Nudging Flexibility

The effect of an environmental nudge on electricity demand-side flexibility among tenants

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Master's Thesis, Spring 2024
Course code: EC9901
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Abstract

This study analyzes the effect of an environmental nudge on electricity demand-side flexibility among tenants. The nudge consists of a daily text message providing information on which hour to reduce electricity consumption in during the following day, as well as reminders of the environmental benefits of doing so. The data includes 14 nudged (treated) apartments and 134 control apartments, all located in Kungsbacka, Sweden. Using a difference-in-difference method and a synthetic control method, a 14-15 % reduction of electricity consumption during the daily peak hours in March 2024 is found. This result holds for several robustness checks such as various types of standard errors, as well as when using the logarithms of electricity consumption. No effect is found when data is collapsed to daily and weekly means, indicating the tenants have not reduced their total electricity consumption but indeed practiced demand-side flexibility. This thesis is written on behalf of IVL Swedish Environmental Research Institute.

Keywords

Demand-side flexibility, demand response program, nudging, nudge, behavioral economics, electricity market, renewable energy

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1 Introduction

Swedish renewable electricity production is growing and will continue to do so in the foreseeable future (Energimyndigheten 2023). One important aspect of several renewable resources such as wind and solar power is their intermittency, meaning they are not fully predictable or available at all times. Since storage opportunities for electricity are limited, an increasingly intermittent electricity supply will require an increasingly flexible demand. Other benefits of demand-side flexibility include a more efficient use of the electricity grid, as well as a lower need for fossil electricity since these plants are dispatched mainly when the electricity demand is high.

According to Energimarknadsinspektionen (2023), the value of Swedish households' demand-side flexibility potential is significant. Thus, it is relevant and valuable to study how households may be engaged in practicing demand-side flexibility.

In this thesis, the effect of an environmental nudge on tenants' flexibility in their electricity consumption is studied. A difference-in-difference as well as a synthetic control method are utilized to study the potential effects. The thesis is written on behalf of IVL Swedish Environmental Research Institute as part of the project ENFLATE[1].

The research question is:

How does an environmental nudge in the form of a daily text message with motivation from the landlord impact electricity demand-side flexibility among tenants?

An effect of a 14-15 % reduction in daily peak hour consumption for the treated apartments is found. The result holds for different types of standard errors as well as when using logarithms. When daily and weekly collapsed data is studied, no effects are found, indicating the effect indeed stems from flexibility, i.e. shifting

[1]ENabling FLexibility provision by all Actors and sectors through markets and digital TEchnologies https://enflate.eu/

consumption between hours, rather than a total reduction. The data consists of 14 treated apartments that receive the environmental nudge, and 134 control apartments.

The thesis is structured as follows. Chapter 2 presents the theoretical background including behavioral economics and nudge theory. Chapter 3 provides summaries of several previous studies in the field of (environmental) nudging as well as demand-side flexibility. In Chapter 4, data and empirical methods are described. Chapter 5 presents the results as well as some robustness checks. In Chapter 6, the results are discussed, and conclusions presented.

2 Theoretical Background

In this chapter, the theoretical framework of the thesis is presented. First, Behavioral Economics is briefly outlined. Then, the concept of a nudge is introduced, including some critical perspectives on the nudge theory. Lastly, nudging in the context of electricity consumption among tenants is discussed.

Behavioral Economics is a field within Economics that aims to explain and understand the sometimes irrational choices made by humans. According to Behavioral Economists, this irrational behavior is a result of “cognitive bias, emotions, and social influences” (Kenton 2023). These effects are enhanced by exposure to advertisement et cetera. In other words, some choice circumstances may influence people’s ability to act rationally.

Nudging is discussed within the field of Behavioral Economics and refers to how choices may be influenced by a gentle push or hint, i.e. a nudge. The term was coined by economist Richard H. Thaler, who received the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2017, and legal scholar Cass R. Sunstein, who received the Holberg Prize[2] in 2018. Their book *Nudge – Improving*

[2] The Holberg Prize is funded by the Norwegian Government Budget through the Norwegian Ministry of Education and Research, and administrated by the University of Bergen, which awards the prize to “a scholar who has made outstanding contributions to research in the humanities, social science, law or theology” (The Holberg Prize n.d.).

Decisions about Health, Wealth, and Happiness was released in 2008 and the second, updated, edition *Nudge – The Final Edition* was released in 2021.

In *Nudge – The Final Edition*, Thaler and Sunstein define the concept of a nudge as follows:

> *"A nudge, as we will use the term, is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not taxes, fines, subsidies, bans, or mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not."*
> *(Thaler and Sunstein 2021, p. 8)*

Throughout the book, Thaler and Sunstein describe nudging as a form of "libertarian paternalism" (Thaler and Sunstein 2021, pp. 6, 16–18, 330–331). *Libertarian* emphasizes the aspect of the free choice, and *paternalism* refers to the conscious direction of the nudge, aiming at making peoples' lives better. A choice architect is the person or group who decides how the choices will be presented to nudge the choice-makers in some direction (Thaler and Sunstein 2021, pp. 3–7).

