Social comparison to promote energy conservation among middle-income households in tropical cities —Two experiments in the Yucatan Peninsula

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Abstract

Middle-income households in emerging economies are key drivers of global electricity demand, particularly in tropical regions where rising incomes and increasing temperatures amplify energy consumption. In many of these contexts, energy price policies are politically or financially unfeasible. This study examines the effectiveness of social comparison nudges in reducing residential electricity consumption in two rapidly growing cities in Mexico's Yucatan Peninsula: Merida and Cancun. We implemented a field experiment in which households received feedback on their electricity usage relative to their neighbors, delivered through personalized flyers. Using a Diff-n-Diff approach, we find that treated households reduced electric consumption by 7.9% on average –comparable to reductions in India and Lithuania. The effect was particularly pronounced in middle-to-upper households.

Our findings contribute to the literature on behavioral interventions for energy conservation in emerging economies, underscoring the potential of low-cost, non-price mechanisms to complement existing policy efforts in high-subsidy, high grow settings.

1 Introduction

Middle-income households in emerging economies will play a critical role in mitigating climate change (Gertler et al., 2016). As incomes rise, so does the demand for energy-intensive appliances, driving substantial increases in residential electricity consumption (Biardeau et al., 2020; Rao & Ummel, 2017). According to the International Energy Agency, despite the improvement in energy efficiency driven by technology, the use of electric appliances will grow 62% between 2018 and 2030. OECD countries will account for only 6.5% of the additional 1,077 Twh of residential energy consumption, while the remaining 93.5% will come from emerging and developing economies experiencing rapid economic growth (Lane, 2020).

At the same time, residential energy is highly subsidized in emerging economies, and political constraints make substantial reforms to these subsidies unlikely in the near future (Di Bella et al., 2015). Governments in emerging economies with limited budgets and limited political capital prioritize social issues such as poverty, inequality, education, and security. Under these conditions, the use of price incentives to drive energy consumption down is not a realistic option (Buckley, 2020).

How can energy conservation be promoted in contexts where price incentives are out of the question? Social comparisons have been put forward as an alternative to reach reductions in energy use in contexts where energy prices are highly subsidized. For instance, Bator et al. (2019) have documented that social comparison interventions trigger summer electricity conservation among low-to-moderate income households that do not pay for energy in New York.

This paper reports the impacts of a social comparison intervention implemented in middle-income Mexican households living in two cities in the Yucatan Peninsula —Merida, Yucatan, and Cancun, Quintana Roo—. These midsize cities have arid tropical climate, and have experienced significant urban expansion in recent decades. As economic growth is occurring in the Peninsula, the states in the Yucatan Peninsula have above-average climate risk compared with Mexico as a whole (Borja-Vega & de la Fuente, 2013). The combination of higher temperatures and an increase in income levels triggers the use of more air conditioning and other electric appliances, resulting in more energy consumption. Given that 86% of the region's population resides in urban areas, and urbanization is expected to continue with economic growth, understanding energy consumption patterns in these households is crucial for designing effective conservation policies (INEGI, 2020a; UNEP, 2015).

Our study finds that social comparison interventions effectively promote energy conservation among middle-income households in the Yucatan Peninsula. Specifically, the intervention led to a 7.9% reduction in electricity consumption. This effect is similar to the 7% impact in India Sudarshan (2017) and to the 9% reduction found in Lithuania Asmare et al. (2021). These results highlight the potential of social nudges as a scalable, low-cost, non-price mechanism for encouraging energy savings, particularly in emerging economies where traditional price incentives may be infeasible.

The observed 7.9% reduction in electricity consumption is significantly larger than the 2.0% reduction documented in similar interventions in the United States Allcott & Mullainathan (2010). One key difference between studies in emerging economies and those in the U.S. is the sample size. While large-scale interventions such as Allcott & Mullainathan (2010) and Costa & Kahn (2013) included 19,928 treated households and nearly 82,000 sampled households, respectively, our study relied on a smaller sample of 769 observations. For comparison, the intervention in India was based on a sample of 452 households (Sudarshan, 2017), and the study in Lithuania included 419 observations

(Asmare et al., 2021). Given resource constraints, our study focused on a more homogeneous sample to enhance internal validity. Additionally, our intervention involved face-to-face household visits, incorporating a personalized element that distinguishes it from the mailed interventions commonly used in the United States. This direct engagement may have strengthened the salience of the social comparison and contributed to the larger effect size observed.

The policy implications of our findings are significant. In 2022, residential electricity consumption accounted for 44% of total electricity use in the Peninsular Region (CONAHCYT, 2022). A 7.9% reduction in residential consumption translates into an estimated 535 GWh annual reduction in electricity demand. In contrast, applying the 2.0% reduction observed in the U.S. (Allcott & Mullainathan, 2010) to the same context would yield a more modest 135 GWh reduction. These estimates highlight the potential for social comparison interventions to drive meaningful energy savings at scale, particularly in regions with high residential electricity demand and limited scope for price-based conservation policies.

This paper contributes to the limited body of research examining the effectiveness of social comparison nudges for energy conservation in emerging economies. Asmare et al. (2021) point out that, when it comes to documenting whether households decrease energy use when presented to social comparisons, available evidence almost exclusively refers to populations of USA and other OECD countries —where households, on average, are richer and consume more electricity. In this respect, this paper relates the closest to Pellerano et al. (2017) and Sudarshan (2017), who have reported how social comparisons decrease energy use of middle-income households in, respectively, Quito, Ecuador, and the National Capital Area of India, respectively. By providing new evidence from Mexico, our findings contribute to a broader understanding of how behavioral interventions can be leveraged to promote energy conservation in emerging economies.

2 Related studies in emerging economies

While existing evidence strongly suggest that social comparisons can promote households' energy-saving investments and conservation behavior, most of this evidence has been gathered in the USA and other OECD countries (Allcott & Rogers, 2014; Allcott & Mullainathan, 2010; Costa & Kahn, 2013). Previous studies covering this evidence include Andor & Fels (2018) —with a focus in the behavioral aspect— and Buckley (2020) —comparing monetary, informational, and behavioral incentives.

Meanwhile, it is agreed that households with rising incomes in emerging economies will most likely be the drivers of residential energy consumption Gertler et al. (2016); Liddle & Huntington (2021). Thus, our literature review focuses on studies documenting evidence gathered in emerging economies, with special attention to middle-income residents.

This paper experimentally tests whether social comparison interventions on middle-income households in Mexico may reduce electricity consumption. It intersects three strands of literature: the first reports the effects of social comparisons, the second reports the effects of experiments aiming to reduce residential energy use, and the third is more specific, focusing on how Mexican public programs have impacted energy consumption.

2.1 Social comparisons

To the best of our knowledge, Pellerano et al. (2017) and Sudarshan (2017) are the only two previous papers reporting how a social comparison can promote energy conservation in emerging economies. Pellerano et al. (2017) conduct a social comparison intervention in Quito, Ecuador, comparing households' consumption to the average consumption. Their focus is on households in the lower middle bracket of electricity consumption (37th to 50th percentiles of consumption in 2013) —i.e. consumption between 100 kWh/month and 125 kWh/month. They document a reduction of 1.3 kWh/month (1.2%) reduction. They also add economic incentives to the social comparison intervention and document that not only economic incentives do not strengthen the effect of the social comparisons but reduce it.

Sudarshan (2017) conducted a social comparison intervention in a complex of 700 apartments in the National Capital Region of India. They compared households' consumption against the average consumption, and also included an incentive of $13 USD that increases or decreases according to consumption. This experiment was conducted in 2012, and the size of the sample treated was 615 households and the control group was 150. Using a Difference in Differences analysis, they find that the monetary incentive yields no effects, but social comparisons results in a 7% decrease in electricity consumption.

2.2 Field experiments

The second strand of literature covered in this paper is slightly more abundant. Experiments of various types have been conducted in emerging economies with the aim of reducing electricity consumption. Most of previous experiments exploring reductions in electric consumption in the residential sector in emerging economies have taken the form of information provision —i.e. information about consumption or information detailing the "block-structure" of the tariff. For instance, Wolak (2015), Ponce de Leon Barido et al. (2018), Asmare et al. (2021), and Kazukauskas et al. (2024) provide real-time information about consumption. Stojanovski et al. (2020) conduct educational workshops where treated households that face block tariff structure are educated on the effects of certain energy-saving behaviors.

