

Pre-analysis plan for the research project “Improving the take-up of energy efficiency assistance by low-income households”

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The study is pre-registered: <https://www.socialscisceregistry.org/trials/11406>

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1. Description of the sample to be used in the study

The sample to be used in the study is based on a field experiment in collaboration with the “Energy-Saving-Check” (<https://stromspar-check.de/sprachen/englisch-english/>), a nation-wide program that aims at lowering the energy bills of low-income households in Germany by reducing their electricity and water bills.

Together with program officials and local site managers, we co-design a set of treatment variations alongside the information letter, which is handed to households during household visits. The information letter is intended to encourage eligible households to enroll in a subsidized refrigerator replacement program, which is a key part of the “Energy-Saving-Check”. The outcome variable of interest are appliance replacement decisions, with data available at the household level.

Following up on results of a previous field experiment which we jointly conducted with the Energy-Saving-Check (Chlond et al. 2026), we augment the information letter by three different interventions to address different behavioral channels including (i) attention, simplification, cognitive ease and (ii) reducing scarcity and facilitating goal setting.

- (1) As a carry-over from a previous RCT (Chlond et al., 2026), we implement a baseline treatment and retain its label, GAIN⁺. This baseline treatment is a graphically enhanced version of a legacy design of the information letter, labeled GAIN. GAIN was used in the program for several years in the past and framed annual savings in electricity costs as a financial gain from successful replacement. The graphical enhancement, indicated by the ⁺ in the label, consists of a small pictogram of a purse and supports the key message of the frame. The reported annual savings in electricity costs are based on individual-level estimates as derived from data collected during the first in-home audit.
- (2) In a first treatment variation, we implement a simplified version of GAIN⁺ which uses simple language and more visual elements. We label this treatment as SIMPLEGAIN⁺.
- (3) In a second treatment variation, we augment the treatments GAIN and SIMPLEGAIN⁺ from our first treatment variation by an additional checklist that breaks up the goal of replacement into smaller subgoals along the replacement process. This enables households to progressively check off by hand process steps that have been

completed. These treatments are labelled as GAINCHECK and SIMLEGAIN+CHECK, respectively.

- (4) As a validity test to our previous experimental results in Chlond et al. (2026), we frame reported annual savings as a financial loss if households miss out the opportunity of replacement (LOSS⁺) compared to a financial gain (GAIN⁺) of successful replacement. In addition, we now also provide a simplified version of the loss frame (SIMPLELOSS⁺).

In total we have 7 treatments: GAIN (legacy), GAIN+ (baseline), SIMLEGAIN+, GAINCHECK, SIMLEGAIN+CHECK, LOSS+ and SIMPLELOSS+.

Guided by own previous work (Chlond et al. 2025, 2026), for our **power calculation** we use an expected effect size of 7 ppt in the share of successful refrigerator replacements during the intervention period. With $\alpha = 0.05$, $\beta = 0.8$ we estimate a required sample size of 591 observations per treatment group. The total planned number of observations then corresponds to 4137.

To address potential **site selection issues**, for our previous field experiment we randomly selected which local sites will be invited to our experiment. To this end, we collected data on the number of long-term unemployment benefit recipients of the 158 municipalities in Germany in which local sites of the program are located. We had determined weights that reflect the share of the number of recipients in a site area relative to the total number of benefit recipients in Germany. The selected sites are then determined by a weighted randomized draw out of a total of 150 sites. For the current study, we use the same 21 selected sites as in Chlond et al. (2026).

The **randomization** is done on the household level.

A **balance test** is done on the household level on observable characteristics including, e.g., energy prices, energy consumption, estimated savings from kWh refrigerator replacement, number of persons living in the household, living space, type of social benefit payment. The data for the balance test comes from the existing program database. We adjust for multiple hypothesis testing.

2. Key data sources

The experimental data will be stored in the administrative database of the program. The data manager of the Energy-Saving-Check will provide extracts.

The major outcome variables are:

- (1) Request (yes/no): Information on whether an eligible household requests the voucher for the replacement subsidy after having received the information letter.
- (2) Replacement (yes/no): Information on whether an eligible household redeemed the voucher and successfully replaced its old refrigerator with a new efficient appliance.

3. Hypotheses

We test five main hypotheses with respect to voucher request and replacement probability. We report the hypotheses for the second-stage outcome refrigerator

replacement. All hypotheses apply to and analyses will be done for both outcomes. The order of the hypotheses may still change in the manuscript.