Examples of successful nudges include for instance implementing green energy as the default option. In a randomized control study in Germany, one group was given the choice to opt-in for green energy, and the other group was given green energy as their default choice. In both groups, the cost for green energy was slightly higher than the cost for non-green energy. In the first group, 7.2 % of the purchased contracts were green, compared to 69.1 % in the default green group (Thaler and Sunstein 2021, p. 306). Here, the choice architecture clearly impacted the choices made and thus the nudge was considered successful.

Furthermore, Thaler and Sunstein emphasize the impact of social norms in nudging. They demonstrate this with an example in which a hotel wanted to nudge their guests to re-use their towels. The campaign did not have a large effect when exclusively environmental arguments were presented. However, when the hotel added the social norms perspective to their message such as "'Join your fellow guests in helping to save the environment.'" and "'Almost 75 percent of guests . . . help by using their towels more than once.'" (Thaler and Sunstein 2021, p. 85), the nudge became more effective, and more towels were re-used.

However, recent critiques have raised considerable concerns against nudge studies. The field has been accused of so-called publication bias, meaning the studies with no significant results have not been published. Nudge studies have also received criticism for not being useful in practice. For example, although a significant non-zero effect may be found, the practical implications may be limited if the magnitude of the nudge effect – albeit significantly non-zero – is small (Osman 2022a).

In the case of environmental nudge studies, criticism concerns e.g. non-durability of nudge effects, meaning the effects do not last over time. Moreover, the effects are criticized for appearing only among already environmentally concerned and motivated people. Also, aspects such as "socioeconomic factors, personal motivation to change behavior, and the context in which a nudge is introduced" (Osman 2022b) may explain a large share of the nudge results.

In some cases, the alternatives to impact people's behavior are limited and nudging may be one of few feasible options. In the case of electricity consumption patterns among Swedish tenants, not all tenants may in practice be exposed to price signals due to the specifics of their electricity bill and payment setup. In many cases, tenants pay their electricity bill as a share of the landlord's total monthly bill. This means each tenant pays for the number of kilowatt hours (kWh) they use, but the timing of their electricity usage is not directly considered. Instead of paying the hourly price for their specific consumption patterns, they pay a price based on a volume-weighed monthly average[3] for the entire housing stock of their landlord. Since such pricing structures are common, also among housing cooperatives, it is relevant to

[3] In short, this means that the tenants pay for the number of kWh, but not for their specific consumption timing. Instead, the timing of electricity use for the entire housing stock determines the average kWh price. More about volume-weighing can be read for example at Konsumenternas Energimarknadsbyrå (2022).

examine the effects of an environmental nudge on tenant electricity consumption behavior. If effects are found, this type of nudge could be used as a tool to engage these households in demand-side flexibility.

3 Previous Studies

In this chapter, a selection of previous studies is presented. The studies cover environmental nudging on tenants in Sweden, electricity demand-side flexibility, and discussions on various methods to estimate baseline consumption.

Linder, Lindahl, and Borgström (2018) show the impacts from a pro-environmental nudge program in Sweden on tenants' behavior regarding composting of food waste. Their study was performed in the area Hökarängen in Stockholm, and the treatment was mainly an informational leaflet describing the benefits of composting and information on how to compost correctly. In the leaflet, the information communicated was e.g. "*Join your neighbours […], recycle your food waste*" and "*If all households in Hökarängen would sort their food waste it would be enough biofuel to support 15 garbage trucks for a year*" (Linder, Lindahl, and Borgström 2018, p. 5).

The treatment group consisted of households receiving the informational leaflet, and the control group of other households in Hökarängen. The authors emphasize the importance of measuring actual data on behavior instead of relying on self-reported data. They use a difference-in-difference method and find a significant increase of food composting for the treated households. The effect persisted even 8 months after the information was communicated. The authors state that their results indicate that this kind of information leaflet may have significant effects (Linder, Lindahl, and Borgström 2018).

While several studies analyze electricity demand-side flexibility in Sweden, these mainly examine demand responses to price signals. Nevertheless, some of the insights from such studies are relevant to mention here. For example, Öhrlund, Linné, and Bartusch (2019) argue that the size of a price signal, i.e. the potential savings, is not the only driver of demand response. Therefore, they suggest informing electricity users about how to reduce consumption during peak hours, rather than informing them about complex details of the pricing mechanism.

Moreover, Bartusch et al. (2024) study peak hour electricity consumption among households in two suburbs of Stockholm. In one suburb, a time-varying price in the form of a time-of-use distribution tariff is in place, while the households in the other suburb are not exposed to such price signal. The authors find no effect in peak hour consumption of the time-of-use tariff and believe this may be partly due to low awareness of tariff type among the households. However, through questionnaire answers from the households, the authors conclude that the main drivers for the households' motivation to practice demand-side flexibility are related to sustainability and a will to "reduce their environmental impact and to mitigate climate change" (Bartusch et al. 2024, p.11).

