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GAMIFICATION AND ENERGY SAVINGS: EVIDENCE FROM EXPERIMENTS

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Gamification and Energy Savings: Evidence from Experiments

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Abstract

Understanding how peer support and social interactions relate to participation and outcomes is important for the design of voluntary household energy conservation programs. Using a longitudinal dataset of 24,443 households participating in the *Familles à Énergie Positive* program between 2010 and 2018, we analyze how engagement intensity and team organization relate to household energy savings.

We find three main results. First, participating households achieve average energy savings of 3,359 kWh, equivalent to a 14.6% reduction in energy consumption during the program period. Second, participation effort, proxied by the number of meter readings submitted, is positively associated with energy savings across specifications. Third, outcomes vary substantially across teams: the 90–10 ratio of team-level energy consumption reaches 32.2, suggesting large differences in consumption levels that are partly related to organizational features, including team size and heterogeneity in support needs.

These results are robust to alternative specifications and measures of engagement. Overall, the findings show considerable variation in both participation intensity and energy outcomes within a large-scale voluntary conservation program and underscore the role of team organization and sustained engagement in the design of behavioral energy policies.

Keywords: Behavioral change; community-based interventions; energy consumption; soft policies; supportive engagement programs.

JEL: D16; D91; H41; Q48

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Gamification and Energy Savings: Evidence from Experiments

1 Introduction

Household energy consumption represents a major margin of adjustment for climate policy in advanced economies. In France alone, the residential sector accounted for 28% of total final energy consumption in 2023, second only to transport[1]. Policies targeting everyday household behaviors have therefore become an important component of the energy transition. The Europe's Energy Neighborhoods program, implemented in France as *Familles à Énergie Positive* (hereafter FAEP), provides households with individual and collective support and contextualized information to promote the adoption of everyday energy-saving behaviors (i.e. *Éco-gestes*[2]). As one of the longest-running and most widely disseminated household energy programs in Europe, FAEP represents a canonical example of non-coercive or 'soft' public policy (Banerjee et al., 2021).

Households rarely adopt energy-reducing behaviors or investments spontaneously (Abrahamse et al., 2005; Wyss et al., 2022), while behavioral interventions can influence such choices (Allcott & Rogers, 2014; Cabrera et al., 2024; Fowlie et al., 2015). Many of these interventions operate through social interactions (Li et al., 2023), norms (Asensio & Delmas, 2016; Cialdini & Jacobson, 2021), and collective learning (Burchell et al., 2016). FAEP is explicitly designed around these mechanisms, combining social comparison, gamification, and group-based support. Despite the growing interest in voluntary participation programs and non-financial behavioral interventions, empirical evidence on long-duration programs remains limited. Existing studies often focus on participation status, with relatively little attention paid to the mechanisms that sustain engagement and effort over time.

This paper studies behavioral support programs by documenting both participant characteristics and the channels through which effort is mobilized. Using a descriptive and exploratory empirical approach, we examine the relationship between energy-saving practices and the effort required to implement them. While previous work has documented direct and indirect effects of behavioral interventions, including spillovers and rebound effects (Maki et al., 2019), the link between observed practices and underlying effort remains largely unexplored.

We draw on a unique longitudinal dataset of 24 443, one of the largest available for a behavioral energy program in Europe. Our first contribution is descriptive: we document the evolution of household energy-related behaviors over nearly a decade, providing new evidence

[1] https://www.eea.europa.eu/en/europe-environment-2025/countries/france/final-energy-consumption?utm_source=chatgpt.com

[2] Guide des 100-écogestes (Spitz, 2011). 'Éco-gestes' is a French term that refers to simple actions aimed at reducing energy or resource consumption. These actions are typically easy to implement and involve minimal cost, such as switching off unused appliances, lowering heating, or reducing water consumption.

on behavioral dynamics and participation patterns. Our second contribution examines the role of household engagement in voluntary programs, focusing in particular on the Energy Master program. Using a fixed effects framework, we characterize the systematic associations between participation effort and energy outcomes, providing structured empirical patterns relevant for program design.

We highlight three main results. First, average energy savings per participant amount to 3 359 kWh, corresponding to a 14.64% reduction in household consumption over the entire period. Second, the program primarily attracts women with children, homeowners of single-family homes, and households located in colder climate zones, highlighting systematic differences in participation patterns and documenting substantial heterogeneity among participants over the long term. Third, there is substantial team-level heterogeneity. Accounting for team fixed effects, the 90–10 ratio of team-level energy consumption in percentage reaches 32.17, indicating large variation in structural consumption across teams, partly associated with observable characteristics such as team size and heterogeneity in support needs. These patterns are robust across specifications.

Overall, our results suggest that non-coercive interventions, especially those combining gamification and group cohesion, can generate measurable short-run behavioral responses. However, the available data do not allow us to assess the persistence of these effects over time.

The remainder of the paper is organized as follows. Section 2 reviews the related literature and describes the FAEP program. Section 3 presents the data and empirical approach. Section 4 reports the results, and Section 5 concludes.

2 Related Literature

A large literature identifies several barriers to changing household energy behaviors, including the influence of social norms, entrenched daily routines, and cognitive biases. Behavioral changes rarely occur spontaneously, and public policies have adopted a range of strategies to support households in this transition. Programs promoting energy sobriety typically rely on either coercive instruments, such as environmental taxation, or voluntary, non-binding interventions, often referred to as 'soft' policies. These soft policies[3] aim to encourage energy-saving behaviors without imposing mandates, leveraging information, social influence, and other behavioral mechanisms to motivate participation.

2.1 Behavioral Effects of Soft Policies

Soft policies aim to influence household behaviors in a non-coercive manner. They operate through monetary or non-monetary incentives, information provision, learning mechanisms, or

[3]In this paper, soft policies are defined as instruments designed to change behavior without restricting individual choice or altering relative prices, including moral persuasion, information provision (e.g., educational campaigns), and nudges (Banerjee et al., 2021).

the activation of social norms (Banerjee et al., 2021). The overarching goal of these programs is to enhance individual and collective responsibility for the provision of a public good while minimizing free-rider behavior (Bohm, 1972).

2.1.1 Non-Monetary Incentives and Interventions : Beyond Ambiguous Effects

A first strand of literature shows that monetary incentives can sometimes backfire when the behaviors at stake involve prosocial or morally salient contexts (Gneezy & Rustichini, 2000; Holladay et al., 2019; Sudarshan, 2017). Energy-related behaviors, which explicitly involve contributing to a public good, are particularly susceptible to crowding out intrinsic motivation (Frey & Oberholzer-Gee, 1997). In response, many interventions emphasize information provision and non-monetary incentives (Barwick et al., 2024; Ornaghi et al., 2018).

Information-based policies, such as real-time feedback through In-Home Displays or email, have produced mixed results. Some studies document behavioral changes but typically only up to a threshold and over a short time horizon (Hargreaves et al., 2013), whereas others suggest potentially more durable effects (Burchell et al., 2016), without establishing their persistence. Moreover, existing research indicates that smart meters do not necessarily affect energy-intensive behaviors that are perceived as normal or immutable. While targeted information can facilitate learning and habit formation, Jessoe and Rapson (2014) concludes that such information must be combined with other signals to be effective, for instance, when coupled with relevant price signals. This combination appears important for amplifying and stabilizing behavioral responses.

2.1.2 Social Norms, Community Anchoring, and Heterogeneous Practices

Behavioral economics research suggests that information alone is rarely sufficient to generate lasting behavioral changes (Iweka et al., 2019). Household heterogeneity, the persistence of routines, and the practical nature of energy use limit the effectiveness of generic messages. The skills and know-how involved in daily energy management are often situated and context-specific, which standardized interventions cannot fully capture (Simcock et al., 2014; Wallenborn & Wilhite, 2014). These limitations underscore the relevance of interventions built around social dynamics (Asensio & Delmas, 2016). For instance, Cabrera et al. (2024) show that personalized advice enhances the impact of information-based policies, while the Smart Communities project suggests that community-based actions can strengthen engagement by creating a framework for collective action. Similarly, interventions leveraging social comparisons or prosocial messaging demonstrate that activating social norms can influence energy consumption. At the same time, numerous studies find that the effects of non-monetary nudges tend to diminish rapidly (Gneezy & List, 2006).

2.1.3 Present Bias and Status Quo Preferences

Persistent barriers to lasting behavioral change in household energy consumption can be attributed to bounded rationality and temporal biases. Individuals often favor inaction when immediate action entails a personal cost, exacerbating the classic commons dilemma. Self-control frameworks, including the planner–doer model (Thaler, 1981) and quasi-hyperbolic discounting (O'donoghue & Rabin, 1999), help explain why individuals overweight immediate benefits while underinvesting in long-term gains—an effect particularly salient in energy-related decisions.

Experimental evidence further demonstrates a systematic preference for the status quo: individuals tend to stick with existing options even when alternatives are equivalent or superior (Samuelson & Zeckhauser, 1988). This behavior indicates that economic choices are not always fully rational. People assign disproportionate weight to the reference option, or 'starting point', making changes appear more costly than maintaining current behaviors. Importantly, inaction should not be interpreted as satisfaction with the existing choice; rather, it reflects a form of behavioral inertia in response to changes in the decision environment. Recognizing the status-quo bias suggests that latent preferences for alternative behaviors may exist and could be revealed if reference points were altered or the costs of change were reduced. This opens the possibility for targeted interventions that exploit these behavioral interstices to encourage change.

