

Improving energy efficiency for low-income families

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Abstract

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety has financed a pilot project to improve the efficiency of electricity use in low-income households. The pilot project was very successful, and the Ministry is planning to implement this program nationwide.

The program is a combination of energy audits, advice, direct installation of efficiency measures, financial incentives and micro-credit.

All participating households received a free energy-audit from the energy agencies of Freiburg and Berlin. The energy-audit was combined with a set of measures called the “instant help package” – the implementation of compact fluorescent light bulbs, the elimination of stand-by losses through switched extension leads, as well as water-saving measures and timers to reduce losses in electric water heating.

If the households had an old fridge with an energy saving potential of more than 200 kWh per year, a financial incentive of 200 Euro was offered to buy a high efficient refrigerator of the efficiency class A++, or 300 Euro for a combination of refrigerator and freezer (efficiency class A++).

As households with low incomes usually do not have enough money to invest into an expensive, highly efficient appliance, they can get a micro-credit to finance the difference between price and financial incentive (usual 200 to 300 Euro).

With this program, 18 percent of electricity consumption could be saved with costs less than 7 cents per kWh. The aver-

age advantage per household was 840 Euros (not taking into account any rise in electricity prices), and the reduction of CO₂ emissions was 3.7 tons per household.

The starting point

Retail electricity prices have risen by some 25% in Germany over the past five years. Low-income families suffer disproportionately from such price hikes. The government therefore began looking into ways of helping such households. A pilot project was conducted to see the effects of the immediate savings potential in these households. Low-income families in Berlin and Freiburg were able to take advantage of free energy audits offered by the energy agencies of Freiburg and Berlin. The energy-audit was combined with a set of measures called the “instant help package” – the implementation of compact fluorescent light bulbs, the elimination of stand-by losses through switched extension leads, water-saving measures, and timers to reduce losses in electric water heating.

Then, a study was conducted to see how much electricity had been saved as a direct result of these 108 energy audits. Finally, a detailed cost-benefit analysis was conducted for these programs.

How were these analyses and direct installations conducted?

The energy audits were conducted according to a set procedure:

- First, the objectives of the project were briefly explained to the customer and some basic data were collected (number

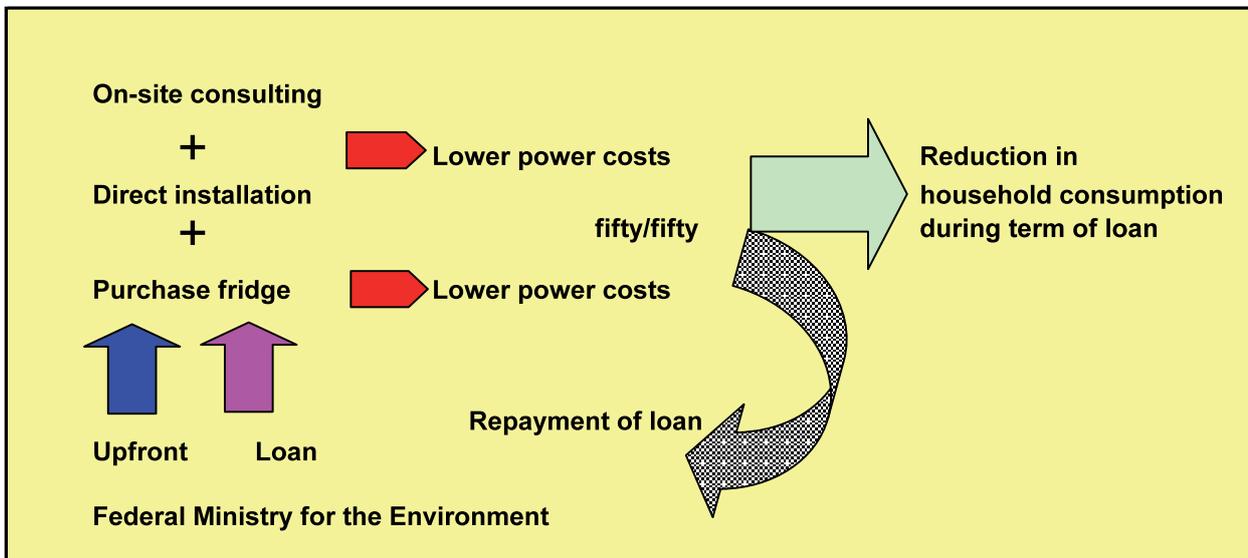


Figure 1: Financing for a new refrigerator from avoided power costs due to the instant help package and a more efficient refrigerator.

of people in household, size of apartment, electricity and water consumption, and reading of power meter).