Furthermore, there are several studies where nudges have been applied to demand-side flexibility for electricity. Before examining specific studies, the main ideas on method selection brought up by D'Ettorre et al. (2022) and Hatton, Charpentier, and Matzner-Lober (2016) will be mentioned. D'Ettorre et al. map out the current state of demand response and describe various types, such as implicit and explicit demand response. In short, implicit demand response means that end-users respond to some signal, e.g. a price signal, and explicit demand response means that end-users' flexibility is sold on a market, often through an aggregator.

D'Ettorre et al. emphasize the complexity of estimating a baseline consumption, to which the measured demand response consumption is compared. For the context of residential customers, they advocate using control group methods over e.g. day and weather matching methods, since residential end-users not only depend on weather but also a lot on "occupancy behaviors, which are more difficult to predict" (D'Ettorre et al. 2022, p. 11).

Hatton, Charpentier, and Matzner-Lober (2016) state that randomized controlled field trials is an ideal approach but agree with D'Ettore et al. that control groups are useful in cases where randomized controlled field trials are not feasible. Hatton, Charpentier, and Matzner-Lober propose selecting a control group based on “individual load curves rather than on the individual characteristics” (2016, p. 1754). The authors argue that this will inherently contain variables that are in-observable and thus that this control group selection may be used even in absence of data on other individual characteristics.

Wylie Pratt and Erickson (2020) study the effects of a pro-social demand response program. Their program took place in Burlington, Vermont, USA, in 2018 and aimed to reduce the annual peak demand. The program consisted of informing grid-connected households (without solar PVs or battery capacity installed) when critical peak hours were predicted to occur. The arguments for reducing electricity consumption during these hours were pro-social (as opposed to economic incentives), and the incentive was a donation to a local charity organization from the utility (which is owned by the municipality).

Just as Linder, Lindahl, and Borgström, Wylie Pratt and Erickson use a difference-in-difference method to estimate the results. However, since all households in their sample received the message, the control chosen was instead of non-treated households defined as non-event days. The results from the study indicate a 13.5 % reduction in consumption during the annual peak event, and the authors conclude that pro-social programs may play a role in demand response program effectiveness (Wylie Pratt and Erickson 2020).

Newsham, Birt, and Rowlands (2011), on the other hand, argue for complex time series analysis to estimate the effect of demand response programs. They study a demand response scheme in Ontario, Canada, called the Peaksaver program, aimed at reducing peak consumption for air conditioners during several days in the summer of 2008, by direct load control of the air conditioners. They find an effect of about 10-35 % reductions in peak consumption. The authors use four different methods: A control group method in which the control group is selected based on shared characteristics with the treated group, a non-event day control group method in which days with similar characteristics (weather, weekday/weekend/holiday, calendar date proximity, et cetera) serve as control group, a simple multiple regression and a time-series regression. They prefer their last method with the main argument that "laundry that began at 2 p.m. may still be active at 3 p.m." (Newsham, Birt, and Rowlands 2011, p. 6379), and that similar energy consuming events may be recurring at similar times every day.

To summarize, there are several approaches to estimate baseline consumptions when studying a demand response program. Based on previous research, I have decided to proceed using a control group method in a difference-in-difference design as well as a synthetic control design with electricity load curves as the predictor. The synthetic control method is further described in Chapter 4.2.

The contribution of this work includes studying the effects of an environmental nudge in the form of a daily text message on electricity demand-side flexibility among tenants using a difference-in-difference and a synthetic control method. Moreover, my contribution also includes the design of the nudge, i.e. the writing of the text messages and weekly informational letters, as well as the use of data which is collected for this thesis and has not been studied before. This study thus contributes to the empirical work on environmental nudging and demand-side flexibility.

4 Empirical Approach

In the first part of this chapter, the details of the nudge and the data used are described. In the second part, the econometric methods (difference-in-difference and synthetic control) are presented.

4.1 Data and Nudge Details

The environmental nudge is performed at the ENFLATE demonstration site at Humlevägen in Fjärås, Kungsbacka. In short, the nudge is a daily text message sent to the tenants at Humlevägen, informing about which hour during the following day to reduce their electricity consumption in, as well as reminding them of the environmental benefits of doing so[4]. The nudge is described in more detail below.

[4] Information communicated to the tenants and the text messages can be found in Appendix.

The nudged tenants at Humlevägen live in apartments owned by Eksta Bostads AB (Eksta), which is owned by the municipality of Kungsbacka. Eksta's housing stock consists of around 3 000 rental apartments[5]. The Humlevägen demonstration site for the ENFLATE project consists of four buildings, divided into 16 apartments. Out of these, 14 agreed to participate[6] in the nudge test and thus receive daily text messages during March 2024.