2.2 Gamification and Behavioral Change

An increasing number of studies in experimental and behavioral economics have examined gamification as an incentive tool aimed at modifying behavior[4]. These studies show that game-based mechanisms can influence effort and engagement; yet, their effects appear highly context-dependent and often fail to translate into lasting behavioral change.

In experimental settings, Banuri et al. (2024) study the impact of game-based incentives on effort in a real-effort laboratory task. They find that gamification significantly increases effort when monetary extrinsic incentives are low, but adds no further effect when such incentives are high, suggesting diminishing returns from combining different types of incentives. Several studies also emphasize the central role of the social dimension: digital tools and game mechanisms can enhance the visibility of behaviors and facilitate peer interactions (Leon & Schobin, 2026). However, these effects often do not translate into observable changes in real-world behavior.

In pro-environmental domains, including active mobility, gamification interventions relying on competition and relative rewards show similar patterns. Campaigns such as Cycling May increased cycling temporarily (Biondi et al., 2022), and large-scale international programs raised participation rates without generating persistent engagement (Weber et al., 2018).

Overall, existing evidence indicates that gamified interventions primarily influence par-

[4]Gamification is defined here as the use of game-design elements in non-game contexts, focusing on changing the flow of information received by users. When implemented, the objective is to induce a targeted change in a distal outcome, such as improved learning (Landers et al., 2018).

ticipation or self-reported behaviors while producing limited long-term behavioral change in real-world settings. This context motivates the present study, which examines the effects of a large-scale, field-based behavioral support program. Specifically, we focus on the French implementation of Europe's Energy Neighborhoods, known as FAEP, which combines personalized guidance, social dynamics, and gamified elements to encourage household energy-saving practices.

2.3 *Familles à énergie positive*-FAEP Program

The FAEP program is rooted in the principles of behavioral economics applied to energy consumption. Originating from the Belgian *Klimaatwijken* experiment launched in 2003, FAEP was subsequently scaled up through the European Union's Intelligent Energy Europe program and the Energy Neighborhoods initiative implemented between 2007 and 2013 across several member states. In France, FAEP was developed in 2008 by the NGO Prioriterre[5]. The program is based on the idea that behavioral failures among households can generate systematic gaps between energy-efficient 'investments' that are desirable and those actually undertaken (Gillingham et al., 2018). FAEP therefore relies on three central principles: (i) engaging the general public in energy-saving goals through gamification; (ii) leveraging collective and community-based mechanisms to reinforce the adoption of energy-efficient behaviors (Bardsley et al., 2019); and (iii) fostering individual-level behavioral change through advisory support, particularly by addressing status quo biases.

The program is predominantly financed through public subsidies provided by ADEME, regional authorities, metropolitan governments, and participating municipalities[6]. As funding is grant-based, implementation costs vary across locations. To give an illustrative order of magnitude, in the Lyon metropolitan area, the total cost of the program for two implementation cycles (2016 and 2017) was estimated at €69,500, corresponding to the recruitment of 80 households organized into nine teams per year[7].

The intervention encourages a predefined set of energy-saving behaviors[8], hereafter referred to as 'targeted actions', aimed at reducing residential heating demand, improving electricity use efficiency, and promoting the use of energy-efficient appliances. Objectives are defined at both the individual and team levels, with a minimum target of an 8 percent reduction in energy consumption relative to a pre-intervention baseline.

[5]Prioriterre was a non-governmental organization based in Haute-Savoie, engaged in climate action and the promotion of energy savings. The NGO ceased operations in 2017.

[6]These entities correspond to different tiers of public administration in France. ADEME is the national public agency providing expertise and financial support for energy and environmental policies, while regional, metropolitan, and municipal governments are subnational authorities involved in the design, coordination, and funding of local energy and climate initiatives.

[7]This figure includes maintenance of the program's digital platform, recruitment and training of households and team leaders, monitoring of team leaders, organization of program-related events, and communication expenditures. See https://venissieux.fr/wp-content/uploads/wpallimport/uploads/seance_26425/37_d1463067100074.pdf.

[8]Illustrative examples are provided in Appendix (Figure 9).

These targeted actions mainly involve low-cost, routine practices that do not require substantial investments, such as turning off lights when leaving a room, lowering heating before ventilating the dwelling, or using lids when heating water[9]. In addition to collective support through the team structure, households have access to an individualized digital tool providing information and feedback on energy use. The tool allows participants to track consumption, visualize savings, and receive tailored recommendations[10].

Between 2010 and 2018, FAEP collected detailed data on nearly 24 443 participants, providing an exceptionally rich empirical framework to analyze the effects of behavioral interventions combining gamification and collective action. This dataset allows us to explore how facilitation, team dynamics, and game-based incentives interact to influence household energy-saving efforts in a real-world setting.

3 Data and Methodology

The empirical analysis is conducted in two steps. We first document the sociodemographic and territorial characteristics of households participating in the FAEP, with the aim of identifying the profiles associated with program participation. We then evaluate program outcomes as a function of the level of effort exerted by households in the challenge, measured using multiple indicators of engagement, among which program support constitutes a key dimension.

3.1 Data

The data used in this study come from the FAEP program's internal database and cover the period 2010–2018. The dataset contains 24 443 complete individual observations, where the unit of observation is a participating household. After excluding participants with no recorded consumption data (–4,895 observations) and those with responses outside the ±90% range of energy and CO_2 reductions relative to the previous year, or outside the range of 2 to 50 readings[11] (–975 observations), the final sample for analysis consists of 18 572 observations. It includes 29 variables collected as part of the FAEP program and is complemented with 12 additional variables capturing the local institutional and territorial context, including region, municipality size and political orientation, local poverty rate, and climate zone. The set of variables used in the analysis comprises four outcome variables, five individual-level variables, four municipality-level variables, and three general contextual variables[12].

[9] Examples are included in the Appendix (Figure 10).
[10] Illustrations are provided in the Appendix (Figures 11 and 12).
[11] These thresholds are chosen based on the empirical distributions of the variables, which exhibit clear outliers beyond these ranges (Appendix Figure 13, 14, 15 and 16).
[12] To avoid overloading the main text, detailed information is provided in the Appendix (Table 4).

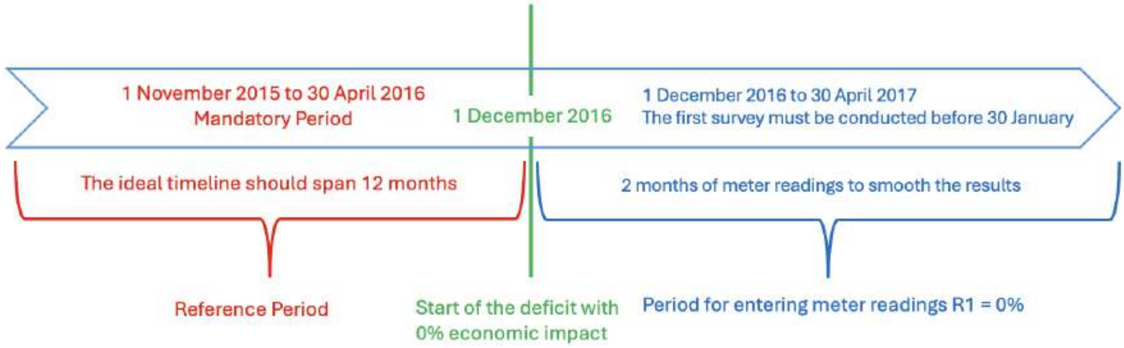


Figure 1: Results computation: example from the 2016–2017 challenge

Registration to the program opens prior to December 1, the official start date of the challenge. Households may either join an existing team or register individually. In the latter case, they are assigned to teams based on geographic proximity whenever possible. Teams typically consist of five to ten households. Participants who cannot be assigned to a team participate individually (25.34%) and therefore do not have a designated team leader[13].

At registration, each household reports its energy consumption[14] for the previous year. This value serves as the reference level against which energy savings achieved during the challenge are calculated. Energy consumption is therefore self-reported by participants; however, all values are processed through standardized conversion rules embedded in the platform, ensuring comparability across energy sources.

A first meter reading, typically collected by the end of January of the challenge year, provides the operational baseline for monitoring consumption during the program. Subsequent meter readings are then used to track changes in consumption relative to this baseline. The program requires at least two meter readings per household, and reported consumption is annualized to ensure comparability with the reference year (Figure 1). According to the program's operational rules, participation is considered valid if two readings are submitted at least two months apart and if the implied change in consumption lies between -50% and $+30\%$ relative to baseline consumption. Households that submit only two meter readings are classified as providing minimal effort, whereas effective participation corresponds to the submission of at least three readings.

These rules are communicated to participants through online guidelines; however, pro-

[13]Within the challenge, a team is formally defined as a group of at least five participants. Participants who are not affiliated with a team are excluded from team-level rankings, and only their individual outcomes are considered. In the empirical analysis, such cases are therefore treated as having no designated Energy Master, and the corresponding indicator variable is coded as zero.

