Evaluation of RWE's KesS Rebate Programme for Efficient Residential Appliances

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1. SYNOPSIS

The largest single DSM programme implemented so far by a German electric utility has realised large electricity and cost savings, and revealed further improvement potential.

2. ABSTRACT

The KesS (Client energy saving Service) programme of RWE Energie AG was the largest single DSM programme implemented so far by a German electric utility. It offered a 100.- DM cash rebate to any customer of RWE Energie who bought an energy-efficient refrigerator, freezer, dishwasher or clothes washer. It was a pilot programme which started in October of 1992 and ended in 1995. In 1994, the Wuppertal Institute for Climate, Environment and Energy evaluated the programme. A combined approach comprising (1) empirical surveys of programme participants (mail survey and group interviews), appliance dealers and utility advisory staff; (2) market analysis data on retail prices and sales data of individual appliance models; and (3) technical data on energy consumption of appliances was used for the evaluation.

The programme was cost-effective from the participant and societal perspectives, but not from the utility perspective. It saved around 450 GWh of electricity, thereby avoiding over 300.000 tons of CO_2 emissions; it also saved three million m^3 of water. It demonstrated, therefore, that cost-effective DSM programmes for residential appliances are possible in Germany. This result is backed up by other recently evaluated appliance rebate programmes like those of Stadtwerke Hannover and Stadtwerke Soest. Improvements for a follow-up refrigerator/freezer rebate programme could make it cost-effective from all perspectives, including the utility perspective.

3. INTRODUCTION

Rebate programmes for efficient residential appliances, esp. refrigerators, have long been among the most common and successful demand-side management (DSM) programmes in the USA. They are implemented by many US utilities as a resource in the context of least-cost planning (LCP) / integrated resource planning (IRP) (e.g., PG&E 1990). During the last few years, utilities in Denmark (Pedersen 1993) and, increasingly, in Germany have also begun to implement appliance rebate programmes. In Germany, more than 20 utilities have started such programmes on a pilot or full-scale level during the last three years (VDEW 1994). They are comparatively easy to implement and, therefore, often used as a start for a utility's DSM activities.

In late 1992, RWE Energie AG started its KesS (Client energy saving Service) pilot programme. It offered a 54 ECU (100 DM) cash rebate to any customer of RWE Energie who bought an energy-efficient refrigerator, freezer, dishwasher or clothes washer; the rebate is the same for all qualifying models. Offering a total budget of about 54 million ECU (100 million DM) to the customers, KesS was the largest single DSM programme implemented so far by a German electric utility. It was also the first DSM pilot programme of RWE Energie for its residential customers. The programme ended in February 1995 after the budget had expired four months earlier than expected. RWE Energie now continues only the freezer part of KesS, with a budget of 11 million ECU (20 million DM) for another two years.

The background for the programme was an agreement between the Government of North Rhine-Westfalia and the utility. Not only for this and for utility regulation purposes (cf. presentation of Leprich/Schulte Janson in this Conference), a careful evaluation of costs and benefits of the programme was needed. There are also many doubts among German utility representatives about the transferability of DSM and LCP / IRP to German electricity sector conditions. Many of these doubts were offset by the fact that the programme achieved a surprisingly good participation of utility customers--more than 50 % of all customers who bought any appliance between October 1992 and February 1995 participated in it. But the KesS programme has also been criticised by environmental organisations because too many (around 50 %) of all models currently on the market are eligible in the programme.

Therefore, the impacts and especially the cost-effectiveness of the KesS programme are important not only to the regulatory authorities of North Rhine-Westfalia, but also for the future of DSM and LCP / IRP in Germany in general.

In 1994, the Wuppertal Institute for Climate, Environment and Energy evaluated the programme in co-operation with the utility and Beratungsgruppe Energie + Marketing, which conducted the empirical surveys. The results are documented in detail in a report in German language (Wuppertal Institute and BEM 1995); the purpose of this paper is to make them available to a wider, international audience.