Wolak (2015) conducted an experiment using an Intelligent Energy System Pilot in Singapore that provided an in-home display (IHD) with information on each household's real-time electric consumption. They gathered data between July 2010 and February 2013. The treatment was applied in October and November 2012 to a sample of 126 treated households. The analysis used a difference-in-difference estimation, and the result was a 4% reduction, representing 180 kWh per year.

In a Latin American context, Ponce de Leon Barido et al. (2018) conducted an experiment in households and micro-firms in Managua. Similarly to Wolak (2015), they distribute electric sensors that allow residents to know their real-time energy consumption. Unlike Wolak, the sensor was temporarily available while the intervention took place. Their samples include 216 households and 219 microenterprises. They concluded that having a sensor allowed users to calculate with relative accuracy their electric consumption and this information enables them to reduce energy consumption.

In a Mexican context, Stojanovski et al. (2020) uses a 20-minute intervention to inform households of their previous consumption, suggest ways to reduce consumption, and educate them about the block tariff structure. The intervention was conducted in June 2015, and data was collected from

June 2014 to July 2016. The treated sample had 265 observations, the intent to treat was 719, and the control group was 46,593 households in Puebla, Mexico. They used a difference-in-difference model and concluded that households facing higher marginal prices consumed 6.5% less than those on the basic marginal price post-intervention.

Two other experiments make use of policies aimed at the residential energy sector. Davis et al. (2020) use a quasi-experimental strategy followed when building new homes with insulation and other energy efficiency upgrades and compared these houses' energy consumption to that of similar homes with no upgrades. This experiment takes place in Northern Mexico in homes occupied by residents with access to credit markets, which implies that they are middle-income. Davis et al. (2020) conclude that energy efficiency upgrades do not have an impact in electricity consumption mostly because users open their windows in hot days, nullifying the effect of insulation. In Cape Town, South Africa, Jack & Smith (2015) take advantage of a pilot program where 4,000 customers switch to pre-paid metering. Tackling the problem of lack of payment and, thus, lack of investment in the electricity grid, they find that payment increases and consumption per household decreases by 14%.

2.3 Impact evaluation of public programs in Mexico

In recent decades, Mexico has launched a number of programs aiming to increase energy efficiency and decrease energy consumption (CONUEE, 2021). These programs have mostly been conducted under the leadership of the National Commission for the Efficient Use of Energy and have largely taken the form of Norms or minimum standards. These policies have aimed at the industry, the residential sector, the transportation sector, and the Federal Administration. Some of these programs have been evaluated by the literature. Three studies stand out in terms of impact evaluation of Mexican energy efficiency policies: McNeil & Carreño (2015); Martínez-Montejo & Sheinbaum-Pardo (2016); Davis et al. (2014).

McNeil & Carreño (2015) evaluate the impacts of Official Norms and minimum standards that regulate products and systems. They consider previous studies with data since 1994 and update their findings to the 2000-2015 period. Minimum energy performance standards are regarded by some of the best tools to improve energy efficiency Lane (2020). Martínez-Montejo & Sheinbaum-Pardo (2016) evaluate the application of minimum standards in residential appliances in Mexico since 1990 and future scenarios. They find savings close to 16 TWh for the year 2013. Finally, Davis et al. (2014) examines the program to replace old refrigerators and air conditioners with energy-efficient models. They find small consumption reductions and claim that the program is an expensive way to reduce externalities from energy use.

In this paper, we present a social comparison experiment that could serve as a relatively inexpensive public policy, potentially reducing energy consumption in the residential sector of a middle-income country.

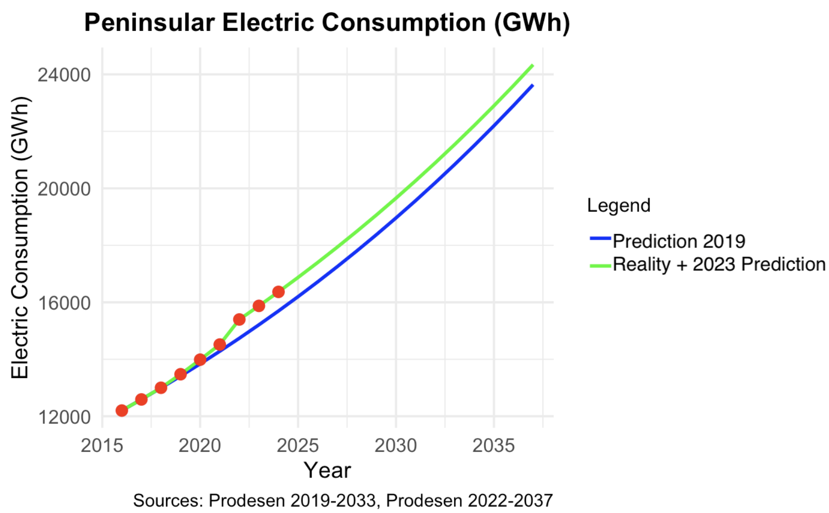
3 Economic growth in the Yucatan Peninsula

The social comparison intervention reported in this study took place in two cities —Merida and Cancun— located in the Yucatan Peninsula, Southeastern Mexico. Two factors converge in these cities: economic growth and increasing temperatures. Both cities are among the fastest-growing cities in the country —from 2010 to 2020, Cancun grew 38%; and Merida grew 20% (INEGI, 2010, 2020a).

During the study's period, the Yucatan Peninsula experienced a steady increase in electricity consumption that outpaced government predictions.

The prediction of electric growth in 2020 was an annual 3.2%; the reality was a national growth of 3.5%. The region with the greatest growth was the Yucatan Peninsula, with a 3.8% growth (CENACE, 2019; SENER, 2023). See figure 1.

Figure 1: Electric consumption growth in the Yucatan Peninsula



According to the official data, the average income in urban Quintana Roo (Cancun) in 2018 was 226,844 pesos (11,350 USD). Our sample, is in the VI decile, with a 163,080 annual income in pesos (8,154 USD). In 2022, the average income in urban Quintana Roo was 287,608 pesos, (14,380 USD). This was a 27% growth in four years (INEGI, 2018, 2020b). The projected trend will outpace predictions since the construction of a new train connecting the main cities in the Maya Peninsula (Maya Train) SENER (2023).

In Yucatan, the average income in urban settings at the time of our survey in 2020 was 213,316 pesos (10,665 USD). Our sample had an average income of 378,950 pesos (18,950 USD). Thus, families in our survey belonged to the IX decile. In 2022, the average income was 249,484 pesos (12,474 USD), which represents a growth of 17% (INEGI, 2020b, 2022). In contrast, the national income level grew 4.6% from 2018 to 2020, and 11% from 2020 to 2022 (INEGI, 2018, 2020b, 2022).

The income growth of the Main Urban Centers in the Yucatan Peninsula: Cancun and Merida, was more than double the growth at the national level from 2018 to 2022. This means that this particular population is subject to greater pressure to increase their energy consumption, and thus, it works as a good simulator for those instances in which the middle class has access to credit and financial stability. Our Cancun sample has a lower income (VI decile) than the Merida sample (IX decile). This allows us to explore the impact of this nudge in the middle-low setting (Cancun) and a higher/middle-class setting (Merida).

The power generation capacity of the Yucatan Peninsula is based on fossil fuels CENACE (2019). The Peninsula depends on Natural Gas and conventional thermal plants CENACE (2019). On the other hand, the Yucatan Peninsula has a very limited transmission capacity that is congested to the point that households are commonly dependent on small, even more polluting generators at home Bracho et al. (2021). Electricity is expensive and unreliable in this area Bracho et al. (2021). Due to weak transmission and volatile pricing, power outages are frequent, and prices are among the highest in the country (Enríquez et al., 2019).

Electric tariffs applicable during the period this study took place were approved by the National Congress on November 30, 2017, (SEGOB, 2017). Table 1 shows the tariffs that residential users faced at the time of our social comparison intervention. However, the bill that households pay also includes other items: a fee for initial capacity, which can vary per household, a fee for the national controlling center (CENACE), which varies each period according to the needs of the center, and a government support fee that also varies per period and per zip code. It can also be the case that the user deposits a payment that is smaller than the full amount of a bill to avoid losing the electric power supply. In this case, the following month includes the unpaid amount and a late fee. If a household consumes more than the average for a whole year, then they are charged a High Consumption Tariff, which at the period of study was $4.3 per kWh in both cities. None of our observations was paying the High Consumption Tariff at the moment of our study.

