LETTER

The impacts of special environmental events on short-run electricity-saving behaviors

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Abstract

Policymakers and academics are increasingly interested in using ‘social nudges’ to influence behavior, which are typically inexpensive relative to price-based and mandatory approaches. This study provides rigorous empirical evidence of the impacts of three big special environmental events, as a specific form of nudge, on short-run electricity-saving behaviors using high-frequency smart meter data in Shanghai, China, for both residential and commercial consumers. We find that World Environment Day and National Energy Saving Publicity Week caused commercial users to reduce their electricity consumption by 1.35 kWh h\(^{-1}\) and 0.6 kWh h\(^{-1}\) intra-event, around 17% and 8% reduction compared to average consumption, but the impacts decayed rapidly once the events ended. Earth Hour did not lead to significant energy-saving effects for both residential and commercial users. We further examine detailed activities implemented during these events to understand the heterogeneous impacts using social media and policy documents data.

1. Introduction

Traditional energy policy instruments focus on changing relative prices (Allcott 2011) or setting mandatory standards as the major force altering energy demand to improve energy efficiency and encourage energy conservation behaviors. These traditional approaches, such as carbon and pollution taxes, energy efficiency subsidies, building codes, and mandatory standards, suffer from expensive legislation and implementation costs (Allcott 2011); these instruments can also possibly generate inequitable outcomes (Hahn and Metcalfe 2021). Academics and policymakers are increasingly interested in another complementary approach—‘social nudges’, such as information provision and persuasion—aimed at altering consumer behaviors. Nudges are typically inexpensive compared to price-based approaches and energy efficiency standards. As Bertrand et al (2010) stated, carefully crafted psychological cues can exert significant effects on consumer demand that are comparable to large changes in relative prices (LaRiviere et al 2014).

Special environmental events, such as Earth Hour, World Environment Day, and Chinese National Energy Saving Week, can be regarded as a form of ‘nudge.’ These events have been globally popular for decades of history (see appendix A1 available online at stacks.iop.org/ERL/16/094035/mmedia). A large number of governments and non-profit organizations have been spending great efforts on organizing them. For example, in the policy document of 2017 working arrangements for energy conservation, emission reduction and tackling climate change, the Shanghai Development and Reform Commission required government institutions at various levels to organize publicity campaigns on the day of big environmental events in order to improve citizens’ environmental protection and energy conservation awareness. These events aroused significant public attention in Shanghai evidenced by social media data (see appendix A2). However, few studies provide
rigorous quantitative evidence of the effect of these environmental events on energy-saving behaviors.

In addition, the practice of Earth Hour provides a new dimension for intervention studies aimed at energy conservation and environmental protection. Studies divide the non-pecuniary interventions aimed at encouraging energy conservation into the following typical categories (Abrahamse et al 2005): mandatory standards, commitment, goal setting, information provision (e.g. workshop, mass media campaign, and energy audits), self-feedback (e.g. energy bill reminder), comparative feedback (e.g. Opower letters, Allcott 2011). The event of Earth Hour adds a new form of intervention, which organizes a unique symbolic action of switching off lights for one hour to arouse people’s awareness of energy conservation and nature protection. Turning off lights is a symbolic action and does not change social reality instantly, because the impact of turning off lights for a limited number of users for one hour alone on the whole electricity consumption is negligible. The final goal of symbolism here is to influence societal perceptions by using visual actions in order to obtain a public benefit (Berrone et al 2009). Few studies examined the symbolic actions in information interventions for energy conservation, and specifically, in big environmental events/campaigns. The symbolic actions have been increasingly widely practiced in the environmental context, such as Earth Hour, ‘Running to Protect the Environment,’ and Greta Thunberg’s sail to New York on a zero-emissions yacht. Related research on these symbolic environmental actions is lacking.

This study provides empirical evidence of the impacts of three special environmental events on consumers’ short-run electricity consumption behaviors using high-frequency (hourly and daily) electricity consumption data in 2017 in Shanghai, China, for both residential and non-residential sectors. Our high-frequency data (as opposed to monthly data commonly used in previous energy behavioral research) makes it possible to study the impact of these events. Specifically, we examine three such environmental events that have been very popular in China and around the world: Earth Hour, World Environment Day, and National (China) Energy Saving Publicity Week. Here we examine the following research questions: do these environmental events/campaigns arouse consumers’ short-run energy-saving behaviors? Do these events show differences in their impacts? If so, what are the mechanisms driving these differences?