The nudge period was preceded by an informational meeting on February 20th, 2024, attended by two tenants. At the meeting, Eksta informed about the ENFLATE project and about the environmental benefits of reducing peak demand. The tenants were also informed that if a high enough number of Eksta's tenants would shift their electricity consumption from the hours with the highest spot prices (i.e. the peak hours), the costs for electricity would decrease over time for all tenants[7]. After participation, Eksta would reward each apartment with a gift card of 300 SEK at a local mall. For the tenants who did not participate in the meeting, an e-mail was sent out and the presentation was posted at My Pages at the Eksta website.

During March 2024, daily text messages were sent to one person in each household. The messages were mainly sent in the evenings and included information about which hour to reduce electricity consumption in during the next day, as well as reminders of the environmental benefits of reducing peak demand. Several of the text messages also included social norms, emphasizing that the tenant was part of the project together with their neighbors, as suggested by Thaler and Sunstein (2021).

Which hour to reduce electricity consumption in was determined by the peak price hour in SE3 at the Nord Pool day ahead-market, which is published at 13:00 one day in advance. The Nord Pool prices do not specifically map the peak hours of

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[5] Eksta also owns and manages elderly care homes, pre-schools, and schools. They have a few commercial customers as well.
[6] The remaining two were deleted from the sample.
[7] This since Eksta's electricity bill to Mälarenergi is based on the aggregate load curves of their tenants. If these load curves are shifted from expensive to cheap hours, Eksta's bill to Mälarenergi could be reduced. However, this would require a larger number of participating households than the households at Humlevägen.

Humlevägen but was considered a reasonable indicator for the daily peak hour. Due to technical issues, the text message for March 8th was not sent, meaning this day was not treated. March 8th is therefore removed from the main dataset. A table of the text messages can be found in Appendix.

Apart from receiving text messages, the tenants could also visit a tab at My Pages at the Eksta website with more information from ENFLATE. Here, some encouraging and informative weekly letters were posted. See Appendix for the information that was communicated.

The 14 complying apartments at Humlevägen are considered the treatment group of the nudge. The (untreated, i.e. not nudged) control group consists of 134 of Eksta's apartments which, like the 14 Humlevägen apartments, are metered for electricity consumption hourly. The treated houses and the control group houses share important characteristics such as similar weather conditions due to geographical proximity. Also, a majority[8] of the control group houses are passive houses, just as the Humlevägen houses. This means they are highly efficient in their heat management with low heat loss rates.

For the difference-in-difference method, a mean of the electricity consumption of the 134 control apartments will be used as the control group, while a weighted synthetic control group will be selected for the synthetic control method. See Chapter 4.2 for further description of the synthetic control method.

The raw data consists of meter readings, where the electricity meter reading reports the cumulative electricity consumption (in kWh) since the meter was installed. To get the hourly kWh consumption, the meter reading in hour $h - 1$ is subtracted from the meter report in hour h. Any missing values[9] have been replaced by the corresponding hour from the day before.

[8] 122 of 134 control group apartments.

[9] In total, there were 12 missing values for the final dataset covering daily peak hours for 148 apartment observations January 1st – March 31st, 2024.

In the econometric context, the words “nudge” and “treatment” will be used interchangeably. The nature of the treatment in this thesis differs slightly from commonly studied treatments in empirical Economics and Econometrics since the treatment does not apply to every period following the implementation of the treatment. Here, instead, the treatment aims to impact only one hour per day. The timing of this hour varies among the treated days since it is determined based on the daily peak spot prices in SE3 at the Nord Pool day-ahead market. Hence, hourly data may not be used since not every hour after the introduction of the nudge is treated. Therefore, only the kWh consumption in the peak hour of every day is studied, both in the pre and post treatment periods. In other words, the time frequency of the data is daily, but the measurement is consumption in kWh/h in the daily peak hour. As an example, if the price on January 1st peaked in hour 08-09, and on January 2nd in hour 18-19, the consumption in hour 08-09 from January 1st and hour 18-19 from January 2nd will be used in the sample.

Since the intention of the nudge is to encourage tenants to shift – not reduce – their electricity consumption, consumption is expected to increase slightly during (some of) the remaining 23 hours of each day. As an extension to my analysis, I will study whether the tenants change their daily and weekly mean electricity consumption.

The data and nudge setup have some drawbacks for statistical inference that should be mentioned. One such drawback is that the nudge is not randomly assigned but specifically implemented at the ENFLATE demonstration site at Humlevägen. This reduces the chance of identifying effects that arise solely from the environmental nudge. Also, the number of treated apartments (14) is quite small. Although the synthetic control method is appropriate in cases with few treated observations, the number of treated units may still be criticized for being insufficient.

Another drawback of this nudge study is the limited time frame of the study, namely that the nudge is only carried out for one month (March 2024). However, it would not have been reasonable to extend the time of the nudge treatment for the limited time and scope of this thesis.