Table 1: Tariffs that residential users faced at the time of our social comparison intervention

Location	**Visit (months billed)**	**kWh**	**Unit Price**
Cancun	First Visit (June-July 2018)	First 75 kWh	0.793
		Next 100 kWh	0.956
		Rest of kWh	2.802
	Second Visit (Sept-Oct 2018)	First 75 kWh	0.793
		Next 100 kWh	0.956
		Rest of kWh	2.802
Merida	First Visit (Aug-Sep 2020)	First 75 kWh	0.845
		Next 125 kWh	1.020
		Rest of kWh	2.990
	Second Visit (Nov-Dec 2020)	First 75 kWh	0.847
		Next 100 kWh	1.022
		Rest of kWh	2.997

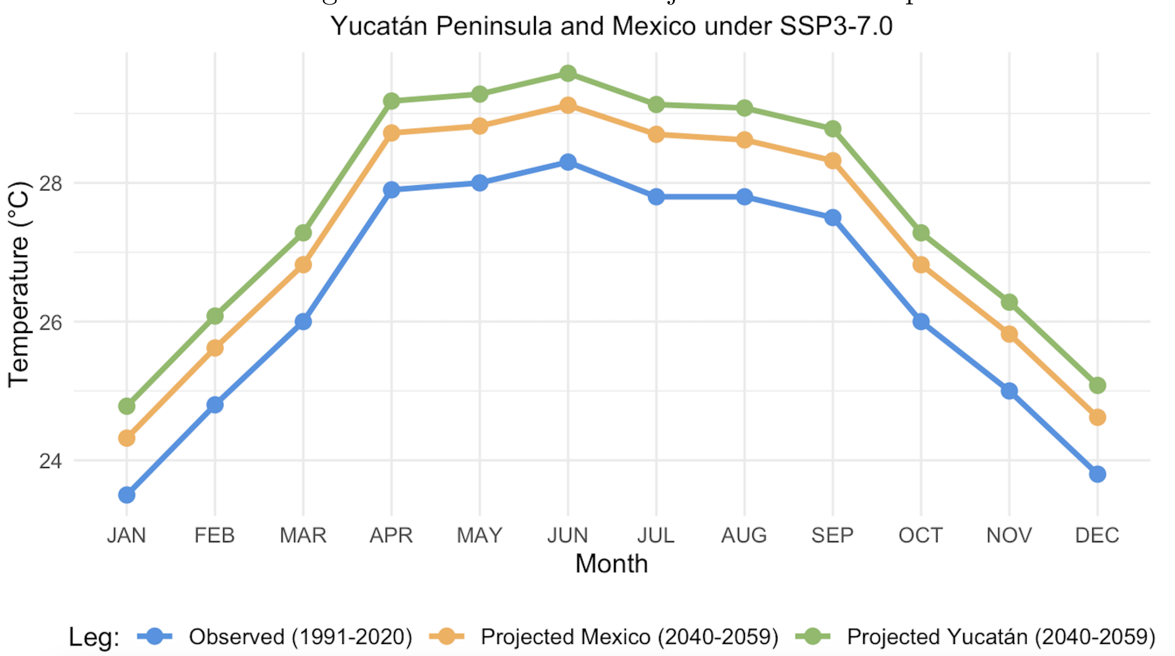
Climate trends in the whole world are increasing. The climate risk scenarios in Mexico are no exception. Under the SSP3-7.0 scenario [1] Mexico's annual mean temperature is projected to increase between 2020-2059 in 0.82°Celsius (0.47°to 1.21°) from the historical reference period (1995-2014) World Bank (2024). According to this projection, on average, Mexico will have more than 20 days per month above 35 degrees Celsius during the summer season.

The climate projection for the Yucatan Peninsula is higher than the average for the rest of the country. It is worth noting that the weather in Merida is Tropical Dry with an observed max of 35.3°C, while Cancun is Tropical Moist with an observed max of 33.2°C. The projection makes an

[1] The Intergovernmental Panel on Climate Change uses SSP3-7 (Socioeconomic Pathways Scenario 3), which is considered a more realistic scenario where warming reaches 3.4-4°by 2100.

average of the Peninsula Region and forecasts a 1.28°increase in temperature in the Peninsula overall. The expected increase is above the national average of 0.82°, but it is not the highest. The greatest increase in the summer months is expected in Coahuila and Zacatecas: a 2.06°C increase by midcentury World Bank (2024). See figure 2

Figure 2: Observed vs. Projected Mean Temperatures



Data from World Bank (2024) using temperatures from Yuc, QRoo and Campeche

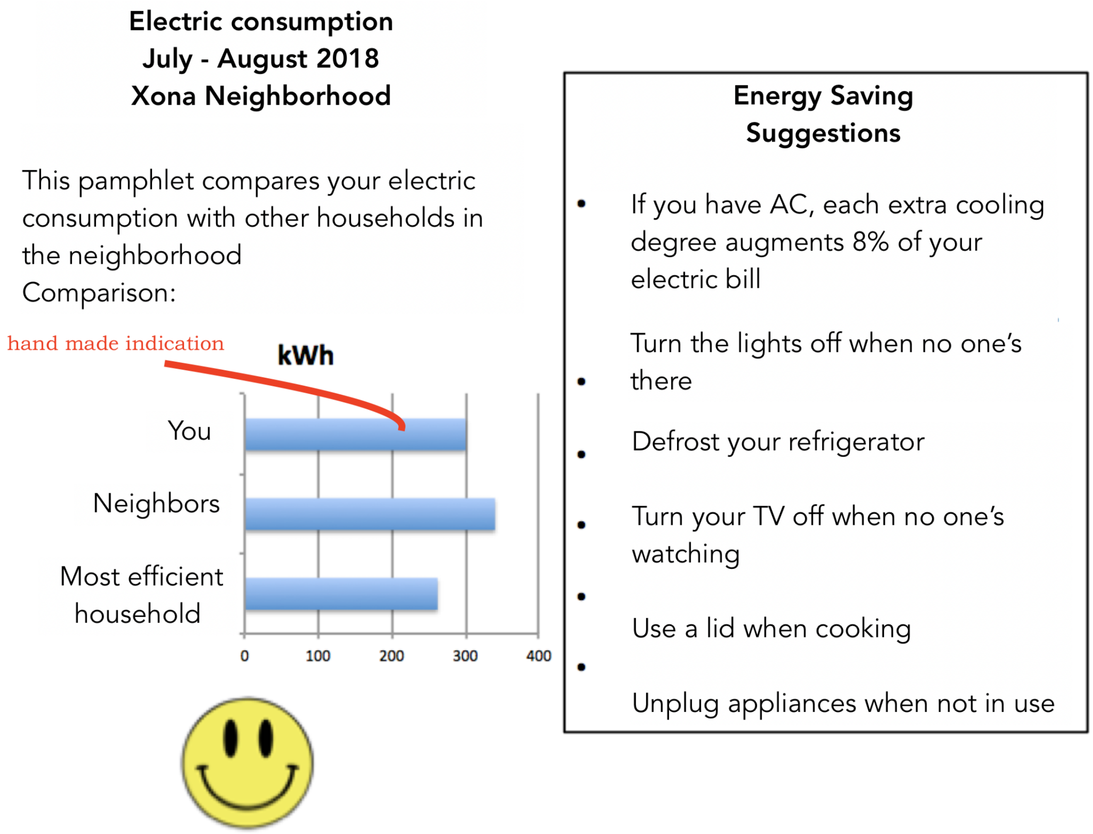
Between 1971 and 2020, Mexico's average mean temperature increased by 0.31per decade World Bank (2024). If we consider the population and climate in the Yucatan Peninsula between 2015 and 2020, we observe that the population grew from 4.5 million to 5.1 million, a 14% increase. Electric consumption went from 12,200 GWh to 13,986 GWh, a 15% increase INEGI (2015, 2020a); Bracho et al. (2021). This shows a clear increasing trend. As climate is expected to continue rising in temperatures, the use of energy is expected to grow as well. Any effort to reduce the increase constitutes a respite for the already frail electric system.

4 Methods and data

4.1 Social Comparison Intervention

The social comparison intervention in this study consisted of randomly presenting participants with a flyer indicating the average electric consumption of participants' neighbors. The first few flyers used the average from the pilot study. If the household had an electric consumption below average, surveyors would hand the flier with a happy face. Otherwise, they would deliver a flyer with a sad face. In both cases, surveyors manually signaled with a marker where the household stands in relationship to neighbors. The flyer also provided a few energy-saving suggestions: to turn off lights and TV when no one's there, defrost the refrigerator, and a claim that said that if they had an AC unit, their bill could go up every degree they lower their temperature. See Figure 3.