[14]Energy refers to electricity and gas but may also include heating oil, wood, or liquefied petroleum gas (LPG). Upon enrollment, households receive support to help them understand their energy bills and the information to be reported in the application. For example, households report wood consumption in steres, which the platform converts into kWh so that all energy consumption is expressed in a common energy unit.

gram facilitators may manually validate certain participations deemed representative of genuine engagement. Because the data rely on information reported by participants for the purposes of the challenge, additional data cleaning procedures were implemented prior to the empirical analysis. Test accounts, observations with zero values, and extreme outliers were excluded. To limit the influence of implausible values, energy and CO_2 reductions are restricted to the interval $[-90\%, +90\%]$, and the number of meter readings is restricted to the range between 2 and 50. These restrictions remove 1 022 observations. The final analytical sample, therefore, comprises 18 572 observations with at least two meter readings.

3.2 Measuring Household Effort

The precision of household energy consumption measurements depends directly on the number of meter readings submitted: the more readings provided, the more reliable the annualized consumption, and the more accurate the assessment of energy savings at the household level. In addition to this statistical role, meter readings provide participants with updated information on their cumulative energy consumption over the challenge period. The frequency of readings, therefore, determines both the precision of the consumption measure from the researcher's perspective and the granularity of the consumption information available to participants. Meter readings themselves do not mechanically generate energy savings; they serve as an informational channel through which participants monitor their consumption.

This interpretation is consistent with the behavioral economics literature (Thaler & Sunstein, 2021), which emphasizes the role of information acquisition in reducing informational frictions and shaping economic decisions. Experimental evidence shows that providing households with information about their energy consumption affects subsequent energy use (Allcott & Knittel, 2019; Boogen et al., 2022). This evidence supports a framework in which access to consumption information can influence energy-saving behavior. In our setting, meter readings constitute one channel through which such information becomes available, while also improving the precision of measured consumption outcomes.

In the context of the FAEP program, the challenge period is fixed across years and is identical for all participants. Conditional on participation, variation in the number of submitted readings does not reflect differences in exposure duration, but rather differences in the frequency with which participants record and observe their consumption. We therefore use the number of readings as a proxy for participants' effort in the program. To mitigate concerns that meter readings may proxy for unobserved motivation to save energy, we control for baseline energy consumption and a set of household characteristics. Baseline consumption is particularly important as it captures pre-existing consumption patterns and structural determinants of energy use. These controls reduce the scope for omitted variable bias arising from systematic differences across households and help isolate the effect of household effort on energy outcomes.

The program covers all major domestic energy sources—electricity, wood, fuel oil, natural gas, and propane—and automatically converts consumption into kilowatt-hours (kWh) to ensure comparability. Carbon dioxide savings are subsequently calculated using source-specific conversion factors, allowing program outcomes to be expressed in both energy savings and environmental impact. To account for climate variability, consumption is further adjusted using standardized heating degree days (HDD), enabling consistent year-on-year comparisons.

The program is organized around teams. Each team is led by a participant designated as an 'Energy Master', and some teams operate in a professional (firm-based) context rather than in a residential setting. Energy Masters complete specific training and are formally responsible for coordinating team activities. In the empirical specification, we include two indicator variables: (i) a dummy equal to one for individuals holding the Energy Master role, and (ii) a dummy equal to one for participants belonging to a firm-based team. All specifications include team fixed effects, which absorb time-invariant team-level heterogeneity. The coefficients on these indicators are therefore identified from within-team variation and capture systematic differences associated with leadership status and implementation setting.

Structural heterogeneity across households is additionally controlled for using housing insulation, proxied by the year of construction or major renovation and categorized as low (before 1972), intermediate (1972–2000), or high (after 2000), reflecting major regulatory changes in building codes[15].

Together, these program features allow us to estimate the effect of household effort—proxied by the number of meter readings submitted—on outcome variables, including energy consumption, CO_2 emissions, and relative changes compared to the previous year. The effect of meter readings captures variation in household effort conditional on baseline consumption, household characteristics, and team-level fixed effects, while explicitly acknowledging that readings themselves do not mechanically reduce consumption[16].

The empirical specification is given by:

$$\begin{aligned} Y_{ijt} = \beta_0 + \beta_1 \,\text{NumReadings}_{ijt} + \beta_2 \log(\text{BaseConsumption})_{ijt} \\ + \beta_3 \,\text{EnerMaster}_{ijt} + \beta_4 \,\text{FirmBased}_{ijt} + \alpha_j + \sum_{t=2010}^{2017} \gamma_t \,\text{Year}_t + \sum_{k=1}^{K} \delta_k \, X_{kijt} + \varepsilon_{ijt} \end{aligned} \quad (1)$$

[15] The first thermal regulation (réglementation thermique, RT) was enacted following the 1973 oil crisis, whereas RT2000 introduced a shift from prescriptive requirements to a performance-based standard for buildings.

[16] In an auxiliary regression of log(Baseline Consumption) on the number of meter readings, controlling for team fixed effects, the coefficient on meter readings is small and negative (-0.0040317, $p < 0.001$). This indicates that households submitting more meter readings tend to have slightly lower initial consumption, but the correlation is weak. These results support the interpretation of meter readings as a proxy for household effort rather than simply reflecting pre-existing consumption patterns.

$$
\begin{aligned}
Y_{ijt} &= \text{Dependent variable} \\
\beta_0 &= \text{Constant term} \\
\text{NumReadings}_{ijt} &= \text{Ranging from 2 to 50} \\
\beta_2 &= \text{Captures pre-program energy use, controlling for prior consumption} \\
&\quad \text{patterns and household characteristics in the estimation of the effect of} \\
&\quad \text{household effort.} \\
\text{EnerMaster}_{ijt} &= \text{Indicator variable equal to 1 if member } i \text{ is the team captain, 0 otherwise.} \\
\beta_3 &= \text{Coefficient associated with the Energy Master, measuring the effect} \\
&\quad \text{of being an Energy Master on individual outcomes within the team.} \\
\text{FirmBased}_{ijt} &= \text{Indicator variable equal to 1 if member } i \text{ is the firm team, 0 otherwise.} \\
\beta_4 &= \text{Coefficient capturing the effect of being in a firm-based context.} \\
&\quad \text{of being an Energy Master on individual outcomes within the team.} \\
\alpha_j &= \text{Team-specific fixed effect, capturing all average differences between} \\
\gamma_t &= \text{Year fixed effects } t \text{ (2010 to 2017)} \\
\text{Year}_t &= \text{Dummy} = 1 \text{ if year} = t, 0 \text{ otherwise} \\
X_{kit} &= \text{Control variables (gender, dwelling size, insulation level, dwelling} \\
&\quad \text{type, household size, municipal density, municipal electricity} \\
&\quad \text{consumption, political orientation of the municipality, poverty rate,} \\
&\quad \text{climate zone, electricity price, region.)} \\
\delta_k &= \text{Coefficient associated with the } k\text{-th control variable} \\
\varepsilon_{ijt} &= \text{Random error term}
\end{aligned}
$$

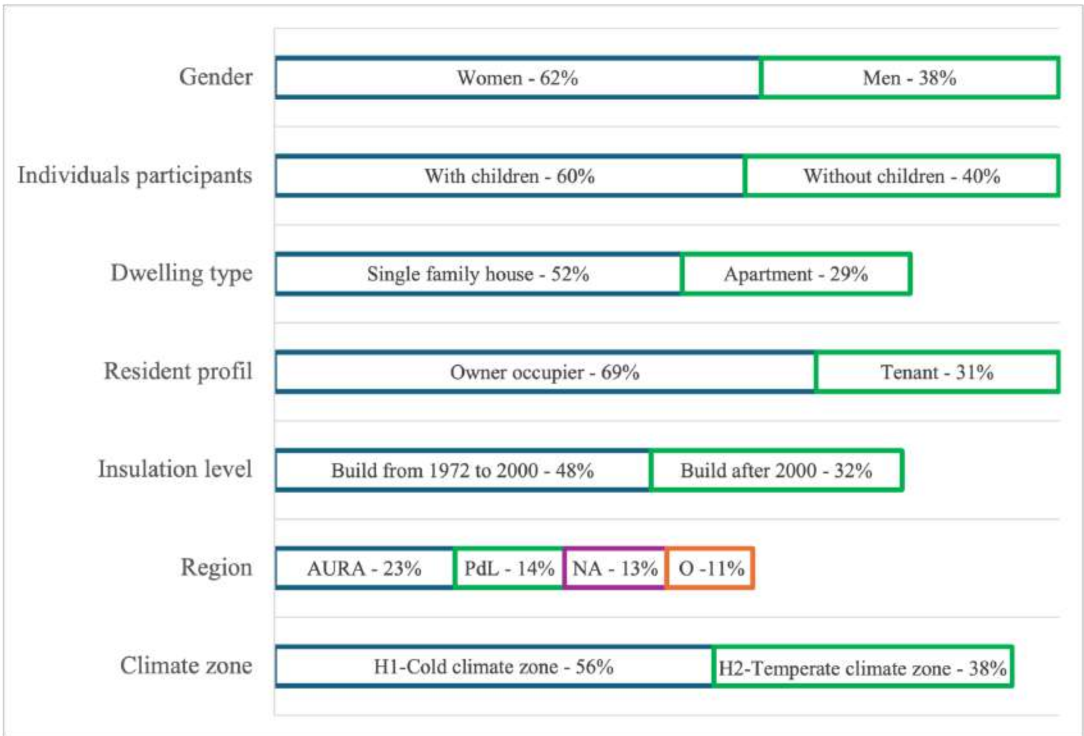
As each individual and team is observed only once per year, our analysis is cross-sectional with year fixed effects rather than panel-based. The fixed effects α_j are normalized to have a mean of zero to avoid collinearity with the constant term. The coefficient β_2 is identified solely from within-team variation in EnerMaster_{ijt}. To compare performance across teams, we rely on the estimated team fixed effects α_j : a lower value of α_j indicates a more efficient team (lower CO_2 emissions relative to the average), while a higher value indicates a less efficient team.