Although the final goal of organizers of these environmental events is to improve the public’s environmental awareness in the long-run, it is difficult to identify the long-run effects of these events with many confounders. Our paper still provides useful insights into the long-run impacts even though we focus on short-run energy conservation. The short-run energy-saving behavior can be an important prerequisite for the long-run improvement of environmental awareness. If we find a larger effect on energy conservation in the short run for one event, it provides crucial suggestive evidence that this event has a greater potential to alter people’s long-run environmental awareness.

We make three contributions to the existing literature on ‘social nudges’ aimed at energy conservation and environmental protection. First, very few studies focus on the impacts of special environmental events on consumers’ electricity consumption behaviors. Analyzing these special events is important because worldwide there have been increasing efforts led by the governments and NGOs to raise energy-saving awareness through these environmental events. The Earth Hour and World Environment Day have grown to engage more than 140 countries worldwide annually. It is critical to understand whether such efforts could alter consumer energy-conservation behaviors, even in the short run. Second, we conduct a comparative analysis of different effects between the Earth Hour (symbolic campaign) and other typical information-provision environmental events. Third, most studies on nudges and electricity consumption behaviors have only examined residential consumers (Allcott 2011, Costa and Kahn 2013, Ferraro and Price 2013, Allcott and Rogers 2014, LaRiviere et al 2014). Our study examines both residential and commercial consumers.

Here we show that World Environment Day and National Energy Saving Week caused commercial users to reduce their electricity consumption by 1.35 kWh h$^{-1}$ and 0.6 kWh h$^{-1}$ within the event, around 17% and 8% reduction compared to average consumption, but the impacts decayed post-event. Earth Hour did not lead to significant electricity-saving behaviors for both commercial and residential users. We further explore the mechanisms behind the different impacts by investigating the interventions adopted during these events, evidenced by related policy documents and social media tweets located in Shanghai. We find most interventions adopted during the World Environment Day and National Energy Saving Week directly provided knowledge and skills about how to implement energy-saving behaviors. Most activities adopted during the Earth Hour are symbolic actions (such as turn off lights, running, art performance, etc). Although the symbolic actions cannot directly teach people how to save energy, they have advantages of fast spread evidenced by social media. Policymakers should combine the merits of the two types of events/campaigns in future campaign design.
2. Data

2.1. Smart meter high-frequency data
To estimate the impact of the events on electricity consumption, we make use of a smart-meter high-frequency data on individual commercial and residential electricity use. (a) We obtained the individual commercial electricity use data at 15 min level from The State Grid Corporation (SGC) of China, which is a panel dataset that covers 684 consumers randomly drawn from all the smart-metered commercial consumers in Pudong district, Shanghai over about one-year period from 1 January 2017 to 28 February 2018. Based on the definition provided by SGC, commercial users are the users that conduct profitable activities (e.g. shopping malls, office buildings, factories, etc). In order to merge with the hourly weather data and reduce data noise, we aggregate the 15 min data to hourly frequency. (b) We obtained the individual residential electricity use data at the daily level from SGC, covering 1780 consumers randomly drawn from all the smart-metered residential consumers in Pudong, Shanghai from 1 January 2017 to 28 February 2018. Both the commercial and residential data provide meter ID, consumer type, timestamps of data records, and hourly/daily electricity consumption (kWh). The smart meter data used in our study is anonymous and de-identified. See appendix A3 for data details.

2.2. Supporting data
We obtain the hourly weather data from a local weather station in Putong, Shanghai from the National Meteorological Information Center of China. The weather data include timestamps of data records, the highest pressure (hPa), maximum wind speed (m s\(^{-1}\)), hourly average temperature (°C), relative humidity (%), and hourly precipitation (mm).

In the section of mechanism analysis, we make use of policy documents data and social media data in order to investigate the intervention activities implemented by these campaigns. We sort out ten Chinese policy documents which are related to the special environmental events. We web-scraped 19 182 tweets including the words of ‘Earth Hour’, ‘World Environment Day’, ‘Energy Saving Publicity Week’, and ‘Energy Saving’ of users located in Shanghai published during the time around the event (from 15 March 2017 to 26 June 2017). See appendix A3 for data details.