4. METHODOLOGY OF IMPACT EVALUATION

A rebate programme provides an incentive to consumers to buy more efficient equipment, thus reducing energy (and possibly water) consumption and saving money. On the German market for electric appliances, there is a large difference between the electricity consumption of different models with equivalent functions and qualities (e.g., a 170 litre refrigerator, or a front-loader clothes washer with 5 kg capacity). Especially with refrigerators and freezers, very inefficient models use about two to three times as much electricity as the most efficient models. This *difference* between models available on today's market exists regardless of the fact that the *average* consumption of today's models has been reduced by 30 to 40 % during the last 15 years. For dish-washers and clothes-washers, electricity savings potentials are smaller, but energy-efficient models consume, on average, also less water than less energy-efficient ones. While electricity consumption was the criterion for qualifying models and electricity savings the main purpose of the programme and the main evaluation goal, we also evaluated water savings as a positive side-effect.

The main purpose of rebate programmes is to motivate consumers to buy one of the most efficient models when they buy an appliance anyway, not to make them replace old, but functioning appliances by new models of average efficiency. If they choose an energy-efficient appliance instead of an inefficient one--which they might have bought without the programme-- they will save energy (and water, respectively) regardless of their usage patterns with respect to that appliance (e.g., frequency and temperature of clothes washing). We call those consumers which have been motivated by the programme to change their decision towards an efficient model *decision-changers*.

The number of decision-changers is equivalent to the increase in sales of efficient models at the expense of inefficient ones. It is therefore crucial for the impact evaluation to identify that increase against the trend that would have taken place without the programme. The most common way to evaluate this is to start with the number of participants (i.e. those customers who have received the rebate during the programme period) and to correct for free-rider and free-driver effects. The electricity savings per decision-changer can be obtained from a technical estimate which should correct for actual behaviour. For the evaluation of KesS, we analysed a database of models sold in North Rhine-Westfalia (see below and Table 1). Unfortunately, no comprehensive "in-field" measurements of actual consumption data (see section 7.1) have been carried out in Germany so far, and due to high costs they were not possible in this project, either. Therefore, we had to rely on an engineering estimate (cf. Table 1). For dish-washers and clothes-washers, this included results for washing frequency and for the shares of washing temperatures from a survey by German utilities.

The *total electricity saved by the programme* was then obtained by multiplying the number of decision-changers (number of participants minus number of free-riders plus number of free-drivers) times the electricity savings per decision-changer, and correcting the result for behavioural effects. This method is widely used by US utilities, e.g. Pacific Gas & Electric (PG&E 1990), to evaluate rebate programmes for household appliances. Its advantages are that it is straightforward and can yield rather accurate results if applied properly, with less analytical effort than, e.g., a conditional demand analysis of participant's bills (Parti et al. 1993). The main analytical problem, however, lies in determining the following effects: *(se next page)*

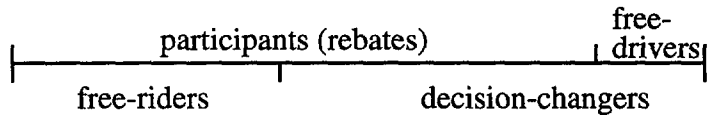
(1) Free-rider effects
A free-rider is a utility customer who would have bought an efficient appliance without the programme but receives a rebate.

(2) Free-driver effects
A free-driver is a utility customer who buys an efficient (eligible) appliance because of the programme--maybe because he has received advice on efficient appliances by the utility or because appliance dealers have changed their stocks towards more eligible models--but does not claim the rebate.

(3) Behavioural effects
Both reinforcing and offsetting behavioural effects are possible with rebate programmes. A reinforcing effect may be that participants use their new appliances more energy-consciously than before, because they have been motivated to do so by the advice connected with the programme. Offsetting effects include "rebound" effects (customers use their new appliances less consciously or more intensively than before because they rely upon the greater energy efficiency of the new technology) and "snapback" effects (customers use the rebate to buy larger, more energy-consuming appliances than originally planned). All those effects can only be measured by empirical surveys.

The following figure displays the relationship between the groups of utility customers that had to be evaluated.

***Figure 1:** Groups of utility customers affected by the programme*



The following efforts were taken to collect data for the evaluation:

- Utility monitoring of participants, individual appliance models purchased by participants, customer consulting contacts concerning residential appliances, and programme costs;
- Detailed evaluation of databases including technical features for (1) models available on the market during programme years, (2) models purchased by participants, and (3) models sold in the region of North Rhine-Westfalia; the latter database was purchased by the utility from a market research institute and also contained data on average retail prices;
- empirical surveys of programme participants (mail survey and group interviews), appliance dealers and utility advisory staff. These surveys also aimed at gaining insight into more qualitative aspects and at contributing to a process evaluation of the programme. They are described in more detail in the following section.