4 Results

We begin by providing descriptive statistics that characterize households participating in the challenge between 2010 and 2018, as well as a summary of the observed program outcomes. We then present the results from our econometric analysis.

4.1 Descriptive Statistics

The sample covering 2010–2018[17] is largely composed of women with children living in households with an average size of three individuals. Most participants reside in owner-occupied single-family homes constructed between 1972 and 2000. The majority of dwellings are located in urban areas (65%) and classified within the H1 cold climate zone (56%), consistent with regulatory definitions (Figure 2). Overall, 75% of participants are assigned to a team, 14% of participants are in firm-based teams, and the average number of meter readings per participant is nine after excluding outliers.



General participant characteristics. Full details are reported in the Appendix (Table 5). Climate zones are defined according to the departmental classification by the French Ministry of Territorial Planning and Ecological Transition. AURA stands for Auvergne-Rhône-Alpes, PdL stands for Pays de la Loire, NA stands for Nouvelle-Aquitaine, and O stands for Occitanie. Percentages are computed on different sample sizes depending on data availability.

Figure 2: Household Profiles of Program Participants, 2010–2017

Figures 3 and 4 illustrate the evolution of participation and program outcomes over the 2010–2017 period. The number of participants and participating municipalities increased until 2014 before declining thereafter. Total energy savings peaked in 2013, reaching 4 113 kWh per participant (–19%), before falling to 2 111 kWh in 2014 (–12%), with an average of 3 359 kWh (–14.64%) over the entire period[18]. CO_2 reductions followed a similar temporal pattern, with an

[17]Because each implementation cycle covers two calendar years, the period from 2010 to 2018 includes eight cycles, not nine.

[18]French official statistics report residential final energy consumption of about 460 TWh in 2023 (SDES, 2024). Dividing this aggregate by the total number of households in France implies an average consumption on the order of 15 MWh per household per year. This figure is provided solely to give an order of magnitude, i.e., an illustrative benchmark only. National aggregates combine heterogeneous dwellings, climatic conditions, and energy carriers and are therefore not directly comparable to participant-level estimates, which rely on different baselines, measurement boundaries, and behavioral responses.

average decrease of 599 kg per participant (–14.96%). The largest absolute reduction occurred in 2010 (843.89 kg), while the highest relative reduction was observed in 2013 (19.61%, 743.81 kg). Overall, both energy and CO_2 savings exhibit broadly consistent trends, with peak relative improvements in 2013, despite slight differences in the timing of absolute maxima.

