ENCHANT
Energy Efficiency through behaviour Change Transition Strategies

Evaluation Report on Pilot Implementations

VERSION: 01

Report No. D4.3 // Date: 30/11/2023

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957115.

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PROJECT NO.: 957115 (H2020) // PAGES/APPENDICES: 90/1

ABSTRACT

This report presents the experience, and lessons learned, from the pilot implementations. It integrates information from three main sources: i) the feedback and information collected by the user-partners from the field, ii) the information collected through the established monitoring mechanisms, and iii) the information obtained through the co-ordination of different pilots in different geographical regions. Thus, this report evaluates the effectiveness, and performance, of the implementation process and interventions.

REPORT NO.: D4.3 ISBN: NA

CLASSIFICATION: Public
CLASSIFICATION THIS PAGE: Public

DOCUMENT HISTORY:

VERSION	DATE	VERSION DESCRIPTION
1	04.11.2023	First version for quality check sent to contributers
2	24.11.2023	Integration of comments by contributers
3	30.11.2023	Submission

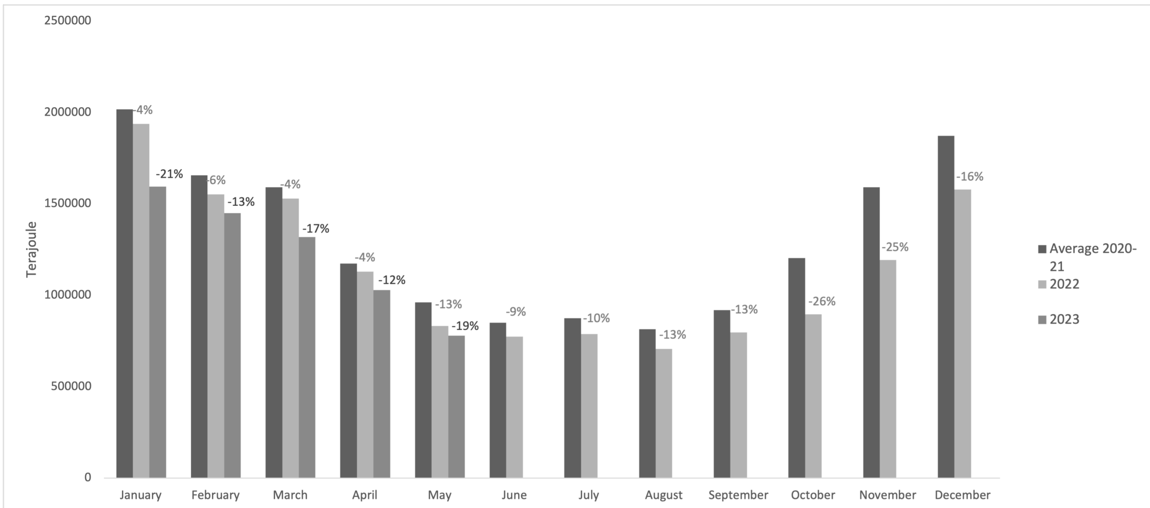
Contents

1 Introduction

The energy crisis of 2022 had a strong impact on various commodity markets around the world. In European countries, which are characterized by a high dependency on natural gas for their energy supply, gas and electricity prices reached all-time highs. While relatively mild weather conditions avoided the risk of energy rationing, European countries were challenged to secure storage levels for the upcoming winter.

The surge in energy prices, coupled with intensive information campaigns, incentivized significant reductions in energy demand from both corporations and households. A comparison of natural gas consumption during the crisis months with the average monthly consumption from two years prior revealed a substantial reduction in energy consumption across OECD countries (see Figure 1). This substantial decline underscores the existence of saving potential and emphasizes the efficacy of behavioral measures, such as information dissemination and adherence to social and personal norms, in promoting energy conservation.

Figure 1: Natural gas consumption EU



Own computation. Source: Eurostat (2022)

Yet we lack a clear understanding of the relative importance of factors such as price increases, weather conditions, information provision, and psychological factors such as (personal, social) norms, habits or attitudes that influence energy conservation and other environmental behaviors. Reducing household energy use can not only help mitigate the current crisis but, if sustained over time, can also support the transition to net-zero and accompany efforts to increase the share of renewable energy in the energy mix.

D4.3's goal is to examine the influence of various behavioral interventions—such as information provision, financial incentives, behavioural feedback, commitment, competition, social norm communication, collective vs. individual framing, or —on behavioral change across three vital domains: a) energy saving, b) public transit usage, and c) investment in energy efficiency (EE) and renewable energy sources (RES). We investigate the effects of these interventions using a range of methods including experiments, randomized control trials, and surveys. In this process, D4.3 encompasses two crucial phases for each field experiment: i) the implementation phase, centered on feedback and insights from our user-partners conducting the field experiments, and ii) the evaluation phase, focusing on the impact gauged through data analysis and economic inference.

1.1 Phase 1: Evaluation of Experimental and Quasi-experimental Results

In traditional economics, the most straightforward approach to behavior change is typically to alter people's incentives in a way that they find optimal to adapt their behavior in the desired fashion. For example, if a policymaker wants to reduce the consumption of a product associated with negative externalities, such as electricity consumption, the first and most effective step would be to impose a per-unit tax equal to its marginal social cost, as advocated by Pigou (1920). However, modern behavioral science research has highlighted alternative methods that can effectively shape behavior beyond traditional economic approaches. These findings underscore the need to explore a broader range of strategies when seeking to promote behavioral change for the benefit of society and the environment. Desired behavioral changes could include adopting more energy-efficient technologies for lighting or transportation (Stoll, Brandt, & Nordström, 2014), curbing overall consumption (Carrus et al., 2021), or adjusting consumption patterns during peak energy demand (Schultz, Estrada, Schmitt, Sokoloski, & Silva-Send, 2015). In addition,Vesely et al. (2022) provides a comprehensive review of various experimental techniques using treatments such as information, social norm communication, competition, commitment, behavioural feedback, individual vs. collective framing, s or monetary incentives and their respective effectiveness.

Since the 1970s, interventions aiming to promote sustainable energy transition have been a focal point in physiological and behavioral research, targeting behavior change for sustainable energy transitions and enhanced energy efficiency across diverse social groups (Carrus et al., 2021; Delmas & Lessem, 2014; Nisa, Bélanger, Schumpe, & Faller, 2019). However, much of the existing research has primarily delved into the impact of various factors, such as social norms, commitment, and framing effects, within controlled laboratory settings, allowing for precise manipulations and enhanced internal validity (Calisi & Bentley, 2009; Cook, Campbell, & Shadish, 2002; McDermott, 2011). Despite this controlled setting, internal validity remains tied to the specific experimental context, and there are inherent biases that can influence study outcomes (Campbell & Stanley, 2015; Cook et al., 2002).

Moreover, the controlled nature of laboratory studies compromises their external validity, limiting their direct application to real-world contexts (Campbell & Stanley, 2015; Cook et al., 2002). Although researchers aspire for findings to align with real-world observations, achieving this alignment is often a challenge, emphasizing the importance of considering external validity and striving for generalizability to diverse populations, contexts, and situations (Cook et al., 2002).

Field experiments aim to combine the internal validity from randomized laboratory experiments with the external validity or generalizability achieved by conducting the experiment in real-world settings (Gerber & Green, 2008). Their objective is to replicate the natural environment, consequently augmenting the experiment's external validity. However, the main challenge is achieving randomized control trials (RCTs), the gold standard in experimental research. RCTs use random assignment of participants to treatment or control groups, ensuring even distribution of observed and unobserved confounding variables among the groups and enabling researchers to establish causal relationships between an intervention and its outcomes. However, conducting RCTs in field settings is challenging due to the complex and uncontrollable nature of real-world environments (Gerber & Green, 2008).

The primary challenge in establishing the causal impact of a treatment lies in utilizing available data to construct an estimate of a counterfactual scenario, predicting the outcome that would have been observed for the treated subjects had they not undergone the treatment (Gerber & Green, 2008). Thus, constructing a robust control group becomes crucial (Levitt & List, 2009). However, as mentioned above, random assignment of individuals into treatment and control groups is often not feasible. Real-world limitations, ethical considerations, and the need for participant consent can hinder the ability to randomly assign individuals to treatment and control groups. Additionally, factors like practicality, compliance issues, and resource constraints further contribute to the challenges of implementing randomization in field settings (Levitt & List, 2009). Additionally, the dynamics of the natural field can differentially affect the two groups, amplifying or reducing the treatment effect. For example, the dynamics of the COVID-19 pandemic have introduced added intricacies, notably in the realm of energy consumption and transit patterns. The widespread adoption of remote work and schooling has led to shifts in energy use, witnessing a surge in residential energy demand during typical working hours, impacting the overall energy consumption. Concurrently, there has been a decline in public transit usage due to safety concerns and remote work arrangements, potentially reshaping urban energy consumption patterns and prompting a reassessment of energy-saving initiatives amidst the evolving energy crisis. The post-pandemic periods have witnessed notable changes in daily routines such as work, education, and travel patterns, which can change attitudes toward energy and shift public focus. These effects were still visible in the post pandemic, as many employers continued to work remotely. Moreover, the current energy crisis has highlighted the importance of renewable energy, energy conservation, and efficiency measures and shifted the attention of many individuals to the broader topic. However, in the realm of RCTs, these effects act as confounding variables, potentially increasing or decreasing treatment effects, or complicating comparisons between pre-treatment and treatment observations, especially if the pre-treatment period predates COVID-19 or the energy crisis.

We acknowledge that both the energy crisis and the still ongoing COVID-19 pandemic exert an influence on our results, which we endeavor to mitigate using statistical methods; however, the complete elimination of these effects is challenging. Consequently, the magnitude of the observed effects may carry some degree of bias. It is important to cautiously interpret the sign of these effects and consider potential implications on internal validity.

1.2 Phase 2: Evaluation of Pilot Implementations

The primary objective of the internal post-intervention survey conducted with the pilot responsibles was to evaluate and monitor the effectiveness of the implemented interventions. This survey was carefully designed and structured to measure and evaluate the interventions using a set of key performance indicators (KPIs). The survey covers three distinct parts: i) the planning phase, ii) the implementation phase, and iii) the post-implementation phase.

The planning phase was designed to provide a comprehensive insight into the overall implementation of each intervention. This phase included an assessment of the duration of both the actual implementation and the pre-implementation phase. It delved into details such as economic costs, barriers and challenges encountered, and the extent of outreach to the target population. For example, whether data collection was a problem. The data collected during this phase will be used to inform future campaigns and organizations interested in replicating similar studies. This part of the study completes the overall picture of an intervention evaluation. In addition to determining the success of an intervention through data analysis and static impact analysis, it provides valuable insight into implementation costs and related factors.

The second part of the survey delves deeper into the implementation of the study. We focus on the challenges encountered before, during, and after the intervention. For example, ethical considerations, privacy issues, data-related challenges during data collection, technical issues, etc. Thereby, we enrich further research to anticipate and mitigate challenges. In addition, key lessons learned from each intervention are presented.

The final part of the post-intervention survey focuses on assessing both the short-term and long-term effects of the implemented interventions.
In the **short** term, we delve into understanding the immediate impact of the interventions

on the target audience's awareness. This includes determining the extent to which the interventions effectively raise awareness and knowledge about the issues or behaviors we aimed to address. Short-term effects on attitudes and behaviors are evaluated to gauge whether the interventions led to any immediate changes.
In the **long** term, the survey aims to assess the lasting effects of the interventions. This involves examining whether the awareness and knowledge generated during the intervention persist over time. It also seeks to understand whether any behavioral changes initiated by the interventions are sustainable in the long run. Long-term effects on attitudes and behaviors are analyzed to identify whether the interventions had a lasting impact on the target audience.

Furthermore, the survey explores the potential for replicability and scalability of the interventions. It assesses whether the interventions can serve as models for future campaigns and if they are adaptable to various settings and audiences. Insights from this part of the survey are valuable for organizations and policymakers looking to implement similar interventions on a larger scale or in different contexts.

In summary, the post-intevention survey extracts essential experiences and lessons learned from the pilot implementations, providing a comprehensive understanding of the interventions' operational aspects, acceptance, replicability, and reproducibility from the perspective of the user partners and thereby add additional information for future research how to conduct large scale RCT.

The structure of the remainder of this report is as follows: we discuss each intervention separately. However, we have grouped these interventions according to overarching themes related to the target behavior. The first set of interventions examines the impact of different approaches on energy conservation behavior, followed by a discussion of interventions related to public transportation use, and concluding with an examination of interventions that affect both energy conservation and renewable energy investment behavior. We present each intervention individually. We start with a brief introduction outlining the primary objectives of the study and key contextual information. Next, our focus shifts to a detailed examination of two critical phases: the implementation of the field experiment and the subsequent evaluation, including an analysis of results. This report ends with a conclusion.

2 Interventions

2.1 Saving Energy

Electricity is commonly perceived as a homogeneous commodity that often lacks attention from households or general users. This perception stems from several factors. First, the invisibility of electricity means consumers receive limited feedback on their usage, lacking a sense of ”diminishing stock” or control over consumption (Fischer, 2008). Users typically are not aware, when, or by which appliances electricity is currently used. They are not informed whether their consumption is relatively high or low, impeding their ability to search for reasons or determine the effectiveness of their actions. Secondly, energy is utilized to perform actions like listening to music or watching TV that are associated with emotional attachment, while energy itself lacks such emotional connection. Finally, the costs of electricity usually do not constitute a significant portion of a household's budget. Thus, all in all, electricity turns out to be a "low interest" product (Fischer, 2008).

Improving sustainable electricity consumption entails enhancing feedback on consumption, its cost, and its environmental impacts. Various studies integrate energy-saving tips as part of broader interventions, with differing degrees of success (Allcott, 2011; Ayres, Raseman, & Shih, 2013; Costa & Kahn, 2013). In 1982, Luyben evaluated President Carter's televised appeal to lower thermostat settings in response to a potential gas shortage (Luyben, 1982). The results showed no significant difference in thermostat settings between those who heard the plea and those who did not. Similarly, Hutton and McNeill (1981) assessed the Low Cost/No Cost energy conservation program by the US Department of Energy, finding that households receiving energy-saving booklets and shower devices reported implementing tips more frequently. In a post survey, households who had received the booklet and the shower device reported implementing the energy-saving tips more often than households who had not. However, it was not measured whether this led to actual energy savings. Similarly, Staats, Wit, and Midden (1996) evaluated a Dutch government mass media campaign on global warming, revealing increased willingness for pro-environmental behavior primarily in individuals who were already environmentally conscious before the campaign. Understanding the nuanced impacts of such interventions is essential for designing more targeted and impactful energy conservation campaigns.

The implemented ENCHANT interventions described and evaluated in the following section aim to observe changes in energy-saving behavior in daily life.

2.1.1 Austria - Energie Kompass

2.1.1.1 Introduction

In Spring 2023, ENCHANT partner Energie Kompass (EK) conducted a newsletter campaign in the Austrian federal state of Burgenland. The aim of the campaign was to test how the framing of energy saving tips influences the energy consumption of the energy communities. In total, five newsletters were sent to all 2,500 members of Energy Communities operated by EK. The data was collected using the digital platform www.team4.energy, developed by EK as a service to establish, administer and account the shared electric power for energy communities.

Table 1: Newsletters in the Austrian campaign

Newsletter	Date sent	# of recipients	Share of recipients who opened the newsletter [%]
1	15^{th} February 2023	2,500	72.7
2	26^{th} February 2023	Group A: 836	64.7
		Group B: 802	67.6
3	1^{st} March 2023	Group A: 796	64.6
		Group B: 829	62.3
4	7^{th} March 2023	Group A: 825	62.3
		Group B: 787	63.0
5	15^{th} March 2023	Group A: 784	62.7
		Group B: 817	58.1
6	20^{th} March 2023	Group A: 814	62.5
		Group B: 779	64.7
		Group C: 829	66.6

The first newsletter was sent to all Energy Community members on February 15th, 2023. It contained the following energy-saving tip[1]:

> *Did you know that most excess energy is generated in an Energy Community during midday hours on weekdays? This is especially true on sunny days when our photovoltaic systems have the highest electricity production. If you activate energy-intensive electricity consumers—such as charging an electric vehicle, washing machine, or electric stove oven during these times—you get the electricity regionally from your Energy Community, thereby saving money. Additionally, you are then exclusively using sustainable solar power!*

Afterward, the community members were divided into three approximately equal-sized groups. Group A received energy-saving tips addressing each community member individually, Group B received tips addressing them as a community, and Group C did not receive any tips, thus serving as control group.

The second newsletter, which was sent on February 26th 2023 provided an energy saving tip about the stand-by consumption of electric devices.

[1]The messages were sent in German, see Appendix for the original texts

Table 2: Austrian Newsletter 2

Message to both groups	Did you know that many devices still consume electricity even in standby mode? Especially chargers, gaming consoles, and many ”smart” devices that you want to have quickly available are power guzzlers even when idle.	
Variation for Groups	Group A: If you want to avoid these devices unnecessarily consuming electricity, it is recommended to turn them off completely or, if that’s not possible, to unplug them. Depending on the device, this could save several hundred kWh of electricity per year.	Group B: For an Energy Community, it’s important to collectively think about responsible energy use. Therefore, it’s recommended to turn off unused power-consuming devices completely.

The third newsletter was sent on the 1st March 2023 and targeted water consumption, providing tips how to save water by checking dripping faucets and toilet flushes.

Table 3: Austrian Newsletter 3

Message to both groups	Clean, always available drinking water is not a given in many parts of the world.Therefore, it should be all the more important for us to handle this precious resource responsibly. Did you know that up to 11 liters of water per day—approximately 4,000 liters per year—can be lost due to a dripping faucet?	
Variation for Groups	Group A: If you want to avoid unnecessary water costs caused by dripping faucets or toilet flushes, then regularly check your fixtures and replace the seals when needed. In most cases, this can be quickly done by yourself, and a small effort can have a big impact.	Group B: Small steps can make significant progress in the energy and sustainability transition when taken collectively. Repairing a dripping faucet is a small step for you, but many small steps take us much further when done together. Acting responsibly together is an important goal for every Energy Community.

The fourth newsletter, sent on the 15th March 2023, focused on cooking and baking in households and how to be more energy efficient.

Table 4: Austrian Newsletter 4

<table>
<tr><td>Message to both groups</td><td colspan="2">In most Austrian households, cooking and baking are done electrically. Did you know that an electric stove consumes between 400 and 500 kWh of electricity annually? This accounts for around 10% of the total electricity consumption of a family of four.</td></tr>
<tr><td>Variation for Groups</td><td>Group A: Using appropriately sized pots, covering pots while boiling water, and not preheating the oven unnecessarily long are small but effective steps that help you save energy and money while cooking.</td><td>Group B: Cooking and dining together is a symbol of coziness for many people. In the same way, we can also collectively save energy and ensure that we don't keep our stoves on unnecessarily long.</td></tr>
</table>

The fifth newsletter, which targeted the topic of more conscious use of private cars, was sent on the 20th March 2023.

Table 5: Austrian Newsletter 5

<table>
<tr><td>Message to both groups</td><td colspan="2">Your own car is the most important means of transport for many people. Did you know that fuel consumption and CO_2 emissions are approximately a quarter higher at 130 km/h compared to a speed of 100 km/h?</td></tr>
<tr><td>Variation for Groups</td><td>Group A: Driving more consciously and at slower speeds helps you save fuel and money. Arriving a few minutes later but in a more cost-effective and relaxed manner is often a better alternative.</td><td>Group B: Taking your time, driving relaxed, and being considerate of others not only contributes significantly to your community but also helps you save on CO_2 emissions and fuel costs.</td></tr>
</table>

2.1.1.2 Evaluation

Figure 2 shows the sum of total electricity consumption for three distinct groups of approximately equal size: Group A, Group B, and control group C. Due to an issue in the data collection, the data for February could not be utilized for this analysis. The figure displays the data starting from 1st March 2023 when the third newsletter was sent to the experimental groups. Figure 3 displays the distribution of electricity consumption for each group. Group B has a higher median consumption (12,299.36 kWh) than Group A (10,364.92 kWh). The highest median consumption (13,911.86 kWh) can be observed in Group C. The summary statistics are displayed in Table 6. This might give a tendency and we can test for differences among the three groups but due to the limitations in this dataset techniques to estimate causal effects are not applicable.

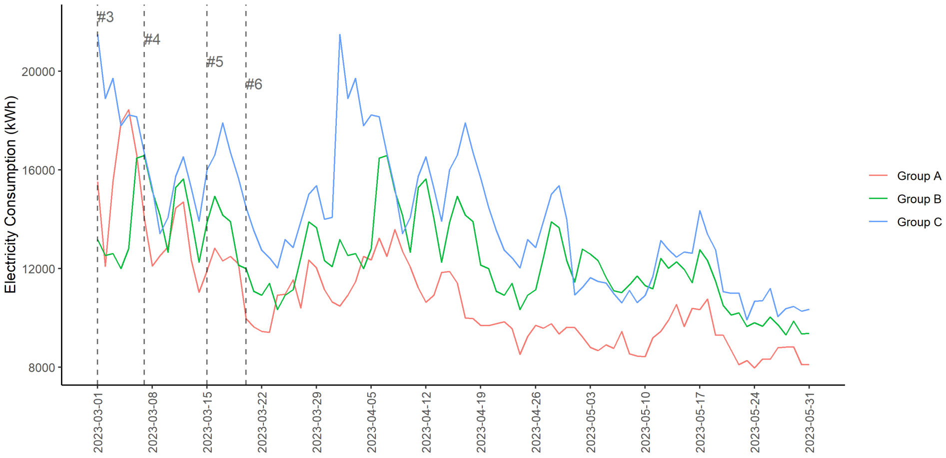


Figure 2: Total electricity consumption (kWh) for each group. The vertical lines represent the dates on which the newsletters were sent.

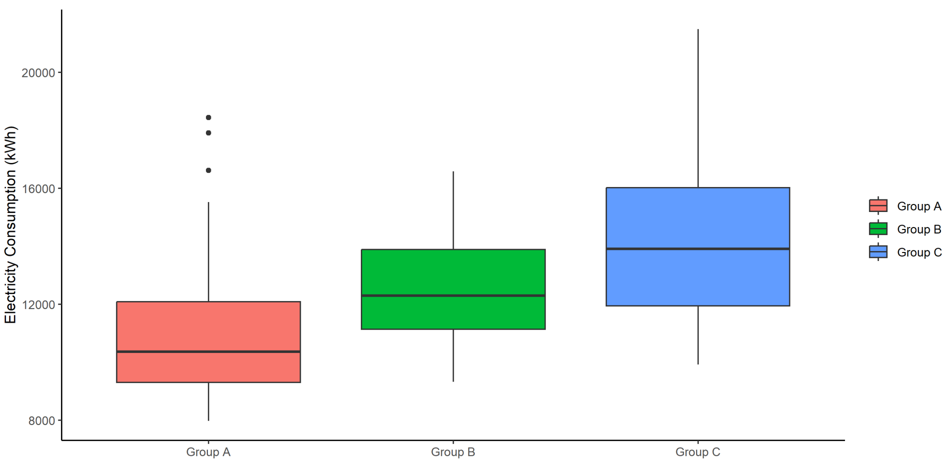


Figure 3: Boxplots of electricity consumption (kWh) for experimental groups (A, B) and control group (C). The median consumption in the groups that received newsletter interventions is lower than in the control group.

Table 6: Summary table of electricity consumption.

