initial sample	2.000	80
Final sample	348	23
Response rate	17 %	29 %
Used method	paper and pencil	paper and pencil

Figure 51: Sample size of the initial survey in comparison to the broad tenant survey in 2007

Most respondents were between 30 and 60 years old, the biggest group were the 51- to 60-year-olds (31 %). The tenants mostly lived in single-person-households. In three of the three-person households there were five children up to 17 years old. The predominant sources of income were pensions (44 %) and income from employment or self employment (39 %). Nearly 70 % of the interviewed persons had a net household income up to 1.300 Euro.

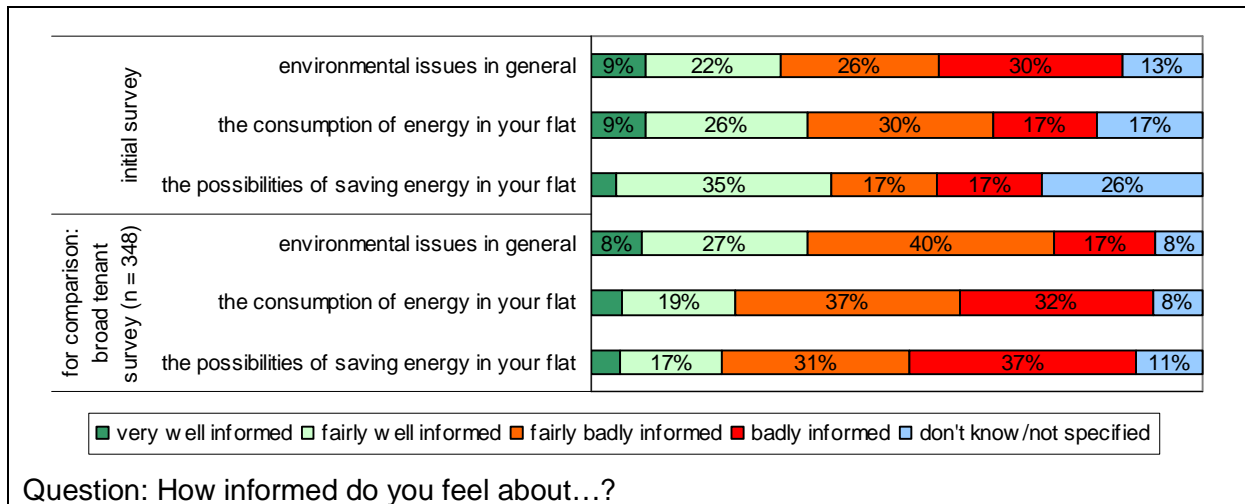


Figure 52: Information level about

The tenant's information about environmental issues in general, the consumption of energy and the possibilities of saving energy in the flat is on a relatively low level. This finding already could be observed in the broad tenant survey in 2007. Two thirds of tenants thought that today their energy consumption is high (43 %) or very high (22 %). One third assessed it as medium.

Nevertheless, with regards to the consumption behaviour of hot and cold water and electricity (except the usage of energy saving light bulbs) most respondents acted environmentally aware (see figure 53). An energy saving potential could be found in the reported heating behaviour. The tenants only sometimes turn the heating down or off when leaving a room unused, opening the windows or leaving the home for a longer period. However, referring to the heating behaviour it must be added that one third of the tenants cannot regulate the heating by themselves.