Moreover, the differences in characteristics between the treatment and control groups should be minimal in an ideal setting. In this case, the tenants' knowledge of electricity consumption and demand-side flexibility should be as similar as possible. A previous study by Bartusch et al. (2019) on Humlevägen about solar photovoltaics, micro grids and passive prosumers[10] may potentially have influenced the tenants' knowledge of energy and electricity consumption. However, this study took place several years prior to the ENFLATE project and the only information communicated to the tenants was an informational leaflet (Bartusch et al. 2019, p. 21). Hence, the impact on the tenants' knowledge and behavior from that study is likely limited.

Furthermore, the two non-complying households at Humlevägen may potentially differ from the 14 participating apartments, in which case the results of the study could be affected. The reason why these apartments did not participate is not known, but it could be, for example, that these households were not as interested in environmental issues as the 14 complying apartments. If so, this could lead to an overestimation of the effect of the nudge, in line with Osman's (2022b) critique towards nudge studies. With this consideration in mind, I proceed with the 14 complying apartments.

4.2 Econometric Method

To study the effect of the environmental nudge, I will use a difference-in-difference method and a synthetic control method. Both these methods make use of a control group, which was suggested in some of the previous studies mentioned in Chapter 3, such as D'Ettorre et al. (2022) and Linder, Lindahl, and Borgström (2018).

The difference-in-difference method is commonly used in empirical Economics and Econometrics. It was likely first used by physician John Snow in 1855 for studying cholera epidemics in London (Angrist and Pischke 2009, p. 227). In short, the difference-in-difference method builds on the assumption that two groups share a common trend for the variable of interest (in this case, kWh consumption during

[10] Prosumer refers to actors who are both producers and consumers.

peak hour) over time. In absence of treatment, the difference between the trends of the treatment and control group are thus assumed to stay about the same over time. If the parallel trends assumption holds, the treatment effect, i.e. the difference in the difference between the two groups before and after treatment is implemented, may be studied.

The synthetic control method was introduced by Abadie and coauthors in the early 2000s (Arkhangelsky et al. 2021) and is an increasingly popular strategy for control group selection in Economics and Social Sciences. The method is particularly popular for cases in which the treated units are few but may also be useful when several units are treated. By combining carefully selected weights of untreated units, a researcher may be able to construct a synthetic control group that is very similar to the treated group prior to the treatment. A selection of observations from the donor pool of untreated observations is weighed into the synthetic control group. This may be compared to the difference-in-difference method where all control units are assigned equal weights. The units constructing the synthetic control group should share crucial characteristics with the treated group to be relevant (Abadie 2021). I will use the lagged dependent variable, i.e. peak hour kWh consumption, as suggested by Hatton, Charpentier, and Matzner-Lober (2016) in Chapter 3, to generate an appropriate synthetic control group.

An important distinction between the difference-in-difference method and the synthetic control method is their different key identification assumptions. The key identifying assumption for the difference-in-difference design is the assumption of parallel trends. This means that in absence of treatment, the (mean outcomes of the) control and treatment groups would exhibit parallel trends over time (Ding and Li 2019). The observations, in this case apartments, may have certain time-invariant features (such as size or number of household members[11]) that can be accounted for by using fixed effects giving each observation its own intercept in the linear

[11] Over longer time periods, the number of family members may not be constant. In the setup at Humlevägen, I will assume that these fixed effects do not vary over time, since the time horizon is three months (January through March 2024).

regression model. Time fixed effects account for time-specific patterns in electricity consumption due to e.g. weather events and the timing of the daily peak hour.

Synthetic control, on the other hand, rests on the ignorability assumption, i.e. that in absence of treatment, “the outcomes for the treated and control groups would have the same distributions, conditional on their lagged outcome and covariates” (Ding and Li 2019, p. 607). Here, the behavior of the dependent variable (in absence of treatment) is determined not by apartment-specific characteristics but instead of the behavior of the apartment in previous periods. Angrist and Pischke emphasize the difficulties in determining which assumption to rely on and thus which model to choose. They suggest studying the results from both types of designs (Angrist and Pischke 2009, p. 246).

The difference-in-difference model for the nudge study in this thesis is specified as follows,

$$y_{it} = \alpha_i + \lambda_t + \beta Treatment_{it} + u_{it} \quad (1)$$

where y_{it} is the electricity consumption (in kWh) for each apartment (subscript i) in each daily peak hour (subscript t), α_i captures fixed apartment-specific effects, λ_t captures time fixed effects, β captures the average treatment effect on the treated where $Treatment$ takes the value 1 for treated apartments in treated periods (i.e. Humlevägen during March) and 0 else, and u_{it} is the error term.

The synthetic control method is instead, as stated above, based on the ignorability assumption. Thus, instead of fixed effects as in Equation (1), the synthetic control method utilizes lagged values of the dependent variable to predict its outcomes. Equation (1) may be re-specified as follows for the synthetic control method, to be understood parametrically:

$$y_{it} = \alpha + \lambda_t + \delta y_{it-h} + \beta Treatment_{it} + u_{it} \quad (2)$$

where y_{it} is the hourly electricity consumption (i.e. kWh in the daily peak hours), α is a common intercept, λ_t captures time fixed effects, δ captures the effect of the kWh consumption in previous periods (h), β captures the treatment effect where

$Treatment$ takes the value 1 for treated apartments in treated periods and 0 else, and u_{it} is the error term.