The starting point for our investigation are the main treatment effects identified in our previous experiment (Chlond et al. 2026). There, GAIN⁺ outperformed GAIN and LOSS⁺.

H1: Refrigerator replacement in SIMPLEGAIN⁺ will be higher compared to GAIN⁺ and GAIN.

Intuition: We expect that a simpler language and additional visual elements will raise attention and facilitate the understanding of the key message of the information letter and consequently foster higher replacement rates.

H2: Refrigerator replacement in GAINCHECK will be higher compared to GAIN.

Intuition: We expect that supporting task completion (replacement) through a structured process of subgoals to address organizational challenges and, therefore, reduce cognitive scarcity, facilitate goal setting, and goal completion.

H3: Refrigerator replacement in SIMPLEGAIN⁺CHECK will be higher compared to SIMPLEGAIN⁺ or GAINCHECK.

Intuition: We expect that the effects of both treatment dimensions (as described in H1 and H2) are additive as they are targeting different behavioral channels.

H4: Refrigerator replacement in GAIN⁺ is higher than in LOSS⁺.

Intuition: This is a validity test of our previous experimental findings. H4 was tested in Chlond et al. (2026). There, the experimental data showed that replacement rates in GAIN⁺ are significantly higher than in LOSS⁺.

H5: Refrigerator replacement in SIMPLELOSS⁺ is higher than in LOSS⁺.

Intuition: Similar to H1, we expect a simpler language and additional visual elements to raise attention, to facilitate the understanding of the key message of the information letter and consequently to foster higher replacement rates.

In contrast to the GAIN domain, we expect the treatment effect in the LOSS domain rather to be smaller. Prior evidence from Chlond et al. (2026) downplays the possible role of attention deficits for explaining the backfiring of LOSS⁺. The attention channel is therefore plausibly attenuated in the loss domain.

In addition to these main hypotheses, we will also test for potential differences between SIMPLEGAIN⁺ and GAINCHECK. A priori, there is little guidance about the effect sizes to be detected when testing H1 and H2. We therefore take an agnostic stance on the question which treatment effect dominates quantitatively.

We will also conduct heterogeneity analyses along three dimensions following the analysis in Chlond et al. (2026).

- i) Income: We will investigate whether treatment effects differ according to income group, splitting the sample in long-term unemployed households, the poorest in our sample, and other households. This analysis shows if income differences moderate treatment effects.
- ii) Estimated energy savings: We will investigate whether treatment effects differ according to the estimated amount that households learn they can save with the refrigerator replacement. This analysis shows if households react to the intensity of the treatment, i.e., if the response is stronger when the stakes are higher.
- iii) Timing of information letter: We will investigate whether treatment effects differ according to whether households receive the information letter with the treatment at the beginning versus at the end of the month. This analysis shows if financial scarcity due to heightened financial worries toward the end of the month moderates treatment effects. Scarcity can impact cognitive capacities and change time and risk attitudes (Mullainathan and Shafir 2013, Haushofer and Fehr 2014), which affects refrigerator replacement and may interact with the effects of treatments.

Moreover, we will follow Chlond et al. (2026) in plotting the replacement timing under the different treatment arms to descriptively reveal potential differences in replacement timing.

4. Treatment effect estimation

For comparing our two major outcomes (request and replace) across treatment groups, we first assign an indicator variable for each treatment group and then run a regression of voucher request and refrigerator replacement (Y_i) on treatment indicators for each household i , with GAIN⁺ as the baseline:

$$Y_i = \beta_0 + \beta_1 \text{GAIN}_i + \beta_2 \text{LOSS}_i^+ + \beta_3 \text{SIMPLEGAIN}_i^+ + \beta_4 \text{SIMPLELOSS}_i^+ \\ + \beta_5 \text{GAINCHECK}_i^+ + \beta_6 \text{SIMPLEGAINCHECK}_i^+ \\ + \text{savingsinfo}_i + X_i + F_i + \varepsilon_i$$

We control for the expected financial savings from replacement as communicated to the household (*savings info*). X_i contains information on household information such as the household's electricity price, electricity consumption, usage of electricity water heating, number of persons within the household, living space, type of social benefit transfer the household receives and the federal state the household lives in. F_i summarizes month - site fixed effects. We estimate the model as a linear probability model in OLS.

Literature

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