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	n
Group A	7,978.45	9,299.81	10,364.92	10,811.37	12,092.25	18,445.34	92
Group B	9,318.39	11,140.93	12,299.36	12,436.93	13,889.40	16,589.23	92
Group C	9,917.53	11,939.52	13,911.86	14,166.61	16,021.55	21,493.37	92

A one-way ANOVA was conducted to test for differences in electricity consumption among the groups. The ANOVA results indicate that there is a statistically significant difference in electricity consumption among at least some of the groups ($F = 49.62$, $df = 273$, $p<0.001$). Tukey's multiple comparisons were conducted to identify which specific groups differ from each other. Among Group B and Group A there is a positive, significant difference (diff = 1625.564, 95% CI [831.7685, 2419.359], $p < 0.001$), indicating that the mean of Group

B is significantly higher than the mean of Group A. The mean of Group C is significantly higher than the mean of Group A (diff = 3355.244, 95% CI [2561.4484, 4149.039], $p < 0.001$). Also the mean of Group C is significantly higher than the mean of Group B (diff = 1729.680, 95% CI [935.8845, 2523.475], $p < 0.001$). Therefore, we can conclude that in Group C, the control group, the mean consumption is the highest among the groups. However, it cannot be confirmed that this is attributed to the impact of the newsletter intervention.

2.1.1.3 Implementation

The outcomes of an intervention on energy saving is inherently context-dependent, influenced by various factors, as highlighted in the introduction. Yet, the efficacy of a field trial entails more than just observing behavioral changes. The other side of the coin pertains to the pre-implementation phase, which can be characterized by its length, complexity, and varying resource demands.

Another crucial aspect impacting the overall evaluation of an effect is the potential for scalability. The ease or difficulty of expanding a field trial and implementing it more frequently in the future is pivotal. To provide a comprehensive view, inquiries regarding these facets were directed to our user partners, Energie Kompass.

This intervention lasted for about a month, in detail from 15.02.2023 to the 20.03.2023. and was carried out entirely through the newsletter. The preparation time took about a week and this established newsletter could be used without issues. No major challenges occured during the implementation phase and there were no modifications or adaptations made to the original intervention design. It was implemented as planned without changes.

Ethical considerations were taken into account during planning and implementation. Communications emphasized that this was part on an H2020 research project, and opt-in was presented as a choice. No pressuring language was used, and the campaign's goals and methods were communicated to ensure informed consent. All data used in the project was aggregated, and no individual personal data was used to address data and privacy considerations.

Looking at the lessons learned in the course of the intervention, it needs to be said that the group addressed (REC members) was highly motivated and as expected the return rate on the surveys was also very high. For future projects with a similar approach, however, it is expected that it will be much more difficult to reach and motivate the general public.

Looking at the aspect of acceptance it needs to be said that acceptance for the introduction of an intervention is essential as it promotes the willingness and cooperation of the people involved and thus supports the success and effectiveness of the measure. The overall acceptance of the intervention among the target population was rated as 5 on a scale of 1 to 5, with people appreciating the topic of energy efficiency. No specific concerns or objections were raised by the target population except for concerns about reducing highway cruise speed to save gasoline.

In the context of awareness, various actors were involved in preparing and distributing the interventions, including two commercial entities. During the implementation, no new ideas emerged that were not previously discussed in the ENCHANT project. One thing that has already been discussed but is still considered important is to utilize the intervention platform (see Section 3) in the Austrian innovation lab. The results of the interventions had an influence on post-implementation activities. It was noted that similar newsletter campaigns would become a standard feature for the REC serviced by the team4.energy platform. This suggests that the intervention had a positive and lasting impact on the communication strategies used in the energy communities.

The replicability of the interventions was rated as 4, suggesting that they can be somewhat easily replicated in other similar contexts. The key factor contributing to replicability is the presence of similarly engaged groups with established newsletters, which should not pose a major hurdle. The main target group for replication would be citizens involved in Energy Communities, and such involved groups can be found within the EU. There are no specific contextual factors, such as climate situations or cultural factors, believed to significantly affect the replicability of the intervention. This implies that the core elements of the intervention are adaptable to various settings and should remain consistent across different contexts.

Financial expenditure was incurred during the implementation of the interventions. The estimated total amount of financial expenditure was related to the newsletter tool, costing about €60 per month. The costs and expenses associated with the intervention were primarily related to the newsletter tool. No other specific categories, such as travel costs, marketing, internal costs, or materials, were mentioned. The financial resources provided for coping with the costs of the intervention were rated as a 5 on a scale of 1 to 5, indicating that the resources were considered highly adequate for covering the expenses associated with the intervention.

There were no interactions with policymakers regarding ENCHANT in this intervention and the Intervention Monitoring Checklist template was not used.

In summary, the "Energie Kompass energy communities" intervention was implemented without major challenges, with an emphasis on ethical and GDPR considerations. It received positive acceptance from the target population and is considered replicable with certain prerequisites. There were financial costs associated with the intervention, but these were adequately covered.

2.1.2 Italy - Energia Positiva Cooperative

2.1.2.1 Introduction

The intervention conducted by Energia Positiva aims to investigate the impacts of descriptive norm messages and injunctive norm messages on the customers' energy consumption behavior. During a time period of 12 months (January 2022 to December 2022), monthly electricity consumption data was collected for households.

Customers were randomly divided into three groups. Between September and October 2022, customers within the experimental groups received four newsletters in an interval of about 15 days. Experimental group 1 ($n = 111$) received newsletters containing injunctive norm messages. Experimental group 2 ($n = 109$) received newsletters containing descriptive norm messages. Customers in the control group ($n = 222$) did not receive any newsletters.

Furthermore, after the experimental phase, a subset of participating customers completed a survey ($n = 117$). Among these responses, 49 came from the control group, 33 from experimental group 1 and 35 from experimental group 2. The survey was conducted in December 2022. It aimed to capture insights into the household socio-demographics (gender and age of the customer, household size, internal surface are of the home), as well as collecting information about their energy saving practices, environmental attitudes, concerns and intentions and the customers' connection to Energia Positiva.

2.1.2.2 Evaluation

This section describes the strategy to estimate the effect of the intervention. To assess the effect of the newsletter treatments, we estimate a two-way fixed effects model, where the dependent variable is the natural log of the monthly household electricity consumption. We use a natural logarithm transformation of the total household electricity consumption to create a model that allows us to interpret coefficients as multiplicative (percentage) changes in the dependent variable rather than total changes on the group level. Two-way fixed effects regression is a statistical modeling approach commonly used in panel data analysis to examine the relationship between variables while controlling for both individual-specific and time-specific effects. However, it relies on strong assumptions such as parallel trends and linear additive effects (Imai & Kim, 2021).
We specified the following model:

$$\log(\text{consumption})_{it} = \beta_1 \cdot \text{treatment } 1_{it} + \beta_2 \cdot \text{treatment } 2_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (1)$$

The variable treatment1 is a dummy variable that equals one for households in experimental group 1 during and after the intervention period. Respectively, treatment2 indicates experimental group 2 during and after the intervention period. The α_i are the household-specific intercepts, the λ_t are the time-specific intercepts.

Figure 4 shows the logarithm of the mean monthly electricity consumption across all groups. While in the first few months of the observation period, the mean log consumption follow a relatively parallel trend, after the start of the intervention, experimental group 1 diverges while experimental group 2 and the control group show a similar pattern.

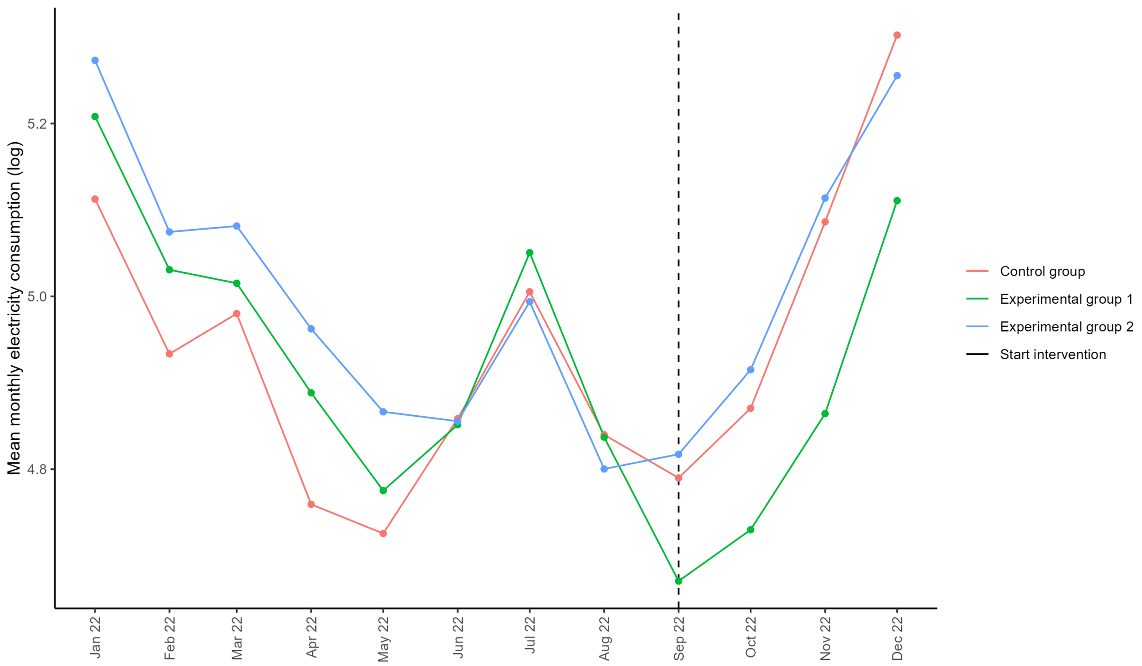


Figure 4: Mean monthly electricity consumption (log).

The results of the regression are shown in Table 7. On average the electricity consumption decreases during the intervention period in experimental group 1 by about 17.3 %. In experimental group 2 the treatment decreases the electricity consumption by about 0.2 %. We note that the treatment in experimental group 2 does not have a statistically significant effect. Injunctive norm messages, such as those sent to experimental group 1 might have a positive impact on the electricity consumption.

Table 7: Results from fixed effects regression.

	Dependent variable:
	Log Consumption
treatment 1	-0.173^{***}
	(0.033)
treatment 2	-0.002
	(0.032)
Observations	4,642
Note:	*p<0.1; **p<0.05; ***p<0.01

In the survey after the experimental phase, customers were asked if they reduced their energy consumption in the last two months. Figure 5 shows that the majority of customers in all groups indicated that they reduced their energy consumption in the last two months. However, customers in experimental group 2 answered more often than customers in the other groups that they reduced their consumption only a little.

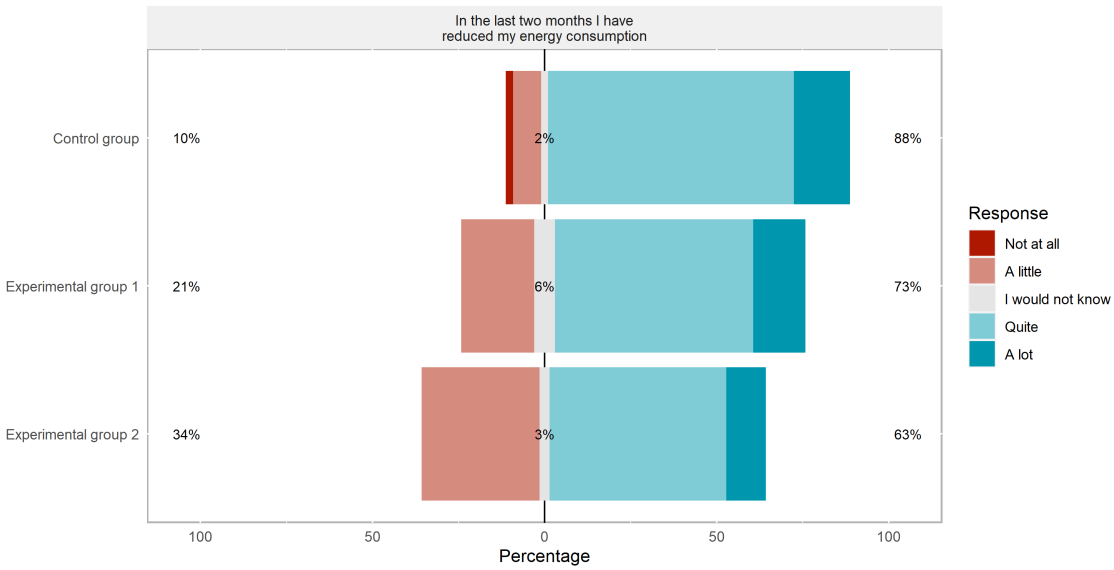


Figure 5: Response to the survey question about energy consumption in the last two months before the survey.

2.1.2.3 Implementation

The ”Energia Positiva” intervention lasted two month from 01.09.2022 to 31.10.2022. It involved the sending of four newsletters every two weeks during this period. The prepa-

ration time for ”Energia Positiva” was approximately 12 months.
Regarding the pre-implementation, the results from the user partner survey reveal that during the implementation phase of the ”Energia Positiva” intervention, challenges were indeed encountered. Specifically, the challenge revolved around the difficulty of associating pre- and post-survey respondents. These challenges were unexpected, catching the team by surprise. To address these issues, efforts were made to ensure the highest possible level of matching between pre- and post-survey respondents, and unclear cases were excluded from the analysis. Looking back, it becomes evident that these challenges could have potentially been prevented by enhancing the commitment and engagement of user partners in the intervention. To avoid encountering similar issues in the future, it is advisable to actively involve user partners in the data collection phase as well through a specific training aimed at equipping them with the necessary knowledge and skills.

This proactive engagement can ensure better alignment and cooperation throughout the project, ultimately contributing to a smoother and more effective implementation. By providing user partners with tailored training, they can better understand the data collection process, the goals of the project, and the expected outcomes. This not only enhances their participation but also empowers them to address potential challenges more effectively. The result is a more collaborative and informed approach that can lead to improved project outcomes and more successful interventions.

No modifications or adaptations were made to the original intervention design for ”Energia Positiva.” The intervention was implemented as initially planned, without any deviations. Ethical considerations were indeed taken into account during the planning and implementation of the intervention. The Roma Tre ethical committee approved the study, indicating that the research design adhered to ethical standards. Furthermore, data and privacy considerations were also a part of the planning and implementation process. The user partner took on the responsibility of ensuring full compliance with privacy regulations, safeguarding the privacy and data rights of participants involved in the intervention.

One of the key lessons learned from the ”Energia Positiva” intervention, both from the implementation and the results, is that individuals with a specific energy-interested mindset (as customers of Energia Positiva are) can be a valuable and precious source of information for studies of this kind. This insight highlights the importance of engaging with individuals who have a genuine interest in energy-related topics, as they can provide valuable insights and data for research and interventions in the energy sector.

The ”Energia Positiva” intervention was well-received among the target population, earning a rating of 4 on a scale of 1 to 5. The good collaboration and response rate contributed to this positive assessment. Additionally, no specific concerns or objections were observed from the target population. Regarding awareness and the actors involved, the intervention engaged one public entity, one scientific organization, and one commercial entity in preparing and distributing the intervention. No NGOs were involved. No new ideas emerged during the process of working with the intervention that were not discussed in the ENCHANT project. For future projects to implement similar ideas, several conditions would be needed, including sufficient financial resources, realistic time management, involvement of relevant stakeholders and the support from suitable partners. The results of the interventions did not appear to have a specific influence on activities in the post-implementation phase.

The "Energia Positiva" intervention was rated with a high level of replicability, earning a rating of 5 on a scale of 1 to 5. This suggests that the intervention can be easily replicated in other similar contexts. The rationale behind this high replicability rating is the increasing popularity of energy cooperatives and energy communities across Europe. These entities are seen as potential vehicles for promoting sustainable behavioral change in energy and climate-friendly lifestyles. Key aspects that contribute to the replicability of this intervention include a very clear research design and a simple intervention format, which can be easily adapted and applied in various settings. No specific contextual factors, such as climate situations or cultural elements, are believed to significantly affect the replicability of this intervention, indicating that its core elements are adaptable and consistent across different contexts. The intervention did have financial expenditure associated with its implementation, including travel costs for meetings with user partners, which amounted to about 1500 euros. However, the financial resources provided were rated as highly adequate with a score of 5 on a scale of 1 to 5, signifying that there were no financial issues in coping with the costs of the intervention.

The "Energia Positiva" intervention had almost no interactions with policymakers regarding ENCHANT. There were minimal engagements with policymakers during the course of the intervention. The Intervention Monitoring Checklist template was not used in this case. Therefore, there are no specific achievements or drawbacks to report related to the use of this checklist in the context of this intervention.

In summary, the "Energia Positiva" intervention faced challenges related to respondent matching, but it was well-received and highly replicable. Ethical and privacy considerations were taken into account, and the financial resources provided were deemed adequate.

2.1.3 Romania - Electrica Furnizare

2.1.3.1 Introduction

Between May and July 2022, the Romanian energy provider Electrica Furnizare SA sent interventions to their customers with online accounts residing in the regions Muntenia

Nord, Transilvania Nord, and Transilvania Sud. The goal of these interventions was to test the effect on customers' energy consumption. Customers ($n = 30,596$) were randomly divided into five groups.

- Control group ($n = 9,586$)
- Intervention 1 ($n = 5,648$), "Individual benefit information"
- Intervention 2 ($n = 5,389$), "Altruism and social norm information"
- Intervention 3.1 ($n = 5,182$), "Individual framing information"
- Intervention 3.2 ($n = 4,791$), "Collective framing information"

A second experiment was conducted with their offline customers ($n = 23,345$), i.e. customers that do not have an online account and prefer more traditional means of communicating with the energy provider. Overall, the intervention was sent to 2.521.474 households. All participating offline customers received Intervention 1 in September 2022. Both online and offline datasets contain monthly electricity consumption data for households between January 2020 and December 2022, type of meter reading, and socio-demographic variables (gender and age of contract holder, city, county, and province).

Figure 6 shows the logarithm of the mean electricity consumption across all online customers. Constant changes in legislation between November 2021 and December 2022 significantly impacted energy suppliers, leading to prolonged periods of non-issuance of invoices. Consequently, this situation resulted in invoicing errors, which were subsequently rectified through regularizations. These irregularities contribute to the observed unusual peaks in the plot of electricity consumption.

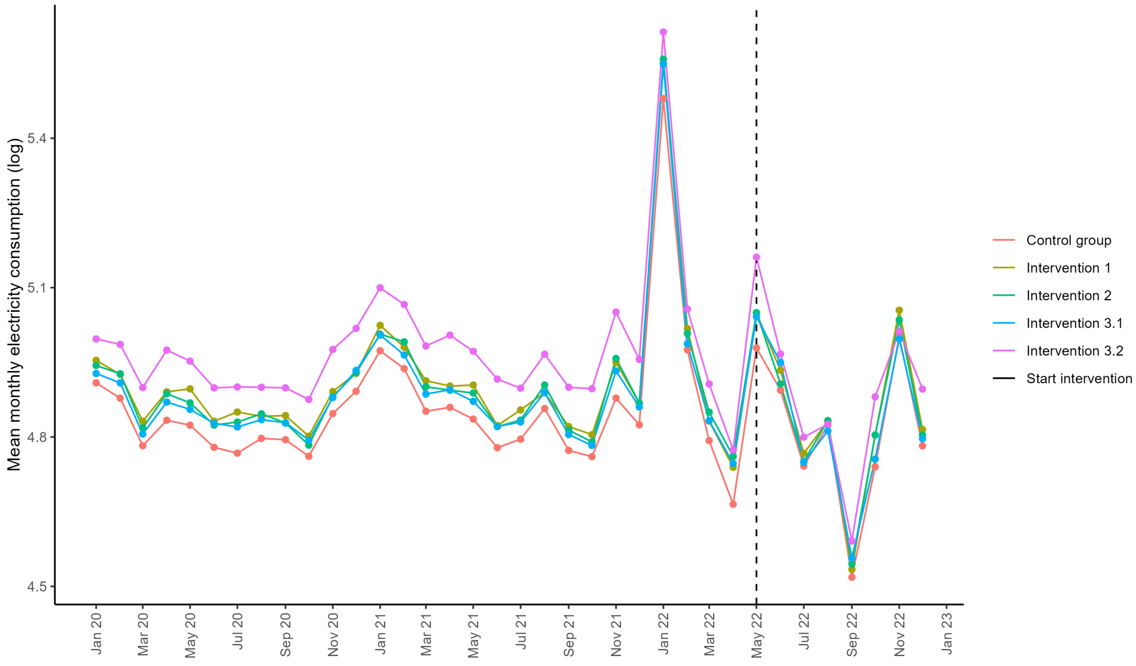


Figure 6: Customers with online account: Mean monthly electricity consumption (log).

Figure 7 shows the logarithm of the mean electricity consumption across offline customers. Due to the absence of a control group among offline customers which was not possible to implement, it is not possible to estimate a causal effect using the difference-in-differences (DiD) method. The DiD technique relies on comparing the changes in outcomes over time between a treatment group and a control group, which allows for the identification of the causal impact of an intervention. Without a control group, it becomes challenging to isolate the effects of other potential confounding variables that might influence the outcomes. As a result, the absence of a control group limits our ability to draw definitive conclusions regarding the causal relationship between the intervention and electricity consumption behavior.

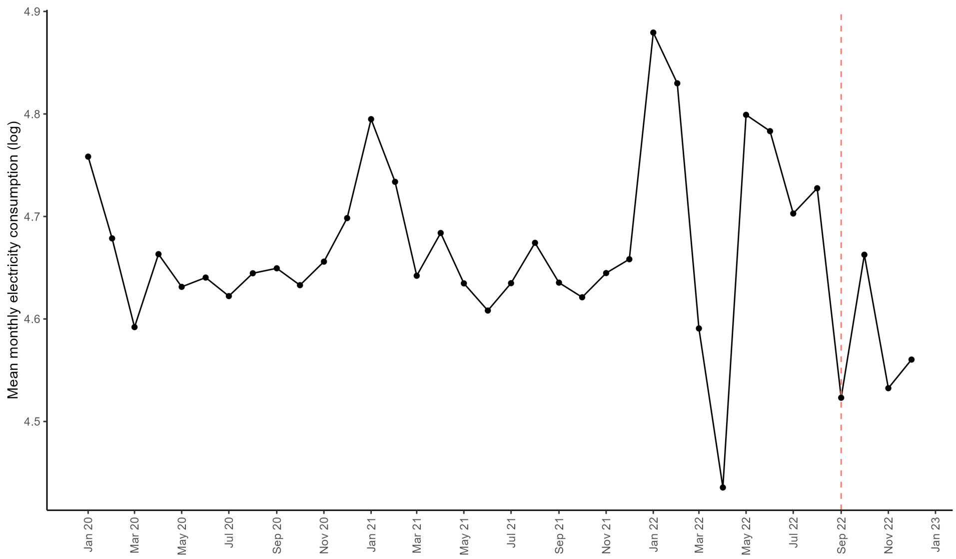


Figure 7: Customers with offline account: Mean monthly electricity consumption (log).

2.1.3.2 Evaluation

To assess the effect of the interventions conducted with online customers, we estimate a two-way fixed effects model, where the dependent variable is the natural log of the monthly household electricity consumption:

$$\begin{aligned}\log(\text{consumption})_{it} = \beta_1 \cdot \text{treatment1}_{it} + \beta_2 \cdot \text{treatment2}_{it} + \beta_3 \cdot \text{treatment31}_{it} \\ + \beta_4 \cdot \text{treatment32}_{it} + \alpha_i + \lambda_t + \varepsilon_{it}\end{aligned} \tag{2}$$

The variable treatment1 is a dummy variable that equals one for households that received intervention 1 during and after the intervention period. Respectively, treatment2, treatment31 and treatment32 indicate intervention 2, 3.1, or 3.2 during and after the intervention period. The α_i are the household-specific intercepts, the λ_t are the time-specific intercepts.

The results of the regression are shown in Table 8. On average the electricity consumption increases after the intervention in experimental group 1 by about 0.3%. In experimental group 2 the treatment decreases the electricity consumption by about 0.6%. We note that the treatment in experimental groups 1 and 2 is not statistically significant. We observed that individual framing information as sent to experimental group 3.1 via newsletters results in a decreased electricity consumption in households of about 1.1% and collective framing information results in a decreased electricity consumption in households of about 1.9% compared to the control group. A comprehensive description of the newsletter can be found in Appendix A (see section 4).