The following table shows how the data obtained from these instruments were used to evaluate the parameters described above.

***Table 1.** Which instruments/data were used to evaluate which parameter?*

parameter	data source / calculation
number of participants	directly monitored by utility
free-rider fraction	empirical survey of participants and data on market share of models
number of free-drivers	monitoring of customer consulting contacts concerning appliances by utility, correcting for numbers of rebates, erroneous contacts (customers were not RWE Energie customers or bought non-eligible models), and customers who would have contacted without the program
energy saved per decision-changer	difference between weighted averages of standard consumption (from databases) of eligible and non-eligible models; weighting factors = sales of individual models; actual consumption calculated as technical estimate, with average lives of 15 years for refrigerators/freezers, 12 years for dish- and clothes-washers
behavioural effects	empirical survey of participants and technical estimates

5. RESULTS OF EMPIRICAL SURVEYS

The following surveys were conducted for the evaluation of the KesS programme:

- mail survey of 2.500 participants (5.000 questionnaires were mailed of which about 50 % were answered);
- seven focus group discussions with selected participants;
- 35 interviews with retail and wholesale appliance dealers;
- 3 interviews with appliance manufacturers; and
- 11 interviews with local energy advice centre staff of RWE Energie.

One of the most striking results of the mail survey was that there were not only "pure" decision-changers (i.e. participants who had consciously changed their model choice due to the programme) and "pure" free-riders (i.e. participants who said they had fixed their model choice from the very beginning) among the participants. On average of the five time periods between July 1992 and January 1994 that were analysed separately, only 46 % of the participants could be identified as belonging to one of these groups: 16 % "pure" decision-changers and 30 % "pure" free-riders. While the share of "pure" free-riders is diminishing during the programme, the share of "pure" decision-changers is slightly increasing.

More than half of the participants surveyed, however, were neither "pure" decision-changers nor "pure" free-riders. Instead they said they were more or less influenced by the programme. Even though they did not change their model selection consciously, based on detailed information about consumption data, a part of them may have switched to more efficient models due to the programme. Twenty four percent of the participants said that they had known about the rebate and looked only for eligible models; there is a certain probability that these customers would have bought non-eligible models had the programme not been in place. We called this fraction of participants "partial" decision-changers. A further 30 % did not inform themselves actively about the consumption data of different appliance models; they may have benefited, however, from the changes in appliance stocks available with retail dealers that occurred due to the programme, i.e. a supply effect.

In order to calculate the electricity savings from these two groups of customers, we used a probability derived from the analysis of databases on the market share of eligible models (s. previous section) to statistically divide these participants into "pure" decision-changers and "pure" free-riders. It has to be noted, however, that this is quite a reductionist point-of-view: the *impact* of a rebate programme on the market for residential appliances is much more complex than the simple mathematical model we used to obtain quantitative data for the impact *evaluation*.

This important finding was confirmed by further quantitative and qualitative results of the surveys among participants, dealers, manufacturers, and utility advisory staff:

- First of all, a rebate programme does not mainly achieve its impact by making consumers inform themselves in detail about electricity (and water) consumption data of different models, who then decide informedly and consciously. Rather, the relevant decision for the majority of appliances purchasers is "eligible or not?". They know they want to buy "an efficient appliance", but in deciding about this they rely upon the information "this model is eligible for the KesS programme". The rebate, therefore, has the function of a label; it has become a well-known mark of quality in the utility's supply area.

- This mark of quality reached its full impact only after several months when appliance retailers had changed their model stocks according to the programmes criteria for eligibility. A minimum duration of two or three years seems to be necessary for a rebate programme in order to give retailers secure market signals for their model stocks. For dish-washers and clothes-washers, the share of eligible models available in shops had reached 86 % in 1994, up from 66 % in 1993 (and probably a little lower before the programme). In a few cases, even manufacturers have optimised models in order to fulfil the criteria of the programme.

- Consumers lacked and urgently missed more information about electricity consumption *costs* of the different models. In Germany, there is no information provided on this, neither by manufacturers nor dealers nor utilities (including RWE Energie during the programme). It has turned out that electricity consumption, "kilowatt-hours" etc. are very abstract figures for most consumers. If they are expressed in monetary terms, however, the purchase price of an appliance and its electricity costs will become comparable for consumers, thus enabling them to perform a more informed decision based on an analysis of overall costs.