An important distinction between the difference-in-difference method and the synthetic control method is how the control group is defined. In the difference-in-difference method, the control group consists of the mean of all untreated apartments. In the synthetic control method, on the other hand, each untreated apartment is assigned some optimal (or no) weight based on a minimization of the difference between the treated unit(s) and the control units before treatment, where each weight is non-negative and the weights sum up to 1, described by Abadie and Vives-i-Bastida (2022) and Clarke et al. (2023).

5 Results

In this chapter, the results from the two methods are reported separately. Then, the results from daily and weekly collapsed data are presented. Finally, a robustness check using logarithms is examined.

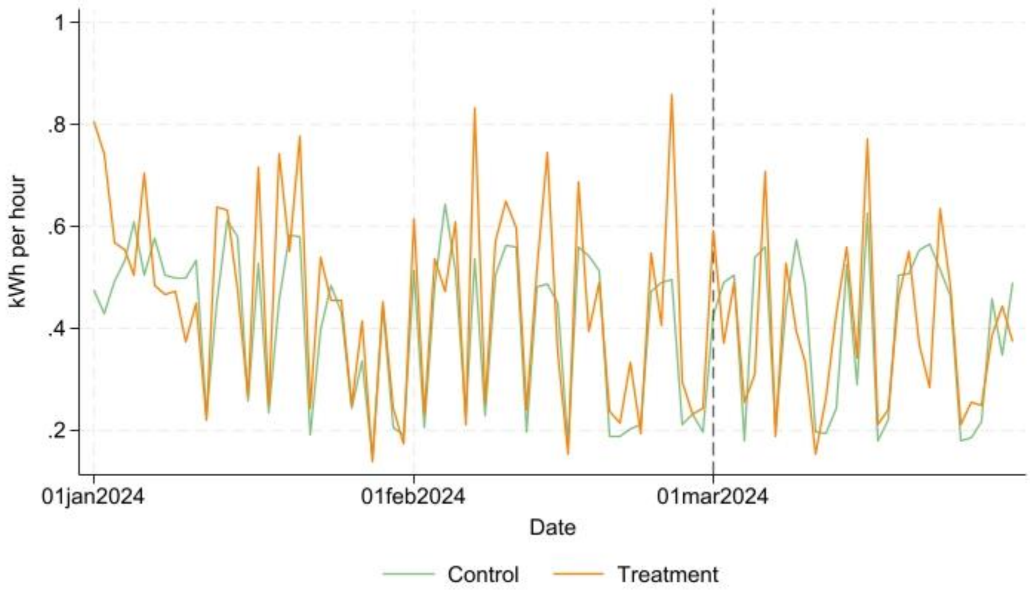
5.1 Difference-in-Difference

A graphical representation of the mean kWh consumption for the treated and the control group, respectively, is shown in Figure 1. Beginning by looking at the pre-treatment period, i.e. before March 1st, I notice that the means of the two groups follow each other closely both in their highly fluctuating patterns and in levels. Since the apartments in the control group are similar to the treated group in terms of size and location, it is not surprising that their electricity consumption is similar in absolute numbers (i.e., in levels). Neither the large fluctuations are surprising, since electricity consumption is highly volatile due to factors such as day of the week, hour of the day[12] et cetera. The similarities of the two groups prior to the treatment implementation suggest the parallel trends assumption seems to hold, although other indicators will be examined too to increase the strength of this argument.

[12] As described in Chapter 4.1, the daily peak hour varies across the days in the daily sample. For example, the peak hour could be 08-09, or 18-19.