- Residents were then questioned to determine their own awareness about power consumption and their behavior as consumers. The questions on consumer behavior were also designed to suggest specific tips on how to improve behavior.
- In the next step, electric appliances, the lighting situation, and related consumer behavior were investigated. Standby losses were identified and recommendations provided. Power strips and timers were directly installed to reduce standby losses as part of the “instant help package.”
- Complex fluorescent bulbs replaced as many as five conventional light bulbs. In selecting the five light bulbs, special attention was paid to choose the spots with the longest operating hours.
- Ways to conserve water were also investigated. If possible, a water-saving shower head was installed, as were an aerator for the sink and a stopper for the toilet’s tank.
- For a week to ten days, a power measurement device was installed to measure the power consumption of freezers and refrigerators considered likely candidates for replacement. Once measurements had been completed, customers returned the measurement device in the shipping boxes provided to the energy agency for assessment.
- Households that could save more than 200 kWh per year if a new refrigerator or freezer was provided were granted up to 300 Euro (but no more than half of the purchase price for the new appliance). Furthermore, they were offered loans with a term of up to three years. Depending on the amount and term, the loans were tailored to the appliance’s purchase price and the expected cumulative savings from the instant help package and the new refrigerator to ensure that the loan installments did not exceed the savings from

lower power costs. The savings in power costs thus had to cover the loans.

- In addition to the tips on more efficient power consumption which has been offered to customers during the energy audits, four weeks after the audit customers received a written report on the audit’s findings, including the power-saving effects of the instant help package and additional tips on conserving electricity.

The financing model is illustrated in Figure 1. Below, the situation of a specific customer is presented.

This three-person household consumes 4,777 kilowatt-hours per year. The old refrigerator consumed 426 kWh per year; the freezer, 605 kWh. A combined refrigerator/freezer unit with an annual consumption of 181 kWh replaced both of these devices. Hence, 850 kWh per year was saved. The unit chosen cost 630 Euro.

This household received a subsidy of 300 Euro within this project (half of the purchase price up to a maximum of 300 Euro). Another 300 Euro was granted as a loan, and the household had to pay 30 Euro from its own pocket.

The loan has a term of two years, resulting in a monthly installment of 13.10 Euro. The monthly savings alone from the use of this new appliance amount to 14.20 Euro. In addition, the household benefits from other power savings from the instant help package, resulting in annual power savings of 200 kWh or 40 Euro per year.

Once the loan has been paid off, the household will save some 16 Euro per month in power costs.

Results of the pilot project

CONSERVATION SUCCESS

The measures described above (instant help package and new refrigerator) resulted in an average power consumption reduction of 18%. However, the savings ratios differed widely from one household to the other. Figure 2 shows the savings ratio for