- We were not able to detect or even quantify any "rebound" or "snapback" effects. Some participants used the value of the rebate to buy more expensive models; the extra cost of these models may, however, be the result of

various causes (e.g., more functions, more efficient model, larger volume) with varying effect on electricity consumption. Instead, we found that the percentage of participants who answered that they used energy-saving features of their new appliances (e.g. special programmes, lower washing temperature, or washing without pre-wash functions) more often was larger than the percentage of participants who answered that they used these features less often. This may be an effect of the information associated with the programme.

6. COST-BENEFIT ANALYSIS

The parameters for cost-benefit analysis were evaluated separately for three sub periods of approximately one year each, and for a total of one million rebates. For the first two years, empirical data were available; for the last year, data were extrapolated from those for the first two years. For the parameters: participants, free-riders, and average electricity (and water) savings per appliance, the analysis was carried out for 25 different classes of appliances (6 for freezers, 14 for refrigerators, 2 for dish-washers, and 3 for clothes-washers).

6.1 Electricity savings and other parameters for cost-benefit tests

6.1.1 Electricity saved by the programme

Using the methodology and data described in section 4 (see Table 1), we calculated the following electricity savings for the KesS programme:

Table 2. *Electricity saved by the programme during useful life of appliances*

	per appliance	**participants less free-riders**	**free-drivers**	**behavioural effects**	**total**
	in kWh	in GWh	in GWh	in GWh	**in GWh**
freezers	*1554*	151	18	0	**169**
refrigerators	*1037*	111	18	0	**129**
dish-washers	*520*	28	6	13	**48**
clothes-washers	*346*	52	8	47	**107**
total		**343**	**50**	**61**	**453**
average	***836***				

Due to rounding errors, rows and columns may not sum up to totals given.

The free-rider fractions for the KesS programme are rather high: on average 59 % of the participants had to be counted as free-riders in the evaluation, with 47 % for freezers, 60 % for refrigerators, 72 % for dish-washers, and 57 % for clothes-washers. This result is not astonishing recalling that about 50 % of all models available on the market were eligible for the rebate.

Besides electricity, the programme has also saved 3 million m^3 of water through more efficient dish-washers and clothes-washers.

6.1.2 Avoided costs

There have not been any comprehensive studies in Germany on the long-run marginal *system* costs of electricity, including generation (fixed and variable costs), transmission, distribution, and line losses. Since it was not the task of our study to attempt this, it was agreed to use a bandwidth of avoided costs. This was to reflect different supply situations but did not refer explicitly to different levels of capacity savings by different appliances (refrigerators/freezers being base load, while dish- and clothes-washers have a larger share of medium and peak loads). The bandwidth was set to the following values:

lower boundary of avoided costs = 0,059 ECU/kWh (0,110 DM/kWh);
upper boundary of avoided costs = 0,092 ECU/kWh (0,170 DM/kWh).

In addition to this, avoided external costs have to be taken into account for the societal cost test. These costs being an even more complex and controversial issue, it was agreed to use a bandwidth of between 0,011 and 0,016 ECU/kWh

(0,02 to 0,03 DM/kWh) as a proxy for avoided external costs. As a rather rough estimate of avoided water costs, a range between 1,60 and 3,20 ECU/m^3 (3,00 to 6,00 DM/m^3) was used. All values given for avoided utility and external costs are discounted at 4 % real discount rate.

6.1.2 Programme costs

These include:

(1) Rebates
The total of rebates amounts to 54,1 million ECU (100 million DM).

(2) Programme administration and marketing costs
These costs were monitored by the utility until January 1994 and extrapolated until the end of the programme. The result totals 21,9 million ECU (40,6 million DM), of which 7,4 million ECU (13,7 million DM) is for marketing, 13,9 million ECU (25,7 million DM) for administration (advice to customers, rebate payment and accounting), and 0,6 million ECU (1,2 million DM) for development and evaluation of the programme.