Figure 3: Flyer provided to Treated Households



4.2 Data collection

The surveys were conducted face-to-face with adults in each household. The surveying team requested a copy of the electricity bill. For those who did not have the bill at hand, we gathered the numbers (bill and kWh) stated by respondents. About 24% of our sample could not remember the kWh used, but all remembered the amount paid, and we gathered the kWh information using their account number.

The population of interest in this study refers to middle-income households whose heads hold a steady formal job and, thus, have access to the house mortgage market. To find a sample with the least variation in observed and unobserved characteristics, we focused on new middle-income housing developments in the two cities. The advantage of these new developments is that dwellings have the same layout, which implies as little variation as possible in terms of dwelling characteristics. In addition, around half of dwellings in our sample are dwellings with an ecological upgrade, which consists of a 1.5-inch insulation on the dwelling's south, east, and west fronts. This insulation aims to cool the dwelling, with a consequent decrease in the use of air conditioning.

The social comparison intervention in Cancun was conducted from August 10 to 15, 2018, with a second visit between November 3 and 10, 2018. The Merida experiment was conducted on October

10, 2020, with a second visit between January 14 and 22, 2021.

We began with a set of 1,430 houses in Cancun and randomly selected 500 for the study. These were randomly assigned to either the control (250 houses) or the treatment group (250 houses). During data collection, surveyors encountered non-responses and missing households, requiring additional random draws from the sampling frame to ensure that the target sample size was met. This process introduced a practical bias, as households willing to open their doors were more likely to participate in the survey. In Merida, we started with a set of 1,677 houses and initially selected 500 houses at random. The surveying team in Merida, prioritizing the dissemination of energy-saving information, decided to allocate 330 houses to the treatment group and 170 to the control group. After accounting for non-responses and removing outliers, the final sample comprised 382 observations from Cancun (198 control, 184 treated) and 387 observations from Merida (126 control, 261 treated).

4.3 Description and comparison of respondents

Table 2 summarizes the variables used in this study as well as the units of measurement, and table 3 presents the statistical summary for the key variables in the analysis, separately for Cancun and Merida. In order to better understand the characteristics of households in both cities, we present table 3 below and table 7 with a summary of post-treatment variables in the Annex.

The statistics in table 3 illustrate the socioeconomic and energy consumption differences between the two locations prior to treatment. The variables include electricity consumption (kWh), the monthly electric bill (MX pesos), household income (MX pesos), and a range of household characteristics such as eco-friendly features, appliances, and demographics.

Table 2: Variable Descriptions

Code Name	**Description**	**Units**
kwh	Monthly electric consumption	kWh
bill	Monthly electric bill	MXN pesos
ecohouse	Eco-friendly house indicator	1=ecofriendly, 0=otherwise
aircond	Air conditioner units	Count
microwave	Microwave ownership	Count
washer	Washing machine ownership	Count
fans	Fans	Count
cars	Cars owned	Count
rents	Renting indicator	1=rents, 0=otherwise
head_female	Female household head	1=female, 0=otherwise
head_graduate	Household head education	1=graduate, 0=otherwise
children	Has children	1=children, 0=otherwise
people	Household size	Count
income	Declared monthly income	MXN pesos

Electricity consumption is notably higher in Merida, with an average kWh of 383.84 kWh compared to 230.76 kWh in Cancun. This is consistent with the higher usage of appliances in Merida, as shown by the greater average number of air conditioners (1.549 vs. 0.312) and fans (3.046 vs.

1.621). The mean electric bill in Merida is also substantially higher at $675.92 compared to $312.97 in Cancun. The greater income and energy consumption in Merida is evident in Figure 5, in the Annex.

Income disparities are evident, with households in Merida reporting a mean monthly income of $31,579.90, more than double the average income of $13,590.86 in Cancun. Surveyors claim that households tend to understate their real income due to security concerns, in which case we use the stated income as a proxy. This income gap is reflected in other indicators of socio-economic status, such as car ownership (0.49 vs. 0.0.97) and the proportion of household heads with graduate-level education (45.6% vs. 5.2%).

The proportion of eco-friendly houses is similar between the two cities (51.7% in Cancun and 50.8% in Merida). However, the composition of the household differs slightly, with Cancun having a larger average household size (4.105 people) than Merida (3.581 people).

Table 3: Pre-treatment Summary Statistics by City

	Cancun				**Merida**			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
kwh	230.76	57.81	120	596	383.84	142.50	147	1286
bill	312.97	161.04	107	1334	675.92	307.38	140	2404
income	13590.86	11386.08	1000	75000	31579.90	15315.23	2000	51000
ecohouse	0.517	0.500	0	1	0.508	0.501	0	1
aircond	0.312	0.512	0	2	1.549	0.768	1	4
microwave	0.301	0.459	0	1	0.657	0.475	0	1
washer	0.710	0.454	0	1	0.817	0.387	0	1
fans	1.621	0.946	0	4	3.046	1.561	1	9
rents	0.290	0.454	0	1	0.178	0.383	0	1
cars	0.097	0.305	0	2	0.497	0.568	0	3
head_female	0.457	0.499	0	1	0.374	0.484	0	1
head_graduate	0.052	0.223	0	1	0.456	0.499	0	1
children	0.726	0.447	0	1	0.606	0.489	0	1
people	4.105	1.423	1	9	3.581	1.441	1	9
Observations	382				387			

Table 10, in the appendix, is the statistical summary of the post-treatment period, providing a comparative overview of Cancun and Merida. Similarly to the pretreatment data, the statistics reveal persistent differences between the two locations, though some notable shifts in electric consumption.

Electricity consumption (kWh) decreased in Merida compared to the pre-treatment average, dropping from 383.84 to 353.10 kWh. In contrast, Cancun experienced a slight increase from 230.76 to 234.65 kWh.

These changes in consumption coincide with shifts in electric bills for both locations. In Merida, the bill shifted from $675.92 to $628.24, while in Cancun, the bill increased from $312.9 to $324.66.

Income levels show no significant variation post-treatment, with average monthly incomes in Cancun ($13,561) and Merida ($31,571) remaining virtually unchanged. Likewise, the distribution of other socio-economic indicators, such as car ownership (0.097 in Cancun and 0.499 in Merida) and educational attainment of household heads (5.2% graduate in Cancun and 45.7% in Merida), mirrors pre-treatment statistics. These stable socio-economic and household characteristics provide a robust foundation for the difference-in-differences analysis. The observed changes in electricity consumption and bills suggest potential impacts of the treatment, which are further explored in the results section.

4.4 Outcome Variables in baseline

Tables 4 and 5 show the results of a comparison between treated and control groups in Cancun first, and then in Merida.

Table 4: Control vs. Treated in Outcome Variable in Cancun

Variable	Group	Obs	Mean	Std. Dev.	Difference	p-value
kWh (Pre)	Control	198	237.30	68.28	13.71	0.0186
	Treated	184	223.76	43.03		
kWh (Post)	Control	198	253.84	81.31	39.85	0.0000
	Treated	184	213.98	38.36		
Bill (Pre)	Control	198	330.67	191.22	37.11	0.0222
	Treated	184	293.55	118.31		
Bill (Post)	Control	198	377.86	226.37	110.45	0.0000
	Treated	184	267.40	104.14		

Table 4 presents t-test results comparing electricity consumption (kWh) and electric bills ($) between the control and treated groups in Cancun, both before and after the treatment. The results reveal differences between the groups even in the pre-treatment phase.

Before the treatment, the control group consumed slightly more electricity than the treated group, with an average difference of 13.71 kWh (p=0.0186). Although statistically significant, this difference is modest. However, after treatment, the gap widened substantially, with the control group consuming 39.85 kWh more on average than the treated group (p=0.000). This pronounced divergence suggests that treatment effectively encouraged energy conservation among treated households relative to controls.

The electric bills followed a similar pattern. Pre-treatment, the control group's bills were, on average, $37.11 higher than those of the treated group (p=0.0222). Post-treatment, the difference increased dramatically to $110.45 (p=0.000), reflecting a reduced consumption among treated households. Here, it's pertinent to recall that the electric tariffs did not change between the two periods in Cancun, and the second period involved slightly cooler weather.