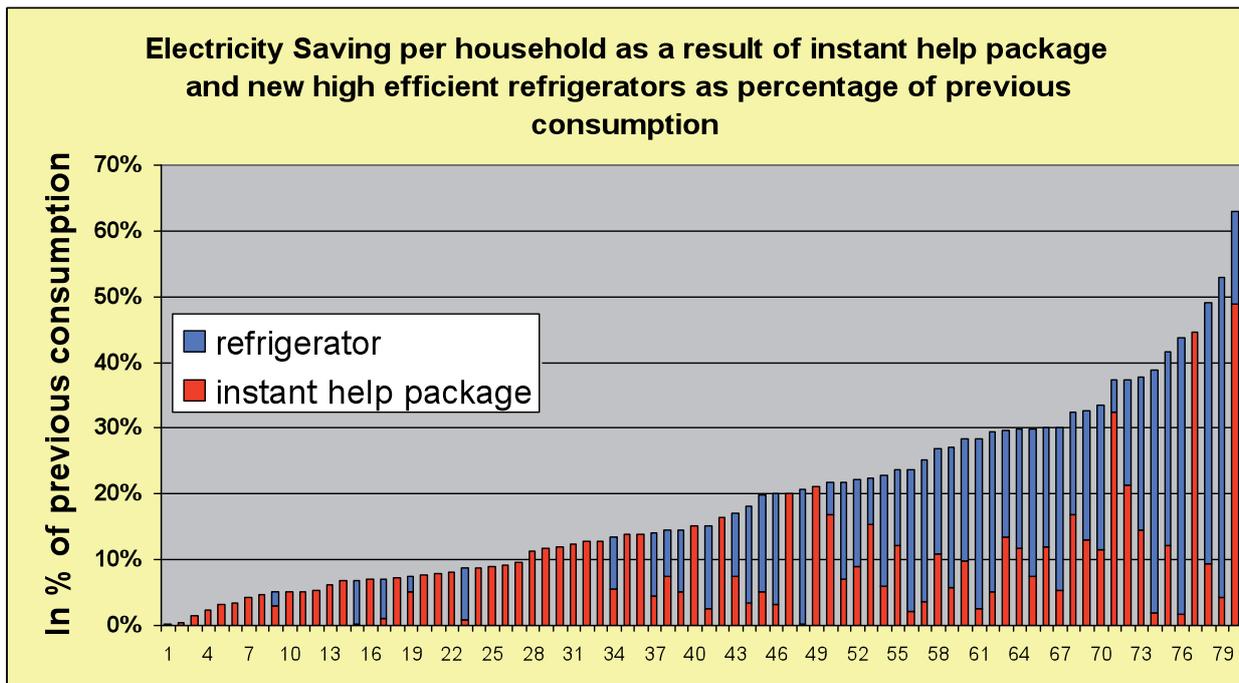


Figure 2: Power consumption savings in low-income households

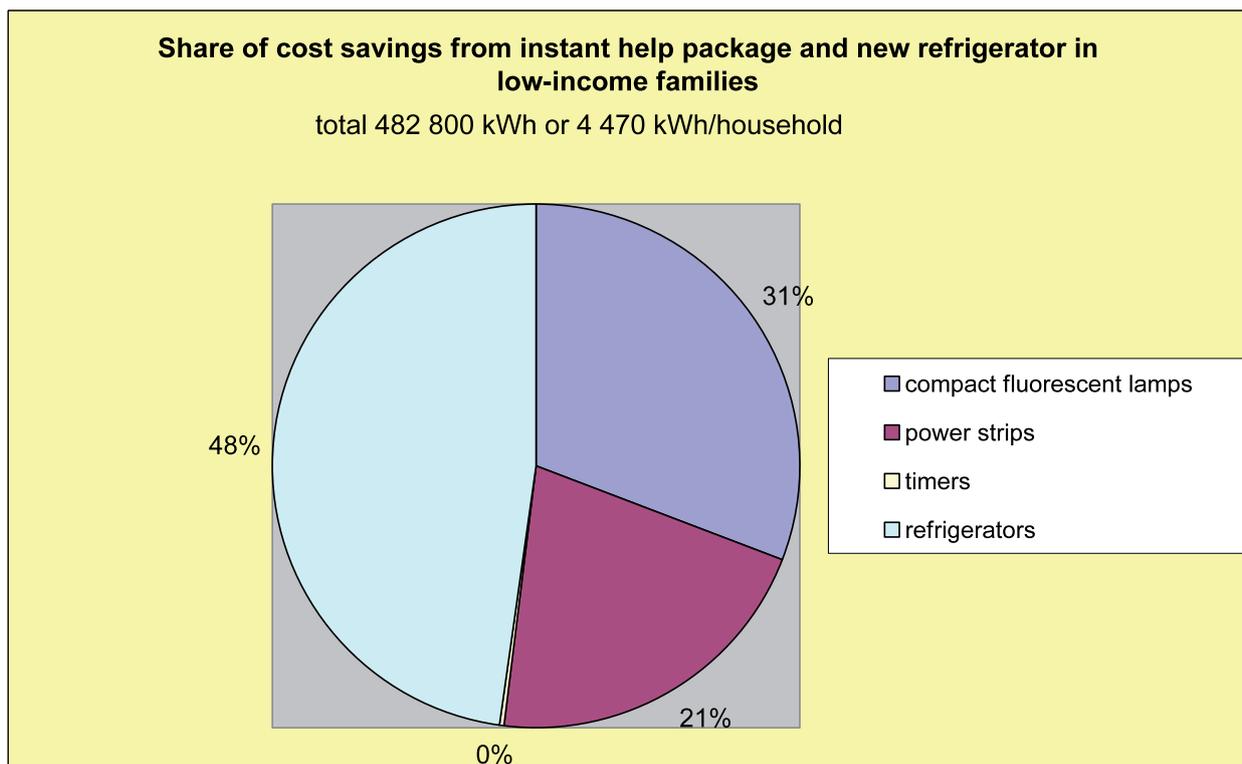


Figure 3: Savings from the instant help package and efficient refrigerators in low-income households