3. Methodology: two-step local linear method

We utilize a two-step local linear method in conjunction with high-frequency data as our main approach to estimate the short-run average treatment effect of special environmental events on consumers’ electricity consumption.

Our approach comes from two-step regression discontinuity in time (Hausman and Rapson 2018), but is not a regression discontinuity (RD). We apply the approach for the following reasons. Because there is no cross-sectional difference in treatment to enable us to conduct a difference-in-differences analysis, we have to estimate and rule out the effect of confounding factors (weather, time periodicity) on electricity consumption. We also need to narrow down the time window of observations to control for unobservable time-variant trends, which makes the estimation of the effect of weather and time (e.g. day of the week, holiday) infeasible in a narrow time window in a single event-study regression. Therefore, we adopt the following two-step approach.

In the first stage of regression, we apply the following econometric model to estimate the impacts of weather, seasonality and time-invariant individual-specific factors on electricity consumption using all the data from 1 January 2017 to 28 February 2018, which helps control confounding factors

\[
\text{Power}_{it} = \beta_0 + \sum_{j=1}^{6} \beta_j f_j(\text{TEMP}_t) + \beta_5 \text{PRS}_t + \beta_2 \text{RHU}_t + \beta_4 \text{WIN}_t + \beta_3 \text{PRE}_t + \sum \pi_k + \gamma_i + \delta_t + \theta_i + \mu_t + \tau_i + \sigma_i + \varepsilon_{it} 
\]

(1)

where \(\text{Power}_{it}\) is hourly/daily power consumption (kWh) for consumer \(i\) in time \(t\). \(\text{TEMP}_t\) is hourly temperature. The functions of \(f_j\) are spline functions because temperature response varies flexibly. The spline functions can allow slopes within bins smoothing the temperature response, and we obtained five knots both for residential and commercial data after using the spline functions (Anderson 2014). \(\text{PRS}_t\) is hourly air pressure. \(\text{RHU}_t\) is hourly relative humidity. \(\text{WIN}_t\) is hourly maximum wind speed. \(\text{PRE}_t\) is hourly precipitation. \(\pi_k\) is a series of fixed effects for all the national legal holidays. \(\gamma_i\), \(\delta_t\), \(\theta_i\), \(\mu_t\), and \(\tau_i\) are respectively year fixed effects, month of year fixed effects, day of month fixed effects, day of week fixed effects, and hour of day fixed effects (only used for commercial hourly data), which control for the impacts of time-variant factors on electricity consumption behavior. \(\sigma_i\) is individual fixed effects, which capture all the time-invariant individual consumer-specific characteristics. \(\varepsilon_{it}\) is an error term. See the first stage estimation results in appendix A4.

In the second stage, we save the residuals from the above model, and then a local linear specification is applied using the residuals which are within a narrow bandwidth. We apply a pre-post event-study regression in our second stage instead of using RD to estimate the single gap in the cutoff because of the
ambiguous cutoff of receiving the treatment\(^4\) in the case of our study. In addition, since we have a high-frequency hourly/daily dataset, we could limit the time window into a narrow bandwidth (four days in the pre-treated period and one day in the post-treated period) with enough observations to relieve shocks of unobservable confounding factors. We use the observations of four days before the events as baseline control group, and we use the observations on each day since the start of events until the fourth day after the event as a treated group respectively, to estimate the treatment effect each day since the event. For National Energy Saving Publicity Week, we use observations four days before 5 June 2017 (World Environment Day) as the baseline control group, because observations four days before 11 June 2017 (Energy Saving Week) could be influenced by World Environment Day. Our bandwidth is much smaller compared to existing studies that generally choose 30 days (Anderson 2014, Bento et al 2014, Hausman and Rapson 2018). We run the following local linear specification:

\[
\text{Residuals}_{it} = \beta_0 + \beta_1 D_t + \varepsilon_{it} \tag{2}
\]

where Residuals\(_{it}\) is the residuals in the first stage regression model, which is power consumption (hourly consumption for commercial users and daily consumption for residential users) excluding the effects of weather, seasonality, time-invariant consumer specific factors. \(\varepsilon_{it}\) is an error term. \(D_t\) is a treatment variable that takes value one after the event and takes value zero otherwise. In order to obtain consistent estimates of standard errors, we implemented a bootstrap procedure in the second stage to allow the variance of the first stage to be reflected. Moreover, we cluster standard errors at the individual level to allow arbitrary correlations within individual users.