Table 8: Results from fixed effects regression.

	Dependent variable:
	Consumption_log
treatment1	0.003
	(0.003)
treatment2	-0.006^{*}
	(0.003)
treatment31	-0.011^{***}
	(0.003)
treatment32	-0.019^{***}
	(0.004)
Observations	1,002,290
Note:	*p<0.1; **p<0.05; ***p<0.01

As previously stated, it was not possible to implement a control group among offline customers. Therefore, we cannot assess causal relationships between the treatment and the electricity consumption. As an alternative approach, we use a linear regression model to assess the impact of the treatment.

$$\begin{aligned} \log(\text{consumption}) = \beta_0 + \beta_1 \cdot \text{treatment} + \beta_2 \cdot \text{province} + \beta_3 \cdot \text{residence} \\ + \beta_4 \cdot \text{year} + \beta_5 \cdot \text{month} + \varepsilon \end{aligned} \tag{3}$$

The variable treatment is a dummy variable that equals one for all households in this dataset during and after the intervention period. Province is a categorical variable denoting the province where the customer resides. Residence is a categorical variable indicating if the customer resides in a rural or urban area. year and month represent the date of the monthly consumption value.

Table 9: Results from linear regression.

	Dependent variable:
	Consumption_log
treatment1	-0.151^{***}
	(0.004)
TRANSILVANIA NORD	-0.003
	(0.002)
TRANSILVANIA SUD	0.067^{***}
	(0.002)
Urban	-0.266^{***}
	(0.002)
Observations	781,292
F Statistic	$1{,}907.107^{***}$ (df = 17; 781274)
Note:	*p<0.1; **p<0.05; ***p<0.01

Note: *Omitted coefficients in the table: Intercept, province, year2021 to year2021 (2020 is reference year), monthFebruary to monthDecember (January is the reference month)*

The results of the regression are shown in Table 9. On average the electricity consumption decreases during and after the intervention by about 15%. The absence of the control group limits the ability to establish a causal link between the intervention and changes in electricity consumption. However, even without a control group we observe an effect worth exploring further. The effect of this intervention (intervention 1; Individual benefit information) among online customers was not significant. This may suggest that different approaches are necessary to address the two distinct types of customers.

2.1.3.3 Implementation

A survey was also issued for this intervention in Romania to the user partners. It was separated into online and offline users and the results are now presented. During the implementation phase of the Electrica online customers intervention several challenges were encountered. These challenges were associated with unexpected market events, particularly those related to COVID-19 and the war in the Ukraine. Under the circumstances, these challenges were unexpected and unforeseen. To overcome these challenges, the intervention had to be postponed or the impact of these unexpected market events had to be taken into account. Unfortunately, these challenges could not have been prevented. No modifications or adaptations were made to the original intervention design. The intervention was implemented as initially planned, without any deviations.

Ethical considerations were taken into account during the planning and implementation of the intervention. Survey questions were formulated in compliance with GDPR rules. Data was collected and disclosed in an anonymized way, and focus groups were performed based on consent.

One of the key lessons learned from this intervention is that interaction with unexpected market events may render the intervention to implementation and analysis challenges.

The overall acceptance of the intervention among the target population was rated as 5, indicating a high intervention access rate for the online population. No specific concerns or objections were observed among the target population regarding the intervention. The actors involved in preparing and distributing the intervention included the scientific organization Babes-Boliay University and the commercial entity EFSA. No new ideas emerged during the process of working with the intervention that were not discussed in the ENCHANT project. For a future project to successfully implement the ideas generated from this intervention, several conditions and factors should be in place. Highlighted factors included specific project objectives, sufficient financial resources, a realistic time management, the involvement of relevant stakeholders, the willingness to learn from problems and challenges and the support of suitable partners.

The results of the online intervention had a direct impact on the design and execution of the offline intervention. The insights and data gathered from the online activities informed the development of the subsequent offline component which is described in more detail below. This illustrates a proactive approach to utilizing data and experiences from one phase of the project to enhance and shape the activities in the next phase.

The replicability of the intervention was rated with a score of 4, suggesting that with the right partner and instruments in place, it can be replicated quite easily. Key aspects that make it replicable include the intervention message, access to an energy provider and their clients, and access to data, ideally smart meter data. Cultural aspects and contextual factors may provide nuanced reactions and influence replicability.

The intervention incurred financial expenditure, including indirect costs related to platform development and management, amounting to approximately 5000 EUR. The financial resources provided were rated as highly adequate, with a score of 5, indicating no financial issues in coping with the costs of the intervention.

Further, there were interactions with policymakers, as ENCHANT results were used in various policy engagements and in the dissemination of the Romanian Energy Poverty Observatory. The Intervention Monitoring Checklist template was used, but the specific achievements and limitations related to its use were not detailed in this response.

All these aspects were also surveyed for the offline customers part. These are now listed here. As well as in the implementation phase of the online customers intervention challenges were also encountered during the implementation phase of the offline customers intervention. These challenges were related to overlapping with unexpected market events caused by COVID-19 and the war in the Ukraine. These challenges were unexpected, and the intervention needed to be rescheduled or adapted to consider the effects of these unforeseen market events. Unfortunately, these challenges could not have been prevented. Further, no modifications or adaptations were made to the original intervention design.

During the planning and the implementation of the intervention ethical considerations were taken into account. Survey questions were formulated considering GDPR rules, data was collected and disclosed in an anonymized way, and focus groups were conducted based on consent. Data and privacy considerations were thoroughly addressed to ensure complience with GDPR and ethical standards.

Key lessons learned from the intervention included the fact that unexpected market events can pose implementation and analysis challenges. The low implementation of smart metering made data collection and impact measurements difficult. Additionally, differentiated contracts related to billing periods complicated the implementation.

The overall acceptance of the intervention among the target population was rated as 5, indicating a high level of acceptance. This was attributed to a good outreach in the offline intervention. Furthermore, various actors were involved in preparing and distribution the intervention, including scientific institutions as the Babes-Bolyai University, commercial entities as EFSA and EFSA subcontracted party for billing, but no NGOs. New ideas emerged from the intervention, including the suggestion that it would have been useful to implement the offline intervention repeatedly to capture changes over time and overcome the effects of unexpected marked events. Access to smart metering data would have eased data collection and impact analysis. To implement these ideas in future projects, several conditions must be met, including specific project objectives, sufficient financial resources, realistic time management, involvement of relevant stakeholders, the review of technical feasibility, the willingness to learn from problems and challenges, support of suitable partners and the long-term perspective of impact. The results of the intervention influenced post-implementation activities, particularly in policy-making initiatives. The data revealed the impacts of various events on different categories of consumers, which was used in policy-making.

The intervention incurred financial expenditure amounting to 17,739.56 EUR, covering costs such as intervention dissemination and material costs such as printing. The financial resources provided were rated as 5, indicating they were very adequate to cover the costs of the intervention.

The intervention led to several interactions with policymakers, including one media campaign, one conference with decision-makers on ETS, one bilateral engagement with the energy minister and staff, one policy proposal, one press club, and various live media interventions. ENCHANT results were used in policy engagements and dissemination of the Romanian Energy Poverty Observatory. The Intervention Monitoring Checklist template was used, but specific details about its achievements or limitations were not provided.

Overall, this intervention faced challenges due to unexpected market events, made ethical considerations, was well-accepted, influenced policy-making, and had moderate replicability potential, among other findings.

2.1.4 Türkiye - Gediz Electricity

2.1.4.1 Introduction

The Gediz intervention was implemented between November 2021 to February 2022, where the intervention timeline for the northern regions of Izmir was the four-month period from November 2021 to February 2022, and the intervention timeline for the southern regions of Izmir was the three-month period from December 2021 to February 2022. Customers within the experimental groups in the north ($n = 136,785$) and south ($n = 320,598$) received intervention messages on their electricity bills. Customers within the control group, in the metropolitan region, ($n = 1,104,261$) did not receive messages. The aim of this experiment was to test the impacts of various energy efficiency information on the electricity consumption of households.

2.1.4.2 Evaluation

Figure 8 shows the logarithm of the average monthly electricity consumption for each group. In order to assess the effects of the interventions, we use a two-way fixed effects model. However, the figure shows that the parallel trend assumption might not hold, especially in the earlier observation period, and after the treatment, the groups do not clearly diverge. This implies that the two-way fixed effects model's assumptions of parallel trends across groups may be too stringent, potentially leading to biased estimates.

Figure 9 shows the average log of the monthly electricity consumption for pre- and post-treatment periods for each group. The mean in the post-treatment period is higher because the post-treatment period is in the winter season. However, the slope of the south region seems parallel to the control group (Metropol), whereas the slope of the north region is shallower, which could indicate a positive effect of the intervention, i.e. a reduction of electricity consumption.

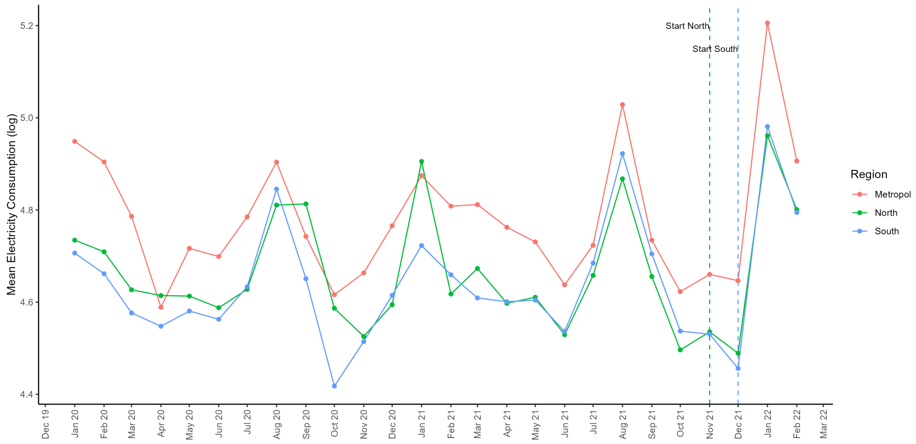


Figure 8: Average monthly electricity consumption (log) for both experimental groups (North and South) and the control group (Metropole) for pre- and post-treatment periods.

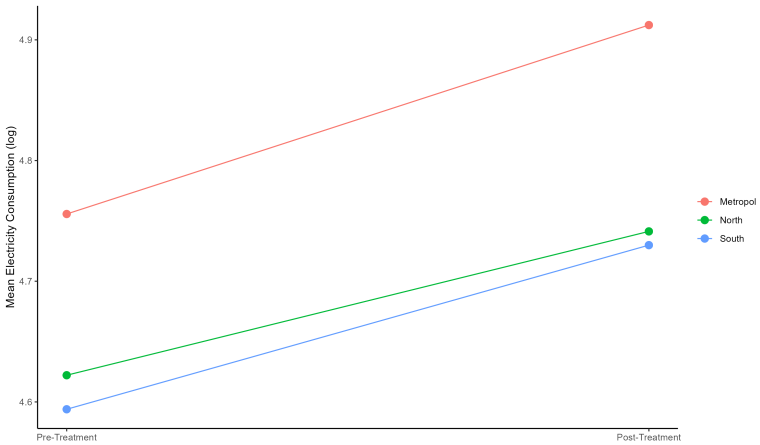


Figure 9: Average monthly electricity consumption (log) for both experimental groups (North and South) and the control group (Metropole).

The majority of the households in the experiment group (North and South regions of Izmir) use electricity for heating (mainly air conditioners, heat pumps, and electric heaters) and cooling (mainly air conditioners) purposes. This suggests that the temperature values may also impact the consumption amounts. Here we use a non-linear term to model the relationship between electricity consumption and temperature reflecting the observation that electricity usage tends to decrease at moderate temperatures but increases notably during both high and low temperatures, primarily driven by the demands of cooling and heating. Another common approach would be using heating degree days (HDD) and cooling degree days (CDD) days or solar intensity. The two-way fixed effects model we estimate to assess the effect of the interventions is specified as follows:

$$\log(\text{consumption})_{it} = \beta_1 \cdot \text{North}_{it} + \beta_2 \cdot \text{South}_{it} + \beta_3 \cdot \text{temperature}^2_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \tag{4}$$

The variable treatment1 is a dummy variable that equals one for households in northern regions during the intervention period (November 2021 to February 2022). Respectively, treatment2 denotes households in the southern region during the intervention period (December 2021 to February 2022). We also include temperature to control for the average monthly outside air temperature[2] in degrees Celsius within a district, which is assumed to have a quadratic effect on electricity consumption. The α_i are household-specific intercepts, the λ_t are time-specific intercepts and ε_{it} denotes the error term.

Table 10: Regression results for Gediz intervention.

	Dependent variable:
	Log consumption
North	-0.019^{***}
	(0.001)
South	-0.013^{***}
	(0.001)
Temperature2	0.0005^{***}
	(0.00001)
Observations	23,763,928
Note:	*p<0.1; **p<0.05; ***p<0.01

The results of the regression analysis are shown in Table 10. The intervention in the northern regions decreased the electricity consumption during the post-treatment period on average by about 1.9% (p <0.01), whereas during post-treatment period in the southern region the electricity consumption decreased on average by about 1.3% ($p < 0.01$).

2.1.4.3 Implementation

[2]Worldweatheronline.com (2022); Timeanddate.com (2022)

Regarding the implementation of the intervention, we see that the Gediz customers' intervention took place from 01.11.2021 to 01.02.2022 and thus lasted around three months. It involved implementing interventions through messages on electricity bills. The preparation for this intervention lasted approximately three months, which included tasks such as identifying data requirements, assessing available data, designing the content of bill messages, scheduling when these messages would appear on bills and navigating through approval processes.

Challenges were encountered during the implementation phase. These challenges included finding suitable communication channels, reaching the right audience, using appropriate networks for intervention implementation, designing effective messages, ensuring accurate translations, deciding where on the electricity bills the messages should be placed, addressing administrative and bureaucratic processes, managing company approval procedures, dealing with personal data and privacy concerns, and reconciling differing perspectives between scientific and user partners regarding intervention methods. While some challenges were expected due to the citywide nature of the intervention and various stakeholders' involvement, others, such as communication and administrative challenges, exceeded expectations. To address these challenges, intense communication was maintained through face-to-face and online meetings, emails and phone calls with company executives. Continuous follow-up and fine-tuning of the intervention were performed to align with project, company and participant needs. In terms of prevention, earlier communication and design of interventions could have been helpful. Initiating discussions and planning with relevant stakeholders at an earlier stage could have enabled the identification of potential challenges and the development of more effective strategies to address them. Additionally, conducting a pilot implementation of the intervention would have been valuable in identifying and addressing potential issues before full-scale implementation. However, it is also acknowledged that the challenge of persuading user partners is to allocate resources for preparatory stages before their actual tasks.

Modifications and adaptations were made to the original intervention design, particularly to tailor the intervention to the Turkish context. This adaptation considered communication channels, legislation, privacy concerns, bureaucratic approval processes, operational constraints and data collection. Ethical considerations were an integral part of the intervention's planning and implementation. Personal information about Gediz Electric customers was not shared or disclosed, and the intervention adhered to Turkish data protection legislation (KVKK) and the General Data Protection Regulation (GDPR).

Key lessons learned from the intervention include the importance of identifying efficient communication channels and the necessity of collaboration among different stakeholders. Regular information exchange among these stakeholders was highlighted as crucial. The overall acceptance rating of the intervention was rated as 3 on a scale of 1 to 5. This rating is based on the intervention results, which demonstrated that the treated population consumed significantly less energy (with a reduction of about 1.3 - 1.9%) compared to the untreated population. These results indicate a positive impact of Gediz Electricity's interventions among the target population, suggesting a moderate level of acceptance.

Several actors were involved in preparing and distributing the intervention, including the scientific organization Izmir University of Economics and the commercial entity Gediz Electricity Company. New ideas and insights emerged during the intervention, such as the importance of selecting the right user partners, choosing appropriate intervention types, recognizing differences between planned interventions and real-life implementations, and emphasizing the significance of the intervention process and design. To ensure the successful implementation of the ideas in future projects, several critical conditions and factors must be in place. These elements collectively contribute to a project's effectiveness and its ability to achieve its intended goals. Highlighted were the specific project objectives, a realistic time management, built-up know-how, the involvement of relevant stakeholders, review of technical feasibility, the support of suitable partners and an appropriate data evaluation. The results of the intervention influenced post-implementation activities, particularly leading to a decrease in electricity usage among the experiment group, which increased Gediz's trust in using electricity bills for disseminating information. This motivated them to participate in similar projects in the future.

The replicability of the intervention was rated as 3 on a scale of 1 to 5. Replicating the intervention in other contexts is deemed feasible with the right partner and resources, considering aspects such as the design of the intervention, data requirements, data processes, guidelines, monitoring processes and effective communication protocols. Cultural and contextual factors, like the specific characteristics of the partner implementing interventions, including administrative setups, bureaucracy and available resources may impact replicability.

During the implementation of the intervention, there was financial expenditure and it was covered from the organization's overhead budget. The answers do not specify the total amount spent or the detailed breakdown of expenses. The intervention report rates the adequacy of the financial resources as 4 on a scale of 1 to 5, indicating that the resources provided were relatively sufficient to manage the costs of the intervention.

Further, the team had several interactions with policymakers, engaging with local authorities such as the Metropolitan Municipality and the district municipalities. Additionally, they collaborated with the Sustainable Urban Development Network, which includes various stakeholders from the greater Izmir area, such as NGOs, universities and municipal sustainability offices. These interactions were aimed at disseminating information and engaging policymakers in discussions related to the project. The team also used the Intervention Monitoring Checklist template, which proved to be beneficial in several ways. The template facilitated efficient monitoring of the intervention's progress, allowed for sharing updates with relevant partners and aided in identifying any issues or challenges during the intervention. It also helped to find effective solutions to address these challenges. It is suggested that this template can be employed in future projects with similar objectives and can be adapted for various phases of the project, including pre-intervention, execution and post-intervention stages, enhancing the overall project management and monitoring process.

2.1.5 Germany - Hansgrohe Pontos

2.1.5.1 Introduction

The collaborative intervention between the German energy provider Badenova and the private enterprise Hansgrohe aims to effectively manage water resources within private households. The water management system Pontos, developed by Hansgrohe, was installed in private households and provides residents with visualizations of their own water consumption. Ten participants were equipped with the Pontos system. Participants were required to complete an initial and follow-up survey, the latter conducted through video interviews. The intervention aims to explore the influence of the visualization of household water consumption and to investigate a potential relationship between water- and energy-saving practices.

Number of Participants	10
Age Range	32 to 46 years
Gender	1 female, 9 male
Employment	All participants are employed full-time
Family Structure	Children reside in 8 households
Notes	5 participants had water damage before

Table 11: Socio-demographic characteristics

2.1.5.2 Evaluation

The first survey aimed to understand the participants' motivation for joining the project, and their knowledge of smart home solutions for water monitoring and leak detection. Participants were asked about their experiences with water damage, expectations from the Pontos system and their current smart home setups as well as energy- and water-saving practices.

The majority of participants (80%) reported that they had never heard of Smart Home solutions for water management. According to the survey results, the participants' main expectations for the Pontos system were as follows: 90% expected the system to monitor water consumption in real-time, 60% expected Pontos to be a reliable protection against water leaks, 30% were interested in integrating the system with other Smart Home interfaces. 30% hoped the system would help conserve water through data analysis, and 20% expected the system to display important metrics, such as water hardness. Reasons for water and electricity saving practices included primarily ecological concerns (50%), ecological and financial aspects are equally important (40%), followed by primarily financial considerations (10%). Half of the participants stated that they prioritize saving electricity over water conservation, while the other half indicated that they prioritize water conservation over saving electricity.

The follow up interviews were conducted four to six weeks after the installation of the Pontos system. The follow-up survey aimed to assess user experience with the app that comes with the system, potential changes in water and energy consumption, and the perceived effectiveness of Pontos in preventing water damage. None of the participants reported a change in their electricity consumption since the installation of Pontos. One participant reported a change in their water consumption. Overall, seven out of ten participants stated that their expectations were met and they would recommend the system.

2.1.5.3 Implementation

In order to gain even deeper insights into the development phase of the intervention, a questionnaire was sent out here as well. The Badenova / Hansgrohe intervention took place from 09.06.2021 to 25.05.2022, spanning a preparation time of three months. Notably, no significant challenges were encountered during the implementation phase of this intervention. In contrast to the absence of implementation challenges, a modification was made to the original intervention design. A third interview was conducted to better assess the impact of Pontos. This adaptation led to an extension of the intervention period, which suggests a willingness to make changes to improve data collection and assessment.

While there were no explicit reports of ethical considerations taken into account during the planning and implementation of the intervention, data and privacy considerations were addressed effectively. This was achieved through the implementation of a declaration of consent and data protection regulation. Additionally, signed agreements between Badenova and test customers were established to safeguard data and privacy.

The key lesson drawn from this intervention was that monitoring consumption does not always have to result in a reduction. This observation emphasizes the nuanced relationship between monitoring and behavioral change. The overall acceptance of the intervention among the target population was highly positive and rated as 5 on a scale of 1 to 5. This rating indicates that the intervention, which included product tests, was well-received. The partnership with Hansgrohe was also highlighted as a helpful factor in achieving high acceptance.

The details provided did not specify the involvement of actors from the public, scientific, NGOs, or commercial sectors in the preparation and distribution of the intervention. Furthermore, no new ideas or strategies emerged during the intervention that were not previously discussed within the ENCHANT project. The intervention was rated with a score of 2-3 on the replicability scale, indicating that while replicating the technical product installation was successful, it may be challenging to find suitable test households and craftsmen who can implement the technology rapidly in the future. The feasibility of replicating the intervention is subject to these logistical considerations.

A notable aspect of this intervention was the absence of financial expenditures associated with its implementation. The costs for hiring personnel, transport, materials, and other expenses were either not applicable or were borne by Badenova itself. The financial resources allocated for the intervention were considered highly adequate, receiving a rating of 5, indicating that there were no financial constraints to cope with the costs of the intervention. The intervention did not employ the Intervention Monitoring Checklist template as part of its implementation process, which sets it apart from some other interventions that used this template for efficient monitoring.

In summary, the Badenova / Hansgrohe intervention proceeded smoothly without significant challenges. It achieved high acceptance among the target population and demonstrated potential for replicability. The intervention was conducted with highly adequate financial resources and did not involve interactions with policymakers. The absence of ethical challenges, coupled with effective data protection measures, underscores the importance of privacy and compliance in such interventions.

2.2 Public Transport

The second part of interventions addresses the usage of public transport means. So far, a substantial body of literature exists on transportation behavioral modification (Cairns et al., 2008; Fujii & Taniguchi, 2006; Kearney & De Young, 1996; Scheepers et al., 2014). However, experimental studies exploring the effects of free public transportation tickets, particularly those published in international journals, are comparatively limited (Abou-Zeid & Ben-Akiva, 2012). The spectrum of studies reviewed spans from earlier experiments by Everett, Hayward, and Meyers (1974) to more contemporary investigations by Thøgersen (2009), encompassing aspects such as mode switching and psychological variables.

In their research, Everett et al. (1974) demonstrated a significant 50% rise in ridership on the experimental bus during the incentive period, primarily attracting pedestrians, undergraduate students, and academic travelers—many of whom were new riders. However, this surge was not sustained once the incentive was discontinued. Similarly, Bachman and Katzev (1982) conducted a study involving 83 participants in the Portland metropolitan area, revealing that interventions, including free bus tickets, significantly augmented public transportation ridership during and after the treatment periods, compared to control conditions. Recent studies have further explored psychological factors affecting mode switching, supplementing the understanding of intervention potential. For instance, Fujii and Taniguchi (2006) provided one-month free bus tickets to students at Kyoto University who primarily used cars, resulting in an immediate and sustained increase in bus usage, underscoring a shift in habit and a more positive attitude toward buses, thereby weakening the habit of car use.