all of the 80 household customers studied in Freiburg. Here, a distinction is made between savings from the instant help package and savings from the new refrigerator.

On the average, these households reduced their power consumption by 18%.

Figure 3 shows the energy savings in terms of technology. Here, we see that replacing the old refrigerators and freezers

with new, more efficient units reduces power consumption considerably in low-income families. Often, such households use very inefficient appliances that other households have already disposed of.

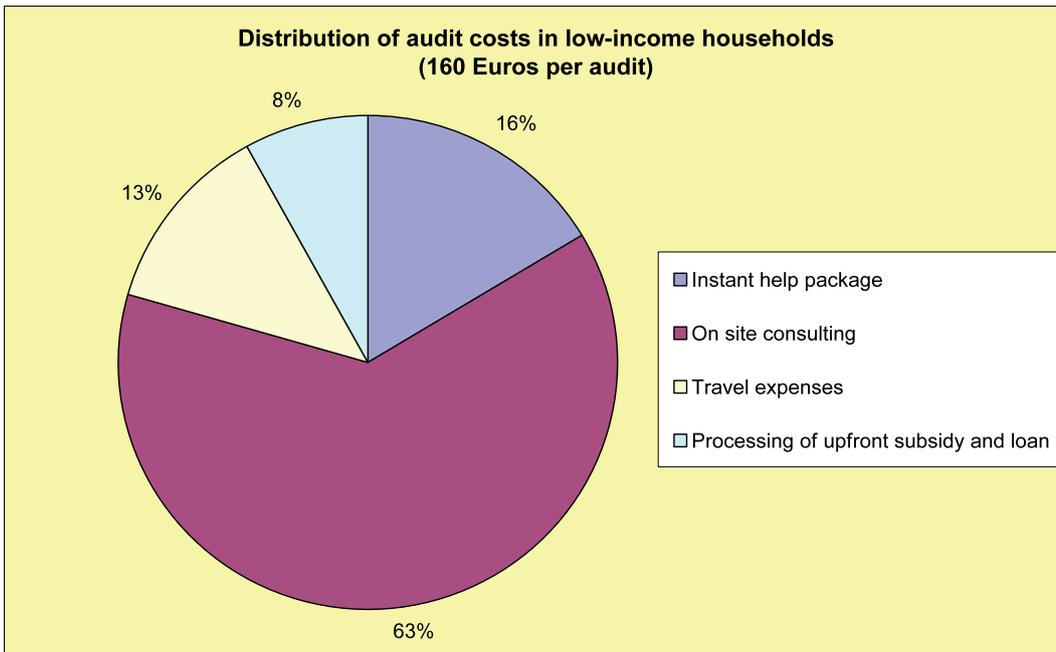


Figure 4: Share of audits and instant help package per customer as part of total costs

