Advances in the use of consumption feedback information in energy billing: the experiences of a Norwegian energy utility

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1 - SYNOPSIS

The paper relates the testing and implementation of various forms for feedback information (historical, normative, and disaggregation) at Stavanger Energi, a Norwegian energy utility.

2 - ABSTRACT

Over the past three years Stavanger Energi (recently merged with four other companies to form the Lyse Energi Group), with support from the Norwegian Water and Power Authority (NVE), has made significant improvements in the layout and information content of its bills. Historical feedback, which shows how much the recipient consumes in every billing period of the current and previous years, is now incorporated in graphic format on all residential bills. Two other types of consumption feedback have recently been tested with positive results. One is normative feedback, which provides households with information on how much energy it uses in relation to other households of similar type and size. The other is desegregation of end use into categories such as heat, light, kitchen appliances, etc., based on questionnaire and consumption data. These efforts are important for two reasons, one to make households aware of their energy use and thereby provide a better platform for energy savings, the other to improve communications between the energy utility and the energy customer. The latter is particularly important in Norway's completely open competitive electricity market where every customer can freely choose its supplier. In order to avoid migration of customers, positive consumer relations and good communication are essential characteristics of a successful utility. These developments in billing information in Stavanger Energi should be of interest for a wide audience, as information-poor bills are still the norm in much of Europe.

3 - INTRODUCTION

Over the past three years Stavanger Energi (recently merged with four other companies to form the Lyse Energi Group), with support from the Norwegian Water and Power Authority (NVE), has made significant improvements in the layout and information content of its bills. These efforts are important for two reasons, one to make households aware of their energy use and thereby provide a better platform for energy savings, the other to improve communications between the energy utility and the energy customer. The latter is particularly important in Norway's open, competitive electricity market where every customer can freely choose their supplier. Positive consumer relations and good communication are essential characteristics of a successful utility.

Three kinds of billing feedback information are discussed in this paper. Historical feedback, which shows how much the recipient consumes in every billing period of the current and previous years, has been thoroughly tested over the past decade and is now incorporated in graphic format on all of Stavanger's residential bills. Two new types of consumption feedback have recently been tested with positive results. One is normative feedback, which provides households with information on how much energy it uses in relation to other households of

similar type and size. The other is disaggregation of end use into categories such as heat, light, kitchen appliances, etc., based on responses to a brief questionnaire and the respondent's consumption data.

In the paper we summarize the process which has lead to full implementation of historical feedback. We then discuss the development of routines for normative feedback and disagregation of end use, including tests of alternative presentations, and a discussion of the potential for stimulating more efficient energy use and customer satisfaction. These developments in billing information should be of interest for a wide audience, as information-poor bills are still the norm in much of Europe.

4 - THE IMPLEMENTATION PROCESS FOR HISTORICAL FEEDBACK

A 1987 study of Nordic electricity bills revealed that the vast majority of bills were complicated, cluttered and came infrequently. The bills did not provide information in a way which made it easy to follow trends in consumption over the calendar year or from one year to the next. (Wilhite and Ribeiro 1988). In Norway and much of Europe, «invoice» type billings were predominant for residential customers (this was still the case in 1998). In invoice-systems, people are billed several times a year for a theoretical fraction of their yearly energy bill, based on the previous year's consumption. On the final bill, customers pay for the difference between invoiced sum and the cost corresponding to actual consumption for the year. Thus people are only confronted with their actual consumption and costs once a year. The bill comes too infrequently to stimulate interest, and the way information is presented makes bills difficult to understand.

4.1. The Oslo-Helsinki experiment.

In 1989, Ressurskonsult set up a three year project to test the energy saving potential of historical feedback information in Oslo and Helsinki (reported in Wilhite et al 1993 and Wilhite and Ling 1995)(1). Considerable effort was made to set up a sound experimental design. A large sample of households (1400 in Oslo; 900 in Helsinki) was randomly selected and assigned to a control and three experimental groups. There was no communication with respondents in the experimental period to avoid changes in behavior of respondents due to researcher interference. The bill incorporated a graphical representation of this- versus last year's electricity use (weather corrected) every 60 days. Energy conserving tips were placed on the bill of one of the experimental groups. Electricity consumption was monitored during the period, and both post-experiment questionnaires and telephone interviews were conducted with participants in all groups.

At the end of the first year, the experimental groups saved on average 10% electricity relative to the control group and those savings held steady over the three year course of the study. In Helsinki, the group which got graphic and tips saved almost 5%. Customer response to the bill was overwhelmingly positive in both Oslo and Helsinki. People indicated that they read the bill more often, felt it was easier to understand, and felt that it gave a better understanding of trends in consumption. 80% of the Oslo participants indicated that they preferred to continue with the tested bill rather than go back to the invoice-type billing.

4.2. The implementation project

In spite of these positive results, utilities were slow to pick up on these new billing practices. This was due in part to institutional inertia. Invoice-type billing systems had been used for over half a century by almost every Norwegian utility. Changing those systems was perceived as costly and technically challenging. Also, the savings potential associated with the new bill was not of particular interest, because for the average retail utility, reduced consumption was equated with reduced revenues. There were only a few utilities eager to exploit either the energy savings or customer relations potential of a more informative bill.