However, most of these studies confront noteworthy limitations. One vital concern is the generalizability of findings beyond the specific regional and demographic contexts targeted. Local factors and population characteristics can confine the broader applicability of observed behavioral modifications, necessitating experiments in diverse political, economic, and social contexts. Additionally, the durability of behavioral changes post-intervention necessitates further investigation. Although short-term impacts have been illuminated, questions remain regarding the enduring effects of behavioral shifts. Extending the existing literature, our study delves into the long-term impacts of such interventions on behavior. Furthermore, earlier studies often grappled with limitations related to sample size. To mitigate this, we employ two large-scale experiments, thereby providing a broader perspective on the robustness of the effects as sample sizes increase.

2.2.1 Romania - Green Friday

2.2.1.1 Introduction

The Municipality of Cluj-Napoca, Romania, introduced a campaign called "Green Friday", aimed at promoting urban mobility prioritization and reducing greenhouse gas emissions.

As part of this initiative, free public transportation is provided to residents every Friday. The campaign has been implemented by the municipality since June 2021.

In the scope of this intervention, a public transportation dataset was collected. It contains data about bus commuters on all bus lines equipped with the data collection system (Thoreb) in Cluj-Napoca between March 2021 and December 2022.

2.2.1.2 Evaluation

Between March 2021 and December 2022, the municipality collected data on the total number of commuters across all bus lines for each Wednesday and Friday using the Thoreb data collection system. Thoreb has a declared technical error of +/-5%. Additionally, information about the number of buses in operation on each of these days was recorded. In total, 94 Wednesdays and 94 Fridays with a combined total of over 21 million passengers counted during this observation period. The passenger count on all Wednesdays is about 10.7 million, and the passenger count on Fridays is about 11.2 million in total.

Figure 10 shows the number of total passengers for the experimental group (Friday) and the control group (Wednesday). During the observed time period, the number of total passengers is increasing. The outliers can be explained by national holidays[3]. No national COVID-10 lockdowns were implemented during this time period. However, there may have been local lockdown measures and restrictions that could have influenced the passenger counts. As we did not observe passenger counts before the COVID-19 pandemic, it remains uncertain whether the observed increase can be attributed to a genuine rise in passenger numbers or to a post-pandemic recovery phase.

[3] `https://publicholidays.ro/`, Accessed: October 2023

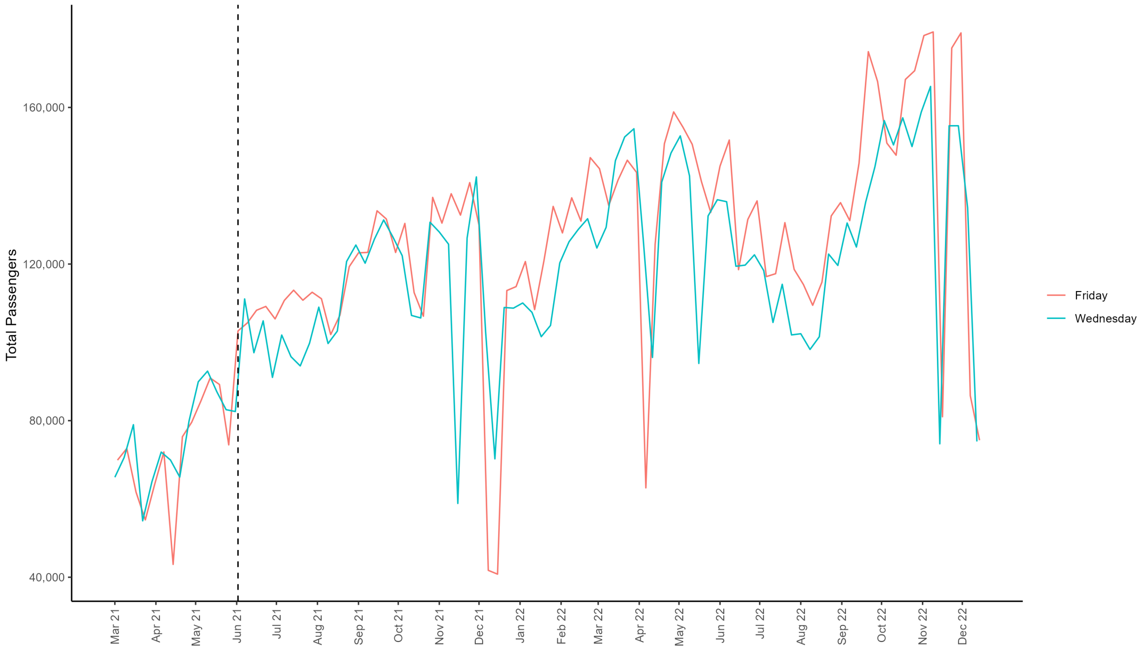


Figure 10: Total number of daily passenger counts for the experimental group (Friday) and the control group (Wednesday). The dashed line indicates the start of the campaign.

To assess the impact of Green Fridays, a difference-in-differences (DiD) analysis was employed. This allows to evaluate the intervention's effect by comparing the changes in passenger counts between Fridays (treatment group) and Wednesdays (control group) before and after the launch in June 2021. We specify the model as follows:

$$\begin{aligned}\log(\text{Passengers}) = \beta_0 + \beta_1 \cdot \text{Post Treatment} + \beta_2 \cdot \text{Treated} + \beta_3 \cdot \text{DiD} \\ + \beta_4 \cdot \text{holiday} + \sum_{i=1}^{11} \beta_{4+i} \cdot \text{Month}_i + \epsilon\end{aligned} \tag{5}$$

We use a log transformation of the total daily passenger count to create a model that allows us to interpret coefficients as multiplicative (percentage) changes in the dependent variable rather than total changes on the group level. Post Treatment is a binary variable indicating whether an observation is from the post-treatment period. treated is another binary variable that equals one for observations that were treated (Fridays), and zero for observations that were never treated (Wednesdays). DiD is the interaction between Post Treatment and Treated, capturing the treatment effect. The dummy variable holiday equals one if the day is a national holiday. A set of monthly dummy variables (Month) is included to estimate monthly seasonal effects. ϵ is the error term.

The results of the analysis are shown in Table 12. The main finding indicates a post-intervention treatment effect of approximately 0.049. This corresponds to an estimated increase in the number of passengers by approximately 4.9%. It is important to note that

Table 12: Regression results for Green Friday

	Dependent variable:
	log(Passengers)
treated (Friday)	−0.013
	(0.070)
Post Treatment	0.575***
	(0.058)
DiD	0.049
	(0.076)
Observations	188
Note:	*p<0.1; **p<0.05; ***p<0.01

Note: *Omitted coefficients in the table: Intercept, holiday, monthFebruary to monthDecember (January is the reference month)*

this effect is not statistically significant. This suggests that the observed increase in passenger numbers may be due to random variation or other unaccounted factors. A possible reason for the lack of significance could be the relatively small sample size or the relatively short duration of the pre-intervention period. Additional factors, such as the impact of local COVID-19 lockdowns, should ideally be considered in the analysis. However, the effect size seems reasonable and gives a good indication for further analysis.

2.2.1.3 Implementation

For a more comprehensive overview, questions were also submitted to the user partner in Romania. The results of the survey show that during the implementation of the Cluj Napoca Green Friday intervention, no specific challenges were encountered. It appears that the implementation phase proceeded without major obstacles. Furthermore, no modifications or adaptations were made to the original intervention design. The intervention design remained consistent throughout the implementation.

The intervention did not involve ethical considerations or privacy concerns. One of the key lessons learned from this intervention was related to the evaluation of its impact. The wide-spread implementation of the intervention prevented the ability to compare the impact between different groups. Additionally, the use of data for analysis was found to be either limited or involved GDPR-related challenges.

The overall acceptance of the intervention among the target population was rated as 2 on a scale of 1 to 5. According to the feedback of the user-partners in Roamania the rating suggests that while the intervention message was widely circulated, it did not lead to significant behavioral changes. Further, there were no specific concerns or objections raised by the target population. The involvement of different actors in preparing and distributing the intervention varied. Public institutions, specifically the local public administration, were involved. However, there was limited or no involvement from scientific institutions, non-governmental organizations (NGOs) or commercial entities. An interesting insight that emerged through interviewing other local authorities was the significance of the political factor in the adoption of the intervention model, beyond simply adhering to good practices. In this context, the political factor could therefore refer to the importance of political support, resource allocation, laws/regulations or public opinion in connection with the introduction of the intervention model.

For future projects to implement similar ideas, several conditions should be in place. These include defining specific project objectives, ensuring sufficient financial resources, securing support from suitable partners and conducting appropriate data evaluation. The answers to the survey note that the intervention continued after the project implementation period, regardless of the results. This was because the intervention had become part of the local political agenda.

The replicability of the intervention was rated as 3 on a scale of 1 to 5. This suggests that it can be replicated as a model in other contexts, provided that sufficient resources are available. Key aspects that make it replicable include having a clear structure, involving the relevant implementing instances, and using effective implementation instruments. Contextual factors that may affect the replicability of the intervention include situations similar to the pandemic, cultural factors related to how public transportation is perceived, and the availability and quality of the public transportation system. These factors should be considered when replicating the intervention in different contexts.

In terms of financial aspects, there was financial expenditure associated with the implementation of the interventions. However, the answers state that a rigorous financial analysis is required and needs to be conducted at the level of various local institutions. Unfortunately, this detailed financial analysis could not be carried out within the timeframe foreseen for this report questionnaire. The costs and expenses included travel costs (subvention from local transportation company), marketing expenses (dissemination materials), internal costs (human resources for design and dissemination), materials costs (design and production) and other indirect costs. Moreover, the costs were completely assumed by the local public administration.

The team had several interactions with policymakers regarding the ENCHANT project. These interactions included weekly reportings at local administration management meetings, project and platform dissemination at various levels, including the National Municipalities' Association and dissemination at European events.

The project did utilize the Intervention Monitoring Checklist template, and its usage was beneficial. Specifically, it provided consortium members with the flexibility to adapt and tailor the monitoring process to their specific activities. This allowed for a more customized approach to tracking and assessing the intervention's progress and impact.

2.2.2 Türkiye - Public transportation

2.2.2.1 Introduction

The Izmir Metropolitan Municipality, with a population of about 4.3 million, carried out an intervention from December 2021 to March 2022, spanning a four-month period. During this timeframe, billboards and infographics were strategically placed at public locations and stations in Izmir to encourage residents to use public transportation more frequently.

To evaluate the impact of these public information campaigns on public transport utilization, data on hourly transportation usage across various modes in Izmir was collected, covering multiple years. This data allowed us to categorize two distinct groups: pre-treatment and treatment groups. Additionally, observations were made on transportation lines that never underwent an information campaign, constituting the control group.

The experimental group includes lines such as the Metro Line, Bostanlı-Üçkuyular Ferry Line, Konak Tram Line, 304 Tınaztepe-Konak Bus Line, and 680 Bozyaka-Lozan Bus Line. The control group contains lines such as the Nostalji Line, Karşıyaka-Alsancak Ferry Line, Karşıyaka Tram Line, and 912 Egekent-Alsancak Bus Line. The dataset provides detailed information about passenger usage of various modes of public transportation on an hourly basis at each station, spanning from January 2017 to March 2022. Overall, more than 466 million passengers were counted in this period.

2.2.2.2 Evaluation

Figure 11 shows the mean (log) number of passengers for three distinct groups: the control group, the pre-treatment group (treatment group before the intervention), and the group during the treatment (treatment). The results show that on average, there are fewer passengers who used the lines and transport systems that were never treated (control group) compared to the experimental group (pre-treatment). However, most importantly, we observe that during the treatment the average number of participants increased compared to the periods before the information campaign.

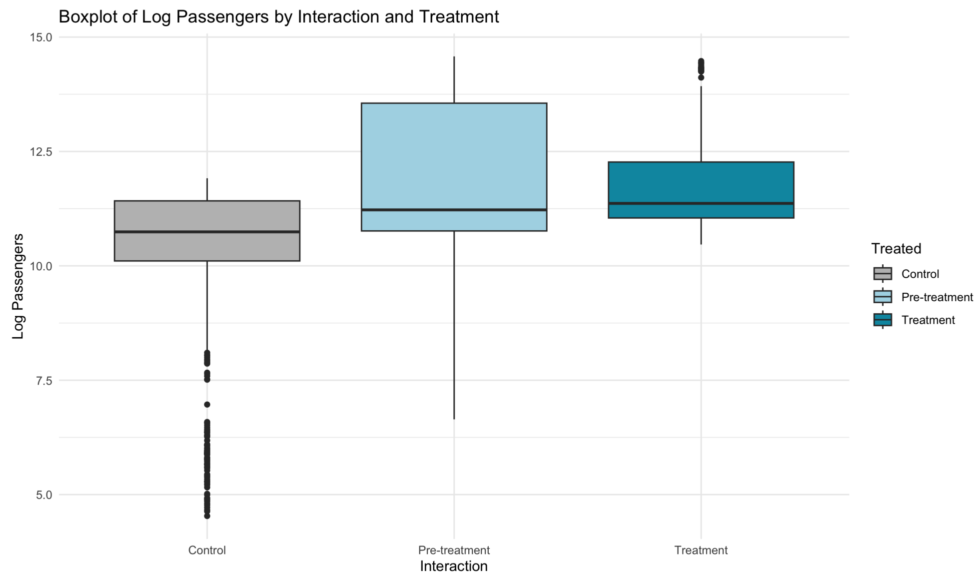


Figure 11: Caption

In order to investigate if this effect is statistically significant, one can use a difference-in-differences (DiD) estimator. An essential assumption underpinning the DiD estimator is the existence of parallel trends. This assumption suggests that, in the absence of the treatment, the trends in outcomes for both the treatment and control groups would have followed similar paths.

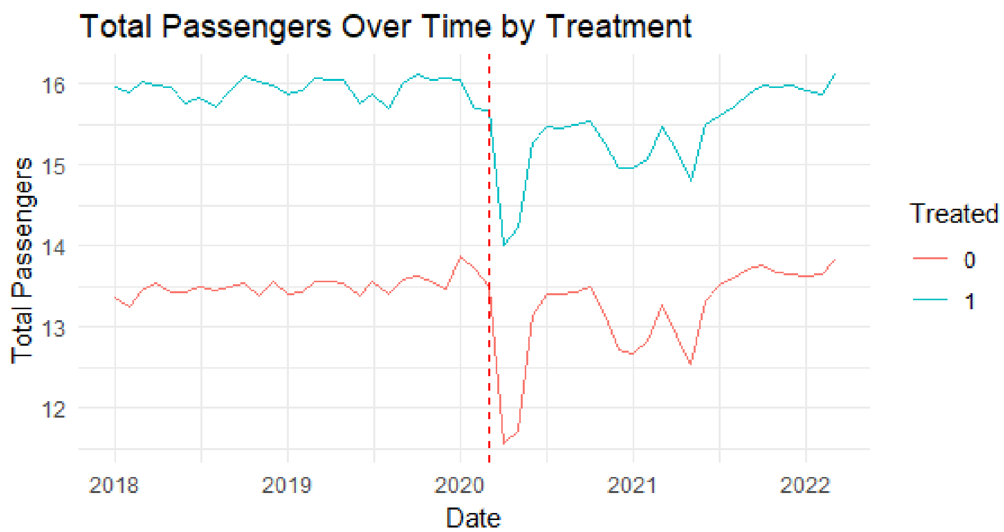


Figure 12: Total monthly passenger counts for the experimental and control groups, examining the parallel trends assumption before and after the onset of the COVID-19 pandemic.

Figure 12 represents the differences in the average number of (log) passengers between the treatment group (pre- and treated) and the control group. The treatment group starts with a higher intercept, indicating more passengers on average. However, both groups exhibit similar patterns of behavior. The dashed line marks the onset of the COVID-19 pandemic, which is followed by a substantial decline in the average number of (log) passengers. Moreover, the drop appears to be slightly more pronounced in the control group. During the recovery phase of the post-pandemic the variance in total passengers increased. Even though this is the case for both groups, the variance is slightly higher in the control group.

Figure 13 illustrates monthly total passengers (log) before and during the treatment period (pre- and treatment). The figure shows that both lines show an upward trend in total passengers, however, the slope seems to be slightly more pronounced in the treated (blue) group. In order to test, if this is a significant difference, we apply a DiD estimator.

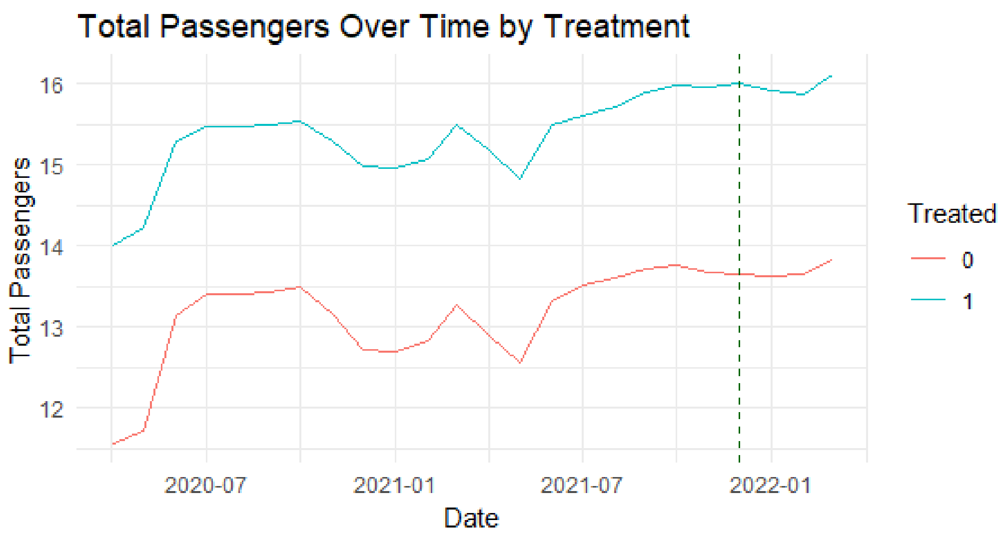


Figure 13: Total monthly passenger counts for the experimental and control groups during the recovery phase of the COVID-19 pandemic

The findings suggest that the behavior patterns were notably consistent before the pandemic. However, post-pandemic, these patterns became more erratic, potentially compromising the parallel trends assumption and diminishing the efficacy of the DiD estimator.

To apply the DiD estimator and minimize variance during the treatment phase, we analyzed the behavior of individual modes of transportation, namely Bus, Ferry, Tram, and Metro. We chose to omit the Metro line from our study, given its lack of a comparable control group. Distinctively, the Metro line registers a markedly larger daily passenger count and demonstrates a quicker rebound post-pandemic. Additionally, we disregarded the Ferry due to a breach in the parallel trends assumption, as depicted in Figure 14.

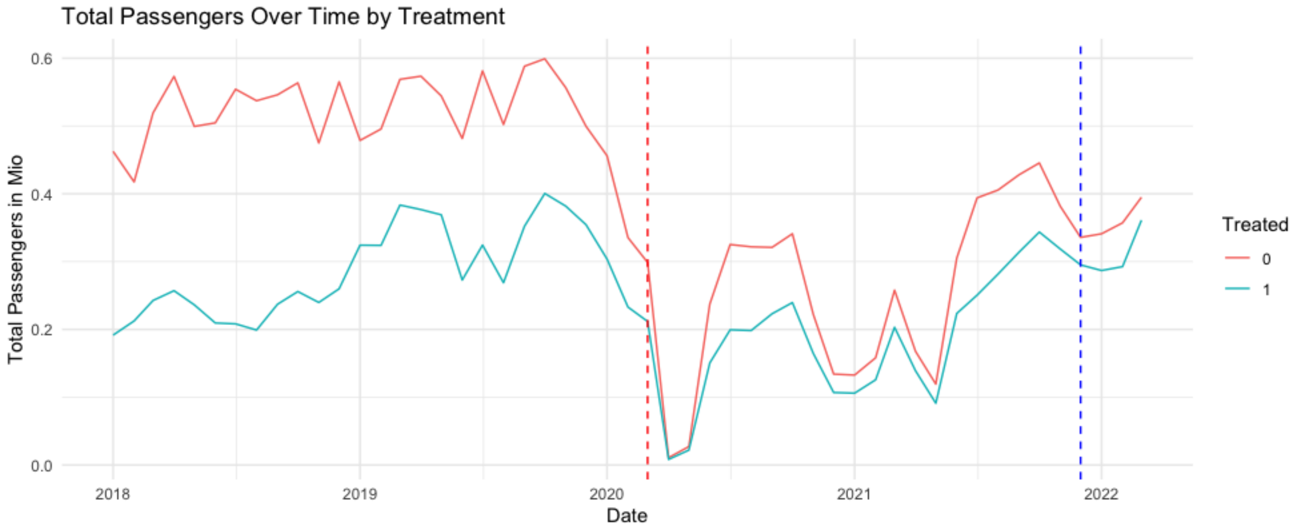


Figure 14: Total monthly passenger counts for the experimental and control groups for the ferry lines

Table 13, shows the results from our difference-in-differences (DiD) regression analysis. The analysis investigates the effects of the intervention on daily passengers, while simultaneously adjusting for daily variations (represented as time-fixed effects) and distinct line types (categorized). Equation 6 shows the specification of the DiD model:

$$\log(\text{Passengers})_{it} = \beta_0 + \beta_1 \times \text{Post Treatment}_{it} + \beta_2 \times \text{Group}_i + \beta_3 \times \text{DiD}_{it} + \gamma_t + \delta_j + \epsilon_{it} \quad (6)$$

In our model, $\log(\text{Passengers})_{it}$ denotes the log number of passengers for a given observation i at time t. The variable $\text{PostTreatment}_{it}$ is binary and indicates whether an observation is from the post-treatment period. Group_i is another binary variable, signifying the treatment group to which observation i belongs. The interaction term DiD_{it} represents the combined effect of the post-treatment period and the treatment group, essentially capturing the actual treatment effect. In this specification, we also control time fixed effects, γ_t. Similarly, δ_j stands for the transport type fixed effects. Finally, ϵ_{it} is the error term.

The coefficient for the **did** variable quantifies the average post-intervention treatment effect. The data implies an elevation of 0.078, which translates to a 7.8% increase in daily passengers. Notably, this enhancement does not attain statistical significance ($p > 0.05$).The **Post Treatment** variable, indicative of the post-treatment period, is associated with a statistically significant increase of 0.631 in the outcome variable ($p < 0.01$). This suggests that there is a substantial positive shift associated with the post-intervention period. This is partially explained by the ongoing post-COVID recovery phase. Interestingly, the **Group** coefficient, which measures the differential effect for units that have at any point received the treatment, is -0.240 and statistically significant ($p < 0.01$), while controlling for time and individual line type fixed effects. This implies that units having ever undergone the treatment demonstrate, on average, a decline in the outcome measure compared to their never-treated counterparts. The model's R^2 of 0.713 suggests a good fit, with approximately 71.3% of the variability in the dependent variable being accounted for by our predictors.

Table 13: Results of the DiD estimator for daily log (passengers) for tram and bus lines

	DiD estimator
	log(Passengers)
Diff-in-Diff	0.078
	(0.076)
Post Treatment	0.631^{***}
	(0.098)
Group	-0.240^{***}
	(0.092)
Observations	6,172
R^2	0.713
Adjusted R^2	0.712
Residual Std. Error	0.939 (df = 6141)
F Statistic	509.678^{***} (df = 30; 6141)
Note:	*p<0.1; **p<0.05; ***p<0.01

2.2.2.3 Implementation

In order to obtain more in-depth information on the pre-implementation phase, further questions were also asked for the Izmir metropolitan area intervention. Between 01.12.2023 and 01.03.2022, this intervention was carried out in the Izmir metropolitan area. These intervention involved the dissemination of messages on various public transportation platforms, including trams, buses, ferries and metro stations, over a span of four months. Throughout the intervention period, several significant aspects were addressed, such as overcoming bureaucratic obstacles, designing the intervention itself, identifying the specific data requirements, determining the available data sources, setting timelines for data collection, specifying the types of data that could be collected, creating the design of the messages and posters, scheduling the dissemination of these materials and navigating through the required approval processes.