(3) Extra costs of more efficient technology (participant costs)
If the more efficient appliances are more expensive to manufacture, this additional cost of technology will have to be accounted for in the total resource cost and societal cost tests. Since there are no technology-based studies on this subject, like they have been conducted for the USA or Denmark (Pedersen 1992), for the German market, we used the differential in average retail prices between eligible and non-eligible models as a proxy. Price data were obtained and evaluated by RWE Energie from a market research institute. The following costs were obtained:

Table 3. Additional costs of eligible over non-eligible models incl. VAT

freezers	78.- ECU	(144.- DM)
refrigerators	42.- ECU	(77.- DM)
dish-washers*	38.- ECU	(70.- DM)
clothes-washers*	54.- ECU	(100.- DM)

** additional costs only partially attributed to efficiency, since most of the additional costs are due to other functions (e.g., more programmes)*

6.2 Results of cost-benefit tests

For assessing the costs and benefits of the KesS programme, we used four of the standard tests used in California and most other US states: the participant test, the total resource cost (TRC) test, the societal cost test, and the utility cost test (CPUC and CEC 1987, Krause and Eto 1989). We did not evaluate the non-participant or rate impact measure (RIM) test. This is not a cost-effectiveness test; it rather measures effects on equity: are participants cross-subsidised by non-participants through higher rates? While it is widely held that such cross-subsidies should be minimised, the use of RIM vs. TRC as a basis for DSM programme selection is a contentious issue. One way of addressing the issue is to ensure that the portfolio of utility programmes available is sufficiently broad as to offer an opportunity for participation to all customers, rather than rejecting single DSM programmes which are cost-effective but fail the RIM test.

6.2.1 Participant test

A necessary precondition for the success of a DSM programme is the cost-effectiveness of participation to utility customers. From the participant's perspective, the costs are the additional costs of eligible vs. non-eligible models (see above). Their benefits include both a lower electricity bill and the rebate. Yielding benefit-cost ratios well above 1,0 (between 2,9 for clothes-washers and 4,7 for refrigerators on average), participation was clearly cost-effective for utility customers. In fact, savings in electricity costs alone are much higher in most cases than the extra cost of efficient models. The rebate is nevertheless necessary to overcome the information and risk barriers mentioned above.

6.2.2 Total resource cost, societal cost, and utility cost tests

The meaning and the cost / benefit components of these tests are as follows:

(1) Total resource cost test

This test measures the cost-effectiveness of a DSM programme to society as a whole, without looking at perspectives of different parts of society. If it has a benefit-cost ratio equal or greater than one, the total of the costs of energy supply *and* energy end-use efficiency for a certain level of *energy service* (e.g., refrigerated volume) will be lowered by the DSM programme. The benefits from this perspective are the avoided long-run marginal costs of supply (without external costs) times the energy saved. The costs are the extra costs of the more efficient appliances plus programme marketing and administration costs. Rebates are not included here since they are only transfers from one part of society (the utility) to another part (the participants).

(2) Societal cost test
This test has the same perspective as the total resource cost test except that it takes the benefits of avoided external costs into account.

(3) Utility cost test
From the utility perspective, rebates clearly are costs while extra costs of efficient appliances incurred by participants are not. Programme marketing and administration costs also have to be counted. On the benefit side, avoided utility supply costs, but not external costs are included. The utility perspective thus is a perspective of the *total* of the *costs* of energy supply and energy end-use efficiency for a certain level of energy service *to the utility*; it is therefore often also called the revenue requirements or total ratepayer perspective. It has to be noted, however, that this perspective gives no information about the economic impacts of a DSM programme on the utility: these depend on how costs, benefits and diminished kWh sales are incorporated into the setting of electricity tariffs.

For these three perspectives, benefit-cost ratios were calculated using all electricity and water saving components discussed above. The following table gives the results.

***Table 4.** Benefit-cost ratios for the total resource cost, societal cost, and utility cost perspectives, at lower and upper boundaries of avoided costs*

perspective	**total resource cost**		**societal cost**		**utility cost**	
avoided cost case	lower boundary	upper boundary	lower boundary	upper boundary	lower boundary	upper boundary
freezers	0,88	1,36	1,04	1,60	0,71	1,10
refrigerators	0,74	1,14	0,87	1,34	0,38	0,58
dish-washers	0,59	0,97	0,67	1,09	0,26	0,43
clothes-washers	0,65	1,12	0,72	1,23	0,38	0,66
KesS average	0,72	1,16	0,83	1,33	0,42	0,68

7. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

From the societal cost and total resource cost perspectives, the programme reached cost-effectiveness for the upper boundary of avoided long-run marginal costs. It only slightly missed cost-effectiveness if the lower boundary of avoided costs is used for evaluation. Due to rather high free-rider fractions, however, the programme clearly missed cost-effectiveness from the utility perspective. From this we draw the conclusion that the share of eligible models (presently 50 % of all models available) should be reduced. Although participation levels will probably be diminished by doing so, free-rider fractions will probably be diminished, too. Missing cost-effectiveness from the utility perspective also indicates that the rebate level might be too high.