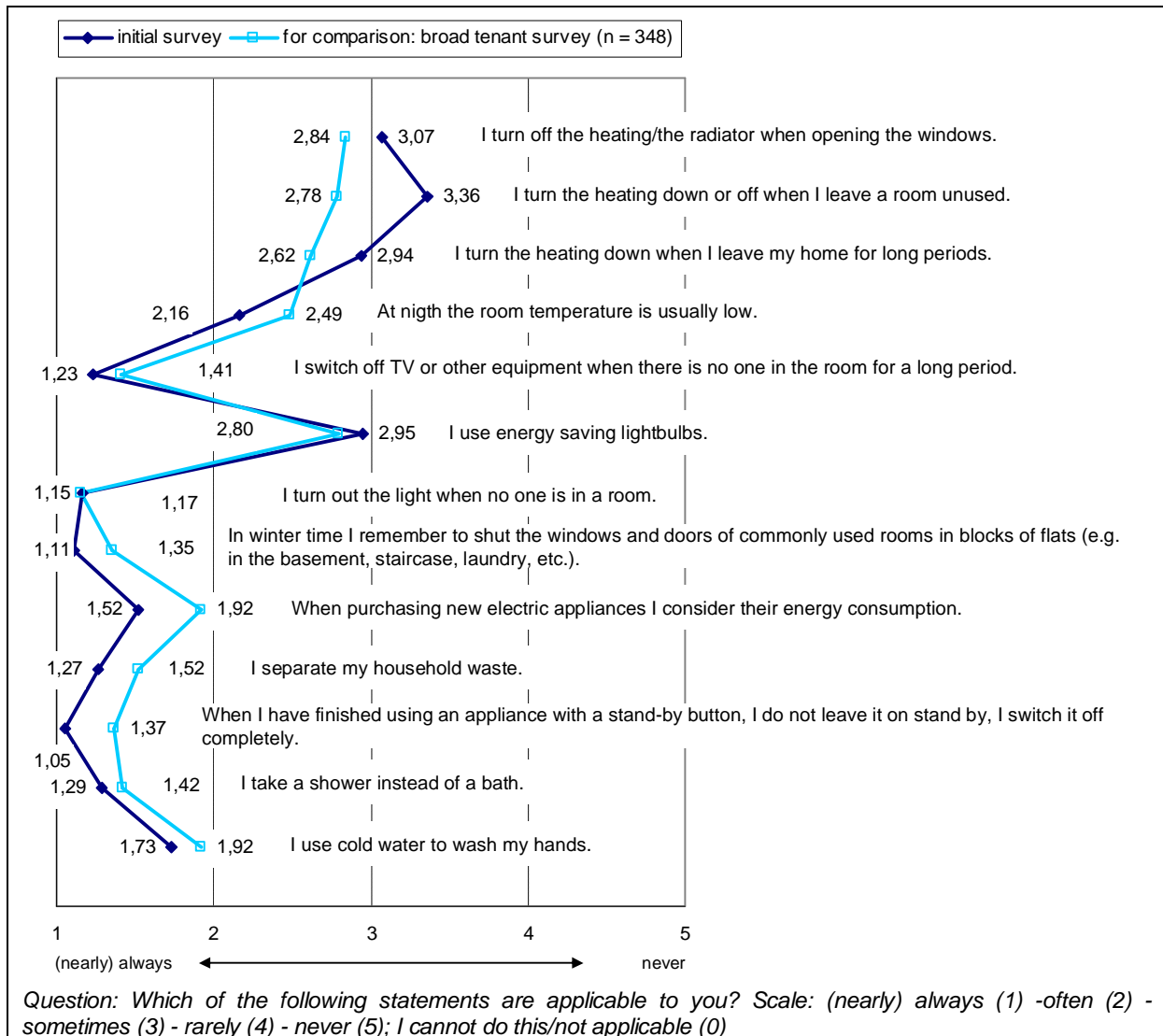


Figure 53: Behaviour pattern, mean values

65 % of the tenants have a room temperature of 19 to 20 °C in their homes in winter. 43 % did not feel comfortable with it - they would like to have higher room temperatures.

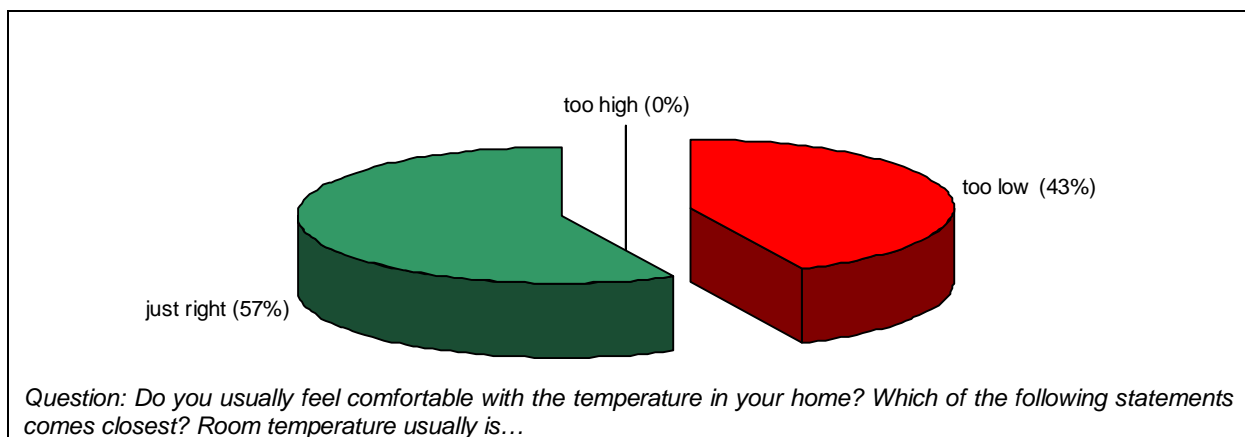


Figure 54: Satisfaction with the room temperature

Most tenants (83 %) were interested in an overview of their current heating and energy consumption and in advice on the best energy saving possibilities. A problem arose with the

technical equipment: Many tenants did not have any access to internet (48 %) or to private computers or notebooks (57 %).