Challenges were indeed encountered during the implementation phase, including the need to find appropriate communication channels, reach the right people within the municipality and address bureaucratic issues. Finding suitable messages for the intervention objective, ensuring the accuracy of message translations, deciding the location of message posters and handling administrative and bureaucratic processes proved challenging. Additionally, involving multiple stakeholders and addressing personal data and privacy considerations presented hurdles. The impact of the COVID-19 pandemic, particularly the closure of public transportation, had longer and more severe consequences than initially expected. Many of these challenges were expected, considering the citywide scale and multiple stakeholders involved, such as finding the right communication channels, dealing with bureaucratic processes and crafting suitable messages. To address these challenges, intensive communication efforts were employed, and the intervention's design was optimized for effective message dissemination. To prevent such issues in the future, early communication and pilot implementations could be helpful, but this might not always be easy due to resource allocation preferences of user partners.

Modifications and adaptations were made to the original intervention design. These changes were made to adapt the intervention to the Turkish context. Factors considered included available communication channels, legal requirements, data protection concerns, bureaucratic approval procedures, operational constraints, and the type and frequency of data that the user partner could collect.

The intervention planning and implementation took no ethical or any data and privacy considerations into account. Messages on public transportation, including trams, buses, ferries and metro stations, did not involve sharing personal information of passengers. The interventions were designed in alignment with the Turkish data protection legislation (KVKK) and the General Data Protection Regulation (GDPR). Also the passengers' personal data was protected through those regulations. The municipality had no problems with anonymising the data.

Key lessons learned from the intervention implementation were the importance of identifying and effectively utilizing communication channels, the significance of collaboration among different stakeholders with regular information exchange, ensuring that passenger transport experiences are not disrupted during intervention implementation and fostering cooperation and regular information exchange between stakeholders.

The overall acceptance of the intervention among the target population is rated as 3. During the first two months, there was a slight increase in public transportation usage, particularly in metro usage. However, the COVID-19 pandemic caused a decrease in public transportation usage, with a gradual increase observed starting from 2021. In the process of preparing and distributing the intervention in the Izmir metropolitan area, actors that were involved were Izmir Metropolitan Municipality as the public entity and Izmir University of Economics as a scientific partner. There were no NGOs or commercial entities directly involved. The project generated some new ideas and lessons, such as the importance of selecting appropriate user partners, the need for the right types of actions, like finding the right communication channels or reaching to the right people, the differences between planned and real implementation, and the recognition of the importance of the intervention process itself alongside its design. For future projects to implement these ideas effectively, several conditions need to be in place. Key factors include specific project objectives, sufficient financial resources, realistic time management, the involvement of relevant stakeholders, the review of technical feasibility, support from suitable partners and an appropriate data evaluation. The results of the actions have shown how efficient the use of public transport is for disseminating messages to a wide audience. Consequently, the municipality is now encouraged to explore more efficient ways of using such tools in its communication strategies in the post-implementation phase.

The replicability of the intervention in other similar contexts is rated as 4 on a scale from 1 (difficult) to 5 (easy). This suggests that the same intervention method, like increasing bicycle use, can be successfully implemented in different contexts through stakeholder collaboration with a specific objective in mind. However, the willingness of the partner, in this case, the municipality and their ability to effectively manage administrative aspects are crucial for a successful replication. Key aspects that make an intervention replicable include the design of the intervention itself, encompassing elements like the experimental setup, data requirements, data processes, guidelines, roles and responsibilities, monitoring processes, and communication protocols. Contextual factors, such as cultural norms and the behavioral patterns of the targeted population, as well as characteristics of the partner implementing interventions, including their administrative setup, bureaucracy and available resources, may significantly affect the replicability of such interventions.

The financial expenditure associated with the intervention was covered from the overhead budget, and specific cost categories were not provided. The adequacy of the financial resources for the intervention is rated as 4 on a scale from 1 (very inadequate) to 5 (very adequate), indicating that the resources were relatively sufficient to manage the costs of the intervention.

The team had 22 meetings with various Izmir Metropolitan Municipality executives, and they organized a press launch event to interact with policymakers. Additionally, they engaged with the Sustainable Urban Development Network, which includes a wide range of stakeholders from greater Izmir, such as NGOs, universities and the municipalities' sustainability offices. They utilized the Intervention Monitoring Checklist template, which facilitated efficient monitoring of the intervention, allowed them to share progress with relevant partners, identify and address issues, and it can be valuable for similar implementations in different phases of future projects. The team emphasizes the importance of considering operational aspects and designing guidelines for implementing and monitoring the interventions. They recognize that the interventions are conceptually robust and therefore suitable for replication. However, they underline the need to consider potential operational challenges that may arise during practical implementation.

2.3 Investment in EE and RES

Finally, the third block of interventions focuses on motivating people to invest in energy efficiency (EE) and renewable energy sources (RES). Addressing this investment is crucial as the European Union's building sector holds significant importance, as it constitutes roughly 40% of the total energy consumption and contributes to 35% of annual greenhouse gas emissions (European Environment Agency, 2023). It is noteworthy that over 220 million buildings, accounting for approximately 85% of the building stock, were constructed prior to 2001 and are expected to remain in use until 2050 (European Commission, 2020). Therefore, the renovation of these buildings is of utmost importance for addressing energy consumption and emissions, achieving the EU's 2030 emission reduction goals, and progressing toward climate neutrality by 2050. Moreover, building renovation efforts are integral to enhancing resilience to climate-related impacts.

The refurbishment of homes to enhance energy and resource efficiency promises not only cost savings on energy bills but also significant improvements in health, comfort, and overall well-being. Moreover, renovation initiatives provide a valuable opportunity for the 34 million Europeans currently facing challenges in affording adequate heating for their homes.

Within the European Union, the building renovation sector has one of the most substantial investment gaps European Commission (2020). Aiming to reach the ambitious 55% climate target by 2030, an annual injection of approximately €275 billion into building renovation is imperative. Therefore, investments in public and private building sectors are needed and require contributions from both the public and private sectors. In this context, the next set of interventions will investigate people's interest in investing in energy efficiency (EE) and renewable energy sources (RES) measures in the public and private sectors using surveys and field experiments. These studies aim to understand the factors influencing individuals' investment decisions and their willingness to participate in energy-efficient and renewable energy initiatives.

2.3.1 Italy - Ninfa Garden

2.3.1.1 Introduction

The objective of the undertaking at Nifa Gardens was to explore visitors' interaction with renewable investments, their energy usage trends, and their commitment to sustaining energy efficiency post their visit. Therefore, after visiting the historic garden, visitors were asked to fill out a short survey ($n = 717$). To identify how varying degrees of information about renewable installations (a historic hydroelectric power station near a lake) at Ninfa Gardens, affect respondents' willingness to invest in such projects, on certain days participants received additional information via billboards, while this information was lacking on other days. Thereby, survey responses can randomly be divided into two groups. The intervention group ($n = 360$) received supplementary information, while the control group ($n = 357$) answered the survey on days without additional information.

2.3.1.2 Evaluation

The survey was designed to collect detailed information about visitors' sociodemographic variables (age, gender, income, education) as well as their environmental attitudes, behaviors, and intentions as well as their willingness and interest to invest in renewable energy solutions. Table 14 shows the distribution of the main sociodemographic variables. The table shows that there are only minor differences between socio-economic variables and Table 16 shows the related questions.

Table 14: Summary statistics for experimental or control group.

Group	Age	Female	Education	Well Being Rating
Control	47.34 years	55%	3.38	2.82
Experiment	46.78 years	53%	3.36	2.84

The levels for education "EDU" are coded on a scale of 1 to 6, where:

Level	**Education**
1	None (No formal education)
2	Primary school
3	First grade secondary school
4	Second grade secondary school
5	University degree
6	Post lauream (Education beyond a university degree)

The variable well being was measured usign this question 'At the end of your visit to Ninfa, how do you rate your level of well-being compared to when you entered?' and answeres collected on a scale from 1= I feel worse, 2 = I feel like before and 3 = I feel better than before.

Furthermore, it's evident that there exist only slight disparities between the responses of both groups, underscoring the success of the randomization process. This is also confirmed by the results from the Wilcoxon Rank Sum Test from Table 15. "Private transport usage" is the only variable that is statistically different ($p < 0.05$), for all other variables there are no statistically significant differences. Table 16 shows the (translated) questions.

Table 15: Wilcoxon Rank Sum Test between control and experimental group.

Variable	p-Value
Global Temp Opinion	0.271
Distant From Nature	0.537
Small Part Of Nature	0.738
Nature Well Being	0.868
Affinity With Nature	0.446
Lift Usage	0.538
Private Transport Usage	0.032
Water Consumption Attentiveness	0.142
Home Winter Temperature	0.594
Energy Saving Tech Usefulness	0.284

A significant portion of visitors from both the Experimental (61%) and Control (63%) groups express a lack of detachment from their surroundings. This sentiment is mirrored in the response to the question “I often feel a connection to the animal and plant kingdom” with over 60% agreement from both groups. Moreover, there’s a strong consensus in both groups that their own well-being is intricately linked to the well-being of the natural world (82% and 84%, respectively).

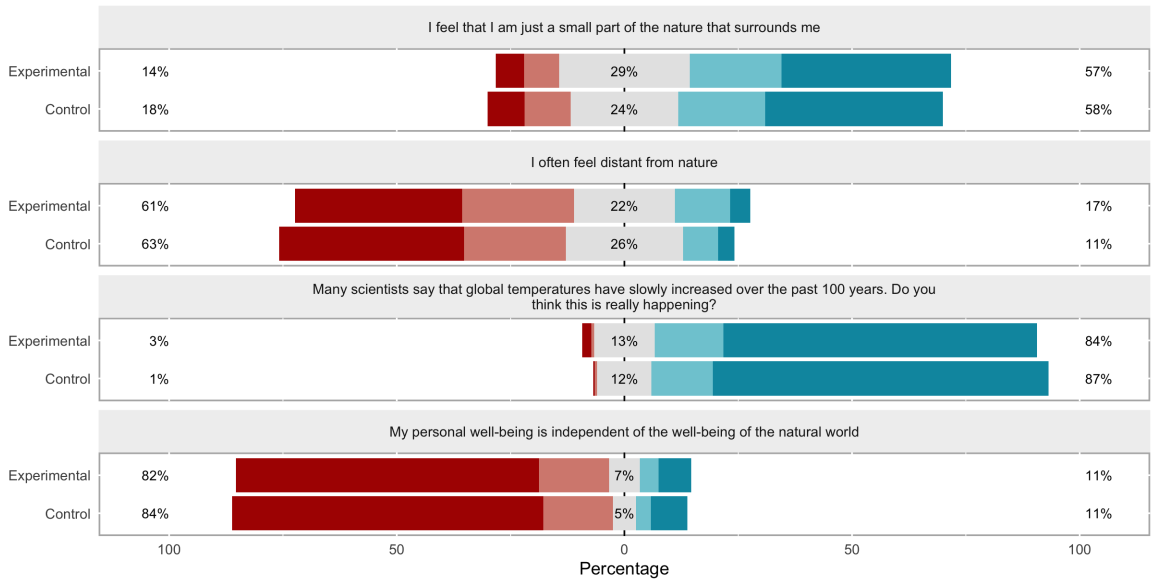


Figure 15: Response to survey questions for both groups

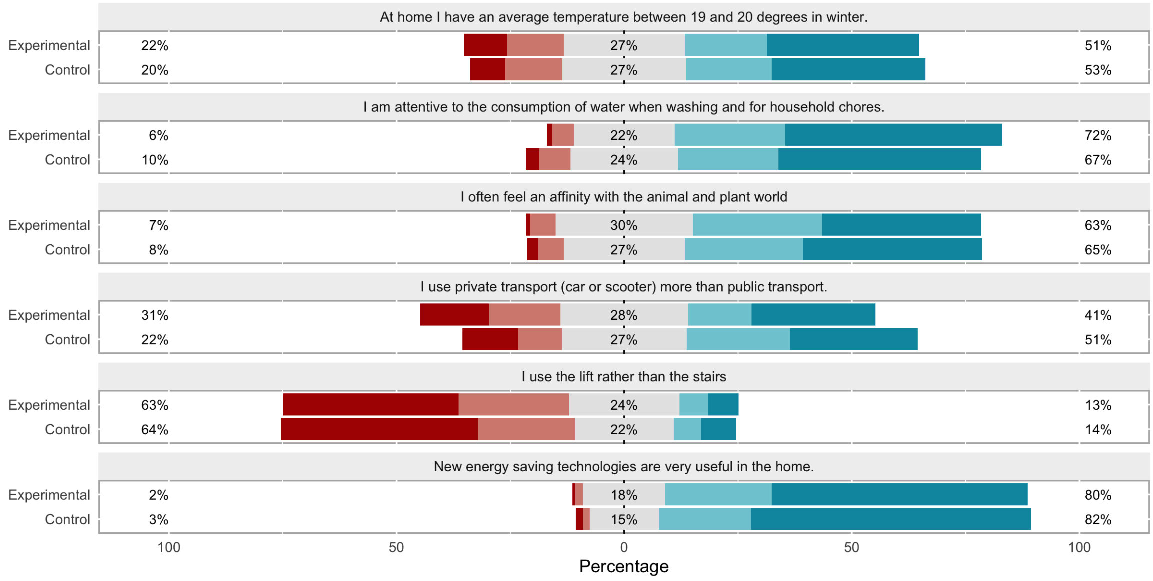


Figure 16: Response to survey questions for both groups

At the end of the survey, participants were first asked to indicate what kind of renewable energy project they would like to support and could choose between two options, a Hydroelectric power plant or a Frescoes restoration or no project. Figure 17 shows that fewer visitors from the control group have selected the sustainable project. Moreover, we see that more people from the control group have not selected any project (169) compared to the experimental group (74).

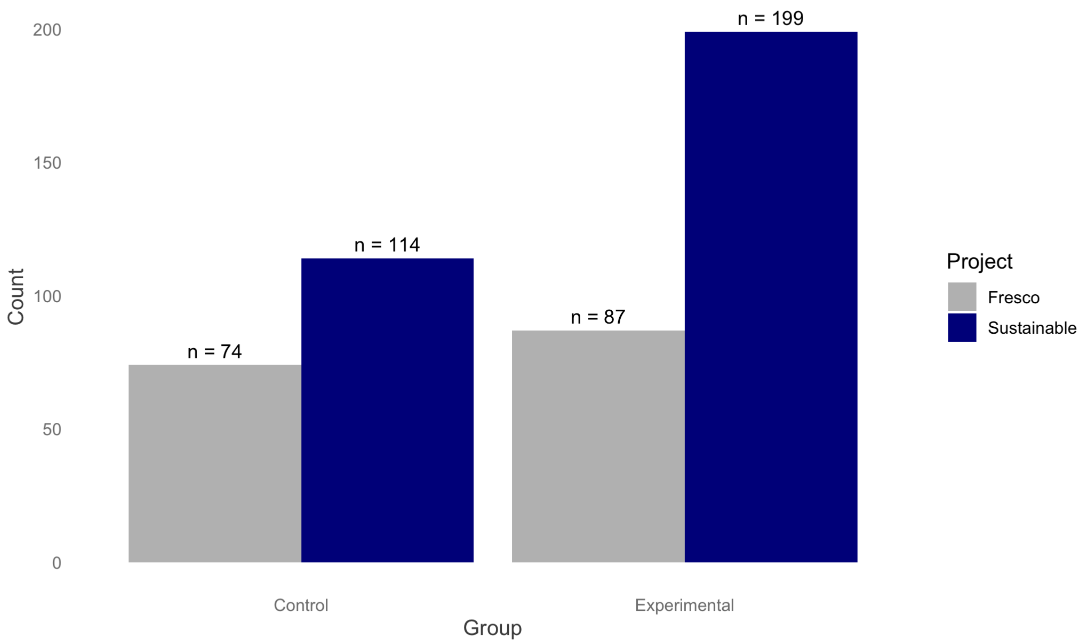


Figure 17: What project would you support?

Afterward, participants were asked to indicate how much money they would be willing to pay in order to invest in the selected project. The exact wording of the question was ”How much more would you be willing to pay than the current cost of the ticket?". Thereby, they had to choose between the following categories: 1, 3 or 5 euros. Around 33% of the visitors did not respond to this question, while 466 participants indicated both their preference for the project and their willingness to pay. Figure 18 shows that the majority ($n = 234$, 50%) of visitors would be willing to pay 1 euro more, around 38% would be willing to pay 3 euros more, and 12% 5 euros more. Comparing the groups and different project choices, we can see that even though the innovation for the fresco renovations was less frequently chosen, the average contribution is higher compared to the sustainable alternative.

An analysis of variance (ANOVA) was conducted to examine the effects of type of innovation (fresco vs. renewable energy) and the two groups (experiment and control) as well as their interaction [independent variables] affect willingness to donate [dependent variable]. Figure 19 shows the results from the ANOVA and post hoc tests. Tukey's multiple comparisons were conducted to further investigate the pairwise differences among the levels of the 'interaction' factor. The results revealed several significant differences among the groups: "Experimental Fresco" and "Control Fresco" (diff = -0.585, 95% CI [-1.143, -0.027], p = 0.036). However, the main hypothesis, that information increases interest in investing in sustainable projects, is not confirmed. No significant mean differences were observed between 'Control Sustainable' and 'Experimental Sustainable' (p = 0.939).

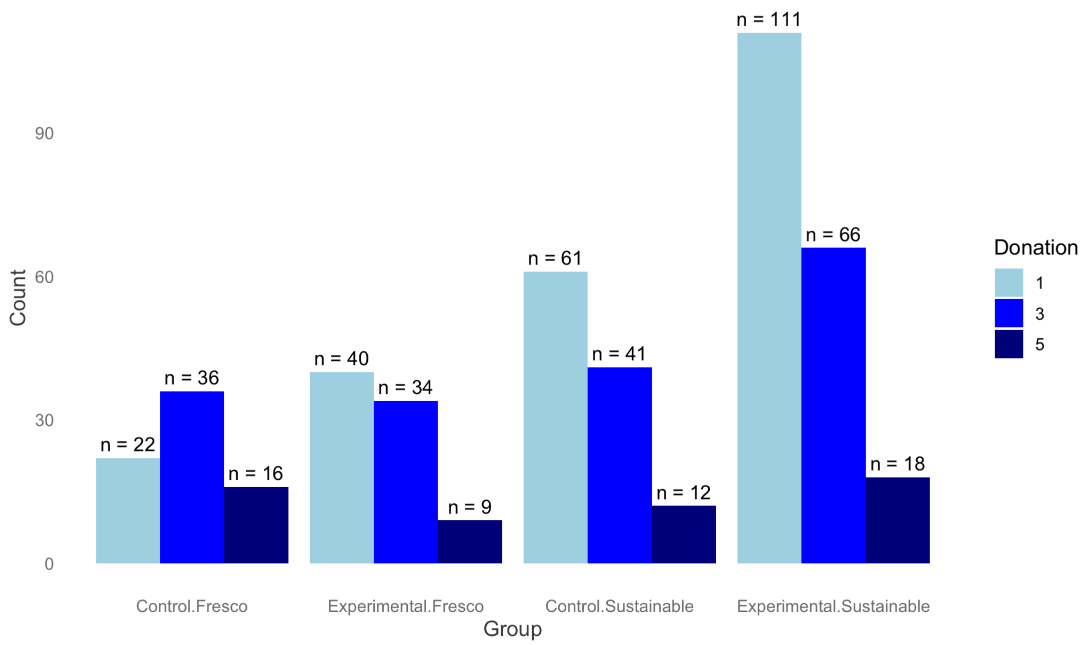


Figure 18: Responses to: "How much more would you be willing to pay than the current cost of the ticket?"

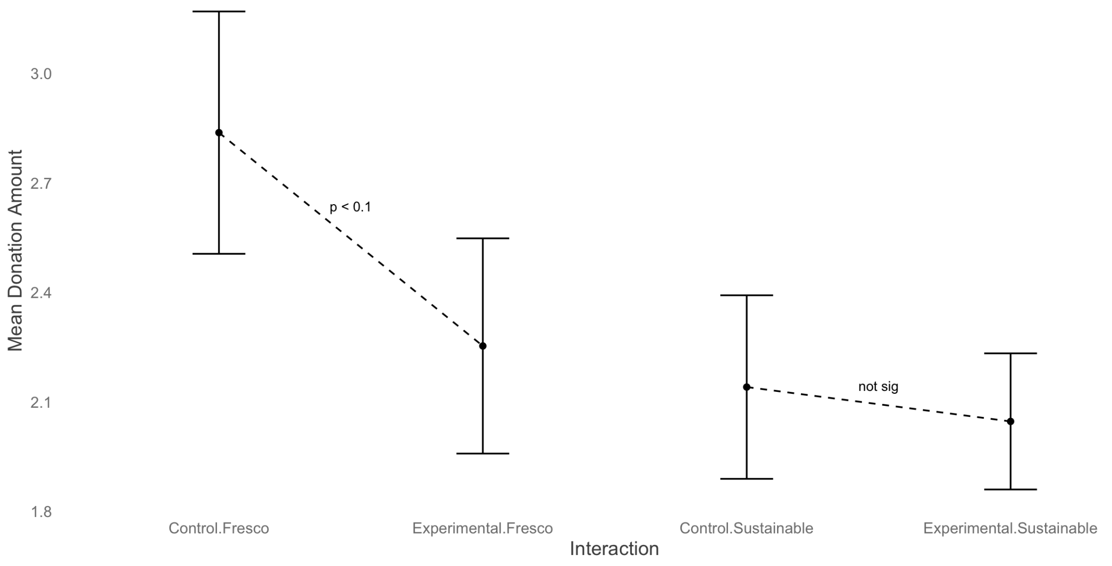


Figure 19: Anova Results

Variable	Description
Global Temp Opinion	Many scientists say that global temperatures have slowly increased over the past 100 years. Do you think this is really happening?
Distant From Nature	I often feel distant from nature
Small Part Of Nature	I feel that I am just a small part of the nature that surrounds me
Nature Well Being	My personal well-being is independent of the well-being of the natural world
Affinity With Nature	I often feel an affinity with the animal and plant world
Lift Usage	I use the lift rather than the stairs
Private Transport Usage	I use private transport (car or scooter) more than public transport.
Water Consumption Attentiveness	I am attentive to the consumption of water when washing and for household chores.
Home Winter Temperature	At home I have an average temperature between 19 and 20 degrees in winter.
Energy Saving Tech Usefulness	New energy saving technologies are very useful in the home.

Table 16: Variable Descriptions

2.3.1.3 Implementation

A survey on the pre-implementation phase was also prepared for the user-partner in Italy with the intervention of Ninfa Gardens. The intervention of the Ninfa Gardens took place from 01.07.2021 to 31.08.2021 for the first wave and the second one lasted from 01.06.2022 to 31.07.2022. During the implementation, several challenges were encountered, primarily in the first wave. The unexpected challenge emerged when it was difficult to obtain post-surveys due to participant fatigue. Due to these challenges, the research team planned the second wave, where they improved the logistics of data collection and implementation procedures in order to prevent similar challenges.

Modifications were made to the original intervention design due to COVID-19 restrictions that affected the planned behavioral measures. Ethical considerations were taken into account, with approval from the Roma Tre ethical committee. Additionally, data and privacy considerations were addressed, ensuring compliance with privacy regulations by the user partner.