To further eliminate the concern of contemporaneous confounding factors around the same time with special environmental events, we check all the big events around the time of the three events. We find no other big events around the same time that may systematically influence consumers’ electricity consumption. We do not control the electricity price change, because there is no electricity price variation during the time window we investigate.

4. Results

4.1. The average effect of special environmental events on electricity consumption

We aim to investigate whether these environmental events/campaigns arouse consumers’ short-run energy-saving behaviors and compare the different effects of these events. Figure 1 plots the average treatment effect of the special environmental events on electricity consumption each day. Commercial users had significant energy-saving behaviors within the National Energy Saving Publicity Week, but the energy-saving effect decayed rapidly to be insignificant when the week ended. Commercial users also had significant energy-saving behaviors on the day of and on the second day after the World Environment Day, but the energy-saving effect decayed rapidly over the next two days. For residential users, World Environment Day and National Energy Saving Publicity Week exert no statistically significant effects on electricity-using behaviors.

Earth Hour had no significant impact on commercial users’ electricity consumption. At the same time, residential users increased electricity consumption on average significantly on the first and second days after Earth Hour. This average increase could be due to the increased consumption of some very-high-consumption residential users who had a higher intertemporal consumption variance and were not influenced by Earth Hour\(^5\).

To conclude, commercial users saved electricity consumption statistically significantly by 1.35 kWh h\(^{-1}\) and 0.6 kWh h\(^{-1}\) on average within World Environment Day and National Energy Saving Publicity Week, around 17% and 8% reduction compared to average consumption. However, Earth Hour did not lead to significant average energy-saving effects for both residential and commercial users. All the statistical estimation results can be found in appendix A5.

We run sensitivity checks by changing the second-stage time window to a different number of days (three days and five days) in the pre-event periods in our two-step local linear method. The results are consistent with our main results (see appendix A6). In addition, we develop an alternative machine learning approach to compute the treatment effects as a robustness check. The results are also consistent with our main findings (see appendix A7).

4.2. The intraday hourly treatment effects

High-frequency data allows us to investigate the intraday hourly heterogeneity of treatment effects. Here we only investigate the hourly heterogeneity for the commercial users on the day/week of the events for two reasons. First, the energy-saving behaviors were most likely to happen during the events based on

\(^4\) Although the events start at a specific point in time, different consumers may receive the information of the events at different times.

\(^5\) We find that residential users’ consumption is more concentrated on small values but also includes much more high-consumption users than commercial users, by comparing the distributions of annual average daily electricity consumption (kWh) of commercial and residential users (see figure A3 in appendix A3). The increased residential average electricity consumption after Earth Hour might be due to the increased consumption of some high-consumption users who had higher intertemporal consumption variance. The average increased usage after Earth Hour only accounts for 2.3% of the average usage of high-consumption users (top 5%).
Figure 1. The average treatment effect of the special environmental events on electricity consumption each day from the start of the event until the fourth day after the event. The x-axis is the number of days. For Earth Hour and World Environment Day, day 0 means the day of the event. For National Energy Saving Publicity Week, day 1 to day 7 mean the days within the event. Y-axis is the amount of treatment effect (electricity consumption change on hourly/daily average) of the event on power consumption each day. We use the observations four days before the event as a baseline control group. The green bar is the 90% confidence interval.

above findings. Second, daily residential data cannot allow us to run the hourly estimation. To examine the hourly heterogeneity, we use the same first-stage regression model and the following model in the second stage for commercial users:

\[
\text{Residuals}_{it} = \beta_0 + \sum_{H=1}^{24} \beta_H I_H \cdot D_t + \varepsilon_{it} \tag{3}
\]

where \(i\) indicates individual commercial customers. \(H\) indicates the hour of the day. \(I_H\) is an indicator dummy variable for each hour of the day. \(D_t\) takes value one in the post-treatment period, and takes value zero in the pre-treated period. The key coefficients of interest are the series of \(\beta_H\) which measures the change in hourly power consumption kWh of commercial users caused by special environmental events.

Figure 2 presents the intraday hourly treatment effects on commercial users. We find that all the significant electricity-saving behaviors under the events’ influences happened in the peak time, because meaningful human activities are a significant source of electricity usage change.

Policymakers should pay special attention to the energy-saving measures during the off-peak times, which can also be a source of energy saving. For instance, shopping malls can switch off all unnecessary lighting equipment to save energy during off-peak hours. Policymakers should pay more attention to encourage energy-saving behaviors during some easily overlooked time windows.