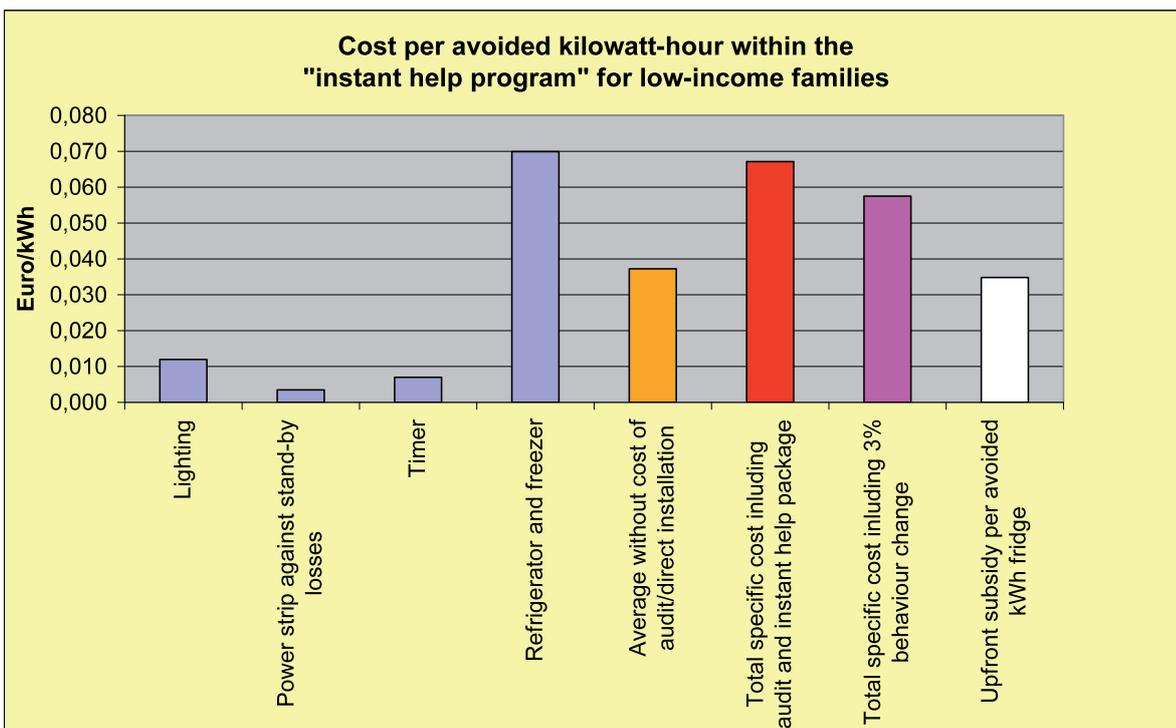


Figure 5: Specific cost of efficiency measures with and without audit costs

COSTS AND BENEFITS OF ENERGY AUDITS AND DIRECT INSTALLATIONS

Costs of energy audits

Below, the costs of energy audits and direct installations are explained. First, the individual technologies and project stages are presented; then, an overview of the entire package (direct installation plus new refrigerator) is provided.

The project set aside 26 Euro (net) in financial aid per household.

An energy audit (without the cost of the instant help package) for low-income households was estimated at 100 Euro. The average audit was assumed to last 1.5 hours not including an hour of preparation and follow-up time (assessment). At an hourly rate of 40 Euro, the cost was therefore 100 Euro per audit (including preparation and follow-up). In addition, travel costs were estimated at 20 Euro per audit (including the cost of travel time). The cost of each direct installation (on a cost-plus instant help package) was calculated to be 146 Euro (net).