From the implementation perspective, according to the user-partner one of the lessons learned was that emotionally moving and psychologically restorative leisure experiences could promote the involvement potential of campaigns based on providing factual information. The overall acceptability of the intervention was rated 4, reflecting an average between lower acceptability in the first wave and full acceptability in the second wave of data collection. There were no particular concerns or objections from the target population.

The intervention involved various actors, including public, scientific, and NGOs, but there was no direct involvement of commercial entities. While no entirely new ideas emerged, the management of Ninfa Gardens expressed interest in enhancing the specific training of their guides on energy and climate-related issues in the post-implementation phase. Conditions needed for a future project to implement these ideas are sufficient financial resources, realistic time management, involvement of relevant stakeholders and the support of suitable partners.

The intervention could be highly replicable in similar contexts and leisure settings. Especially in Italy (but in all Europe) there can be found similar contexts or settings where this kind of informative interventions could be easily replicated or upscaled. The key aspects that make it replicable include the ability to link energy and climate information to various leisure settings in both natural and built environments. However, some contextual factors, such as the unique nature of Ninfa Gardens, may require adjustments in the format.

There was financial expenditure associated with the implementation of the intervention. The total amount of financial expenditure was estimated to be adequate and rated as 5 on a scale of 1 to 5. Various costs and expenses were incurred during the intervention, including travel costs for meetings with user partners and data collection in Ninfa, amounting to approximately 3000 euros. Additional expenses included materials such as flyers with energy tips, free coffee offered to respondents, printing of questionnaires, and the printing and installation of information materials, totaling around 5000 euros. Moreover, approximately 2500 euros were spent on hiring personnel for data collection and data input. It is noted that there were no financial issues provided to cope with the costs of the intervention. Interactions with policymakers were limited to only a few informal talks during scientific or cultural events, and the Intervention Monitoring Checklist template was not used in this case.

2.3.2 Norway - Building Energy Efficiency Online Counseling

2.3.2.1 Introduction

The municipality of Viken has launched several initiatives aimed at mitigating future climate challenges and contributing to a low-emission society. These initiatives include transport targets (fossil-free vehicle fleet and fossil-free transport within the municipality and companies), research projects based on a socially just, low-carbon society, energy efficiency efforts, etc. A specific action implemented in early 2022 was granting citizens in Viken access to an online platform where they could receive targeted advice on energy efficiency improvements that can be implemented with benefit to their specific house based on data from the Norwegian building stock registry. The website (www.energiportalen.no) also gives advice on costs of the measures, links to contractors that can implement it, and informs about subsidy programs - much along the lines of the much-discussed one-stop-shops. ENCHANT used the opportunity that Viken was launching a campaign to promote the platform and conducted an online survey among users of the platform. In ENCHANT's terminology, the intervention in the Viken sample can be categorized as a) information, and b) energy audit(s) and financial incentives, and the goal was to reduce energy consumption through renovation/technology investment. For this sample, it was not possible to conduct a randomized control group, so a comparison group with existing data was used (NTNU had conducted two earlier waves with similar questions on representative samples of house owners in Norway in 2014 and 2018 for the Norwegian Energy Efficiency Agency ENOVA). In addition, an NGO (Naturvernforbundet) also distributed the same survey through a similar website which they promoted (www.energismart.no), which, in addition to the treatments, makes it possible to see how different communication channels work in recruiting participants for further research. To identify how these interventions (treatments) affect decisions, detailed information about energy-related behaviors, facilitators, barriers, attitudes, intentions, and other psychological variables were collected.

The data used in this study consists of four survey rollouts, called waves. Overall, the 8,031 participants finished one of the surveys. The first two survey waves were conducted in the year 2014 with 2,605 and 1,182 responses, of which the smaller sample was recruited among people that either were involved in a deep renovation project the last three years, are in an ongoing renovation project or were planing to implement one in the three years after the survey (renovators). The larger sample from 2014 is representative for the Norwegian population of house/apartment owners. The second wave was conducted in 2018 with 3,807 responses representative for Norwegian house/apartment owners, and 437 individuals participated in the ENCHANT intervention through the website (wave 4). Most (90%) of the 437 responses were recruited by the NGO.

2.3.2.2 Evaluation

Large renovation

Figure 20 illustrates the proportion of large renovation projects conducted or those ongoing or planned across all waves. A large renovation project was defined in the survey as shifting at least 50% of the outer walls, as least replacing 50% of the windows, as shifting the complete roof, and/or working with the connection to the basement. The error bars in the figure indicate the 95% confidence intervals, providing insights into the precision and variability of the estimated frequencies within each sample group. Note that the sample size for Viken and Naturvernforbundet may be insufficient to represent the population adequately. This is also reflected by the large error bars that indicate high uncertainty. The graph shows that the proportion of conducted and ongoing or planned renovation projects in both intervention groups is relatively higher compared to the general population in 2018 and 2014. This indicates that the intervention groups may have a greater focus on large renovation projects compared to the overall population or a general increase in interest in renovation projects over time.

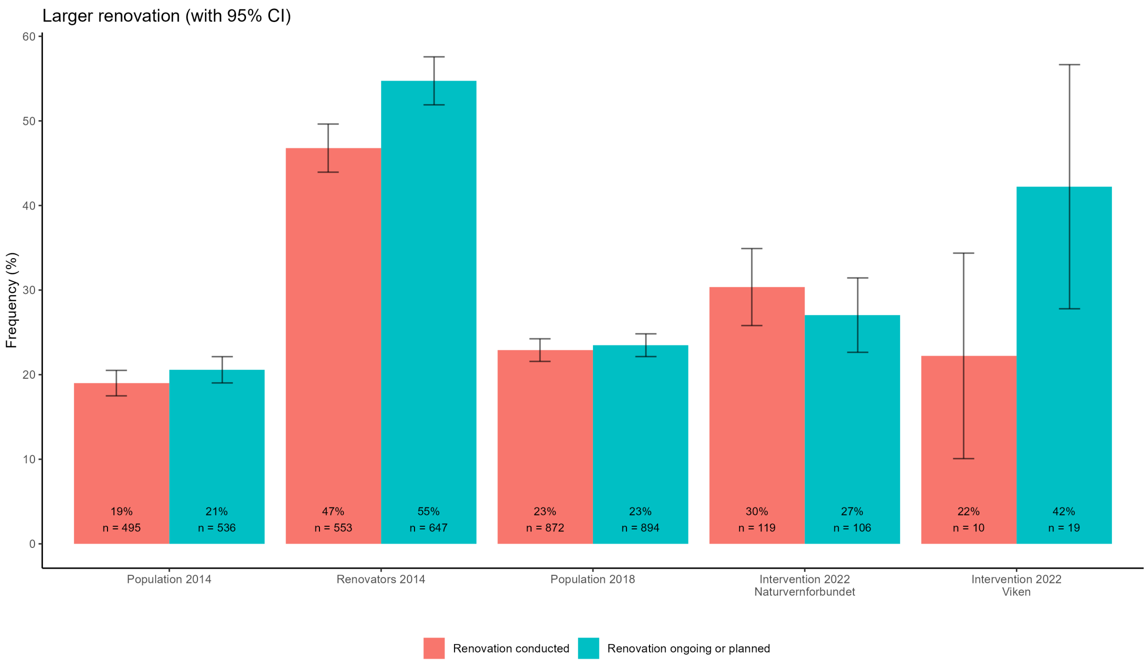


Figure 20: Comparison of large renovation projects with 95% confidence intervals. Proportion of participants that answered "yes" to the following question (translated from Norwegian): "Has your home been rehabilitated in accordance with any of the measures mentioned above in the last three years? (i.e. the entire rehabilitation has been completed and the property has been returned to normal use during this period)" and "Are you planning to rehabilitate your home on accordance with any of the measures mentioned above in the next three years?". `n` denotes the number of non-missing answers.

Renovation ambition

Participants were asked about actions that were carried out in the renovation process. Renovation ambition is derived from the sum of positive answers to the following actions (translated from Norwegian). Therefore a maximum renovation ambition of four can be reached.

- Replacement of cladding on at least half of the home's exterior walls
- Replacement of roofing or other extensive work on the roof or cold attic
- Replacement of at least half of the home's window area
- Extensive work on the foundation wall or floor against the ground or cold basement

Figure 21 shows the renovation ambition of participants with error bars for 95% confidence intervals. The highest mean renovation ambition can be observed among participants from Intervention sample 2022 - Naturvernforbundet.

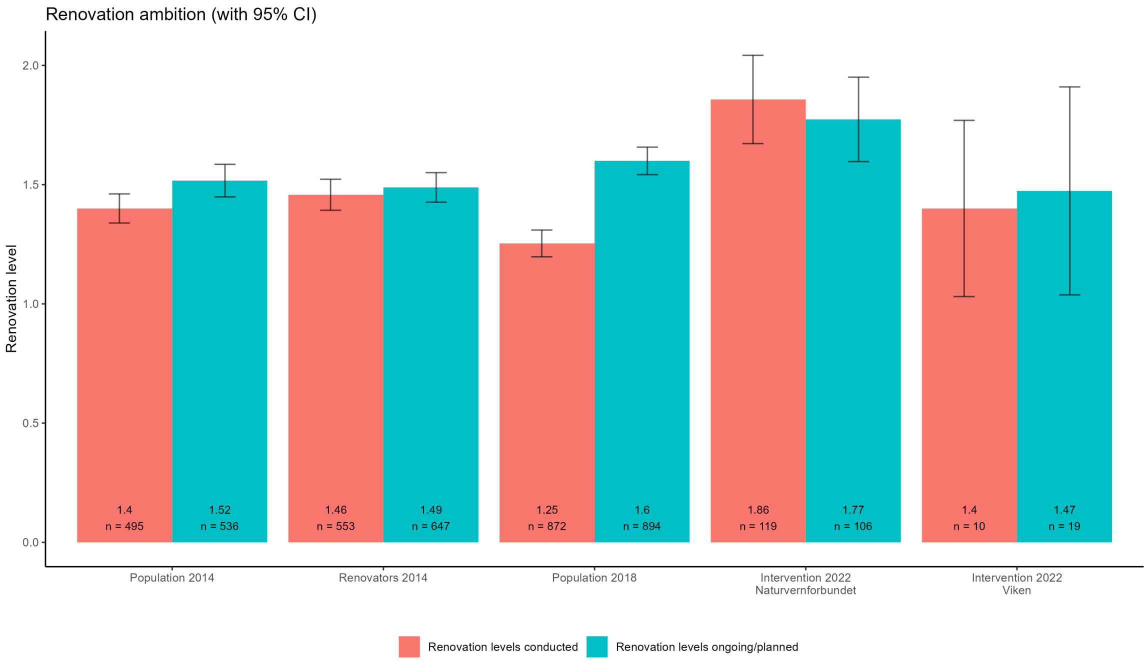


Figure 21: Comparison of mean renovation ambition with 95% confidence intervals. n denotes the number of non-missing answers.

Energy efficiency ambition

Energy efficiency ambition is derived from the sum of positive answers to the following questions (translated from Norwegian). Therefore a maximum energy efficiency ambition of six can be reached.

- Did this renovation also include the installation of new mechanical ventilation (e.g. extraction from bathrooms, kitchens, etc.) in the property?
- Did this renovation also include the installation of a new balanced ventilation system (e.g. separate air ducts to most living areas) in the property?
- Additional insulation of the roof or cold attic (at least 10 cm additional insulation)
- External wall insulation (at least 5 cm additional insulation)
- Change to extra energy-saving windows (U-value 1.0 or lower, or 3-layer windows)
- Additional insulation of the foundation wall or floor against the ground or cold basement (at least 5 cm additional insulation)

Figure 22 shows the mean energy efficiency ambition of participants with error bars for 95% confidence intervals. Note that the sample size for Viken and Naturvernforbundet may be insufficient to represent the population adequately. The graph shows the mean energy efficiency ambition is relatively higher in the intervention groups compared to the population samples in 2014 and 2018 and the renovators sample in 2014. Among the intervention groups, participants from Naturvernforbundet have a higher mean energy efficiency ambition than participants from Viken. This indicates that the intervention groups may have a greater focus on energy efficiency in renovations compared to the overall population or a general increase in interest in energy efficiency in renovations over time.

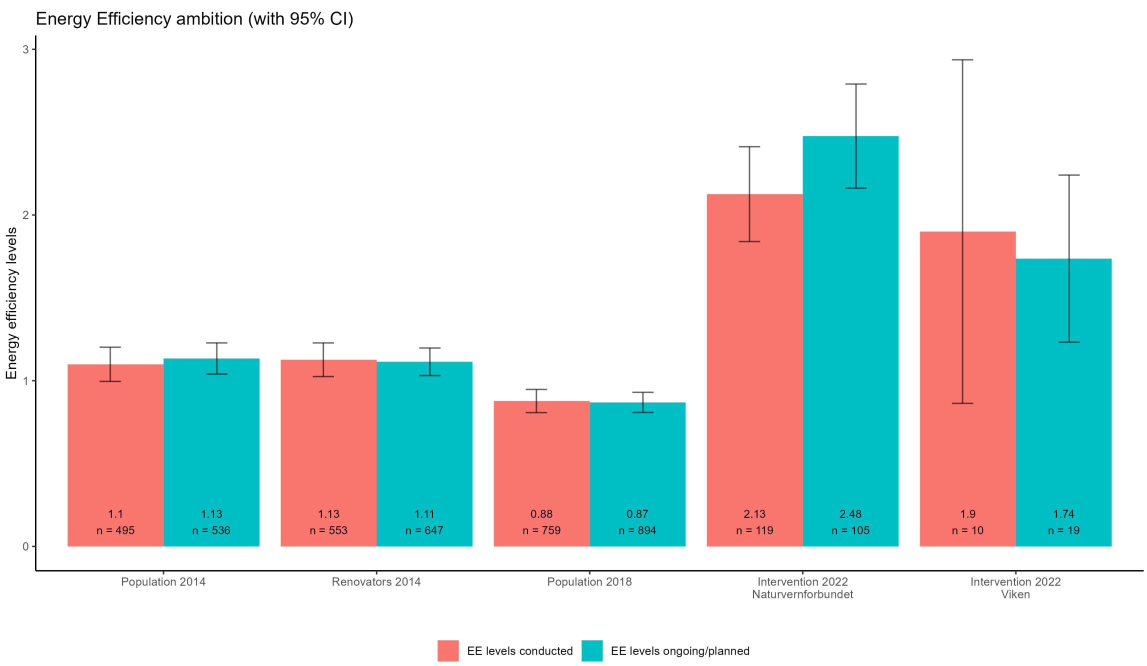


Figure 22: Comparison of mean energy efficiency ambition with 95% confidence intervals. n denotes the number of non-missing answers.

Logistic regression

A logistic regression analysis was conducted to examine the factors influencing the willingness to conduct a large renovation. The willingness to renovate a building was assessed through two key questions. Participants were asked whether they were currently planning or in the process of a significant home renovation to be completed within the subsequent three years. In a second question, participants were asked whether any previous renovation activities had been undertaken within the past three years. A positive response to either of these questions was interpreted as an indication of willingness. This was used as the binary outcome for the logistic regression model. The model incorporates a range of predictors, including demographic variables (gender, age, education, income), psychological variables (social norms, attitudes, personal norms, self-efficacy), and dummy variables indicating sample (Renovators sample 2014, Population sample 2014, Population sample 2018, Intervention sample 2022 - Viken, Intervention sample 2022 - Naturvernforbundet). The psychological variables are represented as scores, derived from the mean values of multiple scale variables. These variables are all on the same scale and encompass various psychological constructs. By computing the mean scores of these variables, we aim to capture the overall psychological factors and attitudes of the participants towards building renovation.
Table 17 shows the regression results. The coefficients for psychological variables including social norms, attitudes, personal norms, and self-efficacy are statistically significant. This indicates that these psychological factors might play a crucial role in shaping the decision regarding renovation activities. According to this model, higher psychological scores correspond to an increased chance that individuals are willing to renovate a building. Among these, the variable with the largest impact appears to be related to attitudes.

2.3.2.3 Implementation

As already mentioned, an online survey was sent out among the users of the platform, which focuses on giving targeted advice on how to improve the energy efficiency of a house. This online survey was circulated by the municipality of Viken, but also by the NGO Naturvernforbundet. For this implementation, too, a survey was sent out afterwards in order to obtain even more precise information about the origin, duration and implementation.

The Naturvernforbundet energy portal intervention, conducted from December 2, 2021, to December 12, 2022, with two months of preparation, was executed successfully without encountering major challenges, and no modifications were made to the original intervention design. While specific ethical considerations were not mentioned, the team carefully addressed data and privacy concerns by following standard GDPR procedures.

The key lessons learned from this intervention highlighted that interest in energy coun-

Table 17: Regression results for willingness to conduct a large renovation. Variables omitted for brevity: gender, age, education, income, sample, and constant.

	Dependent variable: Willingness to Renovate Coefficient	Odds Ratio
Social Norms	0.181*** (0.028)	1.198
Attitudes	0.278*** (0.029)	1.320
Personal Norms	0.149*** (0.027)	1.161
Self-efficacy	0.151*** (0.020)	1.163
Observations	4,234	
Log Likelihood	−2,400.432	
Akaike Inf. Crit.	4,846.863	
Note:	*p<0.1; **p<0.05; ***p<0.01	

seling platforms varied significantly based on energy prices and public discourse. The platform's experience seemed to motivate individuals to progress with their energy upgrade plans. It received a high acceptance rating of 5 among the target population, with no reported concerns or objections.

In contrast, the Viken energy portal intervention spanned approximately a year, from January 19, 2022, to January 11, 2023, with a four-month preparation period. However, it faced challenges due to the unexpected impact of COVID-19, resulting in a delayed and scaled-down rollout of the energy counseling campaign in Viken. Like the Naturvernforbundet intervention, the Viken intervention did not require modifications to its original design, and while ethical considerations were minimal, GDPR compliance was maintained.
Both interventions underscored the importance of energy prices and public discourse in influencing interest in energy counseling platforms. The platform experience in both cases motivated individuals to take action on their energy upgrade plans. Acceptance was high for both interventions, and they involved multiple actors, including scientific and technical entities. However, no entirely new ideas emerged during the projects.

While the interventions had limited influence on post-implementation activities, the replicability score was 3 for both, suggesting moderate challenges. In the case of the Naturvernforbundet intervention, replicability difficulties were attributed to data availability, while for the Viken intervention, it was due to unique characteristics of the Norwegian market. The Viken intervention incurred financial expenditure, including marketing and internal costs, while the Naturvernforbundet intervention did not involve financial expenses. Both interventions reported minimal interactions with policymakers, and the use of the Intervention Monitoring Checklist had limited impact in both cases, indicating its reduced utility.

3 ENCHANT Platform

3.1 Introduction

The **ENCHANT platform** is an online platform designed to evaluate the efficacy of behavioral interventions aimed at reducing household electricity consumption. It is a prime example of how digital platforms can facilitate large-scale environmental research and intervention. So far, the platform has been tested across six European nations: Austria, Germany, Italy, Norway, Romania, and Türkiye.

At the core of ENCHANT are six different types of interventions, each with a unique approach to influencing energy-saving behaviors. Moreover, the intervention platform allows combining different interventions (e.g. Information + Social Norms) in order to test how different combinations work. The main interventions include:

1. **Information Provision**: 1. Information Provision: Educating households about energy consumption and savings with specific tips what to do and why.
2. **Message Framing**: Utilizing collective versus individual framing to motivate energy conservation. This is implemented in the platform through either presenting the tips as individual or collective actions.
3. **Social Norms**: Leveraging the influence of societal norms to encourage lower energy use by informing participants about other people in the same intervention group are doing in relation to them.
4. **Consumption Feedback**: Providing households with direct feedback on their energy consumption patterns in comparison to the first week.
5. **Competitive Elements**: Introducing competition to stimulate energy-saving efforts by creating a leader board in the platform's dashboard showing how well people perform with electricity saving.
6. **Commitment Strategies**: Encouraging households to make pledges to reduce their energy usage. The households can decide to give the commitment privately or in public (the latter results in the participant number being included in a list of pledges on the dashboard).

The ENCHANT platform orchestrates these interventions through a specialized online system, which is adept at managing and monitoring the complex logistics of the trial. Initially, the plan was to assign approximately 1,500-2,000 households from each participating country randomly to one of 12 intervention groups or to one of the two control groups. Table 18 below displays the 14 experimental groups, which were selected by the research team as the most interesting (as a full factorial design was not possible, even with the initially expected number of participants). Some experimental conditions were defined as of higher priority, which means they were recruited with a higher probablily. In countries where the recruitment was going poorly, only the high priority conditions were recruited. Approximately 1,500 households from each participating country are randomly assigned to one of the 12 intervention groups or to one of the two control groups. **The randomization ensures the reliability and validity of the trial's findings.**

Table 18: Experimental conditions and recruitment priority

No	Condition	Priority
1	Control condition with weekly measurements	High
2	Control condition with only two measurements	High
3	Information	High
4	Information + social norms	High
5	Information + collective framing	High
6	Information + social norms + collective framing	Low
7	Information + commitment	High
8	Information + feedback	Low
9	Information + feedback + collective framing	Low
10	Information + feedback + competition	High
11	Information + feedback + competition + collective framing	Low
12	Information + social norms + commitment	Low
13	Information + social norms + commitment + feedback + competition	High
14	Information + social norms + commitment + feedback + competition + collective framing	High

The main goal of the ENCHANT platform is to test how different combinations of main interventions affect electricity consumption. Therefore, the primary metric of success for ENCHANT is the weekly electricity consumption of each household, normalized to account for the number of occupants and compared to the week preceding the trial. This data is gathered through the platform, ensuring accuracy and consistency. Households have to read their electricity meter data and include it in the software. Secondary metrics include peak electricity consumption during the day before measurement (in the Norwegian Sample only because among the participating countries only Norway has a coverage of smart meters and advanced apps to give the participants access to this information) and self-reported adherence to energy-saving behaviors, such as regular defrosting of refrigerators or other specific energy saving behaviours (these behaviours were the ones directly addressed in the electricity saving tips in the information condition).

In addition to electricity data, the platform also collected detailed information about psychological factors, including the intention to save electricity, perceived difficulty of energy-saving actions, attitudes towards energy conservation, electricity saving habit strength, social and personal norms, collective efficacy, emotional responses to energy use, and national identity (which was important to interpret the effect of the collective framing which was done at the national level). These factors are crucial for understanding the mechanisms through which the interventions exert their influence.

The platform's design allows studying the impact of several interventions over time. Overall, we included 14-groups (including two control groups) by 6-time point mixed factorial design enables researchers to dissect the interplay between group-specific interventions and temporal changes in both psychological factors and actual electricity consumption. The findings are far-reaching and can provide insights for policymakers, municipal leaders, NGOs, and community organizations. These stakeholders can then craft targeted strategies that are both impactful and resource-efficient. Moreover, participants in the interventions stand to gain directly from the energy-saving strategies promoted through ENCHANT. The immediate effectiveness of these strategies in real-life contexts can lead to reduced energy bills and contribute to broader environmental conservation efforts.

In summary, the ENCHANT platform is a pioneering initiative that promises to deliver critical insights into household energy consumption and conservation. Its comprehensive design, which integrates behavioral interventions with psychological analysis, sets a new standard for research in energy-saving practices and has the potential to inform and transform energy conservation policies across Europe and beyond.

3.1.1 Implementation

Participants of the ENCHANT platform were recruited through different communication channels. Recruitment efforts in Norway and Germany proved successful for the ENCHANT platform. In Norway, a strong online presence, led by the Viken county Facebook page, attracted 367 participants. The municipality's Facebook page, Instagram, and even sports clubs also proved successful. Similarly, in Germany, a diverse recruitment approach, including a flyer in Badenova invoices, the badenova intranet, events, and mail from BadenCampus TestCommunity, resulted in the recruitment of 677 participants, offering a rich dataset for comprehensive analysis.