5. A mechanism analysis

The above findings suggest two opposite effects. World Environment Day and National Energy Saving Publicity Week caused commercial consumers to decrease electricity use significantly on average. In contrast, Earth Hour led to a significant increase in electricity use on average for residential users post-event and had no significant effect on commercial users. To explain the different effects, we conduct a mechanism analysis by investigating what measures were actually implemented during these events.

We reviewed all the related policy documents and web-scraped tweets in 2017 from Sina Weibo (the largest social media platform in China). Policy documents include the requirements and arrangements for certain activities in China. Subordinate government departments and state-owned enterprises organize the activities following the policy documents. Social media users (including both individual and institutional users) voluntarily publish the activities that they have done.

World Environment Day and National Energy Saving Publicity Week in China are government-lead events while Earth Hour is a voluntary event. In the policy document of 2017 working arrangements for energy conservation, emission reduction and tackling climate change introduced by Shanghai Development and Reform Commission, World Environment Day and National Energy Saving Publicity Week were listed as two key events aiming to improve the public’s environmental awareness. However, Earth Hour did not appear in any government policy documents.
Figure 2. The intra-day treatment effects (electricity savings, hourly kWh change) by hour-of-day on commercial users. The black line represents the coefficients of interaction terms of treatment dummy variable and dummy variables indicating the hour of the day. The green line is the 90% confidence interval.

Table 1. The activities conducted during the events in 2017, Shanghai.

| 2017 Earth Hour                          | 2017 World Environmental Day and National Energy Saving Week                          |
|------------------------------------------|-------------------------------------------------------------------------------------|
| Voluntary symbolic campaigns:            | Government-lead knowledge-based campaigns:                                          |
| Turning off lights                        | Expert speech                                                                       |
| Night running                             | Workshop                                                                            |
| Cycling                                   | Environmental knowledge competition                                                |
| Composition contest                       | Distribution of brochures and advertisements                                         |
| Art performance                           | Soliciting opinions on energy saving                                                |
| Celebrity endorsements on social media    | Technology Innovation Competition                                                   |
|                                          | Environmental policy information session                                             |
|                                          | Exhibition                                                                          |
|                                          | Displaying energy-saving cases and products                                         |
|                                          | Celebrity endorsements on social media                                              |

Data sources: Ten related policy documents, web-scribed social media (Sina Weibo) tweets, see details of the data sources in appendix A3.

For Earth Hour, we only use social media data. We web-scraped 7198 tweets including the words of ‘Earth Hour’ published by users located in Shanghai during the time around the event (from 15 March 2017 to 4 April 2017). We summarize all the activities conducted during the event of ‘Earth Hour’ based on social media texts (see table 1). For World Environment Day and National Energy Saving Publicity Week, Shanghai city government organized these two events together because the dates of the two events are close, according to the policy document activities arrangement for 2017 Energy Saving Publicity Week of Shanghai (introduced by Shanghai Economic and Information Commission). Thus, we treat these two events as one analysis unit and use the data from both policy documents and social media texts. We sorted out ten related policy documents, and web-scraped 1223 tweets including the words of ‘World Environment Day’ and ‘Energy Saving Publicity Week’ published by users located in Shanghai during the time around the event (from 27 May 2017 to 26 June 2017). We summarize all the activities related to the World Environment Day and National Energy Saving Publicity Week (see table 1). The details of policy documents and social media data are in appendix A3. To conclude, we find most activities during the World Environment Day and National Energy Saving Publicity Week are directly related to the knowledge and skills of environmental protection and energy saving, while most activities during the Earth Hour are only symbolic behaviors (like turning off lights). Our analysis provides suggestive evidence that activities providing knowledge and skills may promote more energy-saving behaviors compared to symbolic activities. Future studies could utilize experimental approaches to provide more rigorous evidence on the comparative effects of the symbolic information and the knowledge-based information.

One concern of this mechanism analysis is that the duration of the events might influence their effects. Although turning off lights during the event of Earth Hour happened within only one hour, related information about energy saving and turning off lights was spread all over the day based on our social media data. Thus, the duration of treatment in Earth Hour is similar to that of World Environment Day. Also, although National Energy Saving Week lasted for seven days, World Environment Day only lasted for one day but exerted a bigger energy-saving effect. Moreover, we find that Earth Hour aroused
much more public attention in total than the other two events, according to social media data. Therefore, we cannot attribute the diverse effects to the events’ duration.