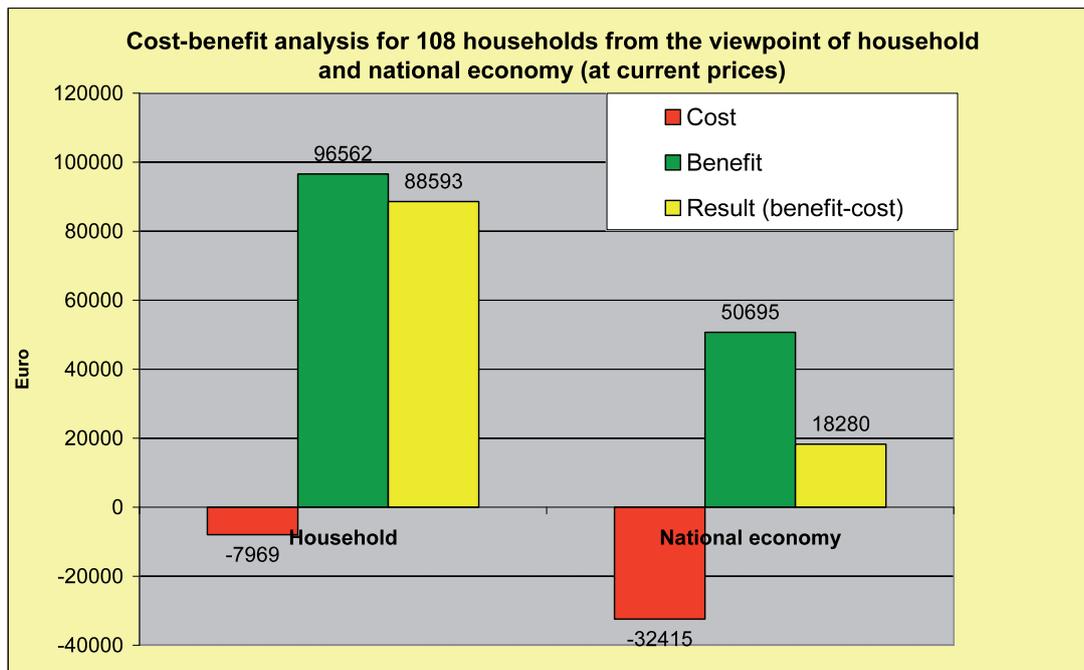


Figure 6: Balance sheet from the perspective of participating households and national economy

An additional 40 Euro was added to cover the processing of the upfront subsidy for the purchase of the refrigerator and the signing of the loan (36 households). In total, a customer who uses a loan to purchase a refrigerator using the upfront subsidy granted after an energy audit incurs additional expenses in the amount of 186 Euro.

The costs are estimated at 160 Euro per customer on the average for the energy audit with and without a new refrigerator.

Cost-benefit ratio for individual energy-saving technologies and the overall instant help package

First, the cost of individual energy-saving technologies are juxtaposed to the power savings that result from the use of these technologies. Both capital costs (interest) and expected electricity price hikes are left out of the equation. The power savings were calculated for the service life of the technology used. Compact fluorescent lamps were assumed to have a service life of 10,000 hours; power strips and timers, 10 years; and refrigerators, 15 years.

The costs per avoided kilowatt-hour are less than one Euro-Cent per kilowatt-hour for power strips and timers. When compact fluorescent lamps were installed, the avoided kilowatt-hour cost 1.2 cents, whereas the specific cost per avoided kilowatt-hour was 7 cents for new refrigerators. On the average, an avoided kilowatt-hour cost 3.7 cents/kWh for all of the efficient technologies used. If we then add in 130 Euro per audit (160 Euro per audit minus the cost of the instant help package), then the specific cost of an avoided kilowatt hour of electricity is 6.7 cents. If we then also assume that the households that took part further reduced their power consumption by 3% as a result of consultation and awareness-raising, the specific cost per kilowatt-hour drops to around 5.7 cents/kWh (see Figure 5).

Expenses from the federal government for the upfront subsidy for refrigerators are listed separately in this calculation

because they do not represent costs, but rather transfer payments. At 236 Euro per subsidy on the average, they amount to 3.5 cents per avoided kilowatt-hour.

Cost-benefit analysis from the viewpoint of households and the national economy

The 108 households will save an estimated total of 96,600 Euro in power costs for the service life of the technologies used if power prices do not rise. The households incur nearly 8,000 Euro in costs (purchase price for refrigerator minus upfront subsidy). From the viewpoint of these families, the program is very effective. The net benefit is around 88,600 Euro, which is equivalent to 820 Euro per family.

In the macroeconomic calculation, the cost of these efficient technologies and audits are juxtaposed with the avoided power generation and distribution costs, which were assumed to be 0.105 Euro/kWh. Avoided external costs were not included in the calculation.

The 32,400 Euro in technology and consulting costs were clearly compensated by avoided generation and distribution costs and the amount of some 50,700 Euro. The net benefit is calculated at 18,300 Euro. Macro economically, the cost-benefit ratio is therefore 0.64. In other words, the macroeconomic benefits easily cover the costs of the project (32,400 Euro).

Avoided cost for CO₂ emissions

The macroeconomic CO₂ avoidance costs can be derived from the figures given above: minus 46/ton of CO₂. The macroeconomic costs for these power conservation measures implemented in low-income households are therefore lower than the expenses that would otherwise have been incurred for power generation and distribution (10.5 cents/kWh).

Recommendation and further development

Based on the results of this pilot project, the German Environmental Ministry was advised to continue to pursue the conservation concept presented here. The German Ministry for the Environment, Nature Conservation and Nuclear Safety follow this recommendation and announced the launch of a similar project at the end of January 2009 to be conducted by Germany's Caritas Association and the Association of German Energy Agencies. More than 30,000 households are to receive energy audits as part of this program in 2009.

References

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