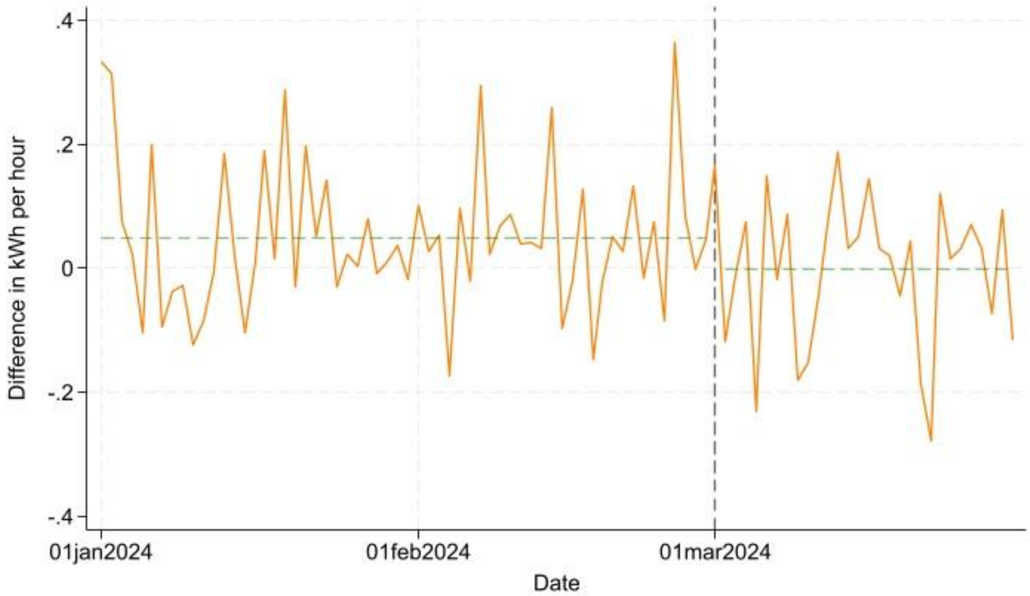
Shifting focus to the post treatment period in Figure 1, beginning on March 1st, no obvious shift for any of the two groups may be observed. However, I notice that the highest notations in the peak hour kWh consumption for the treatment group are at lower levels than before treatment, compared to the control group which visually seems to have its highest consumption at levels similar to the levels before March 1st.

Figure 1 Observed means of kWh consumption in peak hours for the treatment and the control group



Next, the differences between the treatment and control group, shown in Figure 2, will be examined. Here, the control group means have been subtracted from the treatment group means, and the difference is illustrated by the orange line. The total means before and after treatment implementation, respectively, are shown as dashed green lines.

Figure 2 Differences of mean kWh consumption in peak hours between treatment and control group. Mean difference before and after treatment are displayed as dashed green lines



Starting by looking at the period before March 1st in Figure 2, no up- or downward trend may be detected. Instead, the difference between the treatment and control group seems to fluctuate around the mean (0.05 kWh). This strengthens the implications from Figure 1, indicating that the parallel trends assumption holds.

As a final robustness check for the parallel trends assumption, I perform tests for three specifications of standard errors[13]. Neither of the three tests reject the null hypothesis of parallel trends. The test results are found in Appendix. Together with the graphical evidence in Figure 1 and Figure 2, I consider I have enough indications to assume the parallel trends assumption to hold.

Shifting focus to the right side of Figure 2, i.e. after March 1st when the treatment is implemented, the dashed green line for the mean difference moves down to -0.0007 kWh. The peaks in the differences appear to be lower compared to the period prior to March 1st, and the negative notations of the differences are lower,

[13] Robust standard errors, bootstrapped standard errors and standard errors clustered at street level (8 clusters).

too. This indicates that the nudge has had an effect, since something seems to have happened to the differences between the two groups.

Next, I study the results from the regression in Table 1 to examine whether an effect is indeed detected. Three kinds of standard errors are studied, where robust standard errors are displayed in the first column, bootstrapped standard errors in the second column and street level clustered (8 clusters) standard errors in the third column. A small effect of the nudge is found, where the nudged tenants reduce their peak hour consumption by 0.05 kWh. The effect is significant for all three types of standard errors, although the street level clustered standard errors should not be considered since they report suspiciously low standard errors and likely over-reject the null hypothesis of no treatment effect.

Table 1 Difference-in-difference regression results

VARIABLES	(1) kWh	(2) kWh	(3) kWh
Treatment	-0.050** (0.023)	-0.050** (0.024)	-0.050*** (0.007)
Observations	13,320	13,320	13,320
R-squared	0.126	0.126	0.126
Number of id	148	148	148
Robust	Yes	No	No
Bootstrap	No	Yes	No
Cluster	No	No	Street

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

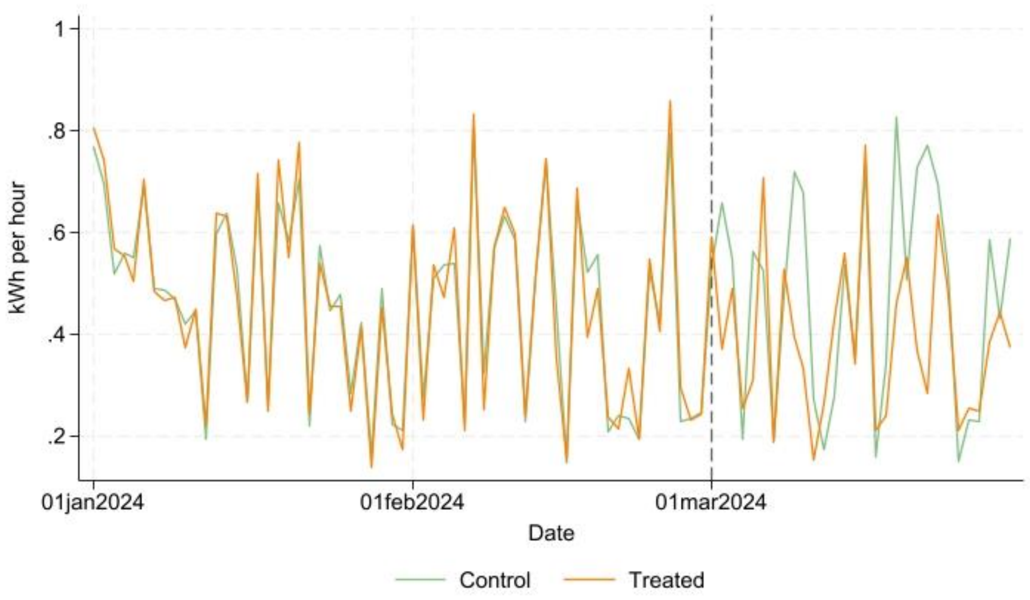
To conclude, the difference-in-difference method seems to be adequate since there are strong indications that the parallel trends assumption holds. The effect of a 0.05 kWh reduction of consumption in peak hours for the treated apartments is significant for both robust and bootstrapped standard errors, which increases the reliability of the model setup and the result.