In Merida, the comparison paints a more nuanced picture. Table 5 shows that, unlike in Cancun, the differences in kWh consumption between control and treated groups were not statistically significant in the pre-treatment period (p=0.1998). In other words, both groups had similar electric consumption before the treatment. The post-treatment difference of 54.33 kWh is significant

Table 5: Control vs. Treated in Outcome Variable in Merida

Variable	Group	Obs	Mean	Std. Dev.	Difference	p-value
kWh (Pre)	Control	126	395.91	112.48	17.88	0.1998
	Treated	261	378.03	154.74		
kWh (Post)	Control	126	389.74	132.04	54.33	0.0002
	Treated	261	335.40	127.93		
Bill (Pre)	Control	126	714.71	238.86	57.52	0.0535
	Treated	261	657.19	334.31		
Bill (Post)	Control	126	714.19	263.54	127.44	0.0000
	Treated	261	586.75	278.23		

(p=0.0002).

The comparison in electric bill, however, do reveal slightly significant differences in the pre-treatment period. Before the treatment, the control group's bills were $57.52 higher on average than those of the treated group (p=0.0535). Post-treatment, the difference increased substantially to $127.44, and this time it is highly significant (p=0.0000).

This suggests that, even though there are no differences in consumption, there are small differences in the amount paid between control and treated groups. Anyhow, the treatment delivers measurable financial benefits for treated households, potentially through behavioral changes or adjustments in energy usage patterns.

Overall, the comparisons for Merida contrast with those observed in Cancun. While the intervention reduced consumption and bills in Cancun, its impact in Merida appears to have been more pronounced financially than in physical electricity usage. These differences may reflect contextual factors, such as the variation in baseline consumption (higher in Merida), the increase in tariffs that Merida experienced in the second period, and other household responses warranting further investigation.

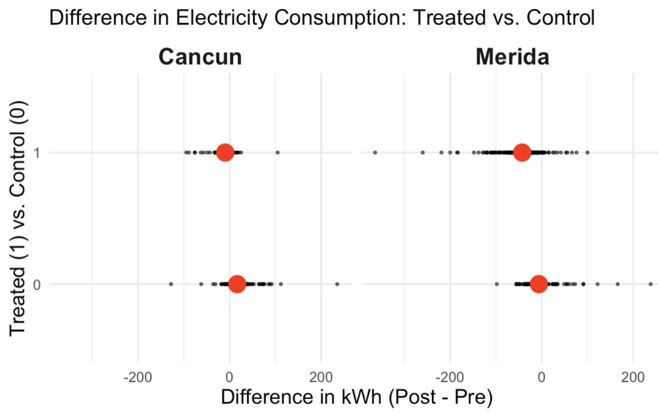
5 Findings

Figure 4 graphically represents the difference in electricity consumption (kWh) before and after treatment by the treated and control groups in each city. In our sample, the treated group consumed less electricity than the control group in both cities.

Table 6 presents the DiD analysis results examining the treatment's effect on monthly electric bills in Merida and Cancun. Three model specifications are reported for each city, with increasing inclusion of covariates to control for household characteristics and demographic factors.

In Merida, the coefficient of the interactive term *"postXtreated"* is negative and statistically significant across all model specifications, indicating less money being spent on electricity after the interventions. The average impact is -69 pesos, about 3.50 USD less dollars paid in electric bills due to treatment. Considering an initial average consumption of $676 pesos, this intervention results in a 10.3% reduction in money spent on electric energy. The impact of the intervention in kWh usage is 36 kWh. Considering that the initial average use was 384 kWh, this reflects a 9.4% reduction in

Figure 4: Comparison Control and Treated



kWh in Merida.

Air conditioning ownership (+210, p< 0.01) and the number of household members (+60.21, p< 0.01) are associated with significant increases in electric bills, while households with graduate-level heads tend to spend less on electricity (-85.5, p< 0.01). These findings highlight the influence of household composition and appliance use on energy expenditure. Income also has a positive and significant impact on the electric bill.

In Cancun, the interaction term *postXtreated* also exhibits a statistically significant negative effect across all models, with a consistent estimate of -73.34, about $3.6 USD. The effect strengthens as additional covariates are included. In the pre-treatment stage, households spent $313 pesos in electricity; therefore, $73 pesos represents a 23% reduction in money spent on electricity. The impact on kWh usage is -26.1 kWh, which represents an 11. 3% decrease in electricity usage in Cancun.

Covariates such as air conditioning ownership (+239.1, $p < 0.01$) and income (0.006, $p < 0.01$) play significant roles in explaining variations in electric bills, while eco-friendly housing and washer ownership show no statistically significant effects. Interestingly, the number of household members does not have a significant impact in Cancun, contrasting with the results for Merida.

These findings demonstrate that the treatment effectively reduced the amount of electricity used in both cities. 26.1 kWh, which represents an 11.3% reduction in Cancun, and 36.1 kWh, which represents a 9.4% reduction in Merida. These results underscore the potential of targeted interventions to reduce electricity use.

Table 7 presents the DiD results for kWh consumption in both cities, with three model specifications for each. These results provide insights into the treatment impact on electricity usage and allow for comparisons with the findings for electric bills, table 6.

The interaction term *"postXtreated"* is negative across all models for Merida, indicating a reduction in electric consumption among treated households. While this effect is not statistically significant in models 1 and 2, it becomes statistically significant in model 3. The treatment's impact on energy consumption is less pronounced than its effects on reducing bills, as seen in table 6. People clearly react by making an effort to reduce the amount paid for electricity, even more than their consumption.

Table 6: Difference-in-Differences Results for Bill by City

Variable	Merida			Cancun		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
(Intercept)	714.7***	513.6***	251.9**	330.7***	246.2***	170.1***
	(21.25)	(30.67)	(41.97)	(24.33)	(27.28)	(9.19)
post	-0.51	-0.51	-1.62	47.20*	47.20***	47.20***
	(31.64)	(30.87)	(27.97)	(2.24)	(3.73)	(4.39)
treated	-57.52*	-83.31**	-40.42**	-37.11*	-26.54*	-15.34
	(29.67)	(27.51)	(23.74)	(-2.30)	(-2.36)	(-1.56)
post×treated	-69.9*	-69.9**	-68.3**	-73.34**	-73.34***	-73.34***
	(41.55)	(39.17)	(33.43)	(-3.05)	(-4.32)	(-4.92)
aircond		150.5***	69.9***		239.1***	166.7***
		(15.74)	(12.45)		(15.48)	(9.00)
ecohouse		-28.4	-18.11		9.423	4.597
		(18.64)	(15.03)		(1.09)	(0.58)
washer			-30.45			-4.669
			(19.76)			(-0.64)
fans			-12.04*			0.232
			(6.10)			(0.06)
cars			139.6***			-25.87
			(17.54)			(-1.43)
income			0.0076***			0.00627***
			(.0060)			(6.10)
graduate			-67.71***			-15.65
			(16.58)			(-1.14)
people			45.03***			3.769
			(6.47)			(1.45)
Observations	774	774	774	764	764	764
R-squared	0.0313	0.1909	0.4842	0.0618	0.5464	0.6512
F-statistic	9.98	26.60	36.73	16.76	72.47	44.11
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The role of covariates mirrors the results for bills. Air conditioning ownership (+70.2, p¡0.01) and household size (+20.17, p¡ 0.01) significantly increase kWh consumption, while having a graduate household head is associated with reduced usage (-28.52, p ¡0.01).

Table 7: Difference-in-Differences Results for kWh by City

Variable	Merida			Cancun		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
(Intercept)	395.9***	303.1***	192.3***	237.3***	207.0***	180.0***
	(39.56)	(20.74)	(9.34)	(48.90)	(64.07)	(26.69)
post	-6.175	-6.175	-6.671	16.55*	16.55***	16.55***
	(-0.40)	(-0.41)	(-0.48)	(2.19)	(3.63)	(4.27)
treated	-17.82	-29.92*	-11.62	-13.71*	-9.929*	-6.061
	(-1.29)	(-2.34)	(-1.01)	(-2.36)	(-2.46)	(-1.71)
post×treated	-36.51	-36.51	-35.77*	-26.14**	-26.14***	-26.14***
	(-1.84)	(-1.95)	(-2.17)	(-3.02)	(-4.25)	(-4.84)
aircond		70.21***	35.52***		85.62***	59.75***
		(9.02)	(5.53)		(15.49)	(8.98)
ecohouse		-15.07	-10.88		3.473	1.680
		(-1.73)	(-1.50)		(1.11)	(0.58)
washer			-14.72			-2.203
			(-1.51)			(-0.83)
fans			-4.954			0.261
			(-1.64)			(0.18)
cars			62.56***			-9.332
			(7.22)			(-1.44)
income			0.00314***			0.00225***
			(10.98)			(6.12)
graduate			-28.52***			-5.518
			(-3.43)			(-1.12)
people			20.17***			1.267
			(6.38)			(1.28)
Observations	774	774	774	764	764	764
R-squared	0.021	0.1748	0.4368	0.0571	0.5402	0.6465
F-statistic	6.47	23.17	32.43	15.46	56.49	47.28
p-value	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000

5.1 Pooled Data

Tables 8 and 9 provide a comprehensive evaluation of the treatment's impact on electricity bills and kWh consumption across Cancun and Merida. Both models reveal critical insights into behavioral responses to the treatment and the broader socioeconomic and geographic context.