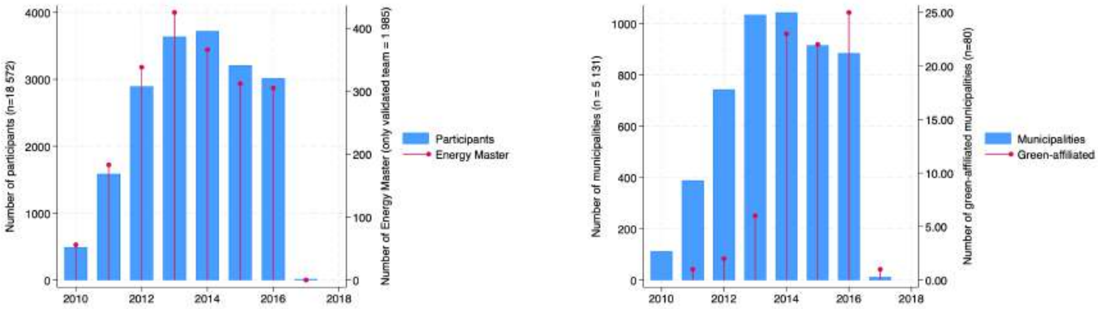


Figure 3: Statistics of the FAEP Challenge, 2010–2017

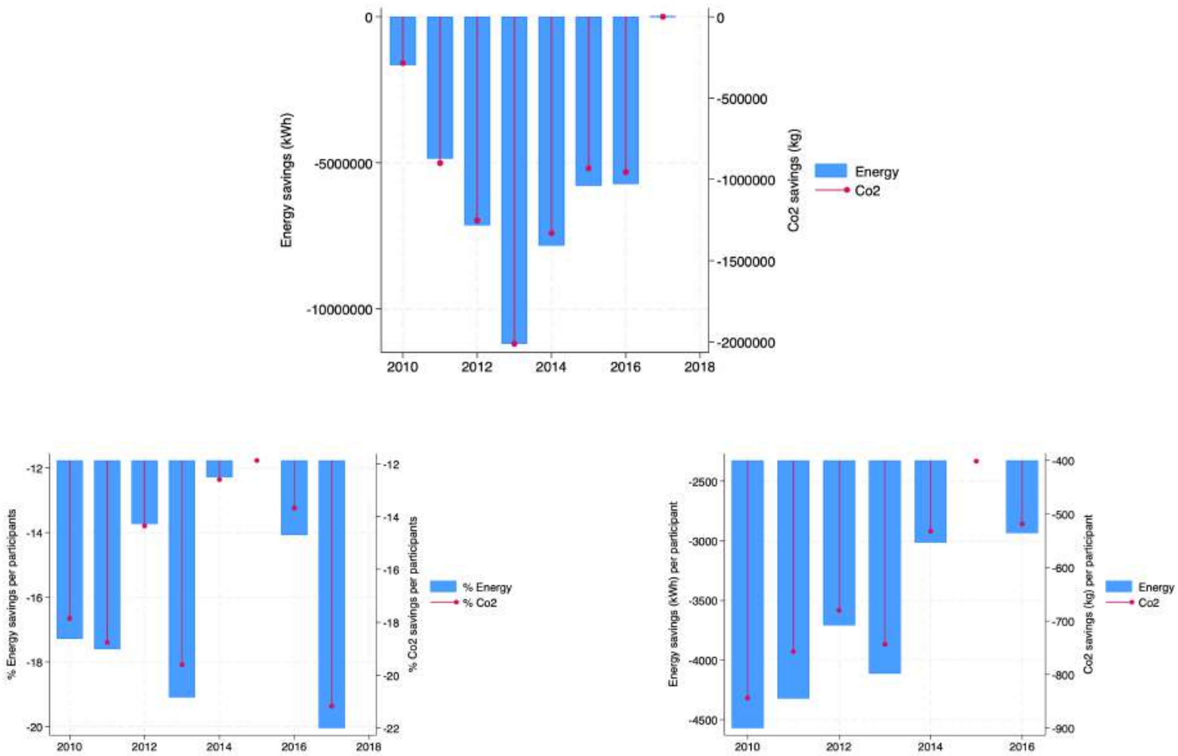


Figure 4: FAEP Challenge Results, 2010–2017

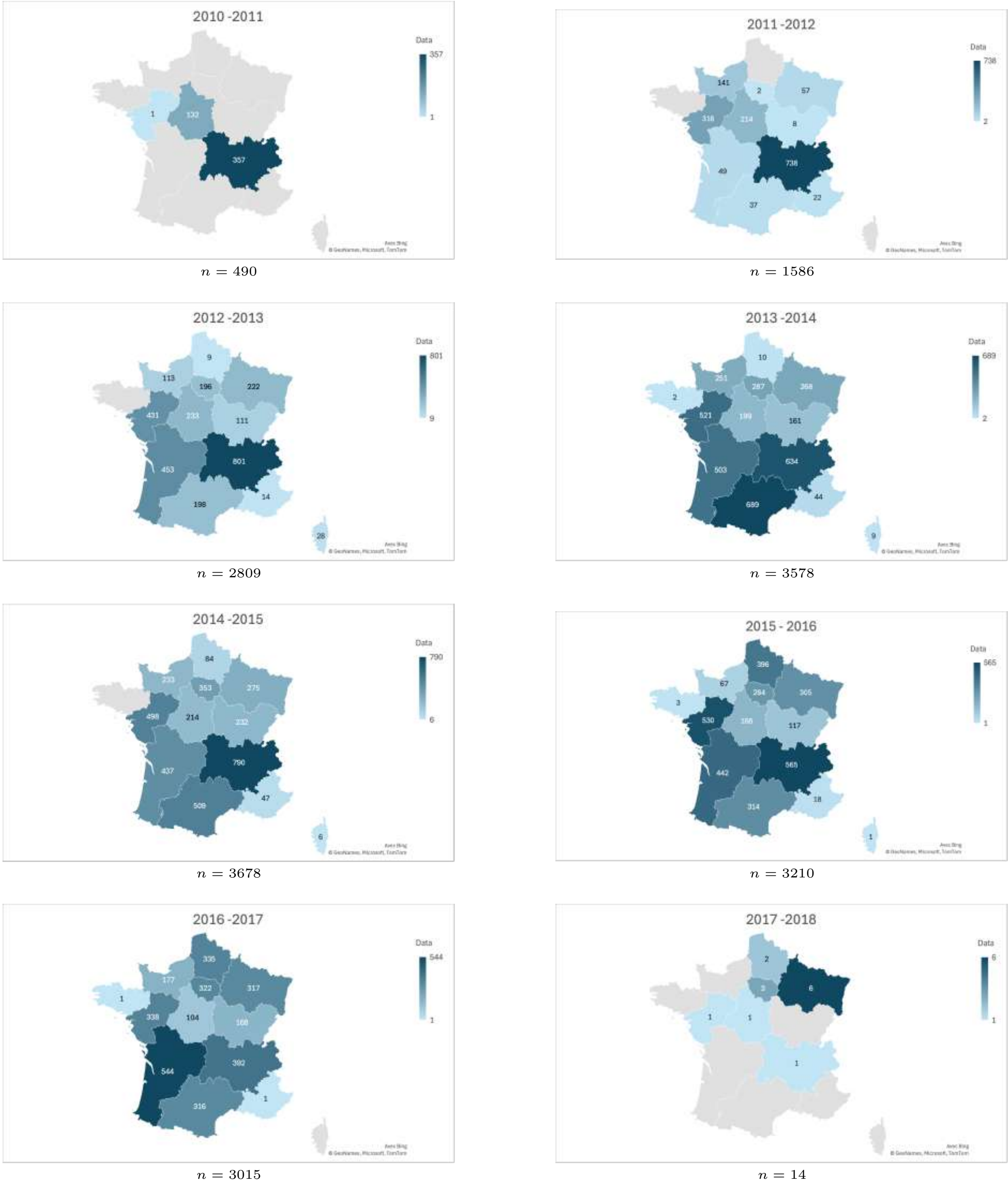


Figure 5: Deployment of the FAEP Challenge (2010–2017)

The program was initially deployed primarily in the Auvergne-Rhône-Alpes (AURA) region, which consistently exhibits the highest levels of participation. This concentration reflects the historical presence of the association Prioriterre, the initiative's founding organization. However, the data reveal a rapid geographic expansion. By 2013, Occitanie recorded the largest number of participants (689 households), and by 2016, Nouvelle-Aquitaine became the most represented region with 544 households. At the national level, the program eventually extended across the entire territory (Table 5), although significant heterogeneity in participation intensity across regions persists. *Bretagne* remains the region with the lowest participation observed over the study period.

4.2 Econometric Analysis

We estimate the following specification using ordinary least squares (OLS), where the annual percentage change is included as the independent variable. The analysis focuses on two dependent variables: (i) the annual percentage change in energy savings relative to the previous year, and (ii) the annual percentage change in CO_2 savings relative to the previous year. Estimates are reported for both specifications. The number of meter readings considered ranges from 2 to 50, based on the observed distribution[19].

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Energy (%)									
Meter readings	-0.136***	-0.128***	-0.145***	-0.136***	-0.125***	-0.119***	-0.118***	-0.116***	-0.115***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.023)	(0.023)	(0.032)	(0.023)	(0.032)
log (Baseline Consumption)		-3.192***	-5.491***	-5.483***	-5.308***	-5.376***	-5.542***	-5.362***	-5.535***
		(0.217)	(0.275)	(0.276)	(0.327)	(0.329)	(0.391)	(0.329)	(0.391)
Observations	18572	18503	18498	18498	12489	12489	11810	12489	11810
R-squared	0.002	0.018	0.035	0.035	0.035	0.039	0.286	0.051	0.288
CO_2 (%)									
Meter readings	-0.155***	-0.147***	-0.147***	-0.132***	-0.129***	-0.127***	-0.127***	-0.125***	-0.124***
	(0.021)	(0.021)	(0.028)	(0.028)	(0.035)	(0.035)	(0.035)	(0.025)	(0.035)
log (Baseline Consumption)		-3.518***	-6.485***	-6.489***	-5.904***	-5.895***	-5.895***	-5.687***	-5.899***
		(0.230)	(0.342)	(0.342)	(0.426)	(0.426)	(0.426)	(0.347)	(0.426)
Observations	18572	18503	17983	17983	11810	11810	11810	12489	11810
R-squared	0.002	0.018	0.270	0.271	0.283	0.283	0.283	0.050	0.285

Notes: Number of readings (2-50), *** p<0,01, ** p<0,05, * p<0,1, s.d in parentheses.
(1)Baseline, (2)+ Baseline Consumption, (3)+ Individual Controls, (4)+ Support Environment Controls, (5)+ Municipality Environment Controls, (6)+ Global Environment Controls, (7)+ team FE, (8)+ year FE, (9)+ team FE + year FE.
Complete regression results are provided in the Appendix (Table 6 and Table 7).

Table 1: Number of Meter Readings vs Program Outcomes (OLS Estimates)

The estimates indicate that meter readings reduce energy consumption by about 0.136 percentage points and CO_2 emissions by about 0.155 percentage points, and the effect is statistically significant. This relationship remains stable across specifications after controlling for baseline consumption and household characteristics, suggesting that the estimated association is not driven by observable differences across households. A placebo test[20] further reduces concerns about reverse causality (Table 1; details in Tables 13 and 14).

[19] Figure 14 provided in the Appendix.

[20] To examine the possibility of reverse causality, we perform a placebo test using baseline consumption as the dependent variable. Specifically, we estimate the following specification:

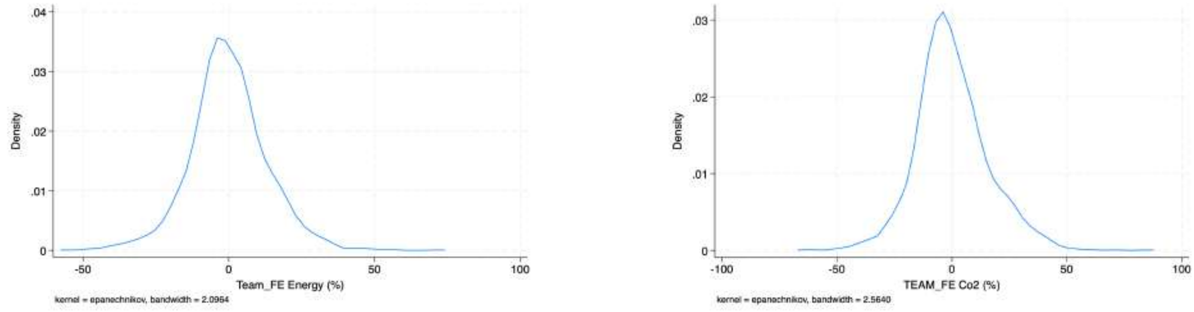
$$\log(\text{BaseConsumption}_i) = \alpha + \beta\,\text{NumReadings}_i + \varepsilon_i$$

where baseline consumption corresponds to household electricity consumption measured prior to the period of analysis. Because this variable is observed before the period during which meter readings are measured, this specification provides a simple check of whether meter reading frequency is correlated with pre-existing consumption levels. The results indicate a negative and statistically significant coefficient. However, the magnitude of this effect is small: an additional meter reading is associated with a decrease of approximately 0.40 percent in baseline consumption. This magnitude is substantially smaller than the effect estimated in the main specification (−0.115 percentage points). This finding suggests that while meter reading frequency may be correlated with certain structural household characteristics, the magnitude of this correlation is limited and unlikely to account for the main effect identified in our analysis.

Variable	Obs.	Mean		Std. dev.		Variance		Share	90-10 ratio
		FE	Resid.	FE	Resid.	Between	Within	Between	$e^{\alpha j}$
Energy (%)	11 810	0.00	-0.00	11.955	18.227	11.955	18.227	0.301	32.171
CO_2 (%)	11 810	-0.00	-0.00	14.388	20.056	14.388	20.056	0.340	38.188

Notes: Fixed effects are estimated from team-level regressions using `reghdfe`.
Between-team variance corresponds to the variance of estimated fixed effects, while within-group variance corresponds to the variance of residuals.
Share Between is the proportion of total variance explained by between-team heterogeneity.
The 90–10 ratio is computed using exponentiated fixed effects and measures dispersion in multiplicative terms.

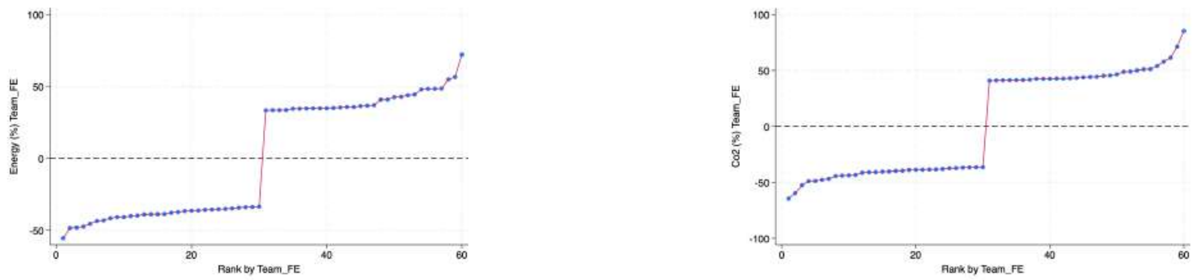
Table 2: Dispersion of Fixed Effects and Residuals



(a) Energy (%) (d) CO_2 (%)

Note: Sample includes only valid teams (more than 5 members) and excludes firm-based participants.

Figure 6: Distribution of Team Fixed Effects



Energy (%) CO_2 (%)

Figure 7: Top vs Lowest Performing Teams FE

At the same time, the substantial dispersion of the estimated team fixed effects α_j (Table 2) reveals pronounced heterogeneity in average outcomes across teams, likely reflecting unobserved differences in team-level characteristics or practices. This heterogeneity is summarized by the distribution of the estimated team fixed effects, which captures persistent cross-team differences.