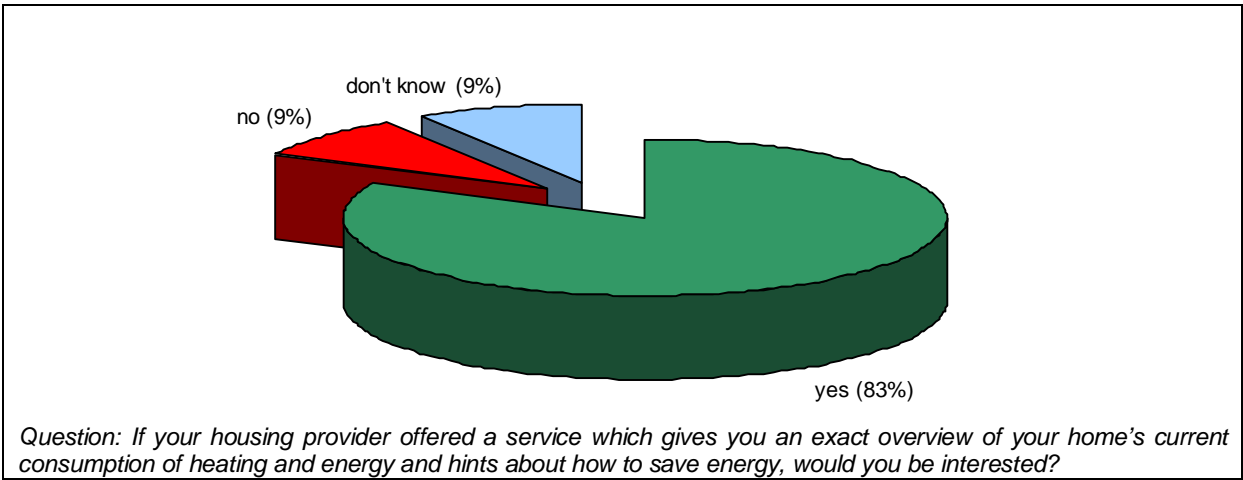


Figure 55: Interest in energy advice

2.6 EVALUATION: LE TOIT ANGEVIN

The Le Toit Angevin evaluation's approach is based on the comparison of portal's user group with a control group which has the same type of flat and number of tenants as the first one. This analysis is developed by a double input: the data analysis and the survey analysis.

2.6.1 Evaluation of the services:

Thanks to the list of flat connected to the portal during a month, it had been possible to isolate the tenants using the portal. There are 10 tenants in April 2009 for 94 connections; consequently they are using the portal an average of 10 times a month.

Civilité	Nom	Prénom	Adresse	Ville	Code postal	Date de connexion
mr	mouget	norbert	4 rue marc sangnier	angers	49000	2009-04-09 12:47:59
mr	mouget	norbert	4 rue marc sangnier	angers	49000	2009-04-09 12:49:51
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-09 14:06:08
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-09 14:06:12
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-09 14:06:28
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-09 14:06:30
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-09 14:13:28
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-09 14:24:05
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-09 15:23:15
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-10 08:55:09
mr	mouget	norbert	4 rue marc sangnier	angers	49000	2009-04-10 08:59:34
mr	bucheron	didier	2 square mont cassin	angers	49000	2009-04-10 14:52:52
mr	bucheron	didier	2 square mont cassin	angers	49000	2009-04-10 14:54:34
mr	alaidine	ali	59 rue marechal juin	angers	49000	2009-04-11 12:08:54
mr	alaidine	ali	59 rue marechal juin	angers	49000	2009-04-11 12:12:59
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-11 14:53:57
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-11 14:54:17
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-11 14:56:18
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-14 14:08:27
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-15 09:13:19
mr	bugeon	didier	59 rue marechal juin	angers	49000	2009-04-15 11:15:11
mr	paumier	sandra	1 square mont cassin	angers	49000	2009-04-15 12:54:06
mr	paumier	sandra	1 square mont cassin	angers	49000	2009-04-15 12:54:23
mr	paumier	sandra	1 square mont cassin	angers	49000	2009-04-15 13:03:39
mr	paumier	sandra	1 square mont cassin	angers	49000	2009-04-15 13:03:45
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-15 14:03:50
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-15 14:04:38
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-15 14:10:34
mr	bugeon	didier	59 rue marechal juin	angers	49000	2009-04-15 14:16:53
mr	bugeon	didier	59 rue marechal juin	angers	49000	2009-04-15 14:32:15
mr	bugeon	didier	59 rue marechal juin	angers	49000	2009-04-15 15:38:01
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-15 15:55:48
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-15 16:31:02
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-16 08:47:11
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 10:13:13
mr	bugeon	didier	59 rue marechal juin	angers	49000	2009-04-16 10:46:59
mr	bugeon	didier	59 rue marechal juin	angers	49000	2009-04-16 10:47:37
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-16 14:24:00
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 14:24:45
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 14:32:22
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 14:34:40
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-16 14:48:35
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-16 15:05:19
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 15:13:11
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 15:15:06
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 15:24:17
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-16 17:41:06
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-16 17:46:30
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-16 17:55:46
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-16 18:08:25
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-16 18:13:20
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-17 08:42:19
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-17 09:47:17
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-17 09:48:02
mr	agence	p	57 rue marechal juin	angers	49000	2009-04-17 10:42:38
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-17 10:50:42
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-17 11:03:23
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-17 11:46:40
mr	mercier	florence	57 rue marechal juin	angers	49000	2009-04-17 12:18:57
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-17 16:46:39
mr	le frapper	frederic	59 rue marechal juin	angers	49000	2009-04-17 18:39:07
mr	simonin	alain	1 square mont cassin	angers	49000	2009-04-18 08:44:26