First, table 8 examines the determinants of household electric bills, focusing on treatment effects while accounting for the interaction between city (Merida vs. Cancun), treatment assignment, and the post-treatment period. The analysis is presented across three specifications, progressively incorporating additional variables to control for household characteristics.

The interaction term *postXtreated* consistently exhibits a negative and highly significant coefficient across all specifications ($\beta = -73.34$, p<0.001). This result indicated that treated households experienced a substantial reduction in electricity bills post-treatment compared to untreated households. This effect remains robust even after accounting for household characteristics such as appliance ownership, income, and household composition. This coefficient's persistent significance underscores the treatment's effectiveness in reducing household electricity expenditure, irrespective of city-specific dynamics. As expected, the baseline Merida indicator shows substantial differences in electricity bills between Merida and Cancun. The significant coefficient on Merida ($\beta = 384.04$, p<0.001 in Model 1) highlights that baseline electricity expenditure is markedly higher in Merida, even after controlling for observable characteristics.

The inclusion of appliance ownership and household composition variables in Model 3 sheds light on how these factors influence electricity expenditure. For instance, the number of air conditioning units is a strong predictor of higher electric bills ($\beta = 166.70$, p¡0.001), with an attenuating effect in Merida (Merida x ACunits = -60.25, p<0.05). This suggests that while AC usage drives bills higher universally, households in Merida may adopt behavioral adjustments to mitigate the costs associated with higher AC usage. It is also the case that one-third of houses in Cancun own an AC unit, while in Merida, each household has 1.5 units on average. Once a house owns one AC unit, the extra units might have lower usage, a case of increasing returns to scale from the investment on the second (and further AC units), which only happens in more affluent Merida homes.

Other significant interactions include *merida X cars* ($\beta = 213.25$, p<0.001) and *merida x household size* ($\beta = 56.44$, p<0.001), reflecting the nuanced role of socio-demographic and geographic factors. These findings suggest that larger households and car ownership have a positive implication for electric expenditures in Merida, possibly due to the higher income level that leads to differences in energy usage patterns.

Table 9 shows that the interaction term *post X treated* is negative and statistically significant across all specifications ($\beta = -26.14$, p¡0.001). This mirrors the results for electric bills, confirming that the treatment effectively reduced electricity consumption in treated households during the post-treatment period.

The estimated reduction of 26 kWh suggests that the intervention achieved tangible reductions in electricity use, aligning well with the observed reduction in monetary expenditures. This dual impact underscores the efficacy of the treatment in fostering a more energy-efficient behavior among treated households.

Baseline consumption in Merida is significantly higher than in Cancun ($\beta = 158.62$, p¡0.001 and $\beta = 84.31$, p¡0.001 respectively in models 1 and 2). However, this difference is not statistically significant in Model 3 ($\beta = 12.34$, p¿0.10) after controlling for household characteristics and appliance use.

Ownership of AC units is again a dominant factor, with a strong positive association with electricity consumption ($\beta = 85.25$, p¡0.001 in model 2). However, the interaction term *merida x AC units* is significant and negative in model 3 ($Beta = -24.23$, p¡0.05), implying that Merida households with AC units may use them more judiciously or have greater access to energy-efficient technologies.

Income also emerges as a significant driver of electricity consumption, albeit with a small size

Table 8: Effect in Bill

	(1) Bill	(2) Bill	(3) Bill
merida=1	384.04***	243.69***	81.87*
	(25.22)	(30.60)	(45.88)
1 if post=1	47.196**	47.196***	47.196***
	(21.061)	(12.674)	(10.743)
merida × post	-47.710	-47.710	-48.818
	(38.011)	(33.436)	(29.964)
treated=1	-37.112**	-26.329**	-15.343*
	(16.154)	(11.231)	(9.836)
merida × treated	-20.409	-56.433**	-25.083
	(33.784)	(29.763)	(25.706)
post × treated	-73.343**	-73.343***	-73.34***
	(24.061)	(16.980)	(14.909)
merida × post × treated	3.422	3.422	5.065
	(48.021)	(42.744)	(36.611)
AC units		238.094***	166.704***
		(15.283)	(18.526)
merida × AC units			-96.828***
			(22.323)
ecohouse=1			4.596
			(7.987)
merida × ecohouse			-22.707
			(17.030)
income			0.006***
			(0.001)
merida × income			0.001
			(0.001)
microwaves			-8.017
			(10.217)
merida × microwaves			-5.527
			(19.761)
washers			-4.668
			(7.325)
merida × washers			-25.785
			(21.077)
fans			0.232
			(3.891)
merida × fans			-12.273*
			(7.238)
rents=1			5.078
			(8.814)
merida × rents			-0.553
			(20.802)
cars			-25.874
			(18.134)
merida × cars			165.497***
			(25.238)
head female=1			13.783
			(7.383)
merida × head female=1			-17.246
			(16.666)
head graduate=1			-15.647
			(13.777)
merida × head graduate=1			-52.059**
			(21.566)
children=1			-5.190
			(8.492)
merida × children=1			-22.461
			(19.300)
household size			3.768
			(2.606)
merida × household size			41.265***
			(6.976)
Constant	330.667***	251.302***	170.075***
	(13.591)	(7.638)	(18.511)
N	1538	1538	1538
r2	0.347	0.511	0.680

Standard errors in parentheses
Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

(β = 0.002, p¡0.001). The *merida x income* interaction is positive (β = 0.001, p¡0.10), reflecting slightly higher income elasticity of electricity demand in Merida. The size of the coefficient might be due to the tendency to underreport the true income level.

6 Conclusions and discussion

The analysis conducted leads to four clear conclusions. First, The treatment is effective. Social comparison does reflect a reduction in electricity usage and expenditure post-treatment. This means that scaling up the intervention or expanding a similar program in other regions could significantly contribute to reducing electricity demand. Similarly to the intervention in Puebla Stojanovski et al. (2020), we find that the nudge reduces electric consumption. Our result is an 11.3% decrease in kWh usage in Cancun and a 9.4% decrease in Merida, almost the same size as the response in Lituania (9%)by the experiment conducted by Asmare et al. (2021).

Second, significant coefficients for household characteristics such as AC units, cars, and household size highlight the role of energy-efficient technologies and practices during demand. Policies that incentivize energy-efficient technologies and encourage smaller energy footprints at the household level can yield substantial benefits. This complements the findings in Martínez-Montejo & Sheinbaum-Pardo (2016) supporting the idea that efficiency standards in appliances reduce energy consumption and emissions.

Third, the differences in behavior between Merida and Cancun suggest that a one-size-fits-all policy may not be optimal. Policymakers should account for regional variations in electricity usage patterns and design specific interventions. It might be the case that the higher income level in Merida, drives this difference, which leads to the fourth implication.

Fourth, the significant interaction *merida X income* highlights the importance of socioeconomic factors in shaping electricity consumption. Policymakers should address socioeconomic disparities in energy consumption by designing programs that encourage conservation without disproportionately affecting low-income households. It is expected that those who use little electricity might be covering basic needs and, therefore, are more inelastic to changes in prices. On the other hand, those who have higher incomes are more elastic both income elastic and price elastic. This means that the block tariff structure can be used as a tool to encourage conservation while supporting lower-income families.

Unlike Stojanovski et al. (2020), the more educated participants in Merida were more reactive to the nudge ($-23KWh$). In their study, those without post-secondary education consumed 5.7% less than their more educated counterparts. Our result is consistent with the theory that the more educated have more information to be energy efficient (Zafar et al., 2020).