There are also differences between the different classes of appliances: while freezers reached cost-effectiveness for all three cost-benefit tests, dish-washers performed rather poorly.
It can be stated, however, that the KesS programme has demonstrated considerable savings potentials from energy-efficient residential appliances in the German market. It has further demonstrated that utility rebate and information programmes can contribute to realisation of these potentials, and to a market transformation through reactions of appliance dealers and maybe even manufacturers. The utility has also become better-known among its customers. More than 20 utilities who have launched similar programmes show the broad acceptance that rebate programmes have gained in Germany through the KesS programme.

Before presenting our recommendations for the improvement of residential appliance rebate programmes in section 7.3, I turn to improvements in evaluation techniques and compare the results of KesS to similar rebate programmes recently implemented in Germany.

7.1 Potentials for enhancement of evaluation techniques and accuracy

We are aware of the fact that there remain considerable uncertainties on the mean values for most parameters calculated, and following from this, also for the results of cost-benefit tests.
Possibilities to enhance evaluation techniques and accuracy include:

- Direct measurements for a sample of households could increase knowledge on actual--instead of standard--consumption data for all types of appliances. Because of the high costs for such measurements, this should be a task for a consortium of utilities and/or financed by the state.
- Further information on free-rider and free-driver fractions might be obtained by an empirical survey of non-participants, i.e. utility customers who bought an appliance during the programme but did not receive a rebate. This might provide insight in the way customers react on the offer of a rebate, and which barriers have to be overcome in order to increase participation further.
- The results of a free-rider/free-driver/technical data analysis might be cross-checked by other approaches, e.g. a conditional-demand analysis using billing data (Parti et al. 1993). It may be difficult, however, to detect the consumption difference between the (slightly more efficient)*new* appliances bought by a participant sample and the *new* appliances bought by a control sample through this approach. Another approach used to cross-check the evaluation of PG&E's refrigerator rebate programme of 1991 was based on monitoring the number of sales inside the utility area and in control areas, before and during the programme (Van Liere, Winch, and Quigley 1993). The difference in the average consumption of *all* models sold in the utility area vs. *all* models sold in the control area(s) can then be attributed to the programme, without monitoring participants, free-riders, or free-drivers. Although we had sales data, their resolution in time and space was not high enough to perform such an analysis.

7.2 Comparison to other residential appliance rebate programmes in Germany

During the last three years, about 25 utilities in Germany have implemented appliance rebate programmes, 15 of which replicated the KesS programme. About 15 to 20 % of German households are now offered rebates for electric appliances. Most of these utilities are small- to medium-sized municipal utilities. Some of them developed their own programme designs; most offer rebates only for 10 to 20 % of the most efficient models available on the market. Our institute evaluated two of them: Stadtwerke Hannover's eight-month pilot programme for refrigerators and freezers, conducted in 1993/94 in the framework of the LCP case study sponsored by the EU SAVE programme (Öko-Institute and Wuppertal Institute 1995), and Stadtwerke Soest's 1994 rebate programme for refrigerators, freezers, and clothes-washers. Stadtwerke Hannover is a medium-sized utility, serving about 270.000 households, while Stadtwerke Soest is serving 20.000 households. The following table summarises key features and evaluation findings.

Table 5. KesS programme compared to two other electric appliance rebate programmes

utility	RWE Energie	Stadtwerke Hannover	Stadtwerke Soest
households served	2.900.000	270.000	20.000
duration of programme	3 years	8 months	1 year
rebate level (ECU)	54.-	27.-	54.-/81.-
types of appliances:			
freezers	x	x	x
refrigerators	x	x	x
dish-washers	x		
clothes-washers	x		x
fraction of models eligible	50 %	17 %	25 %
participation rate	55 %	9 %	13 %
customers who were given advice but did not claim rebate	9 %	20 %	n.a.
energy saved per decision-changer	836 kWh	1.633 kWh	1.517 kWh
free-rider fraction	59 %	40 % *	43 % *
benefit-cost ratios:			
total resource cost test	0,76 ... 1,22	0,77	1,15
societal cost test	0,87 ... 1,40	1,01	1,32
utility cost test	0,41 ... 0,67	0,83	0,68

* *Estimate*

Although this surely is not a comprehensive database, the following trends can be observed:

- Participation has been much lower in both the smaller utilities' programmes than in the KesS programme. Reasons for this may include less comprehensive and sophisticated marketing, shorter duration of programme, and barriers for purchasing eligible models (e.g. dealers not having changed their model stocks and advice).