In 1995 a project was initiated, with support from NVE, to assist four volunteer utilities in implementing historical feedback. Of the four, Stavanger Energi was the only utility to successfully implement the changes. In June of 1996, Stavanger sent out its first bill with historical feedback in graphic form (see figure 1) to approximately 2000 households.

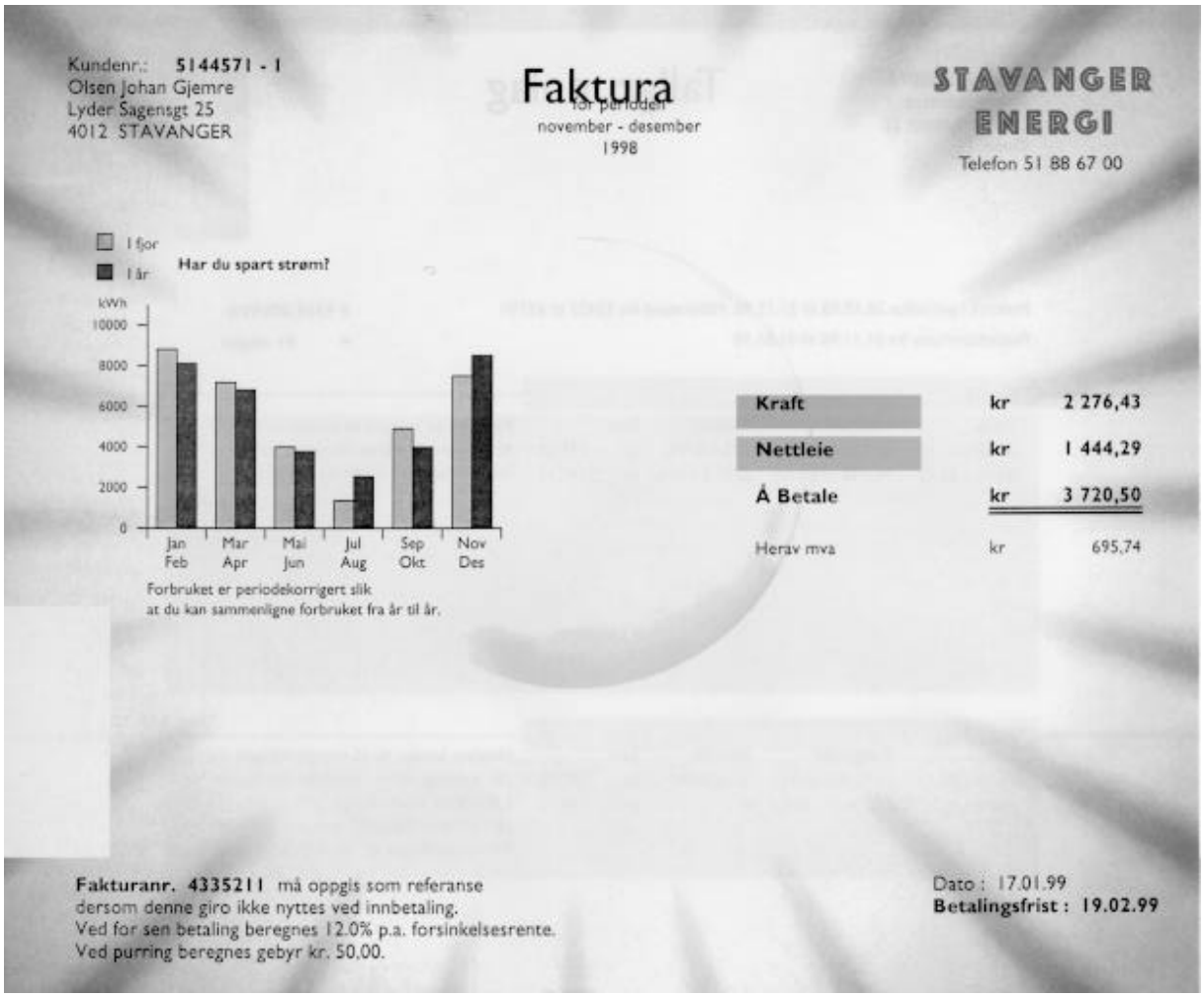

***Figure** 1: Example of a Stavanger Electricity Bill, Front Side*

The bill was sent every 60 days, based on participant self-reading of their electricity meters. The reverse side of the bill is used to show cost calculations, leaving the front side clean and friendly to the eye. Participant's response to the new bill was overwhelmingly positive. Some of the results of the before and after surveys (Wilhite 1997):

- An increase from 55 to 74% in those who either agree or completely agree with the statement «I am satisfied with the way information is presented on my electricity bill» and a halving of those who disagree or completely disagree (from 13 to 6%)
- An increase from 62 to 76% in those who agree or completely agree with the statement «My/our electricity bill is easy to understand» and a reduction from 14 to 6% of those who disagree or completely disagree.
- An increase from 47 to 65% of those who often or always read the electricity bill thoroughly and a halving from 28 to 14% of those who seldom or never read the bill thoroughly. Among renters, there was a doubling from 32 to 63% of those who often/always read the bill thoroughly and a reduction from 40 to 20% of those who never/seldom do so.
- There was a doubling from 38 to 77% of those who agree or completely agree with the statement that the electricity bill provides a good overview over fluctuations in electricity consumption over the course of the year. There was a dramatic decrease from 33 to 7% in those who disagree or completely disagree with the statement.
- Among young people (<30), there was a reduction from 34 to 14% of those who «don't know» whether their electricity use has increased, decreased or remained about the same over the past two years.