Table 2 reports the dispersion of estimated team fixed effects and residual variation. The results reveal substantial heterogeneity across teams. For energy consumption, 30% of the total variance is explained by between-team differences, while 70% reflects within-team variation. For CO_2 emissions, between-team heterogeneity accounts for approximately 34% of the total variance, while 66% is explained by within-team variation.

The magnitude of cross-team heterogeneity is economically significant. The standard deviation of the estimated fixed effects is 11.955 points for energy consumption and 14.388 points for CO_2 emissions, indicating substantial variation across teams. Dispersion is particularly pronounced in the tails of the distribution. The 90–10 ratio of $e^{\alpha j}$ is 32.171 for energy consumption, meaning that teams at the 90th percentile exhibit structural consumption levels roughly 32 times higher than those at the 10th percentile. The corresponding ratio for CO_2 emissions is 38.188. Fixed effects account for a sizable, though not dominant, portion of the total variance—approximately 30–34%—implying that within-team variation exceeds between-team variation. The distribution is highly heterogeneous, with extreme differences captured by the elevated 90–10 ratios (see Table 2 and Figure 7).

For descriptive purposes, we compare selected observable characteristics of teams associated with the highest and lowest estimated fixed-effect coefficients to illustrate the heterogeneity captured by these effects. We construct two indicators $Top30_i$ and $Bottom30_i$, which are equal to 1 if team i belongs to the Top 30 of teams or the Bottom 30 of teams according to its fixed effect, and 0 otherwise. We estimate the following probit model:

$$\begin{aligned} \mathrm{P}(Top30_i/Bottom30_i = 1 \mid X_i) = \Phi\Big[&\gamma_0 + \gamma_1 \log\text{ (Base line Consumption) mean}_i \\ &+ \gamma_2 \text{ Team Size}_i \\ &+ \gamma_3 \text{ Energy Master number}_i \\ &+ \gamma_4 \text{ Team-level average meter readings per person}_i \\ &+ \gamma_5 \text{ Team-level average dwelling surface area}_i \\ &+ \gamma_6 \text{ Team-level average household size}_i\Big] \end{aligned} \quad (2)$$

where $\Phi(\cdot)$ denotes the cumulative distribution function of the standard normal distribution. Average marginal effects are reported in Table 3.

	FE Energy (%)		FE CO_2 (%)	
	Top 30	Bottom 30	Top 30	Bottom 30
log (Base line Consumption) mean	-0.00160	-0.00496	-0.01021**	0.00071
	(0.00442)	(0.00473)	(0.00404)	(0.00450)
Team Size	-0.00318**	-0.00066	-0.00249*	-0.00228*
	(0.00129)	(0.00113)	(0.00146)	(0.00127)
Energy Master number	-0.00308	-0.00549	-0.00070	0.00195
	(0.00559)	(0.00391)	(0.00453)	(0.00312)
Team-level average meter readings per person	-0.00201***	-0.00114*	-0.00100*	-0.00051
	(0.00077)	(0.00066)	(0.00057)	(0.00049)
Team-level average dwelling surface area	0.00007	0.00003	0.00010*	-0.00012
	(0.00006)	(0.00007)	(0.00006)	(0.00008)
Team-level average household size	-0.00241	-0.00404	-0.00102	0.00044
	(0.00213)	(0.00332)	(0.00119)	(0.00089)
Observations	2529	2529	2529	2529

Notes:*** p<0,01, ** p<0,05, * p<0,1, s.d in parentheses.

Table 3: AME Comparison Across Extreme Groups (Top vs Bottom)

The reported coefficients correspond to marginal effects on the probability of belonging to the extreme team performance groups. For the Top 30 Energy group, an increase in team size reduces the probability of belonging to the best-performing teams by approximately 0.32 percentage points (significant at the 5% level), while no significant effect is found for the Bottom 30 group. A higher number of meter readings per person also decreases the likelihood of belonging to the Top 30, with an estimated effect of about 0.2 percentage points (significant at the 1% level), and by roughly 0.1 percentage points for the Bottom 30 group (significant at the 10% level). The effects of average dwelling surface area and average household size are not statistically significant. Similarly, the number of Energy Masters within a team does not appear to be associated with extreme performance outcomes.

For CO_2 reductions, two statistically significant relationships emerge. A higher level of baseline consumption reduces the probability of belonging to the Top 30 CO_2-performing teams by about 1 percentage point, suggesting that higher initial consumption does not necessarily translate into larger reductions. In addition, teams operating in larger dwellings show a slightly higher probability of belonging to the Top 30 CO_2 group.

All observations are purely descriptive and do not imply causal mechanisms. They are intended to illustrate the unobserved heterogeneity captured by team fixed effects, which varies depending on the performance metric considered.

5 Conclusion

The FAEP program supports households in adopting energy-saving behaviors through a combination of feedback, gamification, goal-setting, and community dynamics. This study contributes to the literature on behavioral support programs by documenting participant characteristics and the mechanisms through which engagement is mobilized in a voluntary program.

Using a longitudinal dataset of 18 572 households observed between 2010 and 2018, we identify three main empirical patterns. First, households achieved average energy savings of 3 359 kWh, corresponding to a 14.64% reduction in consumption. Second, participation effort—proxied by the number of meter readings submitted—is positively associated with energy savings, consistent with prior evidence linking engagement intensity to behavioral outcomes (Cabrera et al., 2024). Third, there is substantial heterogeneity across teams. Team fixed-effects estimates indicate that the 90–10 ratio of team-level energy consumption reaches 32.17, reflecting large differences in structural consumption levels across teams.

Descriptive analysis further highlights contrasting temporal dynamics. While program deployment increased steadily in terms of participants, Energy Masters, and municipalities, energy savings per participant fluctuated over time, with both percentage reductions and absolute savings peaking in 2013 before declining in subsequent years.

Examining extreme team performance suggests that organizational characteristics—such as team size and heterogeneity in support needs, proxied by the number of meter readings per participant—may be associated with higher performance levels, whereas household demographic characteristics do not appear to explain the observed differences across teams in this setting. Although these results cannot fully disentangle organizational practices from structural conditions, they suggest that operational characteristics at the team level may play a role in shaping program outcomes.

Another noteworthy finding is that the number of Energy Masters within a team is not significantly associated with extreme performance outcomes. This result should be interpreted cautiously, but it suggests that increasing the number of specialized advisors does not necessarily translate into proportional gains in program effectiveness. This pattern may also be consistent with behavioral mechanisms such as status quo bias, although the available data do not allow us to test these mechanisms directly. Further research would be needed to clarify the mechanisms underlying this relationship.

More broadly, the results also indicate that energy reductions and CO_2 reductions do not display identical patterns, possibly reflecting differences in the energy mix used in residential buildings. However, this interpretation remains tentative and would require more detailed information on energy sources and housing characteristics. Taken together, these findings contribute to the growing literature examining how advisory programs and behavioral interventions translate into measurable environmental outcomes. Similar behavioral mechanisms may also be relevant in other policy domains where individual actions play a central role, including mobility, waste management, and education.

Finally, the available data do not allow for causal inference or the estimation of long-term persistence effects. Further research combining these data with follow-up surveys on household behaviors and attitudes would be necessary to assess the causal impact and durability of the program's effects.