  While there seem to be economies of scale for marketing efforts, the close contact of a small municipal utility (like Stadtwerke Soest) to its customers can also enhance participation. Joint marketing by smaller utilities could enhance participation and cost-effectiveness. As noted earlier, the duration of a programme is also important in order to get both customers and dealers familiar with it.

- The smaller the fraction of models eligible, the smaller is the free-rider fraction, and the larger is the energy saved per appliance. This shows when comparing KesS to Stadtwerke Hannover's pilot programme. Despite low participation rates, the cost-effectiveness of that programme (calculated with avoided costs nearer to the lower boundary for the KesS evaluation) is close to that of the KesS programme; for the utility cost test it is even better. This is due (1) to the fact that only refrigerators and freezers with higher savings per appliance were included in the programme, (2) to the rebate being only half as high as in the KesS programme, (3) a lower free-rider fraction (although uncertainty levels are significantly higher here than in the KesS survey) and (4) a large number of free-drivers (who caused no rebate costs but only for the advisory service they received).

7.3 Recommendations for an improved appliance rebate programme

From the evaluation of KesS and other rebate programmes for electric appliances in Germany we conclude that the following changes should be made in designing such programmes:

- Such programmes should continue for several years in order to achieve full participation by both sides of the market: customers and suppliers, and in order to give every customer the possibility to participate. Of course, cost-effectiveness of the programme should be evaluated regularly.
- For refrigerators and freezers, the fraction of eligible models should be around 25 %. Eligibility criteria and rebate levels should be oriented at the EU label for refrigerators and freezers, making them much easier to understand: for appliances of EU label category A a rebate of ca. 50.- ECU is appropriate, for category B ca. 25.- ECU might be offered. In addition to this, the utility should inform its customers about the difference in *costs* of the electricity consumed during the useful life for eligible and non-eligible models--an information not given on the EU label but critical to the consumer for making his decision.

  A forecast we made for such an improved design but based on the experience of the KesS programme resulted in cost-effectiveness also from the utility perspective, while electricity savings for refrigerators and freezers are predicted to reach the same level--110 GWh lifetime savings per year of programme duration--as in the KesS programme. This result follows from the assumptions of 30 % participation rate (compared to 55 % in the KesS programme), a free-rider fraction of 42 % (average of refrigerators and freezers, compared to 53 % in the KesS programme), and from a higher average electricity conservation per appliance due to lower and better shaped consumption boundaries for qualifying models (EU label criteria compared to KesS criteria).
- For clothes-washers, only a rebate of ca. 25.- ECU is suitable, while eligibility criteria should be tightened here as well. An additional rebate of ca. 25.- ECU, however, might be offered for models which can use hot water (additional to cold water). In Germany, there are only five models available which are ready for connection to hot water from non-electric sources. Because of the economic and environmental benefits, however, this technology should be stimulated by utility DSM programmes.
- Dish-washers should be excluded from rebate programmes in the present market situation. Only for connection to hot water from non-electric sources (which is possible with nearly all models but rarely done by customers or their installers), a rebate in the order of 25.- ECU is suitable.
- Apart from rebate programmes, "golden carrot" efforts (a group of utilities offering a considerable amount of money to manufacturers: the one who develops and sells the most efficient appliance which meets a set efficiency target in a given time takes the prize) should be pursued in order to address special market transformation targets. For the German market, such a target might be the introduction of a furniture-integrated refrigerator which is as efficient as stand-alone models available today.

In total, the chances are good that improved rebate programmes for electric appliances can achieve better participation levels and cost-effectiveness for all relevant perspectives. They should therefore become standard DSM

programmes for German utilities as long as the large differences in electricity consumption between different residential appliance models on the market exist.

7.4 Further recommendation concerning DSM activities

From the results of the LCP case study for Stadtwerke Hannover (Öko-Institute and Wuppertal Institute 1995) we have no doubt that, like in North America, the bigger and more cost-effective potential for electricity conservation programmes exists in the commercial and industrial sectors. German, and generally European, utilities should address these sectors with much more DSM activity than today.

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