There was also evidence of energy savings. The questionnaires revealed that there was an increase of 8% and 6%, respectively, in those who lower the room temperature in their homes at night or when they go away for the weekend.

Based on these positive results, Stavanger expanded the recipient group for the new bill from 2,000 to 25,000 customers in 1997 and to virtually the entire residential customer base of 50,000 in 1998. Their success in implementation can be related to considerable effort in informing customers about the new bill, how to interpret the changes and how the new information could be of value. Another important success factor was the creation of alliances with the local consumer affair authorities and a local environmental organisation, both of which assisted with the marketing of the new bill.

Based on results in Stavanger, NVE introduced new billing guidelines for all Norwegian utilities, effective in 1999. The guidelines require billing for actual use a minimum of 4 times per year, and the incorporation on the bill of graphical historical feedback.

4.3. A recent evaluation of attitudes and energy conservation actions among the original 2000 participants

In November of 1998 the same survey questionnaire was sent to the original Stavanger recipients of the historical feedback. The background was a rough check on the energy consumption of the group which seemed to indicate that their consumption had decreased about 4 % over the past two years while at the same time the consumption of the entire residential population had increased by 4 %. The purpose was to compare responses to the questions on energy saving behaviours and attitudes to the bill to the early responses from 1995 (before) and 1996 (immediately after).

The results from the November 1998 questionnaire came available in January 1999, just before the submission of this paper. We extract some of the important findings: 90 % of the respondents are now satisfied with the way information is presented on the bill; 91 % agree that getting the graph of «this» and «last» years consumption is worth the extra work demanded of them in the form of self reading of meters; 92 % find the bill to be easy to understand; 87 % feel they have a good overview over their electricity expenses. When it comes to indications of energy savings, 27 % say that their electricity use has decreased over the past 2 years, 11 % that it has increased and 54 % that it has remained about the same. This is an indication, albeit self reported, of savings. Looking at questions on indoor temperatures and temperature setback, there have been some significant changes, including an increase from 4 % to 22 % of the participants who maintain living room temperatures less than 20 degrees on winter evenings, and a corresponding decrease in those who maintain temperatures in the range from 20 - 22 degrees. There are also increases in the numbers who set back thermostats in the evening and when they go away for the weekend, the latter increasing from 71 % in 1995 to 77 % in 1996 and to 82 % in 1998. Since the group has received no special attention since the initial contacts in 1995, these changes can be attributed to the new bill.

The electricity savings potential of historical feedback may be higher in Norway than in other countries, primarily because of the extensive amount of electric space heating in Norway. These techniques could however be applied to natural gas billing. And the customer satisfaction aspects should be universal.

5 - RECENT RESULTS FROM THE DEVELOPMENT AND TESTING OF NORMATIVE FEEDBACK AND DISAGGREGATION OF END USE

Another consequence of the positive results of efforts with historical feedback was an initiative to explore other ways of providing feedback information on energy consumption. In the Spring of 1997, a project was initiated to test customer response to normative feedback and disaggregation of end use. The project was supported by NVE and the two participating utilities, Oslo Energi and Stavanger Energi. The project set out to answer the following questions:

- are customers interested in these kinds of consumption feedback?
- is the information useful?
- does it increase awareness?
- what are the problems and challenges in programming and production?
- would it be worthwhile to provide the information on a large scale?

5.1. Normative feedback

Normative consumption feedback is defined as follows: information which gives the recipient the ability to compare their level of consumption with others in similar circumstances. The theory is that those who are on the high side in relation to others will be made conscious of this; that some of these will be stimulated to examine more closely why this is the case; and that some of these in turn will be motivated to reduce their consumption level.

As far as we know, the only other study of normative consumption feedback is a project which is running concurrently in the United States, financed under by the DOE Energy Star Program, and lead by Willett Kempton and his colleagues at the Un. Of Delaware (see Egan, et. Al. 1996). The Norwegian project has benefited from an exchange of information and experiences with this project, though there are differences in both approach, and in results, which we will point out below.

The U. S. Study uses a «neighbourhood comparison» approach, the comparison group being all of the households in a given neighbourhood. There are no corrections made for differences within the group, either concerning the house (i.e. size, type of heating) or household characteristics (number of persons). In the Norwegian study, it was decided to place recipients into groups of like households drawn from the entire greater metropolitan area. It was felt that this «like household» comparison would be viewed as more legitimate for recipients who could otherwise rationalise differences in consumption as being attributable to differences in the neighbours home. After giving consideration to which variables have the greatest impact on energy consumption, and which can be elicited on a brief questionnaire, the variables chosen to define the placement into groups were:

1) *Total number of people in the household (P)*. Three categories: P 2, 3 < P 4, P > 4
2) *Type of dwelling*. Four categories: Single family detached, row house, apartment in small building (2-6 apartments), apartment in large building (more than 6 apartments).
3) *Dwelling size (S) in m2*. Four categories: S 50, 50 < S 100, 100 <S 150, S > 150
4) *Use of electric heating.* Three categories: 100% electric, mix of electric and other, no electric.
5) *Hot water a)* included in household electricity bill or *b)* not included in the bill.