Figure 56: Service users

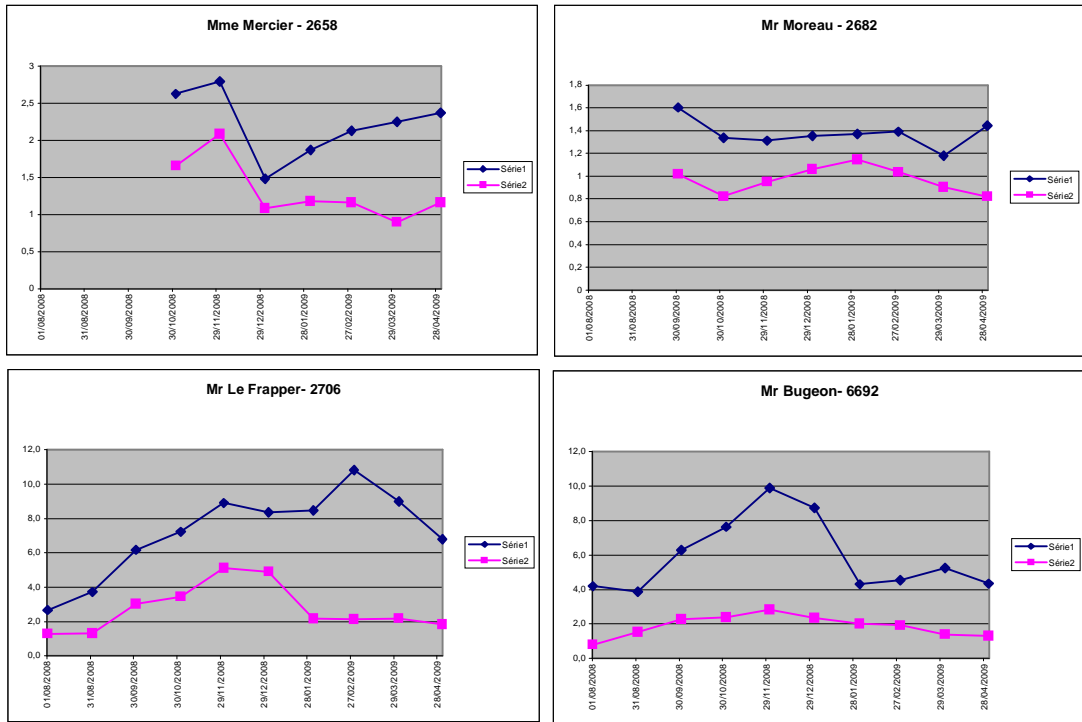


Figure 57: Comparison of water consumption (cold water in blue and hot water in red)

Unfortunately, the comparison of the two different cases does not permit the drawing of relevant conclusions because of the relative low level of utilisation and of the specific behaviours of the tenants.

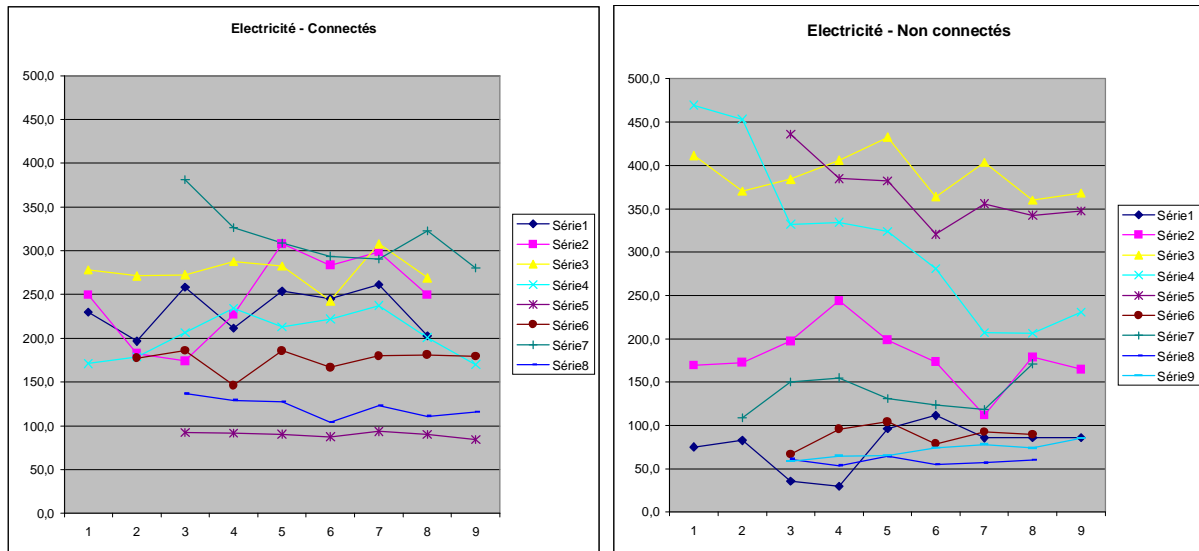


Figure 58: Comparison of electricity consumptions

The two graphics show that the connected tenants seem generally more average in their consumptions than the non users. Nevertheless, as for water consumptions, the data are insufficient to dress conclusive analyses.

Survey results

Concerning the survey, the Le Toit Angevin evaluation approach was designed as a longitudinal study with a control group design. Because of the fact that two comparable survey periods could not be realised, the following data analysis covers a comparison of the

experimental and the control group living in similar residential estates. In doing so it must be borne in mind that both groups had the same requirements - at the moment of the survey they did not have any access to an awareness service. While the experimental group got a login subsequently, the control group did not get any information service during the whole pilot project.

The experimental group of the initial survey contains in total 50 households. The control group covers 56 tenant households.

	Experimental group		Control group
	Initial survey	Final survey	Final survey only
Survey period	April 2008	April 2009	April 2009
Initial sample	50	7	56
Final sample	50	3*	56
Response rate	100%	42;8%	100 %
Used method	Directly in flat	By phone	By phone

* The final survey included still no tenant who took part in the initial survey. The final survey should be continued.

Figure 59: Sizes and characteristics of the experimental and the control group

As figure 59 shows, both groups differ only slightly differently. The experimental group covers more single-person households, the control group more households with children.