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Appendix

Figure 8: Behavioral tools

Figure 9: Pro-environmental behaviors

Figure 10: Pro-environmental behaviors

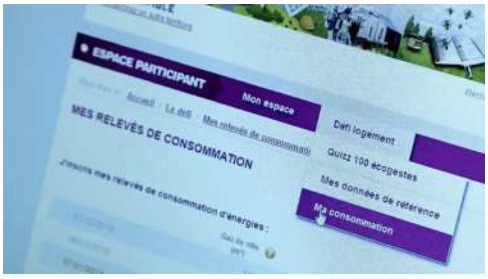


Figure 11: FAEP Program

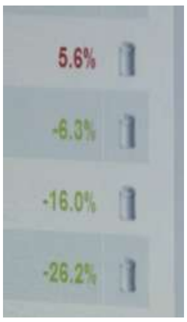


Figure 12: Energy consumption monitoring and feedback

Variable	Stata Name	Description
Period	Periode	5-month participation period (Dec 1 – Apr 30)
Start Year	StartYear	Year of participation
End Year	EndYear	Year of participation
ID	Id	System ID
Postal Code	ZipCode	Participant identification
Municipality Code	MunCode	Participant identification
Municipality	Municipality	Participant identification
City	City	Participant identification
Phone	Phone	Participant identification
Energy Master	EnMaster	Participant role in team
Participates	ParticipOK	1 if participant completed > 2 readings 2 months apart, 0 otherwise
Results OK	ResulsOk	1 if participant completed > 2 readings, 0 otherwise
Region	Region	Participant identification
Territory	Territory	Used by coordination team
Zone	Zone	Used by coordination team
Team	Team	Participant's team name
Energy Saved (%)	PctEnergie	Percentage of energy saved
CO_2 Saved (%)	PctCO_2	Percentage of CO_2 saved (system-converted)
Energy Saved (kWh)	EnergieKwh	Energy saved per participant (converted to kWh if non-electric)
CO_2 Saved (kg)	CO_2Kg	CO_2 saved per participant (converted using energy-specific factor)
Previous Consumpt. (kWh)	ConsoAvantKwh	Participant-reported consumption previous year
During Challenge Consumpt. (kWh)	ConsoDuringKwh	System-calculated based on participant readings
Number of Readings	NumReadings	Number of readings reported
Insulation Reference	IsulationRef	Housing insulation by construction year / standard (1,2,3, RT2012/BBC. . .)
Insulation Consumption	IsulationConso	Insulation during challenge, no difference from reference
Household Changes	Hous.Changes	Declared installations during challenge
Dwelling Type	DwellingType	4 types: detached house, semi-detached, apartment . . .
Resident Profile	ProfilResident	Tenant or owner
Dwelling Area (m2)	DwellingArea	Floor area of dwelling
Household Size	HousSize	Number of people in household per registration
Construction Year	Const.Year	Year of construction
Renovation Year	RenovYear	Year of renovation (if any)
Phone Number	PhonNum	Participant identification
Aggregated Region	Region	Region
New Aggregated Region	RegionNew2016	Region2016
Municipality-Year	MunYear	Created for file merging
Municipal Area	MunArea	Area of municipality (2024, data.gouv.fr)
Municipal Population (thousands)	PopMill	Population of municipality (2024, data.gouv.fr)
Municipal Density	Density	Population density of municipality
Municipal Electricity Consumption	MunElecCons	Electricity consumption per municipality (MWh/year, residential points)
Municipal Gas Consumption	MunGazCons	Gas consumption per municipality (MWh/year, residential points)
Municipal Political Affiliation	PoliAffil	Political color of mun. (0 others, 1 alliance w/ greens, 2 LVEC, data.gouv.fr)
Municipal Poverty Rate	MunPoverty	Poverty rate of municipality (INSEE)

Table 4: Variable Description

Variable	Total (N=18 572)
Gender	
Female	11 556 (62.2%)
Male	7 013 (37.8%)
Region	
Auvergne-Rhône-Alpes	4 278 (23.0%)
Pays de la Loire	2 638 (14.2%)
Nouvelle-Aquitaine	2 428 (13.1%)
Occitanie	2 063 (11.1%)
Île-de-France	1 447 (7.8%)
Grand Est	1 450 (7.8%)
Centre-Val de Loire	1 265 (6.8%)
Normandie	982 (5.3%)
Hauts-de-France	836 (4.5%)
Bourgogne-Franche-Comté	797 (4.3%)
Martinique	159 (0.9%)
Provence-Alpes-Côte d'Azur	146 (0.8%)
Corse	44 (0.2%)
Guadeloupe	31 (0.2%)
Bretagne	6 (0.0%)
Valid Team	
No	4 610 (24.8%)
Yes	13 962 (75.2%)
Company Participation	
No	15 988 (86.1%)
Yes	2 584 (13.9%)
Number of Readings	9.31 (7.67)
Resident Profile	
Tenant	1 869 (30.7%)
Owner	4 215 (69.3%)
Dwelling Type	
Apartment_1	5 303 (28.6%)
Semi-detached_2 (2 sides)	1 394 (7.5%)
Semi-detached_3 (1 side)	2 229 (12.0%)
Detached house_4	9 641 (51.9%)
Household Size	3.21 (2.63)
Insulation by Construction Year	
Before 1972_1	3 599 (19.4%)
1972–2000_2	8 905 (47.9%)
After 2000_3	5 985 (32.2%)
Municipal Density	18.63(40.66)
Municipal Electricity Consumption	5.82 (1.60)
Municipal Political Affiliation	0.04 (0.23)
Municipal Poverty Rate	7.53 (9.07)
Climate Zone	
Coldest (H1)	10 358 (56.2%)
Temperate (H2)	6 981 (37.9%)
Warmest (H3)	1 100 (6.0%)
Electricity Price (c€/kWh)	15.51 (1.02)

Notes: Indicators are reported as counts (percentages) or means (standard deviations). _n denotes an ordinal categorical variable indexed from 1 to n.

Table 5: Descriptive Statistics

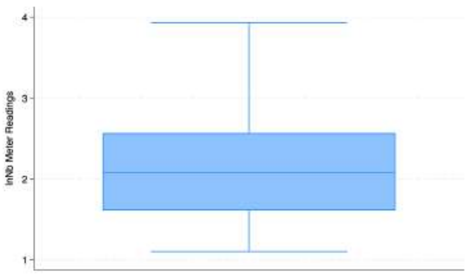


Figure 13: ln number of readings

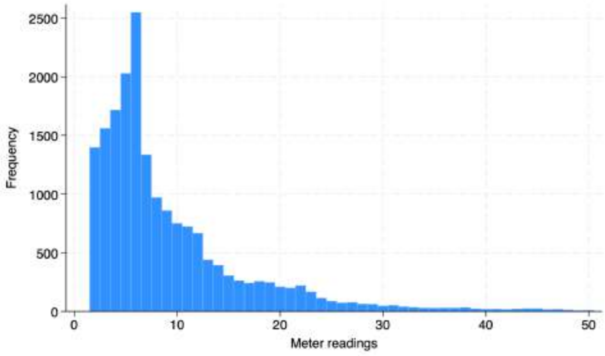


Figure 14: Number of readings

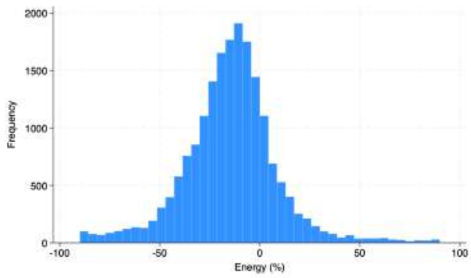


Figure 15: Energy(%) distribution

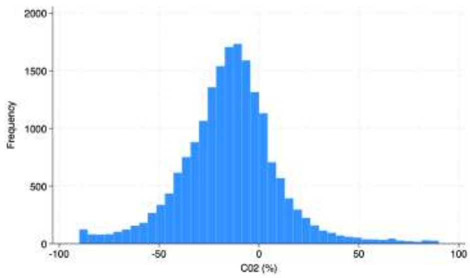


Figure 16: CO_2(%) distribution

Energy (%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Meter readings	-0.136***	-0.128***	-0.145***	-0.136***	-0.125***	-0.119***	-0.118***	-0.116***	-0.115***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.023)	(0.023)	(0.032)	(0.023)	(0.032)
log (Baseline Consumption)		-3.192***	-5.491***	-5.483***	-5.308***	-5.376***	-5.542***	-5.362***	-5.535***
		(0.217)	(0.275)	(0.276)	(0.327)	(0.329)	(0.391)	(0.329)	(0.391)
Gender			0.459***	0.478***	0.289	0.297	0.381	0.267	0.350
			(0.166)	(0.166)	(0.199)	(0.198)	(0.240)	(0.197)	(0.240)
Dwelling area			0.025***	0.025***	0.018***	0.019***	0.017***	0.017***	0.016***
			(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Insulation type			0.006**	0.006**	0.001	0.002	0.002	0.002	0.002
			(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Type of dwelling			1.472***	1.456***	1.596***	1.657***	1.963***	1.715***	1.949***
			(0.160)	(0.160)	(0.205)	(0.206)	(0.253)	(0.205)	(0.253)
Household size			0.391***	0.390***	0.500***	0.493***	0.464***	0.487***	0.469***
			(0.085)	(0.086)	(0.101)	(0.102)	(0.114)	(0.102)	(0.116)
Energy Master				-1.701***	-1.647***	-1.613***	-1.872***	-1.548***	-1.892***
				(0.465)	(0.559)	(0.559)	(0.614)	(0.555)	(0.615)
Team				-0.485	-0.420	-0.132	0.000	-0.195	0.000
				(0.398)	(0.467)	(0.470)	(.)	(0.468)	(.)
Firm-based Team				-0.610	-0.570	-0.896	-15.565	-0.543	-15.690
				(0.483)	(0.564)	(0.572)	(9.876)	(0.569)	(9.847)
Municipal density					0.003	-0.009	-0.003	-0.012	-0.006
					(0.008)	(0.009)	(0.023)	(0.009)	(0.024)
Mun. elec. consumpt.					-0.345**	-0.265	-0.295	-0.522***	-0.406
					(0.162)	(0.162)	(0.332)	(0.164)	(0.331)
Mun. political aff					1.465**	1.084*	-0.766	0.349	-0.830
					(0.619)	(0.629)	(1.354)	(0.627)	(1.351)
Mun. poverty rate					-0.007	0.012	0.011	-0.009	-0.003
					(0.029)	(0.029)	(0.063)	(0.029)	(0.063)
Climate zone						-2.017***	-0.379	-1.911***	-0.539
						(0.390)	(1.771)	(0.389)	(1.759)
Elect price (c€/kWh/year)						1.074***	1.175	-1.879	-14.893***
						(0.208)	(1.182)	(3.958)	(3.521)
Region						0.053	-0.042	0.092**	-0.082
						(0.042)	(0.285)	(0.042)	(0.288)
2010								0.000	0.000
								(.)	(.)
2011								1.105	4.517
								(5.727)	(6.883)
2012								5.748	15.898***
								(5.585)	(5.127)
2013								2.344	27.967***
								(7.530)	(6.693)
2014								9.688	43.615***
								(9.300)	(7.946)
2015								11.777	50.330***
								(11.103)	(9.538)
2016								8.677	51.763***
								(11.588)	(9.786)
2017								0.000	0.000
								(.)	(.)
Constant	-13.375***	16.733***	29.472***	29.926***	30.618***	16.093***	16.180	56.271	232.681***
	(0.273)	(2.081)	(2.330)	(2.338)	(3.006)	(4.653)	(18.568)	(55.879)	(50.331)
Observations	18572	18503	18498	18498	12489	12489	11810	12489	11810
R-squared	0.002	0.018	0.035	0.035	0.035	0.039	0.286	0.051	0.288

Notes: *** p<0,01, ** p<0,05, * p<0,1. s.d. in parentheses.