An example of a comparison group is: P < 2, row house, 100 < S 150, 100 % electric heating, hot water included in electricity bill.

Test of displays in focus groups.

The first step was to test various forms for display in a total of 6 focus groups in Oslo and Stavanger. Three types of displays were chosen to visualise the comparison: a linear version which placed the recipient's consumption in relation to the highest and lowest energy consumers in the group; a normal (bell) curve version which shows not only the placement, but the distribution of households within the group; and a variation on the normal curve, in which the shape of the curve is represented with small houses. The latter is similar to the display preferred in the U. S. Study (figure 2 is a representation of this type of display).

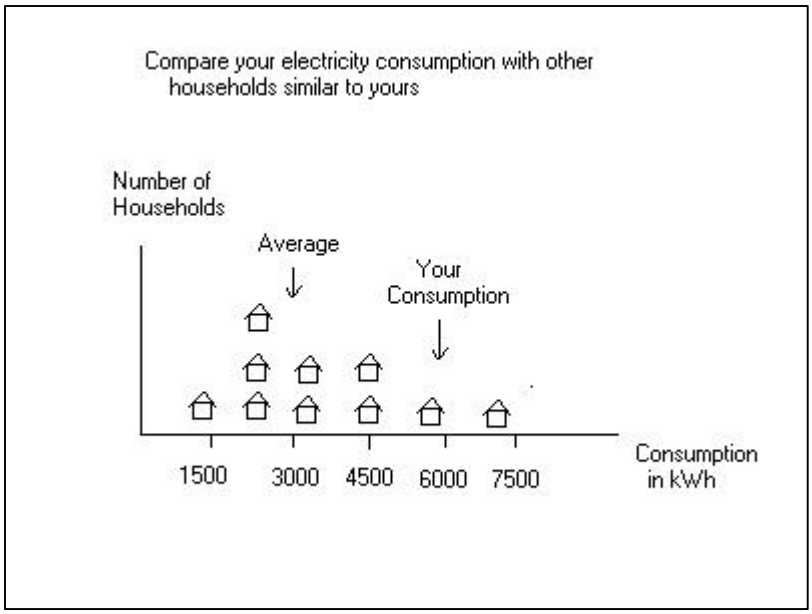

Figure 2: Normative feedback using houses to show the distribution of the group's consumption

On the whole, focus group participants did not like the version with the small houses. Some participants characterised them as childish. Others were not certain as to whether each house was representational of a larger number or whether they represented one real house (2). The focus group participants pointed to advantages and disadvantages of both the linear and normal versions and were about equally divided as to which they preferred. Based on the focus groups, it was decided to test both the linear version and the normal curve version, but not the small house version, with a larger sample. The focus groups lead to modifications to the displays of both versions. The most significant of these was adding a pointer indicating the average consumption for the group. Figures 3 and 4 are examples of the final versions of the linear and normal curve representations which were used in the test with the larger sample.