		Experimental group	Control group
Gender	Female	44 %	54 %
	Male	56 %	46 %
Average age		43,1 years	45, 7 years
Household size	Single-person household	64 %	34 %
	Two-person household	24 %	18 %
	Three-person household	10 %	16 %
	Multi-person household (four or more persons)	2 %	32 %
Household type	Household with children aged 0 -17 years	14 %	43 %
	Senior household aged 60 and more years	18 %	21 %
	Other adult households without children	68 %	36 %
Income from employment/ self employment		68 %	43 %
Amount of the net household income per month	Below 500 €	8 %	2 %
	Up to 900 €	22 %	15 %
	Up to 1.300 €	38 %	54 %
	Up to 1.500 €	16 %	15 %
	Up to 2.000 €	12 %	6 %
	Up to 2.600 €	4 %	8 %
Permanent access to internet at home		46 %	52 %
Availability of a computer		62 %	79 %

Figure 60: Socio-demographic characteristics of the experimental and the control group

Considering the fact that both compared groups had the same basic conditions the findings are very similar.

Most tenants of both groups feel fairly or very well informed about environmental issues in general. Bigger knowledge gaps can be found concerning the consumption of energy and the possibilities of saving energy in their flats. Referring to this more than one third in each group felt (fairly) badly informed.

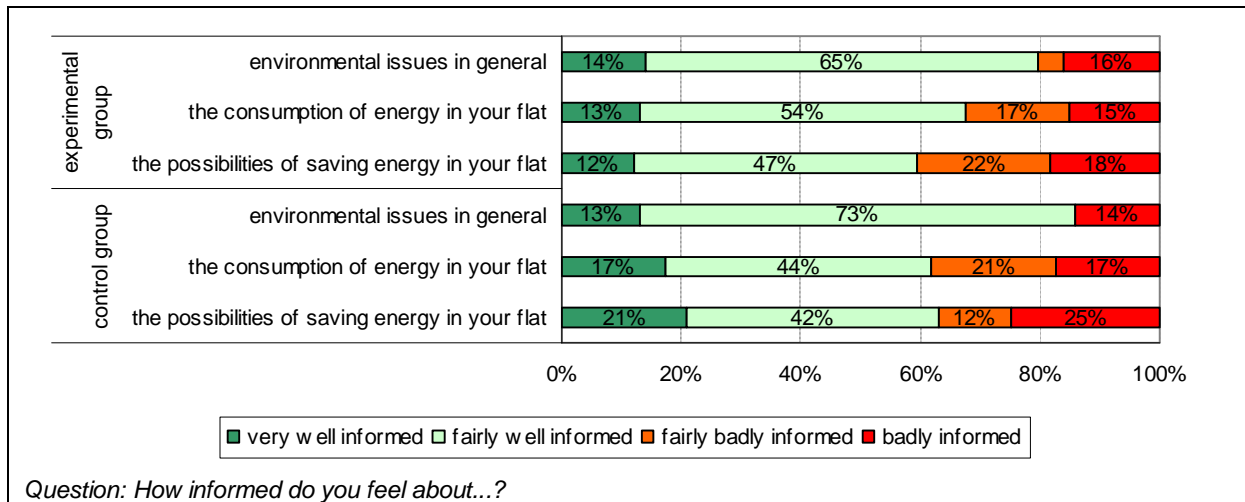


Figure 61: Information about environmental issues

Big similarities between both groups could also be observed with regard to current energy consumption which could be estimated by the tenants themselves. About 40 % think that their consumption in space and water heating or other uses is high or very high.

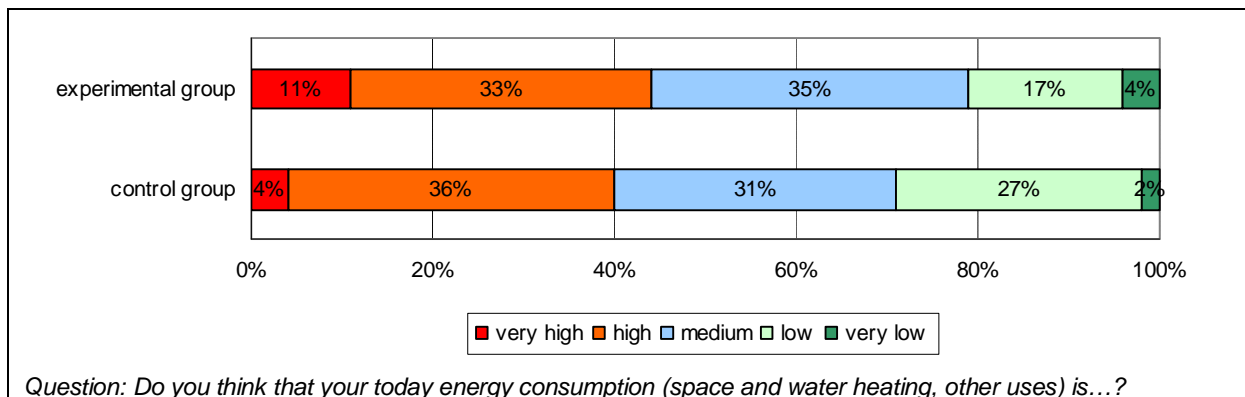


Figure 62: Subjective estimation of the today energy consumption

The everyday behaviour patterns are very similar too. The items concerning the heating issues¹⁴ are missing here because 51 of 56 tenants of the control group cannot regulate the room temperature. The same applies to 24 households of the experimental group.

¹⁴ "I turn off the heating/the radiator when opening the windows."; "I turn the heating down or off when I leave a room unused."; "I turn the heating down when I leave my home for a longer time." "At night the room temperature is usually low."