However, to describe it in a litte more detail the Multinational intervention platform faced several challenges during its implementation phase, including delays in programming and testing, difficulties in recruitment, and high dropout rates, which were largely unexpected. To address these challenges, the team made efforts to use various recruitment channels and even hired a company for additional recruitment in Romania. Looking back, higher emphasis on recruiting and enhancing the platform's user-friendliness might have helped prevent these issues. Modifications to the original intervention design were made due to poor recruitment numbers in four of the six countries, resulting in the dropping of some intervention conditions in these countries. While there were no specific ethical considerations mentioned, data and privacy concerns were taken into account, with discussions about data storage solutions involving the data protection officer at NTNU and the Norwegian data protection agency. Key lessons learned included the difficulty of recruitment, the effectiveness of information interventions, and the variable impact of commitment and competition, which depended on whether they were accepted or rejected. Social norms were found to be effective for some individuals and cultures.

The overall acceptance of the intervention among the target population was rated as 3, indicating mixed acceptance, as the participants in the trial responded well, whereas recruitment rates suggested lower overall acceptance. Specific concerns raised by the target population included feedback that electricity-saving tips were not original enough, as participants had heard similar tips during the ongoing energy crises. Some individuals also reacted to questions about social status. The intervention involved various actors in its preparation and distribution, including three public entities, two scientific partners, one NGO, and one commercial entity. Although no entirely new ideas emerged, plans for the use and further evolution of the platform were developed in follow-up projects, of which one already has secured funding. Regarding the conditions that would be needed for a future project the main answers were sufficient financial resources, a realistic time management, built-up know-how, involvement of relevant stakeholders, the review of technical feasibility, the willingness to learn from problems and challenges, the support of suitable partners and necessarily infrastructure.

The results of the intervention are still new, with their influence on post-implementation activities expected to become clearer in the coming months. In terms of replicability, the intervention was considered relatively easy to replicate (score of 4), given the standardization of the platform and the wealth of collected experience. Standardized infrastructure, including electrical meters or smart meters that could be directly coupled to the platform and this avoiding the hazzle to provide meter reading, was identified as a key aspect for replicability. Cultural and contextual factors, such as climate conditions and cultural attitudes towards electricity use, may affect the replicability of the intervention as clear cultural and structural differences in effects on electricity consumption were found (see results below). The platform was considered suitable to address such variations effectively. Economic aspects included financial expenditures related to platform development, maintenance, data services, recruitment, and paid Facebook ads. Financial resources were generally considered adequate (rating of 4) for covering these costs. The intervention also had interactions with policymakers, with plans to present the platform and results to policy makers in various formats. The Intervention Monitoring Checklist template was used, but it was noted that it did not significantly support the daily implementation work of the project.

Below one can see the people recruited per recroutment channel in the municipality of Viken and at Naturvernforbundet in Norway.

Table 19: People recruited per recruitment channel by the municipality of Viken in Norway

Channel	**Recruited through this channel**
Viken county facebook page	367
Climate Østfold facebook page	15
Climate Viken facebook page	19
Fossil free 2030 facebook	1
Climate partners Viken facebook page	5
My municipality's facebook page	79
Another facebook page	45
Viken county Instagram	149
Climate Viken Instagram	13
Climate partners Viken Instagram	2
Another Instagram	17
LinkedIn Viken County	3
Another LinkedIn account	1
Homepage of Climate Østfold	1
Homepage of Viken County	21
Homepage of my municipality	59
Another website	7
Through the Klimasmart campaign	3
A newspaper article	17
Twitter	3
Through another channel	86
Through my sportsclub	3
Tot.	**916**

Table 20: People recruited per recruitment channel by Naturvernforbundet in Norway

Channel	Recruited through this channel
Friends of the Earth Facebook page	79
Friends of the Earth Instagram	4
Homepage of Friends of the Earth	5
Newsletter of Friends of the Earth	156
Members' journal of Friends of the Earth	2
Energismart.no	1
Another facebook page	45
Another Instagram	17
Another LinkedIn account	1
Another website	7
A newspaper article	17
Twitter	3
Through another channel	86
Tot.	**423**

There were also relatively high numbers of recruited people in Germany. A more detailed description is therefore given. The Multinational intervention platform in Germany faced several challenges during its implementation phase, including a surprising delay in the platform's launch and difficulties with registration, both of which were unanticipated. Preventative measures could include searching for participants at a later stage and simplifying the registration process with clear instructions. There were no modifications or adaptations to the original intervention design except for the late platform launch. While there were no specific ethical considerations, data and privacy concerns were addressed through registration and clear communication. Key lessons learned from the intervention included the recognition that motivating people to engage in activities over an extended period requires significant time and effort.

The overall acceptance of the intervention among the target population was rated as 3, indicating moderate acceptance. No specific concerns or objections were raised by the target population. The intervention involved various actors in its preparation and distribution, with no scientific actors, NGOs, or commercial entities involved. No entirely new ideas emerged during the project.

Regarding replicability, the intervention was considered relatively easy to replicate (score of 4), primarily due to the presence of a clear framework. Clear documentation was identified as a key aspect that would make the intervention replicable. Contextual factors, such as the willingness to save energy influenced by factors like war, energy crises, inflation, and weather changes, may affect the replicability of the intervention. Economic aspects included financial expenditures related to marketing and materials, which amounted to

7,000 € and 5,000 €, respectively. Financial resources were generally considered adequate (rating of 4) for covering these costs. Interactions with policymakers regarding ENCHANT were not reported, and the Intervention Monitoring Checklist template was not used.

Table 21: People recruited per recruitment channel in Germany

Channel	**Recruited through this channel**
Facebook	36
Instagram	45
Linkedin	43
Flyer in badenova invoice	191
Events (TestCommunity or with KPO)	5
Mail from BadenCampus TestCommunity	73
badenova intranet	85
Sustainability survey	12
Newsletter	42
Advertisement in 'Der Sonntag'	5
badenova's customer magazine 'meine Energie'	59
Link in e-Mail from badenova	18
Greenflair festival	3
Other channel	60
Tot.	**677**

In contrast, recruitment in regions such as Romania and Austria yielded limited results, with 118 and 63 participants, respectively. Therefore, a recruitment company was hired in Romania to recruit additional participants, which resulted in 523 new participants added to the Romanian sample. Recruitment in Italy and Türkiye also had modest outcomes, with 27 and 9 participants, respectively. These regions and Austria thus lacked substantial recruitment numbers for in-depth analysis, but are included in the analyses concerning all countries.

In Austria, the Multinational intervention platform was implemented from April 3, 2023, to July 15, 2023. It initially targeted municipalities through various channels, later extending to select companies. Challenges included Facebook marking posts as "political" (because they included the topic climate change), difficulties in communicating with partner companies, and issues with timing and responsible contacts in municipality newsletters and websites. These issues were somewhat expected except for the Facebook problem. No modifications were made to the original design. Ethical considerations were taken into account, and data privacy compliance was ensured. Key lessons learned included the need for careful planning of communication channels and the recognition that energy is a politicized topic. Overall acceptance was rated as 4. The intervention involved various actors, and no entirely new ideas emerged. Results' influence on post-implementation activities was unknown. It was considered highly replicable, requiring straightforward communication channels. Financial expenditure was negligible, and the financial resources provided were rated as highly adequate. Interactions with policymakers were limited, and the Intervention Monitoring Checklist template was not used.

In Italy, the Multinational intervention platform was implemented from April 13, 2023, to May 30, 2023, with an estimated end date due to recruitment uncertainties. Challenges included extreme difficulty in recruitment, partially expected, and partially unexpected. No modifications were made to the original design. Ethical considerations and data privacy compliance were taken into account. Key lessons included the challenge of obtaining participation without compensation. Overall acceptance was rated as 2. The intervention involved various actors, and no entirely new ideas emerged. Conditions for future projects included sufficient financial resources, realistic time management, and involvement of relevant stakeholders. The influence of the results on post-implementation activities was unknown. It was considered relatively replicable, with a score of 4, but may require commitment from respondents. Financial expenditure was incurred, and resources were rated as fairly adequate. Interactions with policymakers were limited, and the Intervention Monitoring Checklist template was not used.

Table 22: People recruited per recruitment channel in Romania

Channel	**Recruited through this channel**
Survey panel recruitment	523
Facebook	2
Newspaper	16
From the municipality	31
My employer	51
Other channel	18
Tot.	**645**

Table 23: People recruited per recruitment channel in Austria

Channel	**Recruited through this channel**
Newsletter team4.energy	50
From my municipality	6
My bank	6
Another channel	1
Tot.	**63**

Table 24: People recruited per recruitment channel in Italy

Channel	Recruited through this channel
Facebook	2
Other channel	27
Tot.	**29**

Table 25: People recruited per recruitment channel in Türkiye

Channel	Recruited through this channel
Electricity bill	6
Other channel	3
Tot.	**9**

3.1.2 Evaluation

Table 26 and 27 present the participant counts for each experimental group across the duration of the study for Norway and Germany, respectively. The Norwegian cohort saw 601 participants at the outset (week 1), with a reduction to 392 by the study's end (week 5). The German cohort began with 461 participants, which declined marginally to 397 by the fifth week. Despite a lower initial participant count in Germany, a reduced attrition rate resulted in a final sample size comparable to Norway's. In total, the study amassed 2465-meter readings and survey responses from Norway and 2161 readings from Germany. Moreover, in 2199 meter reading collected in Romania. Participants in Romania were recruited and paid for participating in the study, this reduced the relative drop out rate compared to the other two country samples.

Table 26: Number of Norwegian participants for each experimental group for over time

Norway	Week					
Experimental Group	1	2	3	4	5	Total
Control 1 (weekly)	64	59	52	43	39	**257**
Control 2 (start-end)	30	30	30	30	30	**150**
Info	56	51	46	43	37	**233**
Info + SN	54	45	43	37	33	**212**
Info + collective framing (CF)	50	48	42	37	33	**210**
Info + SN + CF	36	32	30	27	25	**150**
Info + commitment (CO)	50	42	38	32	28	**190**
Info + feedback (FB)	38	36	33	32	30	**169**
Info + FB + CF	29	24	22	22	19	**116**
Info + FB + competition (Comp)	51	42	38	38	34	**203**
Info + FB + Comp + CF	27	26	22	17	16	**108**
Info + SN + C0	26	23	20	18	18	**105**
Info + SN + C0 + FB + Comp	40	38	34	30	27	**169**
Info + SN + CO + FB + Comp + CF	50	46	42	32	23	**193**
Total	**601**	**542**	**492**	**438**	**392**	**2465**

Germany	Week					
Experimental Group	1	2	3	4	5	Total
Control 1 (weekly)	46	44	42	39	35	**206**
Control 2 (start-end)	19	19	19	19	19	**95**
Info	39	36	34	31	29	**169**
Info + SN	42	41	40	37	36	**196**
Info + collective framing (CF)	29	29	27	27	25	**137**
Info + SN + CF	25	24	24	23	19	**115**
Info + commitment (CO)	37	37	35	33	32	**174**
Info + feedback (FB)	20	21	22	22	22	**107**
Info + FB + CF	24	24	23	22	22	**115**
Info + FB + Comp	20	20	20	19	19	**98**
Info + FB + Comp + CF	30	28	27	26	26	**137**
Info + SN + C0	24	24	24	23	21	**116**
Info + SN + CO + FB + Comp	55	52	53	49	45	**254**
Info + SN + CO + FB + Comp + CF	51	49	48	47	47	**242**
Total	**461**	**448**	**438**	**417**	**397**	**2161**

Table 27: Number of Romanian participants for each experimental group for over time

Romania	Week					
Experimental Group	1	2	3	4	5	Total
Control 1 (weekly)	60	59	59	60	60	**298**
Control 2 (start-end)	1	1	1	1	42	**46**
Info	48	46	45	45	45	**229**
Info + SN	54	49	52	53	51	**259**
Info + collective framing (CF)	57	54	51	55	58	**275**
Info + commitment (CO)	61	61	65	65	61	**313**
Info + FB + Comp	51	53	51	53	52	**260**
Info + SN + CO + FB + Comp	53	54	55	54	54	**270**
Info + SN + CO + FB + Comp + CF	50	52	49	50	48	**249**
Total	**435**	**429**	**428**	**436**	**471**	**2199**

Figure 23 shows the average consumption of electricity for the full sample. The plots show that the average consumption has declined over time in Germany and in Norway, while it was more stable in Romania, as the start of the intervention was later and thus weather effects are less pronounced. Moreover, the figure reveals significant disparities in consumption levels between countries. Such differences underscore the necessity of adjusting for environmental factors like temperature, as well as recognizing the influence of cultural and geographical distinction.

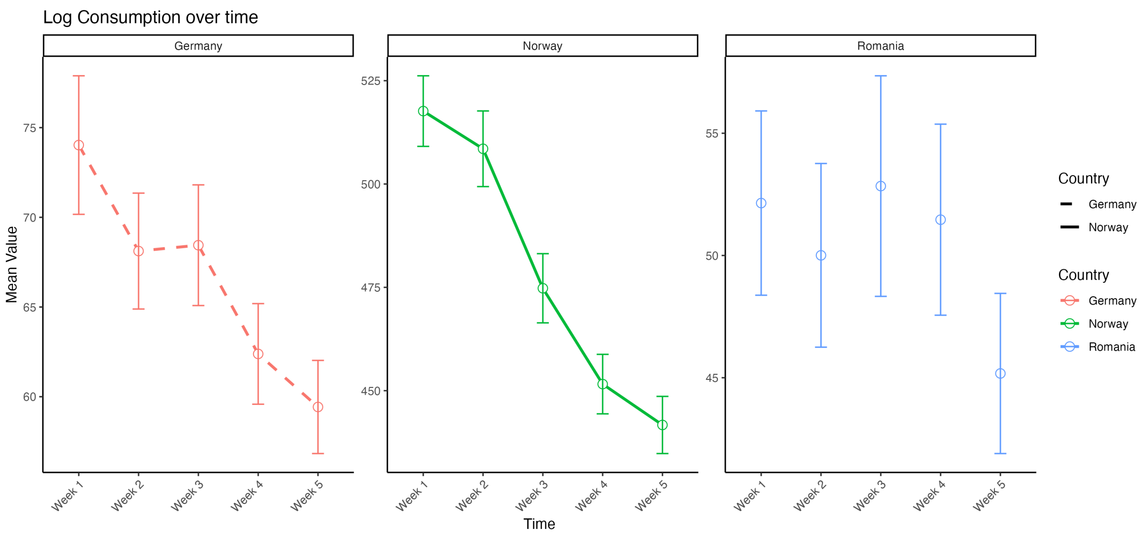


Figure 23

An examination of average electricity consumption over time reveals initial disparities among the groups. Figure 24 indicates that the weekly control group (depicted in dark blue) began with a marginally higher consumption level. While consumption remained fairly stable in both control groups (dark and light blue), those receiving interventions exhibited a more pronounced reduction in electricity usage. Notably, the group exposed to information plus social norms (Info + SN) demonstrated a significant decline in consumption over the study period. However, this decline is slightly less pronounced in Romania. This shows, that the effect of single interventions might also differ among countries.

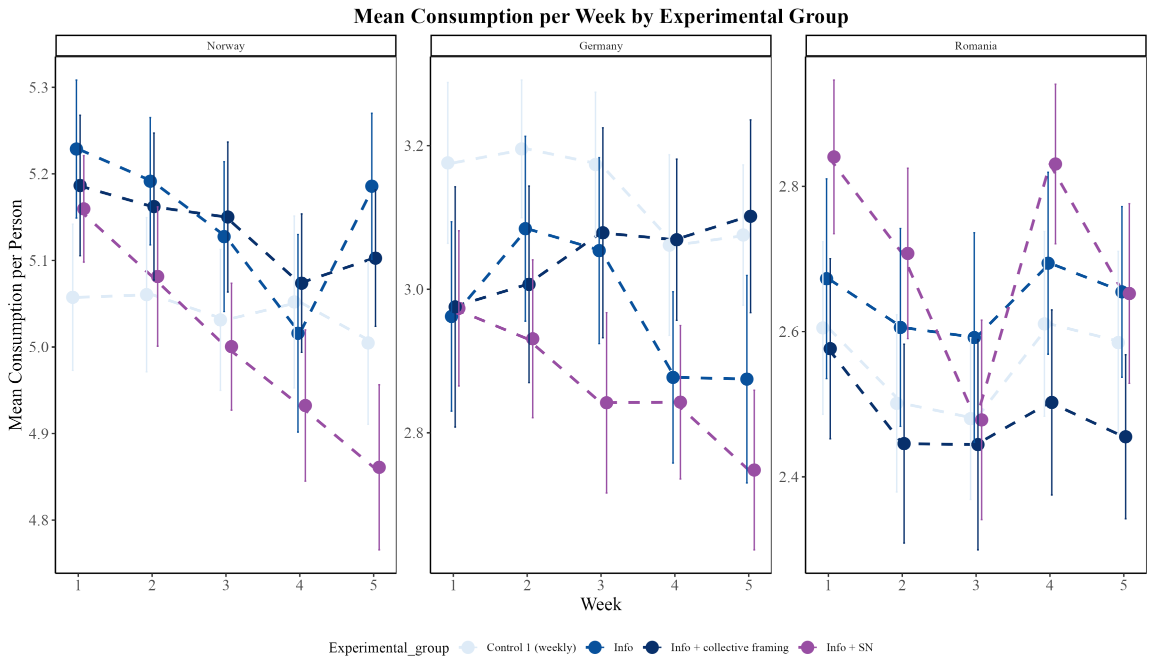


Figure 24: Log electricity consumption between treatments over time

The data presented in Table 28 illustrates the comparative analysis of electricity consumption changes from the first to the last week across different intervention groups. While the control groups in both Norway and Germany exhibited a marginal reduction in energy use, the effect was notably more pronounced in the intervention groups.

For instance, in Norway, the ’Info’ group showed a substantial decrease in electricity consumption with a mean difference of -68.322 kWh per household member per week, as opposed to the control group’s modest -4.520 kWh reduction. Similarly, the ’Feedback’ group in Norway demonstrated the most significant decline, with a mean difference of -85.773 kWh. In Germany, the ’Commitment’ group’s mean difference stood at -14.151 kWh, indicating a more considerable reduction compared to the control group’s -2.360 kWh.

These figures suggest that targeted interventions can lead to more significant energy-saving behaviors among participants. The standard deviations (sd diff) reflect the variability within each group, with the Norwegian groups generally showing greater variance in consumption changes than their German counterparts.

Table 28: Mean Difference in Electricity Consumption from Week 1 to Week 5 by Group and Country

Country	Group	mean_diff	sd_diff	n_observations
Norway	Control	-4.520	99.470	50
Norway	Info	-68.322	164.255	222
Norway	SN	-75.113	175.840	72
Norway	Commitment	-69.065	163.181	56
Norway	Feedback	-85.773	162.495	103
Norway	Competition	-75.085	158.871	66
Norway	Collective	-69.816	140.387	74
Germany	Control	-2.360	34.935	50
Germany	Info	-9.239	41.273	314
Germany	SN	-13.363	52.596	153
Germany	Commitment	-14.151	53.185	131
Germany	Feedback	-9.773	47.015	164
Germany	Competition	-12.410	52.426	124
Germany	Collective	-4.457	41.489	130
Romania	Control	0.055	32.140	97
Romania	Info	-9.742	68.832	344
Romania	SN	-8.497	70.799	146
Romania	Commitment	-11.306	84.983	156
Romania	Collective	-7.311	66.872	148
Romania	Competition	-7.311	66.872	148
Romania	Collective	-2.620	43.513	95

For a deeper understanding of the data, we implemented a mixed model analyses as a last step, where the full sample and each of the three countries with sufficient data was modelled. Here, each of the five campaign weeks was analysed in a nested design, evaluating the effects on electricity consumption in each week depending on interventions in this particular week or previous weeks. The electricity consumption was controlled for heating degree days (HDDs), cooling degree days (CDDs), heating with electricity, heating water with electricity, the interactions between HDDs and heating and heating water with electricity, owning an air condition, the interaction between CDDs and air condition, charging an EV at home, the average electricity price in the region in the week, and household size. Controlled for these structural factors, the effects of intentions to reduce electricity consumption during the week (measured before the week), the six intervention types, if the competition was accepted, if the commitment was accepted, and if it was given public were tested.

In order to understand the impact of various interventions on electricity consumption, we have employed a linear mixed-effects model. This model is particularly suitable for analyzing data with nested structures, such as individuals within experimental groups, and can handle repeated measurements over time. The model for our analysis, focusing on the data from Norway, is specified as follows:

Table 29 below shows the results of this mixed model for the complete sample and the three countries separate. Missing values for these analyses were imputed using an EM estimator, based on the information available at other time points and in other variables. The effects of HDDs, CDDs, and the average electricity price were standardized to reduction per standard deviation increase in these variables. Figure 25 shows the effects of all variables in the total sample, a visual comparison of only the intervention effects is presented in Figure 26.