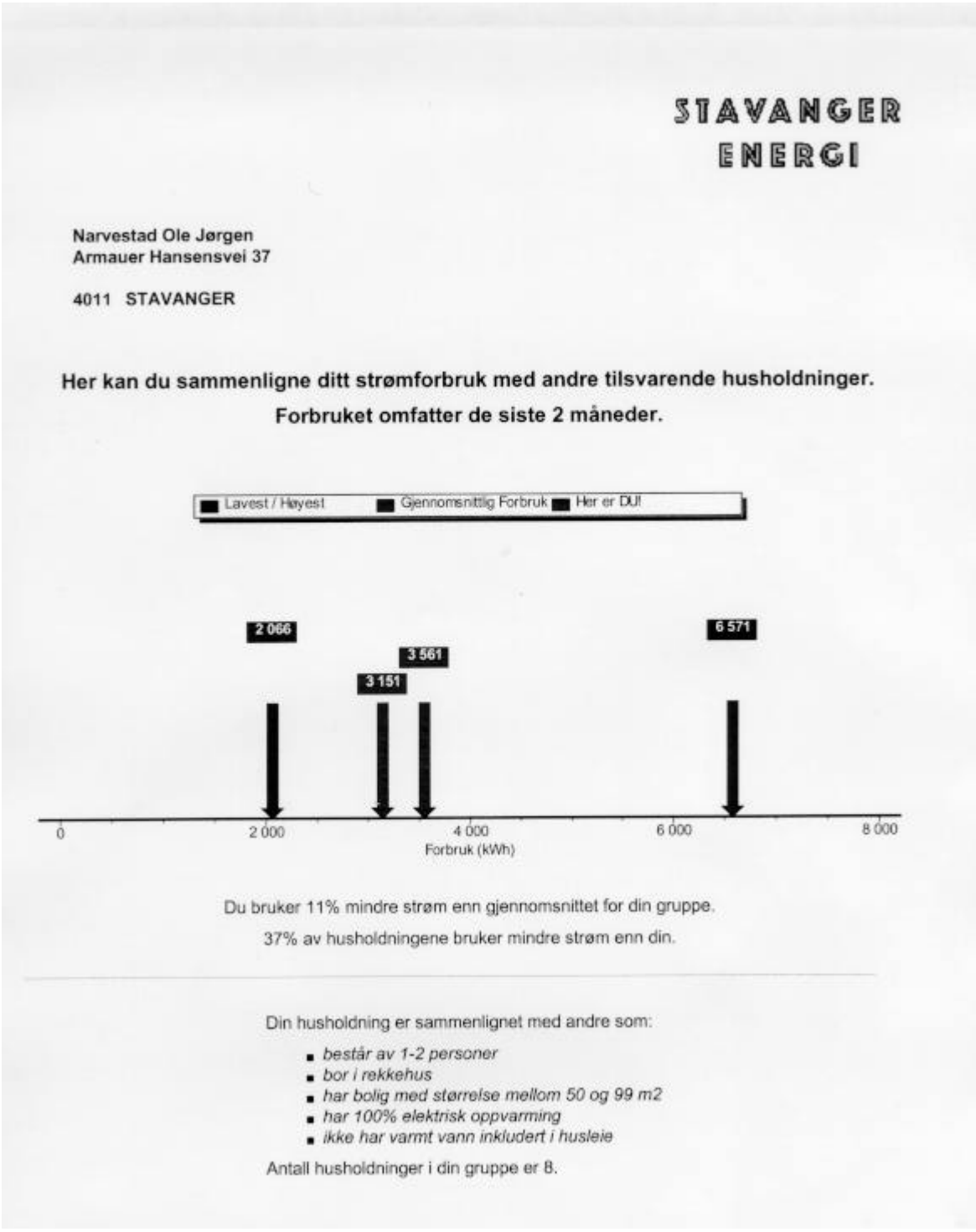

Figure 3: An example of normative feedback, linear presentation

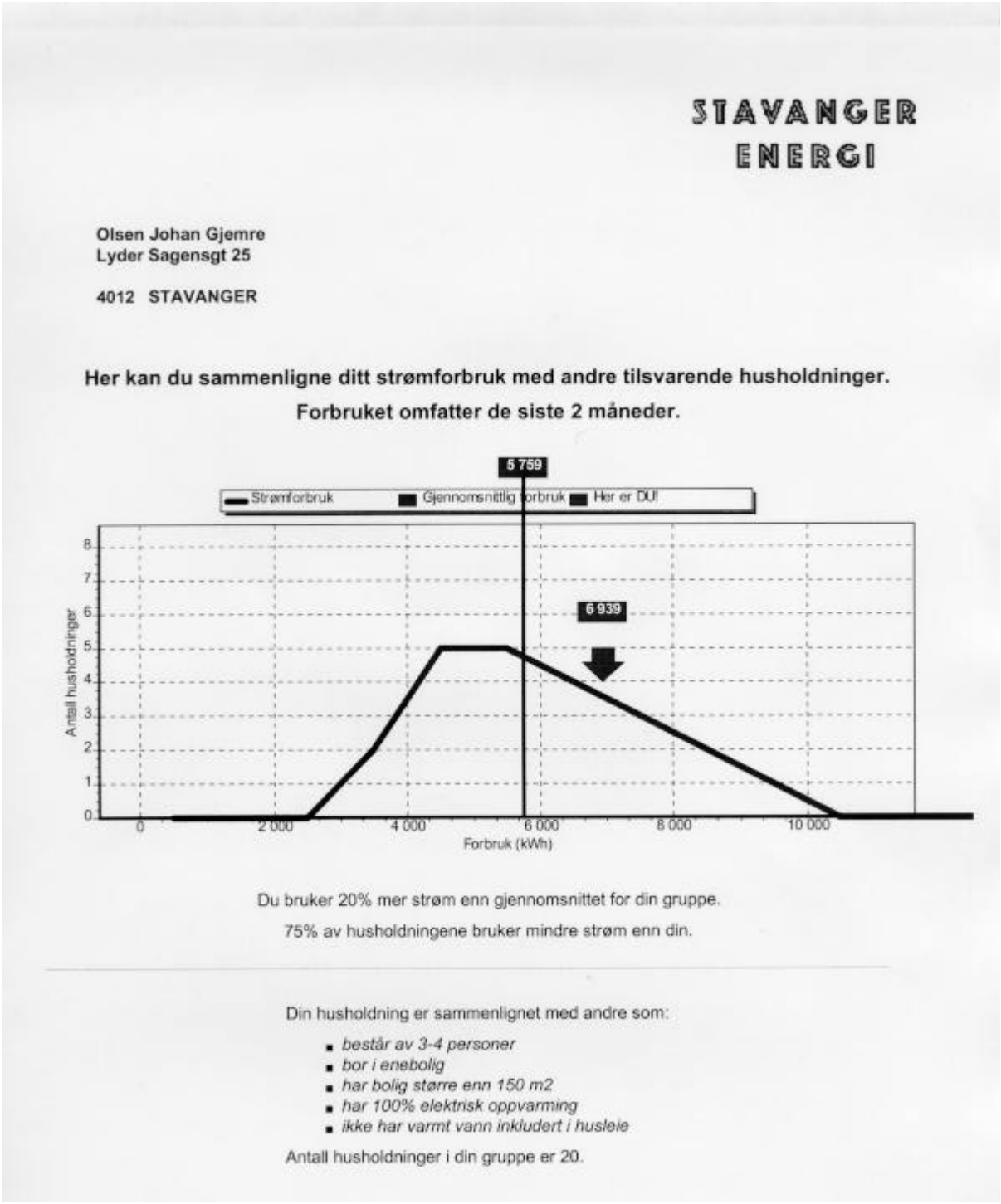

Figure 4.: An example of normative feedback, normal (bell) curve presentation

Data input and programming

A one page questionnaire was developed to provide input on the key variables. As the questionnaires came in, the answers were scanned into an electronic file. A program was developed by the firm Episteme in Oslo which allowed each participating utility to create the comparison groups, using the questionnaire answers and consumption data of each household for the billing period. The program generates the diagram and places arrows indicating consumption for the low, average, high and recipient's consumption. It also generates the text below the figure indicating how the recipient's group is defined.

5.2. The test with a sample of 2000 households

The one page questionnaire was sent to 2000 households, along with a cover letter and a sample of the figure they would receive. In each city, 500 recipients received the normative questionnaire together with one used for disaggregation (discussed below), while 500 were sent the normative questionnaire alone. The return rate was around 50% in both cities, exceptionally high for this type of survey. Based on the answers, the recipients were placed into 59 comparison groups in Oslo and 50 in Stavanger. About a month after the questionnaire was returned, the respondents were sent either the linear or normal curve version of the diagram. In general, the linear version was used for the smaller groups, since a normal curve looks irregular when sample sizes are small.

A single page evaluation questionnaire was sent together with the diagram, which in addition to gathering some facts on the dwelling, asked questions concerning interest level, usefulness and understanding. Again, the return rates were close to 50%.

In what follows we present some of the highlights from the evaluations, concentrating on Stavanger, but pointing to differences between Stavanger and Oslo where they were meaningful. We first discuss interest, comprehension, and the raising of awareness and motivation for saving energy. We then discuss variation among demographic subgroups and summarise the strengths and weaknesses of the two versions tested. In the discussion below, N1 represents the normal curve version and N2 represents the linear graph version.

5.2.1. Interest

The following table summarises the level of interest in the information.

Stavanger	N1	N2
Agree/completely agree: the information is useful	88	83
Disagree/completely disagree: the information is not interesting	85	88
I am interested in receiving the information should it be offered	94	98

These numbers indicate a strong interest in the information. Only a very small proportion of recipients found it to be useless or uninteresting. Virtually the entire sample is interested in receiving it should it be offered in the future.

5.2.2. Comprehension

One question asked whether the figure was difficult to understand. These were the results:

Stavanger, The figure was difficult to understand	N1	N2
Agree/completely agree	16	9
Unsure/don't know	8	6
Disagree/completely disagree	77	83