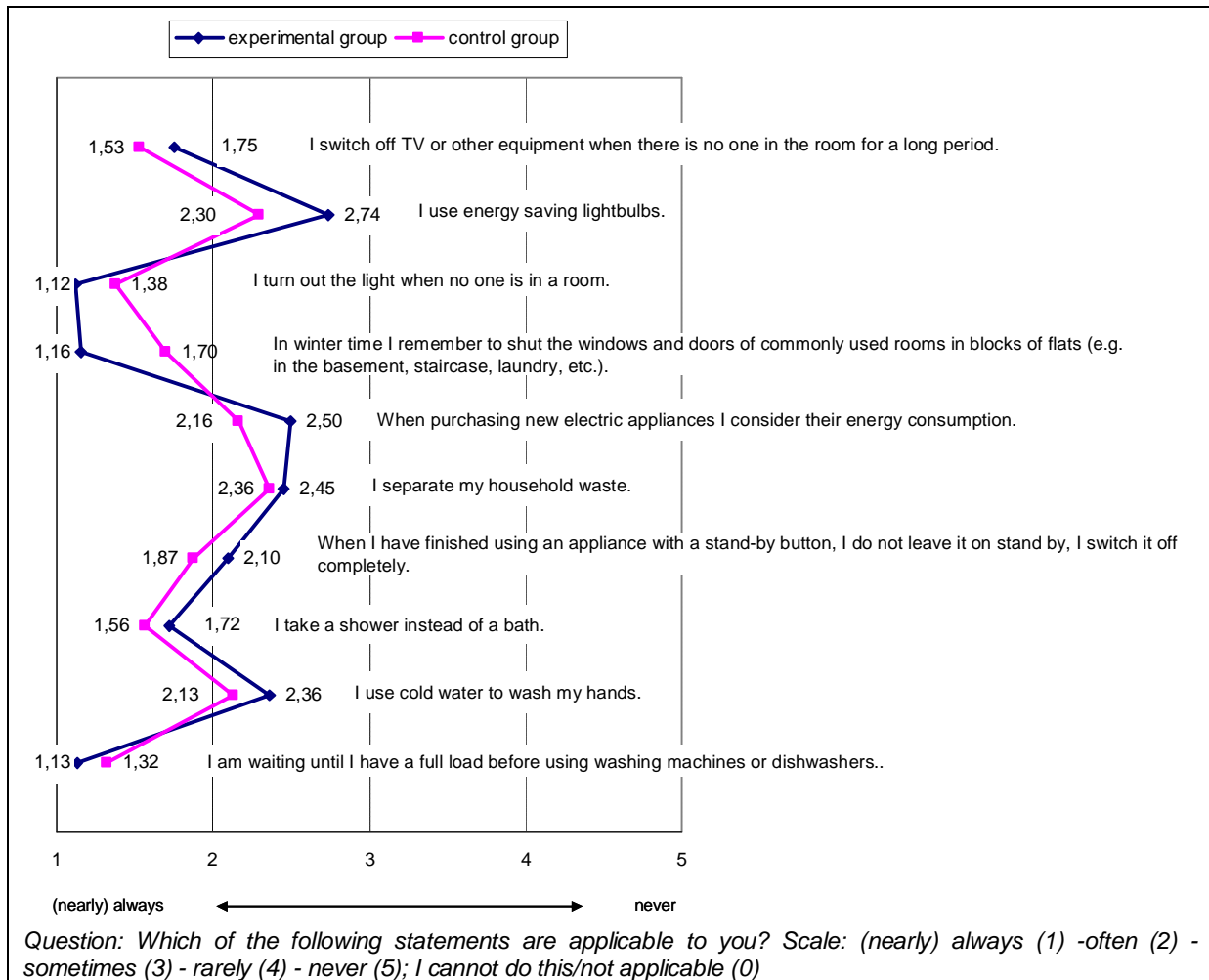


Figure 63: Behaviour pattern, mean values

In this context, the interest is in the room temperature tenants feel comfortable with. In those cases where the tenants cannot regulate the room temperature easily they more often feel uncomfortable with the temperatures in their homes. By using the example of the experimental group, 77 % of tenants with easy regulation feel comfortable with the room temperature. In the other case this was only 62 %.

With regard to the ventilation behaviour of households having a mechanical ventilation system - as shown in figure II.6.1.6 - a big energy saving potential is obvious. Depending on the use of the various rooms between 38 % and 52 % of the respondent tenants do not ventilate correctly.

35 households of the control group with no ventilation systems act slightly better: About 25 % leave the windows ajar often or all the times.