(1)Baseline, (2)+ Baseline Consumption, (3)+ Individual Controls, (4)+ Support Environment Controls, (5)+ Municipality Environment Controls, (6)+ Global Environment Controls, (7)+ team FE, (8)+ year FE, (9)+ team FE + year FE.

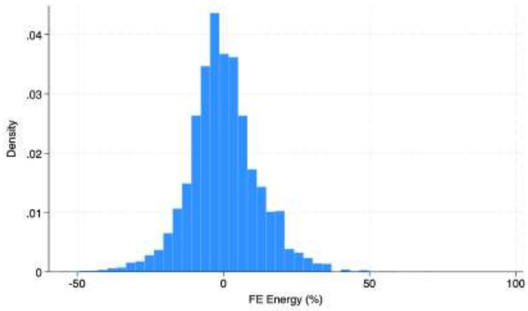
log (BaseCons.) means log(Baseline Consumption). Elect price means Electricity price in centime €/kWh/year.

Table 6: Year-on-year energy savings (%) vs number of readings

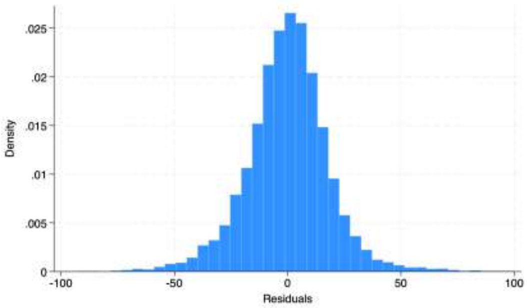
CO_2 (%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Meter readings	-0.155***	-0.147***	-0.147***	-0.132***	-0.129***	-0.127***	-0.127***	-0.125***	-0.124***
	(0.021)	(0.021)	(0.028)	(0.028)	(0.035)	(0.035)	(0.035)	(0.025)	(0.035)
log (Baseline Consumption)		-3.518***	-6.485***	-6.489***	-5.904***	-5.895***	-5.895***	-5.687***	-5.899***
		(0.230)	(0.342)	(0.342)	(0.426)	(0.426)	(0.426)	(0.347)	(0.426)
Gender			0.510**	0.538**	0.224	0.226	0.226	0.078	0.186
			(0.210)	(0.209)	(0.263)	(0.263)	(0.263)	(0.216)	(0.263)
Dwelling area			0.029***	0.030***	0.020***	0.020***	0.020***	0.018***	0.020***
			(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
Insulation type			-0.000	-0.000	0.001	0.001	0.001	0.002	0.001
			(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
Type of dwelling			2.037***	2.020***	2.147***	2.143***	2.143***	1.855***	2.130***
			(0.216)	(0.216)	(0.276)	(0.276)	(0.276)	(0.219)	(0.275)
Household size			0.387***	0.387***	0.422***	0.418***	0.418***	0.476***	0.425***
			(0.107)	(0.107)	(0.138)	(0.138)	(0.138)	(0.124)	(0.140)
Energy Master				-2.144***	-2.277***	-2.262***	-2.262***	-1.857***	-2.280***
				(0.564)	(0.707)	(0.708)	(0.708)	(0.631)	(0.708)
Team				0.000	0.000	0.000	0.000	-0.350	0.000
				(.)	(.)	(.)	(.)	(0.511)	(.)
Firm-based Team				-16.169**	-22.992**	-23.342***	-23.342***	0.218	-23.611***
				(7.460)	(9.010)	(8.947)	(8.947)	(0.617)	(8.921)
Municipal density					0.011	0.012	0.012	-0.010	0.010
					(0.026)	(0.027)	(0.027)	(0.010)	(0.027)
Mun. elec. consumpt.					0.036	0.056	0.056	-0.522***	-0.052
					(0.368)	(0.370)	(0.370)	(0.182)	(0.370)
Mun. political aff					-1.013	-1.150	-1.150	0.390	-1.235
					(1.619)	(1.637)	(1.637)	(0.718)	(1.632)
Mun. poverty rate					0.043	0.045	0.045	-0.010	0.031
					(0.070)	(0.070)	(0.070)	(0.032)	(0.069)
Climate zone						0.262	0.262	-1.888***	-0.058
						(2.024)	(2.024)	(0.420)	(2.016)
Elect price (c€/kWh/year)						1.417	1.417	-1.716	-13.977***
						(1.226)	(1.226)	(4.189)	(3.616)
Region						-0.156	-0.156	0.068	-0.249
						(0.314)	(0.314)	(0.046)	(0.321)
2010								0.000	0.000
								(.)	(.)
2011								-0.933	6.848
								(5.726)	(6.906)
2012								4.496	17.194***
								(5.723)	(5.165)
2013								0.770	29.166***
								(7.978)	(6.893)
2014								8.626	46.840***
								(9.917)	(8.116)
2015								10.877	50.043***
								(11.865)	(9.852)
2016								7.793	51.444***
								(12.386)	(10.071)
2017								0.000	0.000
								(.)	(.)
Constant	-13.523***	19.663***	36.382***	38.706***	35.039***	13.861	13.861	57.746	219.508***
	(0.294)	(2.200)	(2.929)	(3.109)	(4.727)	(19.315)	(19.315)	(58.834)	(51.494)
Observations	18572	18503	17983	17983	11810	11810	11810	12489	11810
R-squared	0.002	0.018	0.270	0.271	0.283	0.283	0.283	0.050	0.285

Notes: *** p<0,01, ** p<0,05, * p<0,1. s.d. in parentheses.
(1)Baseline, (2)+ Baseline Consumption, (3)+ Individual Controls, (4)+ Support Environment Controls, (5)+ Municipality Environment Controls, (6)+ Global Environment Controls, (7)+ team FE, (8)+ year FE, (9)+ team FE + year FE.
log (BaseCons.) means log(Baseline Consumption). Elect price means Electricity price in centime €/kWh/year.

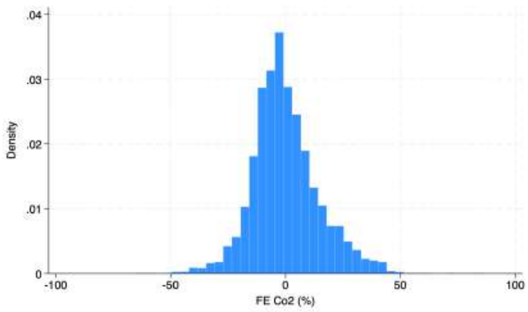
Table 7: Year-on-year CO_2 savings (%) vs number of readings



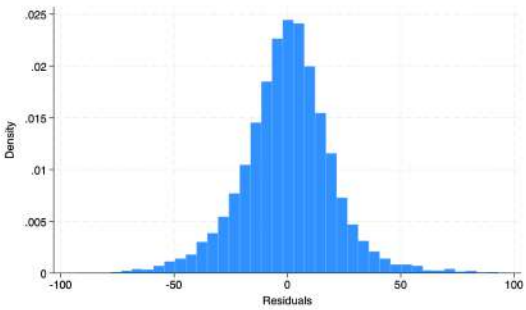
Fixed Effects α_j



Residuals ε_{ij}



Fixed Effects α_j



Residuals ε_{ij}

Figure 17: Distribution of Fixed Effects and Residuals for Energy and CO_2

Rank	**Energy (%)**		**CO_2 (%)**	
	Team Id	**FE coefficient**	**Team Id**	**FE coefficient**
1	Team 1	-15,52	Team 9	-64,54
2	Team 2	-48,53	Team 1	-59,71
3	Team 3	-48,25	Team 5	-52,58
4	Team 4	-47,54	Team 140	-48,92
5	Team 5	-45,64	Team 27	-48,86
6	Team 6	-43,59	Team 48	-47,76
7	Team 7	-43,23	Team 29	-46,92
8	Team 8	-41,68	Team 13	-44,36
9	Team 9	-40,88	Team 3	-43,97
10	Team 10	-40,86	Team 20	-43,75
2520	Team 2520	42,62	Team 2508	48,75
2521	Team 2521	43,73	Team 2523	48,91
2522	Team 2522	44,27	Team 2449	49,91
2523	Team 2523	47,86	Team 2519	50,94
2524	Team 2524	48,29	Team 178	51,08
2525	Team 2525	48,34	Team 2527	53,92
2526	Team 2526	48,47	Team 2528	57,78
2527	Team 2527	54,75	Team 1553	61,34
2528	Team 2528	56,46	Team 2529	71,13
2529	Team 2529	72,05	Team 2404	85,23

Notes: To preserve confidentiality, team identifiers are anonymized. We report the ten teams with the highest and lowest estimated fixed effects for each of the four dependent variables. These fixed effects capture persistent differences across teams after controlling for observed characteristics.

Table 8: Top 10/Bottom 10 Teams by Estimated Fixed Effects

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