The fact that only 16% of those who received N1 completely agreed/agreed with the statement is a remarkable result, given the sophistication of the normal curve. The results of N2 reveal that it is widely understood, and comparatively speaking, fewer had problems understanding it as did N1.

Looking at the demographic subgroups, the only group which had greater problems than the average was those over 60 years old. 29% of this group found N1 difficult to understand. None of the subgroups had greater than average problems with N2.

5.2.3. Increased knowledge or awareness

There were two questions which gave an indication of whether the respondents learned something new about their energy use or increased their awareness.

Stavanger, I am surprized by how the amount of my electricity consumption compares with others	N1	N2
Agree/completely agree	35	51
Unsure/don't know	32	24
Disagree/completely disagree	22	24

Stavanger, The placement of my electricity consumption was further to the right in the diagram than I would have believed	N1	N2
Agree/completely agree	29	39
Unsure/don't know	28	22
Disagree/completely disagree	42	38

With both versions, somewhere between a third and a half of the respondents were surprised at their placement with respect to others and around a third found their electricity consumption to be higher than they had assumed it to be compared to others. Thus the feedback had the desired effect of correcting misconceptions and raising awareness for a large portion of the recipients.

A question raised by the above responses is why more of those who received N2 were surprised about their placement. We can only speculate - greater comprehension of N2 might explain part of the difference. This is supported by the fact that the «unsure» category was smaller for N2 in response to both questions. Another consideration, however, is that the groups which received N2 were smaller and thus the placement of each individual household in relation to the group was less certain to reflect the statistical reality.

5.2.4. Motivation to reduce electricity consumption

Stavanger, If my electricity consumption were higher than the average, it would motivate me to save energy	N1	N2
Agree/completely agree	72	77
Unsure/don't know	15	16
Disagree/completely disagree	11	6

About three fourths of the recipients say they would be motivated to reduce their electricity use if they were using more than the average. Since about half have electricity consumption higher than average, one could deduce that 36% of the respondents who received N1 and 38% who received N2 would be motivated by the feedback to save energy. There is a long step from motivation to action, but the size of the group of potential energy savers is encouraging.

5.3. Summary of experiences with normative feedback

Normative feedback has received high marks when it comes to customer interest, and it clearly has had the desired effects of increasing awareness and acting as an incentive to reduce energy use. Questions which remain open are how large a group will be offered normative feedback and how often it will be sent. There are significant costs associated with modifying customer data bases to accommodate normative feedback, but the positive customer relations consequences make large scale implementation a real possibility.