One of the main limitations of this study is that we don't know if the effect is persistent over time. From Allcott & Rogers (2014) and Ferraro et al. (2011), we learn that the treatment effect decreases, or it can become insignificant over time (Dolan & Metcalfe, 2013). The time difference between the first and the second visit did not capture an increase (or decrease) in appliances. There could be a rebound effect in the long term that we cannot possibly predict with our data.

Table 9: Effect in kWh

	(1) kWh	(2) kWh	(3) kWh
merida=1	158.615***	84.308***	12.341
	(11.121)	(14.465)	(21.662)
1 if post=1	16.545**	16.545***	16.545***
	(7.546)	(4.556)	(3.875)
Merida × post	-22.720	-22.720	-23.217
	(17.177)	(15.723)	(14.438)
treated=1	-13.711**	-9.850**	-6.061*
	(5.800)	(4.043)	(3.548)
Merida × treated	-4.114	-19.775	-5.561
	(15.033)	(13.457)	(12.090)
post × treated	-26.143**	-26.143***	-26.143***
	(8.663)	(6.146)	(5.407)
Merida × post × treated	-10.364	-10.364	-9.628
	(21.642)	(19.706)	(17.351)
AC units		85.248***	59.752***
		(5.470)	(6.653)
merida × AC units		-13.739	-24.232**
		(9.631)	(9.245)
ecohouse=1			1.680
			(2.877)
merida × ecohouse			-12.563
			(7.807)
income			0.002***
			(0.000)
merida × income			0.001*
			(0.000)
microwaves			-2.836
			(3.691)
merida × microwaves			-2.992
			(8.805)
washers			-2.203
			(2.650)
merida × washers			-12.512
			(10.121)
fans			0.261
			(1.426)
merida × fans			-5.215
			(3.346)
rents=1			2.248
			(3.176)
merida × rents			-2.926
			(9.306)
cars			-9.332
			(6.500)
merida × cars			71.897***
			(10.835)
head female=1			4.243
			(2.697)
merida × head female=1			-8.967
			(7.656)
head graduate=1			-5.518
			(4.912)
merida × head graduate=1			-22.997**
			(9.661)
children=1			-1.392
			(3.160)
merida × children=1			-9.874
			(9.015)
household size			1.267
			(0.986)
merida × household size			18.899***
			(3.310)
Constant	237.298***	208.882***	179.966***
	(4.853)	(2.730)	(6.743)
N	1538	1538	1538
r2	0.311	0.462	0.626

Standard errors in parentheses
Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

A second important limitation is the size of our samples. We can suggest that future studies should try to conduct large-scale studies in emerging economics. However, the reticence of government officials to collaborate in Academic Research has grown as populist leaders have risen. Populist governments have incentives to withhold or misreport data due to their anti-elite, pro-state sovereignty views(Carnegie et al., 2024). Still, emerging economies keep growing, and the impact on climate change will be felt strongly. Research that advances understanding of the behavior of the middle class and the policies or mechanisms to ameliorate negative consequences of economic growth into energy consumption is needed.

The nature of our intervention: A flyer comparing the neighbor's energy consumption to the neighbor's is easy to conduct in settings with low internet penetration or no access to smart meters. The strong social network in Mexico and other emerging economies could serve as an opportunity to use this cultural advantage to promote energy-saving behaviors.

The setting of this study represents a limitation for the analysis but an opportunity in terms of public policy. This experiment takes place in a peculiar environment. The setting is a literally closed neighborhood with families that share many characteristics: similar income levels, similar ages, similar types of jobs, and similar household composition. It's easy to imagine that the closeness of the community enhances the effect of a social comparison (Burchell et al., 2016). That might be one of the reasons for the higher than usual response: 11% versus the 6% in Stojanovski et al. (2020), or the 4% in Allcott & Mullainathan (2010). In terms of policy-making, the influence of social comparisons may have a multiplicative effect in closed-knit communities.

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Tables and figures

7 Annex

Figure 5 below shows the differences between Cancun and Merida prior to the treatment.

Figure 5: Comparison Cancun-Merida

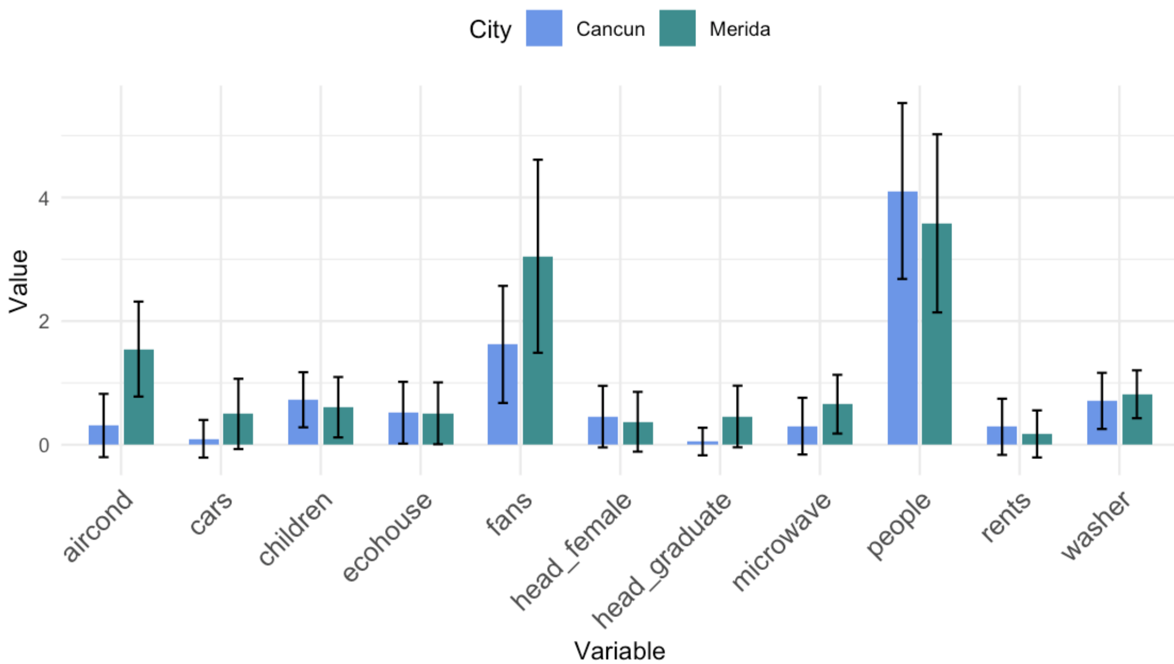

Table 10 below presents the summary statistics of the main variables after the treatment.

Tables 11 and 12 present Balance Tests PRE and POST treatment. There are two significant variables in Merida(90% significance level): the use of AC in Merida is 0.2 more likely for the treated group, and the income level is \$200 per year higher in the control group. In Cancun there is only one slightly difference between the groups: the education level is .037 higher in the control group.

The balance tests, below, should go to the Annex.

Table 10: Post-treatment Summary Statistics by City

	Cancun				Merida			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
kwh	234.65	67.27	90	681	353.10	131.73	147	960
bill	324.66	186.49	80	1572	628.24	279.66	140	1795
income	13560.99	11385.98	1000	75000	31571.06	15334.07	2000	51000
ecohouse	0.518	0.500	0	1	0.509	0.501	0	1
aircond	0.312	0.512	0	2	1.548	0.768	1	4
microwave	0.301	0.459	0	1	0.656	0.476	0	1
washer	0.709	0.455	0	1	0.817	0.388	0	1
fans	1.623	0.947	0	4	3.049	1.562	1	9
rents	0.291	0.455	0	1	0.176	0.381	0	1
cars	0.097	0.305	0	2	0.499	0.568	0	3
head_female	0.455	0.499	0	1	0.372	0.484	0	1
head_graduate	0.052	0.223	0	1	0.457	0.499	0	1
children	0.728	0.446	0	1	0.607	0.489	0	1
people	4.105	1.423	1	9	3.581	1.442	1	9
Observations	382				387			