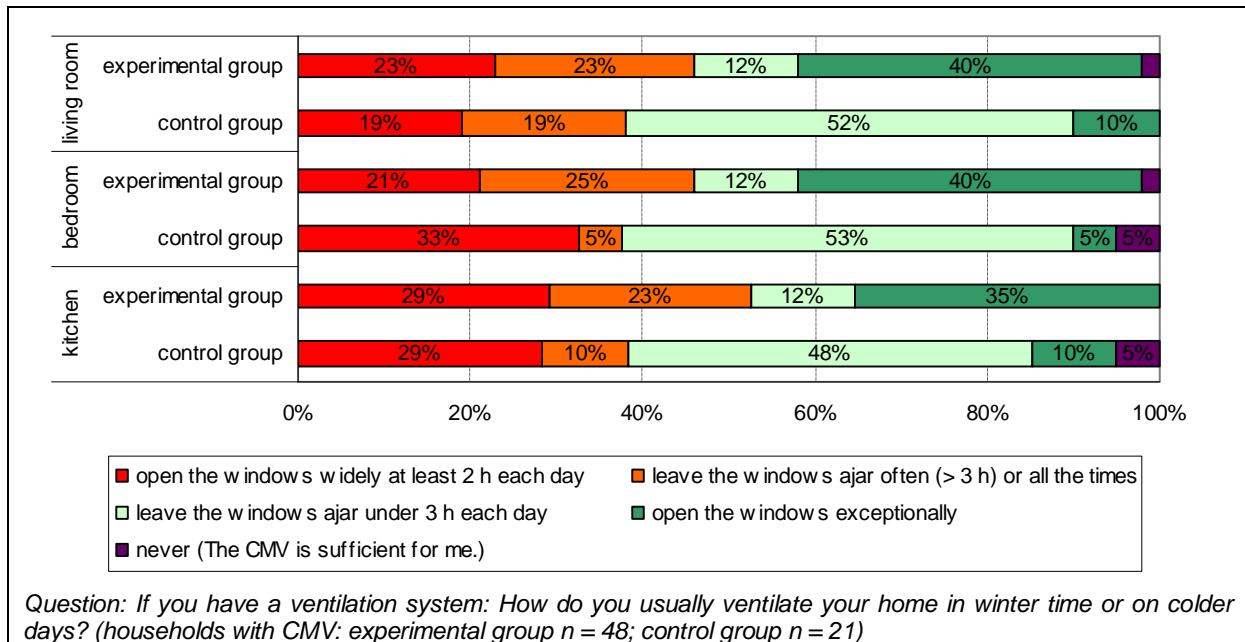


Figure 64: Ventilation behaviour in winter times or on colder days (households with CMV only)

Some differences between both groups arise in their motivation to save energy. The control group is much more interested in saving money than the participants of the experimental group.

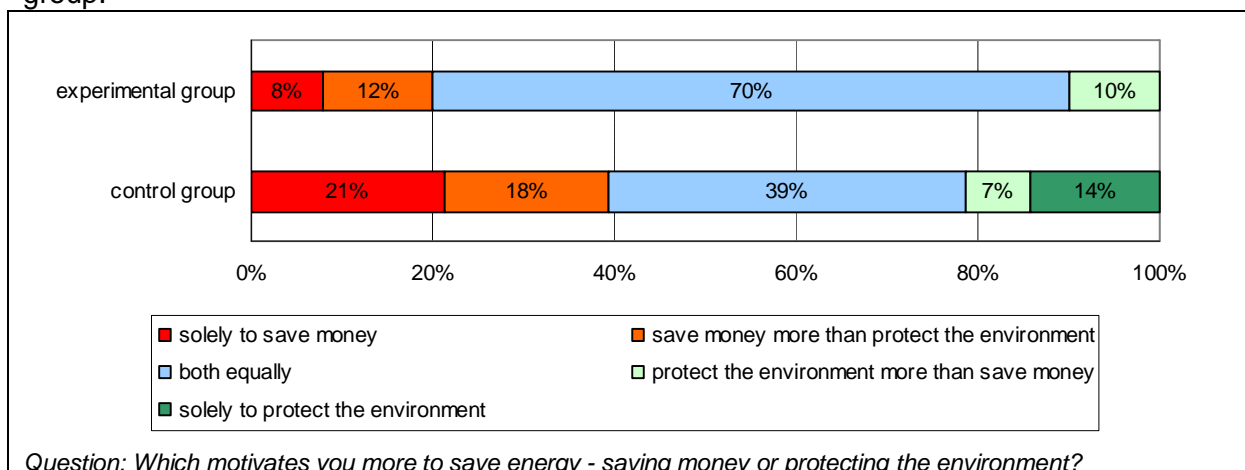


Figure 65: Motivation to save energy

68 % of the tenants' households in the control group are interested in an awareness service. 52 % already noticed this offer because of a letter of Le Toit Angevin. As mentioned above, only three households, who are using the tenants' password protected internet portal, took part in the final evaluation survey. Some results:

- They log in between once a month and several times a week.
- They are very much interested in water and electricity consumption data and in real-time consumption figures. In addition to that a self-assessment tool is of interest.
- All tenants are satisfied with the offer of information, the layout and the manageability/ease of use of the tenants' portal.
- One household is now more interested in energy saving issues and knows a little more than before about the consumption of energy.

3. Conclusions

In the SAVE@Work4Homes project the tenant's perspective occupied a central position. First of all, research into tenant energy consumption behaviour, attitudes and information requirements was essential for selecting options in respect of the Energy Awareness Service components, their design and specification. At the beginning of the project therefore a broad tenant survey was carried out which covered the responses from 2,637 tenants living in the building stock of the six participating housing providers.

Most relevant findings are:

- Most tenants were interested in a service which gives an exact overview of their energy consumption and tips about how to save energy. Tenants were mostly interested in current consumption figures (74 %) and information about how to save electricity (77%), water heating (73 %) and space heating (72 %).
- A large minority of tenants appears to overheat their flats by several degrees. Taking into account that decreasing indoor temperature by only 1°C typically saves around 6% of heating energy, the potential for savings is clearly large.

Therefore, changing tenants' behaviour is an essential component of achieving significant energy saving in social housing. Services and tools developed in SAVE@Work4Homes propose to assist tenants in adapting their behaviour to more efficient use of energy in various forms.

Workpackage 6 of the project played a central role by gathering and collating information from the pilot sites to evaluate the success of the various energy awareness raising strategies and techniques implemented by the partners. One technique used was to survey tenants before introduction of services and during their use.