Almost two thirds of respondents indicated they would prefer to have the feedback every 60 days, accompanying their bill. The remaining third preferred getting it once a year. Should it be sent with every bill, the strategy would be to send the questionnaire, and form the comparison groups only once each year. For the remaining 5 bills, all of the relevant consumption statistics for the group would be recomputed each time. The recipients placement within the group and with respect to the average might change.

When it comes to a choice between N1 and N2, interest levels were about the same for both, but comprehension was higher for N2. Since the costs for programming and producing N2 are lower, it would seem to be the natural choice if the information is to be implemented on a larger scale.

5.4. Disaggregation of end use.

By disaggregation, we mean making visible for the energy consumer how much energy goes to important end uses in the dwelling.

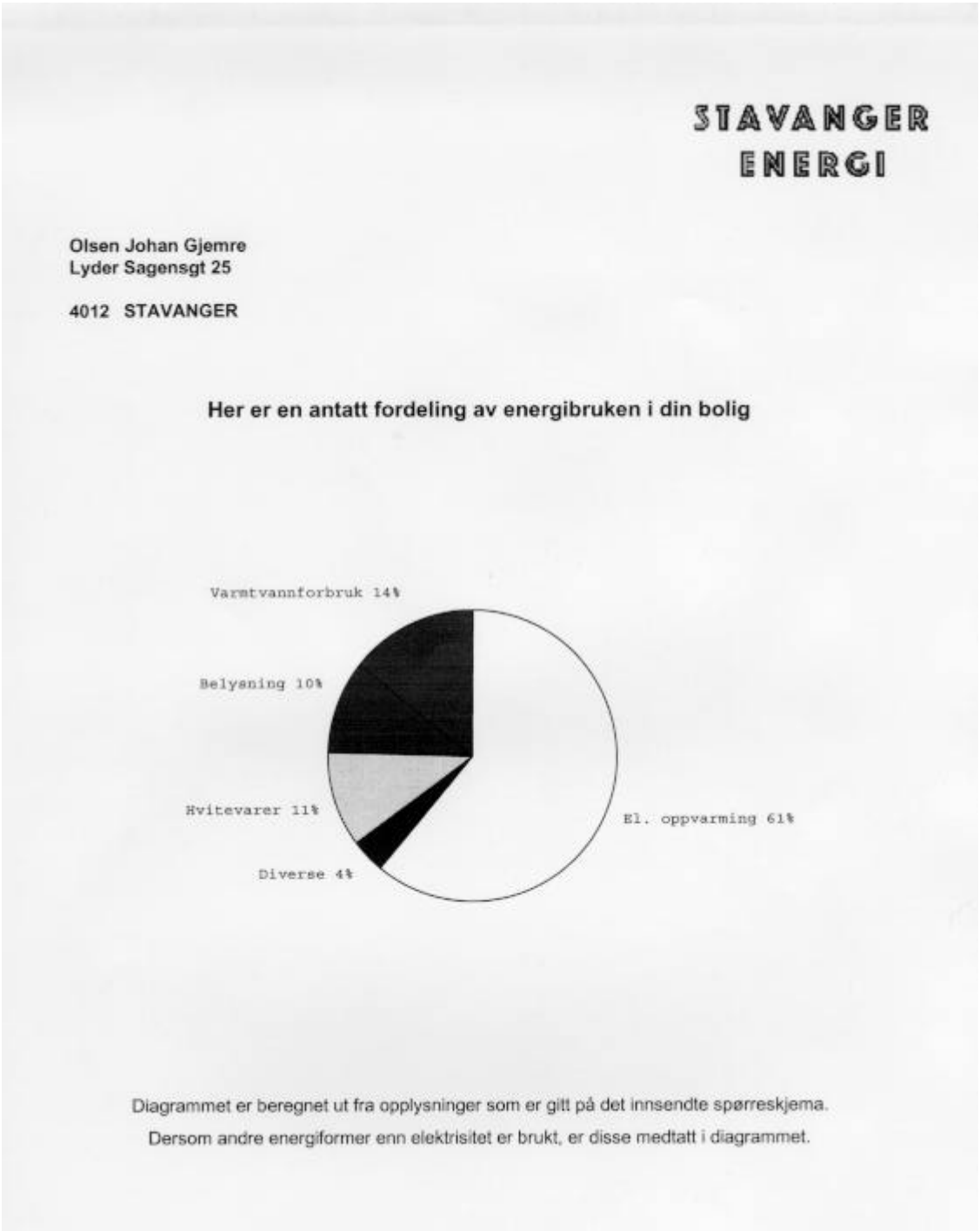

***Figure 5**: An example of the pie diagram used for disaggregation*

Since individual end-uses are not metered, there are widespread misconceptions about how much energy goes where. A common misconception is that more energy goes to lighting and cooking (visible) than actually does, and less to space heating and cooling (invisible) (Kempton and Montgomery 1982; Wilhite 1984). The objective of desegregation is to correct misunderstandings and raise awareness about the contribution of important end uses like space heat and hot water.