6. Discussion and policy implications

Worldwide, governments and environmental communities have paid increasing attention and efforts on using the environmental events as a way of nudging consumers to save energy. Given the pressing challenge of climate change, policymakers need to evaluate the effectiveness of various types of instruments (e.g. taxes, standards, or nudges) on reducing energy use and associated carbon and environmental emissions. No prior research has analyzed the effects of special environmental events. We provide the first empirical analysis of the treatment effects of three special environmental events on short-run electricity consumption behaviors for both residential and non-residential consumers. More importantly, we summarize all the activities (including symbolic activities and knowledge-based activities) conducted during these events in the mechanism analysis. It provides practical implications for social-nudge activity organizers in the future. We use data from Shanghai China but our findings can be extended to other cities in the Yangtze River Delta of China because of the similarity in climate, economy, and political institutions. Our estimations also have implications for other cities in other emerging markets in which the estimates are hard to conduct. Since a large amount of CO₂ emissions in China comes from heavy industry, future studies on policies to induce behavioral change can be broadened to include heavy industry regions (e.g. northeastern provinces of China) and also investigate the heterogeneous effects across different industrial and commercial sectors.

Here, we find two major results. On the one hand, commercial users saved electricity consumption statistically significantly by 1.35 kWh h⁻¹ and 0.6 kWh h⁻¹ on average during the events of World Environment Day and National Energy Saving Publicity Week, around 17% and 8% reduction compared to average consumption. On the other hand, Earth Hour did not lead to any significant energy-saving effects on average for both commercial and residential users.

Moreover, although the World Environment Day and National Energy Saving Publicity Week led to a short-run average energy-saving effect, the effect decayed rapidly once these two events ended.

This study has several implications for policymakers and environmental communities. First, policymakers should combine the merits of the symbolic campaigns and knowledge-based campaigns when they aim to organize large-scale environmental campaigns to arouse people’s awareness and behavior of energy conservation and environmental protection. The symbolic campaigns show advantages on faster and wider information dissemination. For instance, Earth Hour arouses much greater public attention on social media than the other two events by organizing a unique and impressive symbolic action—switching off lights for one hour. The knowledge-based campaigns show more advantages in promoting behavioral change. Policymakers should combine the merits of the two types of campaigns. For instance, the organizers of Earth Hour should adopt more activities that directly distribute procedure knowledge about environmental protection and energy saving in the future, in addition to its symbolic action of switching off lights.

Second, policymakers and environmental communities should pay more attention to residential users. We find that commercial users are more likely to respond to the events, while there are no significant energy-saving effects on residential users. More policy mechanisms as well as targeted strategies should be adopted to facilitate energy-saving behaviors of residential users when organizing the environmental events.

Third, our study contributes to the literature on ‘demand side management’ (DSM) (Zhang et al 2011, Barbato and Capone 2014, Esther and Kumar 2016). Policymakers are increasingly interested in utilizing the DSM to balance energy demand. Special environmental events can be used to increase the willingness of consumers to accept smart appliances to apply the DSM more effectively. Also, we find the electricity demand during the off-peak period should be paid more attention to. There is no significant electricity savings during the midnight and early morning. Policymakers should pay more attention to the off-peak period, which could also be a source of energy saving. For instance, shopping malls and office buildings can turn off all the unnecessary lights to save energy during the midnight.

Policymakers and environmental communities should continue to support the special environmental events. Although the short-run energy-saving effect caused by the events decayed post-event, we should acknowledge that the short-run behavior change reflects a change in people’s awareness. Only the change in awareness can determine people’s long-run behavior. Also, ‘social nudge’ is a good supplement to the established price-based and mandatory policies. The Chinese government is planning to reduce subsidies on residential electricity consumption (Reuters 2021). Public campaigns can be used as a complement to such a price reform and to help alter residential consumers’ energy demand. Public campaigns can also help promote the legislation of other ‘green’ policies, such as carbon and pollution taxes, which are politically difficult to implement. The government and environmental communities should...
continue organizing special environmental events to improve people's energy conservation and environmental protection awareness.

Data availability statement

The data generated and/or analyzed during the current study are not publicly available for legal/ethical reasons but are available from the corresponding author on reasonable request.

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