Table 11: Balance Tests PRE-TREATMENT

	Merida			Cancun		
Variable	Treated	Control	p-value	Treated	Control	p-value
Dwelling Characteristics						
Ecohouse	0.4981	0.5362	0.5132	0.5326	0.5051	0.5913
	(0.5009)	(0.5010)		(0.5005)	(0.5012)	
Air Conditioning	1.6015	1.4365	0.0340	0.2880	0.3333	0.3863
	(0.8099)	(0.6633)		(0.4775)	(0.5426)	
Washer	0.8084	0.8333	0.5472	0.6865	0.7323	0.3086
	(0.3942)	(0.3742)		(0.4652)	(0.4438)	
Fans	2.9733	3.1984	0.1973	1.6902	1.5606	0.1826
	(1.5423)	(1.5951)		(0.9732)	(0.9201)	
Cars	0.4771	0.5397	0.3074	0.1135	0.0808	0.2956
	(0.5719)	(0.5607)		(0.3181)	(0.2912)	
Respondent and Household Characteristics						
People	3.60	3.55	0.7528	4.07	4.13	0.6520
	(1.42)	(1.48)		(1.38)	(1.46)	
Female	0.40	0.33	0.2692	0.41	0.49	0.1086
	(0.49)	(0.47)		(0.49)	(0.50)	
Graduate	0.45	0.48	0.6075	0.033	0.07	0.0900
	(0.50)	(0.50)		(0.18)	(0.26)	
Cars	0.48	0.54	0.3221	0.11	0.08	0.2880
	(0.57)	(0.56)		(0.32)	(0.29)	
Income	30309	34184	0.0157	12520	14527	0.0834
	(15747)	(14143)		(10400)	(12178)	
Observations	261	126		184	198	

Table 12: Balance Tests POST-TREATMENT

	Merida			Cancun		
Variable	Treated	Control	p-value	Treated	Control	p-value
Dwelling Characteristics						
Ecohouse	0.4981	0.5362	0.5132	0.5326	0.5051	0.5913
	(0.5009)	(0.5010)		(0.5005)	(0.5012)	
Air Conditioning	1.6015	1.4365	0.0340	0.2880	0.3333	0.3863
	(0.8099)	(0.6633)		(0.4775)	(0.5426)	
Washer	0.8084	0.8333	0.5472	0.6865	0.7323	0.3086
	(0.3942)	(0.3742)		(0.4652)	(0.4438)	
Fans	2.9733	3.1984	0.1973	1.6902	1.5606	0.1826
	(1.5423)	(1.5951)		(0.9732)	(0.9201)	
Respondent and Household Characteristics						
People	3.60	3.55	0.7528	4.07	4.13	0.6520
	(1.42)	(1.48)		(1.38)	(1.46)	
Female	0.40	0.33	0.2692	0.41	0.49	0.1086
	(0.49)	(0.47)		(0.49)	(0.50)	
Graduate	0.45	0.48	0.6075	0.033	0.07	0.0900
	(0.50)	(0.50)		(0.18)	(0.26)	
Cars	0.48	0.54	0.3221	0.11	0.08	0.2880
	(0.57)	(0.56)		(0.32)	(0.29)	
Income	30309	34184	0.0157	12520	14527	0.0834
	(15747)	(14143)		(10400)	(12178)	
Observations	261	126		184	198	

Table 13: Studies exploring social comparison to reduce residential energy consumption in emerging economies

Study	**Location**	**Motivation**	**Intervention Design**	**Comparison (Method)**[b]	**N**	**Outcome KWH (%)**
			Studies exploring social comparison to reduce energy consumption			
Pellerano et al. (2017)	Quito, Ecuador	This study explores the interaction between extrinsic financial incentives and intrinsic motivations. The findings reveal that combining financial rewards with normative messages does not enhance the effectiveness of the messages and may even weaken their impact.	1)social comparison with a message in the bill 2) social comparison + lower price if consumption is reduced	Diff-n-Diff, FE model	treatment 1: 9,359, treatment 2: 9,359, control: 9,425	group1: −1.36kWh, group 2:not significant
Sudarshan (2017)	National Capital Region, India	This study examines how behavioral interventions and price changes affect electricity use in India. Using a randomized trial and quasi-experiment, it finds that households receiving weekly peer comparison reports reduced summer electricity consumption by 7%	1) were compared with average households plus feedback on energy saving tips, 2) Same as 1 + a 13 USD reward that could increase or decrease according to consumption, 3) control.	FE Model	treatment 1: 119, treatment 2: 233, control: 1213.	group1: −3530 kWh or -7%, group 2: not significant
			Field Experiments			
Wolak (2015)	Singapore	In this study, some households received in-home display (IHD) units showing real-time electricity use.	1) The intervention is an in-home display unit	OLS, FE	1147 control, 126 treated	-4%, 180kWh

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Table 13: Studies exploring social comparison to reduce residential energy consumption in emerging economies

Study	Location	Motivation	Intervention Design	Comparison (Method)[b]	N	Outcome KWH (%)
Ponce de Leon Barido et al. (2018)	Managua, Nicaragua	This study is a randomized pilot in Latin America (Managua, Nicaragua) combining behavioral energy efficiency strategies with flexible demand using distributed sensor networks. Homes and microenterprises reduced energy consumption by 9%, with over 80% engagement	1) The intervention is a sensor configured to collect energy consumption and the possibility to unplug some appliances + monthly reports of energy information, 2) Control group	Bayesian inference-Monte Carlo simulations.	n.a.	-9%
Stojanovski et al. (2020)	Puebla, Mexico	This experiment educated households on how their electricity use impacted bills. A small individual workshop significantly reduced consumption, especially among those paying the highest rates and less-educated households.	1) The intervention is a 20-minute mini-workshop 2) Control group	Bayesian inference-Monte Carlo simulations.	208 treated, 32,228 control	-1.7%
Asmare et al. (2021)	Lithuania	This study examines how the provision of electricity information impacts energy use in Lithuania, a less wealthy OECD country. A randomized experiment shows that access to hourly electricity data reduces electric consumption. The reduction is the strongest among high-energy users, rural residents, and those in detached homes.	1) Descriptive feedback of energy use, 2) Control group	Diff-n-Diff, FE model	treatment: 419, control: 632	-9% -241 kWh

Continued on next page

Table 13: Studies exploring social comparison to reduce residential energy consumption in emerging economies

Study	Location	Motivation	Intervention Design	Comparison (Method)[b]	N	Outcome KWH (%)
Davis et al. (2020)	Northeast Mexico	This study evaluates a field trial in Mexico where new homes received insulation and energy-efficient upgrades. Using high-frequency temperature and humidity data, the study found no significant impact on electricity use or thermal comfort compared to non-upgraded homes because people open their windows.	1) The intervention is an ecological upgrade of thermal insulation in some homes, 2) Control group	t-tests, OLS, FE	388 treated	no significant effect
Jack & Smith (2015)	Cape Town, South Africa	This study examines the impact of switching from monthly billing to prepaid electricity meters. The greatest net revenue gains came from switching poorer and more indebted customers.	1) switch to prepaid meters in phases	t-tests, OLS, FE	4175 households treated	-1.9 kWh/day, -14%
Kazukauskas et al. (2024)	Lithuania	This study examines the effect of peak price notifications and social comparisons in the electric consumption of prosumer households (those that generate, consume, and sell electricity). Both interventions together reduce overall net electricity use.	1) Treatment information on pricing, 2) pricing + social comparison, 3) Control group	Diff-n-Diff, FE, 2SLS	treatment 1: 912, treatment 2: 708	-9% from pricing, -10% social comparison + pricing

Program Evaluations

Continued on next page

Table 13: Studies exploring social comparison to reduce residential energy consumption in emerging economies

Study	Location	Motivation	Intervention Design	Comparison (Method)[b]	N	Outcome KWH (%)
Martínez-Montejo & Sheinbaum-Pardo (2016)	Mexico	This study assesses the impact of Mexico's Minimum Energy Efficiency Standards (MEES) on residential electricity consumption and CO_2 emissions. Focusing on appliances like refrigerators, washing machines, and lighting, it analyzes 1990 to 2012 and projects outcomes to 2030 under stricter standards.	Engineering measurement	n.a.	by 2013, MEES saved energy and reduced CO_2 emissions by 9.5 Tg	16.06 TWh saved
Davis et al. (2014)	Mexico	This paper examines a large-scale appliance replacement program in Mexico (2009–2012) that assisted 1.9 million households in upgrading to energy-efficient refrigerators and air conditioners.	Analysis of household electricity bills	refrigerator and AC upgrade	saved 8%, $500 per ton of CO_2, costly	
McNeil & Carreño (2015)	Mexico	This evaluation examines the impact of Mexico's national energy efficiency standards and labeling program on residential refrigerators, window air conditioners, and mini-split air conditioners.	Engineering analysis of appliances	refrigerators became 17-27% more efficient, window Ac 4% and split AC 7%	saved 6TWh of electricity and 24 million metric tons of CO_2	