Considerable effort was made in evaluating which end-uses should be selected and displayed. One consideration was how people cognitively group things, i.e., should hot water uses be separated or grouped? Another consideration was the make up of the information-gathering instrument itself, which could not be too long or

complex if people were to take the time to fill it out and return it. Finally, a program would have to be written to take the information from the questionnaire, incorporate energy consumption data and produce the desired desegregation. Based on tests in focus groups and on the limitations on questionnaire length and programming, 6 end uses were selected for display: electric space heating, other space heating, hot water, light, «white appliances» (in Norway these are kitchen appliances and washing machine), and «diverse».

Test of displays in focus groups
Two different displays were tested in the focus groups. One was a bar chart and the other a pie chart. The pie chart version was overwhelmingly favoured in all of the groups. It was considered to be easier to interpret and to give a more facile overview of the disaggregation.

5.5. Programming
After investigating a few fully developed commercial models for residential disaggregation, they were found to be too costly. As a result, one of the members of the project team, Britt Helleren of Oslo Energy Enøk, took on the task of developing a questionnaire and accompanying formulas for converting results into a disaggregation. She worked on simplifying existing Norwegian models, which required long questionnaires to be filled out by respondents. Helleren worked with the company Episteme to write a program which would create a pie diagram from a two page questionnaire and the respondents electricity consumption. The resulting disaggregation, based on normative data and self reports, is not a perfect reflection of the true breakdown, but nonetheless gives the respondent a rough idea of the proportions of energy which go to important end uses.

5.6. The test with approximately 2000 households
The questionnaires were sent to 1000 households in each city. As with the normative feedback questionnaire, the return rate was high, approximately 47% in Stavanger and 43% in Oslo. Respondents were sent the pie chart accompanied by an evaluation questionnaire, which had a 50% return rate. In the following we present the results from Stavanger, which do not differ significantly from those from Oslo except on one issue, which we point out below.

5.6.1. Interest
The following table summarises the level of interest in the information.

Stavanger	
Agree/completely agree: the information is useful	81
Disagree/completely disagree: the information is not interesting	85
I am interested in receiving the information should it be offered	95

The result shows that interest is very high. The fact that 95% would be interested in getting it in the future is in itself an extremely positive evaluation.

5.6.2. Comprehension of the figure

Stavanger, The figure is difficult to understand	
Agree/completely agree	7
Unsure/Don't know	5
Disagree/completely disagree	89

Again, these results are convincing. Very few had trouble with comprehension. There were two groups which were somewhat weaker than the norm, those whose age was over 60 years old and those who had 9 years or less of education. In both groups, about 19% found the figure difficult to understand.

5.6.3. Increased knowledge
There were three questions which asked about knowledge and understanding.

Stavanger, The figure gives me a better understanding of my dwellings energy use	
Agree/completely agree	84
Unsure/Don't know	9
Disagree/completely disagree	7

Stavanger, The figure provides me with knowledge about my energy use that I don't get through other information.	
Agree/completely agree	81
Unsure/Don't know	9
Disagree/completely disagree	8

These are two of the evaluation's most convincing results. The disaggregation has lead to better understanding among 84% of the participants, and 81% indicate that the information is unique.

Stavanger, The breakdown of energy into the various categories is different from what I had previously thought.	
Agree/completely agree	38
Unsure/Don't know	34
Disagree/completely disagree	28

Given that the disaggregation was correct, this result means that 38% had misconceptions set straight. The fact that 34 % answered unsure/don't know suggests that many were uncertain about the «breakdown» beforehand. These responses indicate that the disaggregation has had its desired effect for a significant proportion of the sample.

Of all of the questions in the two surveys, this is the one which evidenced the greatest difference between Stavanger and Oslo. 46% of Oslo participants agree/completely agree with the statement, significantly higher than Stavanger. A possible reason for this is the experiences of many of the Stavanger participants with historical feedback. Most homes in Stavanger use mainly electrical space heat. By comparing June/July, when almost no space heat is used, to Jan/Feb, the coldest months, the contribution of space heat is revealed.

5.7. Summary of experiences with disaggregation

The customer evaluation gives a number of strong indications that the disaggregation is something which people are interested in and that it has the desired pedagogical effects. Respondents were about equally divided on whether they would like to have the information with every bill, or only once a year. Given the costs of producing the diagram, a yearly sending might be more appropriate. Another option would be to offer the diagram via an interactive internet site. In response to a question on whether people would be interested in getting the information by internet, 20% responded yes.

6 - CONCLUSIONS

Stavanger's experiences reveal that each of these various forms for consumption feedback information (historical comparative, normative and disaggregation) are highly valued by customers and in addition have the effect of increasing awareness and knowledge about energy use. In the case of historical comparative feedback, it has definitely lead to energy savings. The two new forms for feedback show promise to do the same. While the initial investments in training, programming and equipment are significant, the effects appear to be lasting and the running costs are reasonable. The benefits are considerable: increased customer satisfaction, better informed customers, and energy savings.

7 - ENDNOTES

Funding was provided by the Nordic Council of Ministers, the Energy Ministries in both countries and the participating utilities, Oslo Energi and Helsingfors Stad Energiverk.

(1) The U. S. version would not have this problem, because it would be clear that one house on the graph would represent one house in the neighbourhood.

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