The evaluation of tools developed and implemented during the project did show that a change in behaviour can be achieved. However, several factors need to be taken into account when judging the evaluation results. Analysing consumption and investigating reasons for change in more detail, revealed several influences:

- The price of energy varied considerably during the project period and the financial crisis might have a significant impact on consumption.
- A comparison of heating seasons, also corrected by degree days, is still rather imprecise (a very warm year 2007 whereas 2008 was much closer to the long-time average).
- Measuring equipment and data offered by suppliers is not very accurate and includes estimated values.
- Little data is available on the number of tenants per dwelling or variations in tenancy due to tenancy changeover, births, deaths, etc.
- There is only an imperfect knowledge of who the service users are and their consumption in previous years, month by month, is unknown in most cases.
- It was also shown that sites which needed to co-operate with external companies had problems to overcome (negotiations with the operators took months/years, late and/or inaccurate data delivered) – changes implemented then enabled parties to offer services with better results

In order to evaluate the tenant's acceptance with the Energy Awareness Service provided, a longitudinal study including a control group design was conceived. Due to delays in developing and implementing the services not all of the sites could carry out the complete two stage survey until the end of the project. In addition, the willingness of tenants to participate was very low. The target change in energy consumption behaviour need two preconditions fulfilled - a fairly long habitation time and a sufficient motivation on the part of the tenants.

Nevertheless, with regard to the pilot sites some results can be presented:

- Nassauische Heimstätte and Stadt und Land most of the service users used the monthly delivered pamphlet which is very similar to the layout of the tenant portal. In general they were satisfied with the offered information. Accordingly the highest satisfaction was with the clarity and illustration of the provided consumption data. Tenants often now know more about the consumption of energy and the possibilities of saving energy in their flats. By using the offered service the tenants primarily were interested in tips for energy saving behaviour.
- Concerning potential changes in consumption behaviour, it could be observed that the tenants often improved their ventilation behaviour in winter time or on colder days. In before-after-comparison now most of the respondents ventilated their homes by opening the windows widely at times. In addition to that they optimised the temperature choice in winter time, in little used rooms the temperatures were clearly lower than in much used rooms.
- In Berlin the comparison between experimental and control group showed that the ventilation behaviour of the experimental group was ideal. Furthermore they acted more environmentally friendly in heating and electricity consumption and attached more importance to the separating of the household waste than the control group.
- In Northern Ireland most of the tenants were satisfied with the service provided. After the more-in-depth advice they felt (very) well informed about the use of the heating system and the heating controls. Compared with the results of the above mentioned broad tenant survey the respondents of the retrospective survey described to a lesser extent knowledge gaps concerning the consumption of energy and the possibilities of saving energy in their homes. Predominantly they did not notice any topics they need to know more about in order to save energy.
- In Karlsruhe the level of information about environmental issues in general was very high, too. Between 50-70 % of tenants felt well or very well informed. Especially with regard to the heating issues the reported everyday behaviour patterns were very environmentally conscious. The tenants nearly always often turned the heating down or off when opening the windows, leaving a room unused or leaving the home for a longer period. At night they usually had low temperatures.
- In Moulins most tenants were interested in an overview of their current heating and energy consumption and in advice about the best energy saving possibilities. Two thirds of the respondents thought that their today energy consumption is high or very high.
- In Angers at the end of the project tenants used the portal in between once a month and several times a week. They were very interested in water and electricity consumption and in real-time consumption figures. In addition to that a self-assessment tool was of interest.

The feedback received from the surveys shows that the activities from social housing organizations to increase awareness of energy savings have modified behaviour of their tenants. Also tenants in the control group (who had no access to services, yet) have changed their behaviour. The survey also proved that tenants are very much interested in the services offered, even though it can be used more efficient in the future.

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Not all tenants had access to the Internet, and the initial number of tenants connected to services was not sufficient. During the project period partners have found ways to reduce this by offering the service through other channels (e.g. paper versions at SuL and NH) or to increase the connectivity of tenants by offering them hardware and assistance to connect to the internet (LTA). NIHE decided to use Personal Digital Assessors (PDAs) to bring the Self Assessment Tool into tenants' homes during routine housing visits by Neighbourhood Wardens.

Individual consumption values vary very strongly by a factor of 6 – importance to reduce the demand of the “high consumers” down to the average of all tenants.

Domestic hot water consumption: spread in demand, which is similar to the heating but there is no correlation between domestic hot water consumption and the level of heating energy consumption. Behaviour of the inhabitants in one flat is rather consistent (with exceptions): in a flat, where the domestic hot water consumption demand is high in January, it will in general be high also, say, in September then, a decrease of consumption is possible with EAS (VoWo).

The evolution in the tenant’s behaviour needs more long term evaluations: Energy consumption is routine behaviour, which - learnt once – takes place mostly unconsciously. In order to achieve behavioural changes first of all tenants need to be aware of their habitual behaviour patterns. Only afterwards a new learning process can be started, supported by the offered Energy Awareness Services. In doing so, the target change of mindset includes two preconditions – a fairly long habituation time and enough motivation on the part of the tenants. The last-mentioned is much easier and successful if economical incentives take effect. From a social psychological point of view the saving-money motivation is much more behaviour-relevant than the environmental awareness. But in terms of the project, tenants could not always get the relevant cost feedback because of the fact that the billing periods covered more months than the tenant portals were running.

The project, however, showed the importance of relevant information to change the behaviour of tenants with respect to their energy consumption. It remains to further explore the results obtained in the years ahead also by taking account of the huge development in this area. By doing so, and by increasing the effort to maintain support for tenants, they will persist in their desire to change their habits to save energy.