Table 29: Regression Results

Variable	Total	Norway	Germany	Romania
Intercept	139.74***	237.47***	31.28***	46.21*
Heating Degree Days (HDD)	70.21***	19.59***	7.23*	3.33
Cooling Degree Days (CDD)	7.24***	1.87	11.90***	4.62*
Heating with electricity	0.91	29.52	8.15	-0.99
Heating with electricity*HDD	15.60***	1.23	-0.51	1.57
Warming water with electricity	-9.45*	127.52*	-15.51*	5.41
Warming water with electricity*HDD	23.89***	-7.83	6.33*	-5.92#
Air condition	4.69#	-2.63	-1.17	-0.75
Air condition*CDD	0.28	2.48	12.02***	1.68
Average electricity price	-19.55***	-7.87**	0.44	-1.36
Charging an EV at home	25.65***	32.99***	7.74*	7.49
HH size	-17.97***	-37.23***	-6.08***	-6.85***
Intentions to save electricity	-1.63#	-5.31**	1.25	-0.74
Information intervention	-10.30***	-14.31**	-3.24	-5.04
Social Norms intervention	-0.35	-10.20#	-0.42	7.86#
Collective framing intervention	-0.86	3.99	-0.07	-4.91
Feedback intervention	-0.97	-10.40#	-2.05	-9.86
Commitment intervention	3.65	3.89	6.07#	0.52
Commitment accepted	3.41	4.26	-9.16*	3.65
Commitment public	-9.92*	-9.88	7.36	-12.23*
Competition intervention	4.00	12.01#	10.38**	0.11
Competition accepted	-5.84	-20.43*	-12.59***	9.16

Note: *** $p<.001$; ** $p<.01$; * $p<.05$; # $p<.10$

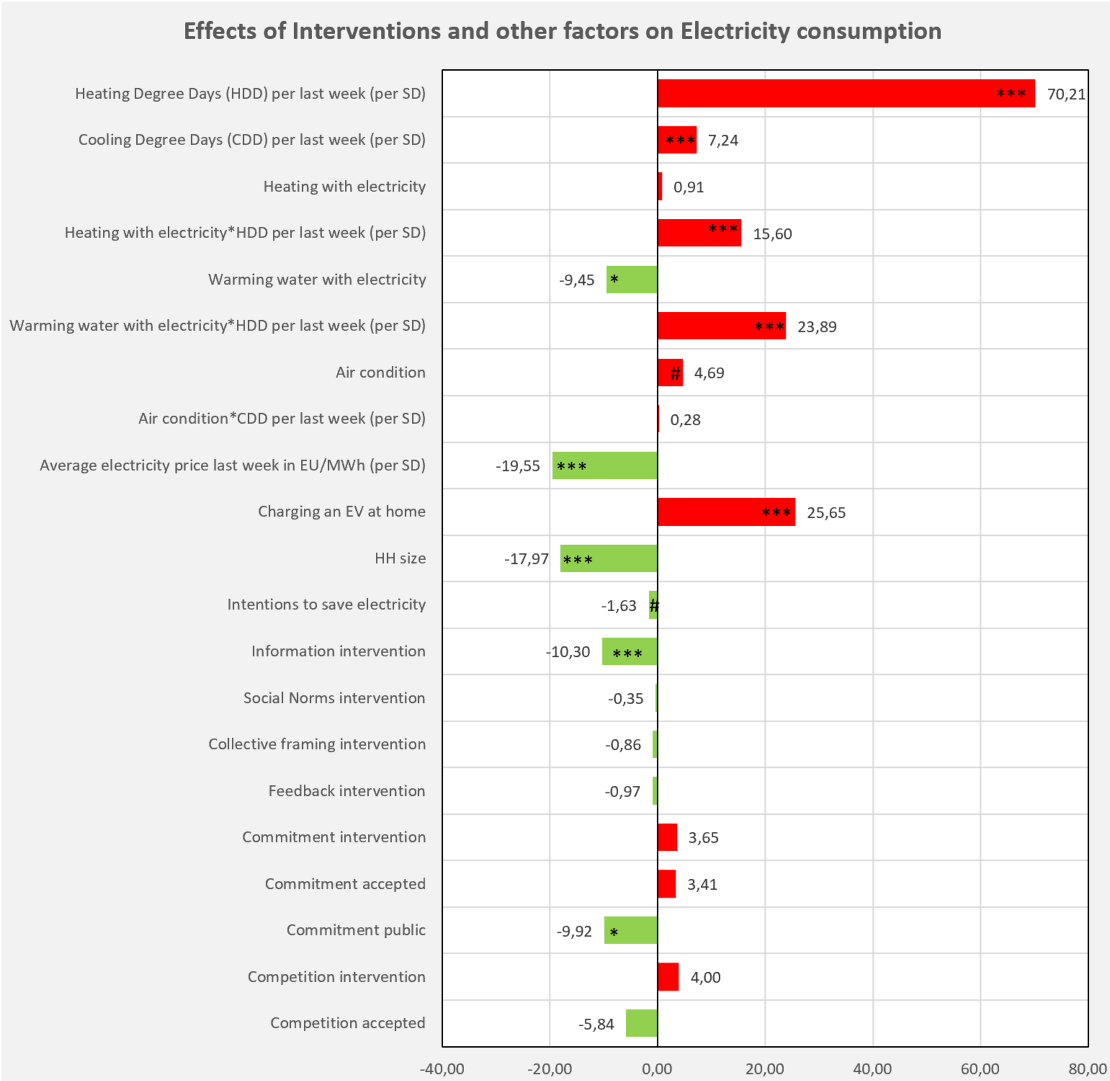


Figure 25: Visualization of the structural and intervention impacts on weekly electricity consumption

In this figure, red bars represent factors that are associated with an increase in electricity consumption, while green bars indicate factors that are associated with a decrease in consumption. The effect size is represented as a percentage within the bars. Significance levels are denoted by: * for $p < 0.1$, ** for $p < 0.05$, and *** for $p < 0.01$.

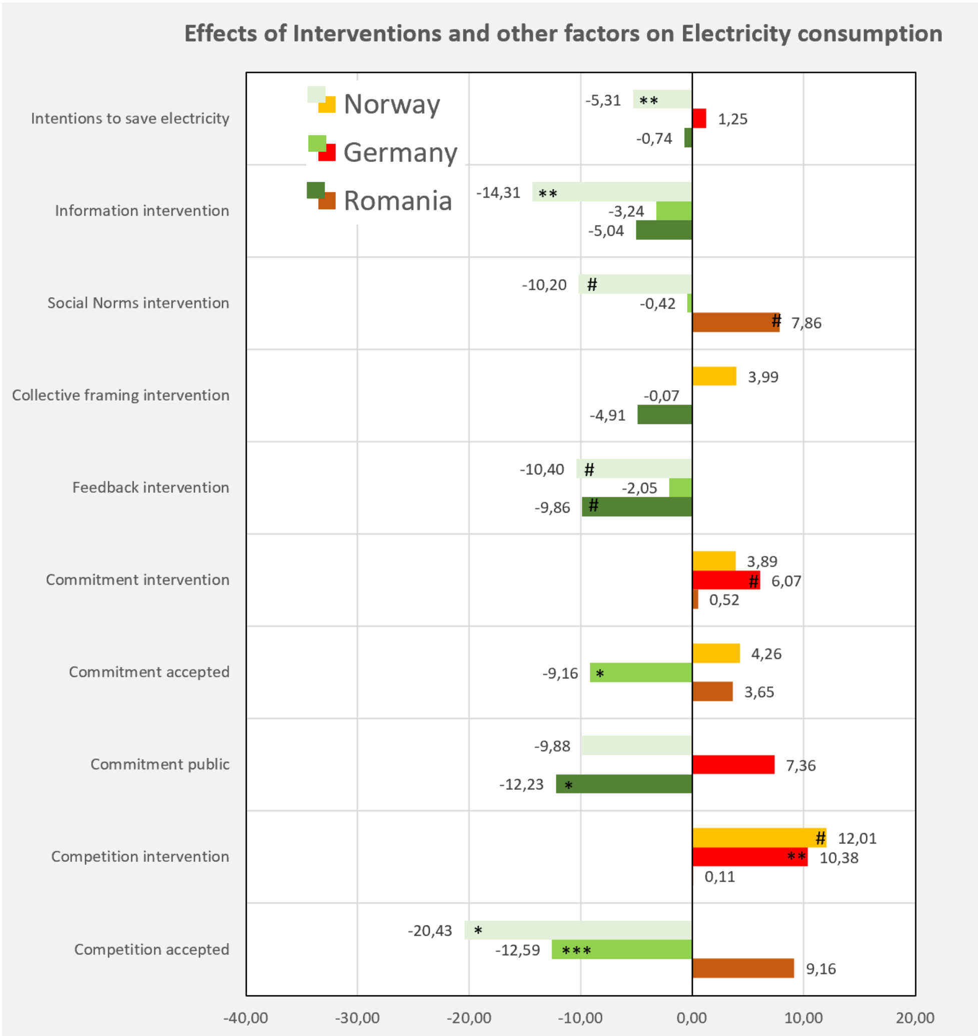


Figure 26: Visualization of the structural and intervention impacts on weekly electricity consumption for each country

In this figure, red bars represent factors that are associated with an increase in electricity consumption, while green bars indicate factors that are associated with a decrease in consumption. The effect size is represented as a percentage within the bars. Significance levels are denoted by: * for $p < 0.1$, ** for $p < 0.05$, and *** for $p < 0.01$.

Here, we summarize the results:

- The structural impacts on electricity consumption are (not surprisingly strong): One standard deviation increase in HDDs increases the electricity consumption in the whole sample by more than 70 kWhs per person per week. If heating with electricity, this effect is even stronger (more than 85 kWh/p/w increase per SD in HDDs). There is also a strong interaction between HDDs and heating water with electricity, indicating that this becomes a major consumer in a household in the winter. The effect of air conditioning is modest in relation, but it needs to be acknowledged, that (a) the included countries with sufficient respondents are mostly in central and northern part of Europe and (with exception of Romania) were studied in winter/early spring. Charging an electric vehicle at home not surprisingly increases electricity consumption (by 25 kWhs/p/w on average). Household size on the other hand comes with a benefit of scale: The more household members, the lower the average consumption per household member.

- Electricity prices clearly are related to electricity consumption, the higher the prices were, the lower the consumption (each SD increase on average lead to a decrease of almost 20 kWhs/p/w).
- Intentions to reduce electricity consumption only had a marginally significant effect on electricity consumption, reducing it slightly (when controlling for all other factors).
- Consistently with what has been described above, providing specific tips to reduce electricity consumption leads to less consumption (about 10 kWhs/p/w).
- In the overall sample, public commitment also had a significant reduction effect of about the same size, but it needs to be acknowledged that this is offset by people with private commitment or refusing commitment having a higher consumption in these intervention groups.
- On the country level, it shows that some structural effects and the intervention effects differ, depending on the context: First of all, average electricity consumption per person per week is massively different in Norway as compared to Germany and Romania (which are approximately on the same level). HDDs are not relevant for electricity consumption in Romania (during summer), whereas CDDs are not relevant in Norway in winter. EV charging is not a relevant factor in Romania. Air conditioning is only a relevant factor in Germany.
- Intentions to save electricity are only a significant predictor in Norway, and many interventions are more effective in Norway than in the other two countries (information, social norms, feedback, and accepted competition), probably, because the level of electricity consumption in Norway is much higher and offers more room for behavioral adjustments. Commitment accepted has a strong effect only in Germany, whereas it needs to be public in Norway and Romania to have a saving effect, feedback has a marginal effect also in Romania, but not in Germany. Competition seems to work in Norway and Germany (if people accept it), but not in Romania. As a conclusion, it might be said that the intervention effects depend strongly on the structural and cultural context, not the least on the level of electricity consumption to begin with.

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4 Appendix

Romania Newsletters

- Intervention 1 - Individual benefit information

  EMAIL SUBJECT 1: Lower energy bills? Here's what you can do.

  Headline: Efficiency measures that benefit you. Did you know that our homes are the biggest energy consumers in Romania? By adopting consumption efficiency measures, you can reduce your bill by up to 20 %.

  Here are some tips that will help you save energy without significantly changing your lifestyle (ANRE, 2018):

  – Unplug all household appliances when you are not using them (washing machine, dryer, batteries, TV, computer or other devices with remote control or LED). Thus, in one year, you can save up to 180 lei.
  – Do not use the washing machine, dryer or dishwasher in the evening, during peak consumption hours, use them at maximum load capacity. Use long wash programs and high temperatures only when absolutely necessary.
  – The refrigerator is the biggest consumer of electricity in the home. Adjust its temperature to no less than 4 degrees.
  – Do not let the freezer form ice inside, otherwise it will require more energy to cool.
  – Move the refrigerator and freezer away from any heat source.
  – Use natural light as much as possible and turn off light where it is not needed. By installing economical bulbs you can save up to 60 lei/bulb annually.
  – Reduce the temperature from the thermostat by only 1 °C and you can save between 5 %-10 % of annual energy costs.
  – Shorten your daily shower by 3 minutes. This way you can save up to 115 lei/person/year. Don't let the faucet run when you brush your teeth or wash the dishes. A running tap consumes up to 10 l/min.
  – Reduce the airing time of the rooms. Energy consumption in a home is due to: heating the environment (64 %), water (15 %), lighting (14 %), cooking (6 %), cooling (0.4 %), other activities (1 %) (EUROSTAT, 2019). 7 % of the energy on the bill is wasted by switched-off devices that are plugged in (ANRE, no year).

- Intervention 2 - Altruism and social norm information

  EMAIL SUBJECT 2: The quality of the environment depends on your consumption!

  Headline: The information you need. Energy consumption directly affects the quality of the air we breathe, the water we use, the environment and our lives as a whole. Energy consumption is at the root of climate change, and our homes are the biggest consumers of energy[1]. Climate change generated by our energy consumption has global repercussions:

- Sea level rise, extinction of a large number of species, both animals and plants.
- Extreme temperatures and natural phenomena, torrential rains, hurricanes or droughts that produce devastating socio-economic and political effects.
- Climate changes resulting from energy consumption are a promoter for the migration of diseases.

66 % of Romanians agree that the way they consume energy has an impact on the environment and 91 % of those interviewed want to make their consumption behavior more efficient.[2] What are the activities in your home where you waste the most energy? Improve your consumption behavior! By changing the way you consume energy at home, you can contribute to improving environmental conditions!

Here are some tips that will help you make a difference without significantly changing your lifestyle (ANRE, 2018):

- Unplug all household appliances when you are not using them (washing machine, dryer, batteries, TV, computer or other devices with remote control or LED).
- Do not use the washing machine, dryer or dishwasher in the evening, during peak consumption hours, use them at maximum load capacity. Use long wash programs and high temperatures only when absolutely necessary.
- The refrigerator is the biggest consumer of electricity in the home. Adjust its temperature to no less than 4 degrees.
- Do not let the freezer form ice inside, otherwise it will require more energy to cool.
- Move the refrigerator and freezer away from any heat source.
- Use natural light as much as possible and turn off light where it is not needed. Install economical light bulbs.
- Reduce the temp from the thermostat by only 1 °C.
- Shorten your daily shower by 3 minutes. Don't let the faucet run when you brush your teeth or wash the dishes. A running tap consumes up to 10 l/min.
- Reduce the airing time of the rooms. Energy consumption in a home is due to: heating the environment (64 %), water (15 %), lighting (14 %), cooking (6 %), cooling (0.4 %), other activities (1 %) (EUROSTAT, 2019). 7 % of the energy on the bill is wasted by switched-off devices that are plugged in (ANRE, no year).

* Intervention 3.1. - Information individual framing

  EMAIL SUBJECT 3A: How do you live healthy? Consuming head on. Headline: Healthy consumption. Healthy body.

The consumption behavior you adopt in your home has important effects on your health and that of your family.[3] Pollutants released into the environment or into the atmosphere associated with energy consumption (EEA, 2004) generate up to 43 % of annual premature deaths, and other chronic diseases such as cardiovascular diseases, asthma, allergies, respiratory diseases or even neurological diseases and disorders. What are the activities in your home where you waste the most energy? Consume more responsibly! Your health depends on your consumption behavior!

Here are some tips that will help you make a difference without significantly changing your lifestyle (ANRE, 2018):

- Unplug all household appliances when you are not using them (washing machine, dryer, batteries, TV, computer or other devices with remote control or LED).
- Do not use the washing machine, dryer or dishwasher in the evening, during peak consumption hours, use them at maximum load capacity. Use long wash programs and high temperatures only when absolutely necessary.
- The refrigerator is the biggest consumer of electricity in the home. Adjust its temperature to no less than 4 degrees.
- Do not let the freezer form ice inside, otherwise it will require more energy to cool.
- Move the refrigerator and freezer away from any heat source.
- Use natural light as much as possible and turn off light where it is not needed. Install economical light bulbs.
- Reduce the temp from the thermostat by only 1 °C.
- Shorten your daily shower by 3 minutes. Don't let the faucet run when you brush your teeth or wash the dishes. A running tap consumes up to 10 l/min.
- Reduce the airing time of the rooms. Energy consumption in a home is due to: heating the environment (64 %), water (15 %), lighting (14 %), cooking (6 %), cooling (0.4 %), other activities (1 %) (EUROSTAT, 2019). 7 % of the energy on the bill is wasted by switched-off devices that are plugged in (ANRE, no year).

• Intervention 3.2 - Collective framing information

EMAIL SUBJECT 3B: Consume responsibly and do everyone a favor.

Headline: Let's change our consumption behavior! Our behavior has an impact on the environment! Together we can change something!

The consumption behavior that we have in our homes produces important effects on the health of Romanians.[4] The emission of pollutants in the environment or in the atmosphere associated with energy consumption (EEA, 2004) generates up to 43 % of annual premature deaths in our country, but also other chronic diseases that are increasingly common in society such as cardiovascular diseases, asthma, allergies, respiratory diseases or even neurological diseases and disorders. Climate change resulting from energy consumption is a promoter of disease migration (NIEHS, 2010). What are the activities in our homes where we waste the most energy? Let's consume more responsibly! The health of others depends on our consumption behavior!

– Unplug all household appliances when you are not using them (washing machine, dryer, batteries, TV, computer or other devices with remote control or LED).
– Do not use the washing machine, dryer or dishwasher in the evening, during peak consumption hours, use them at maximum load capacity. Use long wash programs and high temperatures only when absolutely necessary.
– The refrigerator is the biggest consumer of electricity in the home. Adjust its temperature to no less than 4 degrees.
– Do not let the freezer form ice inside, otherwise it will require more energy to cool.
– Move the refrigerator and freezer away from any heat source.
– Use natural light as much as possible and turn off light where it is not needed. Install economical light bulbs.
– Reduce the temp from the thermostat by only 1 °C.
– Shorten your daily shower by 3 minutes. Don't let the faucet run when you brush your teeth or wash the dishes. A running tap consumes up to 10 l/min.
– Reduce the airing time of the rooms. Energy consumption in a home is due to: heating the environment (64 %), water (15 %), lighting (14 %), cooking (6 %), cooling (0.4 %), other activities (1 %) (EUROSTAT, 2019). 7 % of the energy on the bill is wasted by switched-off devices that are plugged in (ANRE, no year).

Table 30: Mean comparison between experimental conditions

	1 vs erimental Conditions													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
age	1974.54	1969.91	1972.1	1974.62	1970.95	1973	1970.62	1972.69	1970.51	1973.96	1969.87	1975.75	1970.13	1973.54
gender	1.43	1.37	1.44	1.36	1.39	1.37	1.26	1.36	1.38	1.41	1.44	1.32	1.39	1.36
county	47.53	42.69	45.38	51.67	43.77	46.83	51.39	42.34	51.96	35.9	58.64	56.37	63.43	59.03
hhsize	2.97	2.8	2.93	2.94	2.82	3	3.02	2.77	2.7	2.98	2.58	2.44	2.82	2.89
under6	0.26	0.3	0.25	0.38	0.26	0.13	0.27	0.18	0.2	0.29	0.14	0.25	0.28	0.38
under12	0.25	0.15	0.36	0.2	0.28	0.41	0.34	0.41	0.23	0.42	0.12	0.32	0.27	0.31
under18	0.41	0.17	0.34	0.39	0.33	0.46	0.32	0.47	0.3	0.24	0.3	0.26	0.28	0.34
education	3.69	3.88	3.63	3.64	3.56	3.61	3.69	3.72	3.54	3.69	3.58	3.63	3.58	3.54
occupation	2.12	2.12	2.22	1.91	2.3	1.9	2.07	2.11	2.16	2.14	2.24	1.93	2.21	1.85
socialstatus	6.8	7.24	6.65	6.58	6.47	6.53	6.82	6.72	6.67	6.44	6.74	6.68	6.68	6.65
energypoverty	1.44	1.45	1.51	1.48	1.71	1.35	1.36	1.47	1.54	1.33	1.4	1.56	1.41	1.42
energypovpercent	2.27	2.04	2.42	2.29	2.36	2.18	2.28	2.1	2.24	2.24	2.25	2.36	2.52	2.28
LED	0.73	0.69	0.7	0.75	0.78	0.69	0.67	0.82	0.68	0.76	0.65	0.7	0.72	0.76
washing_machine_ef	0.8	0.85	0.77	0.83	0.83	0.88	0.84	0.78	0.6	0.86	0.77	0.81	0.75	0.78
dishwasher_eff	0.74	0.72	0.66	0.74	0.82	0.85	0.73	0.67	0.55	0.74	0.7	0.67	0.65	0.76
heat_pump	0.34	0.43	0.33	0.36	0.34	0.34	0.3	0.32	0.24	0.47	0.2	0.42	0.24	0.29
tumble_dryer	0.68	0.63	0.6	0.59	0.61	0.56	0.68	0.61	0.7	0.69	0.52	0.52	0.67	0.67
airconditio	0.05	0.14	0.13	0.17	0.16	0.12	0.05	0.16	0.15	0.18	0.12	0.1	0.1	0.08
EV	0.36	0.49	0.29	0.29	0.35	0.35	0.3	0.37	0.33	0.49	0.33	0.28	0.33	0.3
heating	0.46	0.55	0.5	0.47	0.57	0.52	0.42	0.54	0.44	0.59	0.38	0.49	0.43	0.46
warm_water	0.6	0.63	0.62	0.56	0.63	0.6	0.49	0.68	0.57	0.72	0.44	0.59	0.49	0.54
shut_off	0.95	0.97	0.88	0.94	0.9	0.89	0.97	0.93	0.92	0.93	0.89	0.95	0.92	0.89

Note: 1 corresponds to **Control 1**, 2 to **Control 2**, 3 to **Info**, 4 to **Info + SN**, 5 to **Info + CF**, 6 to **Info + SN + CF**, 7 to **Info + com** , 8 to **Info + FB**, 9 to **Info + FB + CF** , 10 to **Info + FB + comp** , 11 to **Info + FB + comp + CF** , 12 to **Info + SN + com**, 13 to **Info + SN + com + FB + comp** and 14 to **Info + SN + com + FB + comp + CF**.

Table 31: Mean comparison between experimental conditions continued

	1 vs erimental Conditions													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
climate_worry	3.07	3.52	3.08	3.26	3.15	3.52	3.25	3.47	3.03	3.32	3.52	3.39	3.41	3.49
environmental_concern	3.06	3.6	3.21	3.29	3.35	3.46	3.31	3.56	3.06	3.28	3.46	3.36	3.36	3.45
el_concern	2.87	2.98	3.02	2.93	3.07	2.89	2.82	3.2	3.07	2.9	3.1	3.26	2.94	2.95
pnorms	4.03	4.02	4.04	3.84	3.96	3.94	3.57	4.12	3.79	3.73	4.28	4.17	4.01	4.06
curtains	3	3.43	3.3	3.37	2.93	3.33	3.33	3.3	3.16	3.51	3.24	3.08	3.05	3.37
aircondition	1.65	1.73	1.81	1.7	1.44	1.65	1.87	1.65	1.67	1.91	1.92	1.75	2.02	1.69
boiling	1.7	1.52	1.63	1.57	1.65	1.73	1.88	1.68	1.55	1.97	1.38	1.93	1.53	1.63
ovendoor	1.27	1.18	1.34	1.25	1.12	1.18	1.39	1.2	1.12	1.35	1.61	1.21	1.24	1.19
dishwasher_temp	2.13	2.01	2.28	1.89	1.96	1.84	2.32	1.93	1.83	2.31	1.92	1.64	1.86	2.01
fridge_temp	1.53	1.42	1.62	1.42	1.59	1.54	1.68	1.58	1.53	1.59	1.63	1.5	1.56	1.62
showers	2.56	2.1	2.5	2.37	2.25	2.57	2.66	2.35	2.16	2.52	2.37	2.35	2.4	2.65
heat	2.35	1.95	2.25	1.93	2.17	2.12	2.24	2.1	2	2.48	2.17	1.98	2.29	2.06
lids	1.33	1.38	1.38	1.3	1.43	1.28	1.44	1.32	1.47	1.51	1.62	1.63	1.28	1.23
washing_temp	2.4	2.3	2.38	2.26	2.27	2.09	2.51	1.98	1.94	2.49	2.31	1.78	1.9	2.12
fridge_dust	3.09	3.73	2.82	2.85	3.33	3.05	3	3.51	2.59	3.52	3	2.91	3.39	3.28
peak	3.04	2.78	3.34	3.05	3.05	3.2	2.94	2.64	2.89	3.69	2.78	2.82	3.22	3.45
fridge_ice	2.24	2.56	2.47	2.14	2.41	2.43	2.16	2.22	2.3	2.64	2.17	2.59	2.55	2.36
kettle	1.61	1.61	1.37	1.49	1.3	1.6	1.67	1.27	1.53	1.69	1.45	1.27	1.33	1.35
bath	1.39	1.14	1.25	1.14	1.34	1.14	1.24	1.11	1.16	1.45	1.16	1.3	1.13	1.26
lightbulbs	1.81	1.66	1.93	1.74	1.64	1.86	1.79	1.43	1.81	1.76	1.96	1.57	2.01	1.75
standby	2.73	2.86	2.56	2.72	2.52	2.83	2.53	2.38	2.59	2.69	2.27	2.55	2.75	2.81
peek	2.62	2.59	2.7	2.17	2.19	2.76	2.7	2.25	2.26	2.65	2.39	2.29	2.95	2.49
tumble	2.54	2.68	2.46	2.75	2.26	2.76	2.67	2.35	2.37	2.7	2.29	2.02	2.38	2.5
coolfood	1.36	1.26	1.45	1.28	1.48	1.46	1.44	1.37	1.53	1.69	1.42	1.41	1.53	1.38