5.2 Synthetic Control

In the synthetic control method, a selection of the control units has been weighed together to closely track the pre-treatment patterns of the treatment group. The weights of the donor pool apartments, i.e. the available control group apartments, are found in Appendix.

In Figure 3, the treatment and the control group follow a similar pattern prior to the treatment, like what was shown in Figure 1. The two groups are, as expected, even more similar here since the synthetic control group is selected to track the treatment group as closely as possible prior to treatment.

Figure 3 Treatment and synthetic control group weighted values of kWh consumption in peak hours



After the treatment implementation on March 1st, the treated group generally appears to shift down to a lower level compared to the control group in Figure 3, similar to the plotted means in Figure 1. The point estimate reported by the synthetic control method is a reduction of 0.078 kWh in the peak hours and is significant at the 5 % level for bootstrapped standard errors, see Table 2.

Table 2 Synthetic control regression results

VARIABLES	(1) kWh
Treatment	-0.078**
	(0.036)
Observations	13,320
Bootstrap	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Thus, the difference-in-difference and synthetic control results are similar to each other, where both methods detect a significant treatment effect of the nudge. The reported point estimates of the reduction are 0.05 and 0.078, respectively. These results are discussed in Chapter 6.

5.3 Flexibility or General Reduction?

Both the difference-in-difference and the synthetic control method show significant results for demand reductions in the treated (peak) hours. The intention of the nudge was to make the tenants shift their electricity consumption in time, not necessarily to reduce their consumption. By only examining the daily peak hour data, it is not possible to tell if the treatment effect arises from flexibility (i.e. shifting consumption from peak hours to other hours) or from a general reduction in electricity consumption. By collapsing data and studying daily and weekly means, it will be possible to study which of the mechanisms that is in place.

Thus, I return to the dataset with 24 hourly observations each day. Then, I collapse the data to daily and weekly means, respectively. Since March 1st, i.e. the first day of the treatment, is a Friday, the first three days of March are included in the subsequent week. Hence, this “week” (week 10) has ten days, and the last pre-treatment week (week 9) has only four days. This should not be a considerable concern since I use means and not totals, although the last pre-treatment week does not include any weekend which could potentially affect the results.

No significant treatment effect is found when using the difference-in-difference method on the collapsed data, neither for the daily nor for the weekly aggregation, see Table 3. Note that since clustering on street level for the peak hour data returned suspiciously small standard errors, this clustering is not considered for the collapsed data regressions.

Table 3 Difference-in-difference regression results for daily and weekly collapsed data

VARIABLES	(1) kWh	(2) kWh	(3) kWh	(4) kWh
Treatment	-0.011	-0.011	-0.011	-0.011
	(0.015)	(0.014)	(0.014)	(0.012)
Observations[14]	13,468	13,468	1,924	1,924
Number of id	148	148	148	148
Collapsed	Day	Day	Week	Week
Robust	Yes	No	Yes	No
Bootstrap	No	Yes	No	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

No significant treatment effect of a demand reduction is found by the synthetic control method performed on the day and week collapsed data either, see Table 4.

Table 4 Synthetic control regression results for daily and weekly collapsed data

VARIABLES	(1) kWh	(2) kWh
Treatment	-0.004	-0.003
	(0.014)	(0.014)
Observations	13,468	1,924
Collapsed	Day	Week
Bootstrap	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To conclude the collapsed data analysis, neither of the two methods report any significant results for demand reductions, which suggests the effects found in Chapter 5.1 and 5.2 indeed arise from flexibility and not from reducing total

[14] The number of observations for the daily collapsed data is 13,468, compared to 13,320 in the peak hour data, see Table 1, since March 8th is not excluded in the collapsed data. The choice to keep March 8th for the collapsed data was that in this analysis, all hours and not only the nudged hours are of interest.

electricity consumption over a day or week. Hence, it seems like the nudge had the intended effect of enhancing demand-side flexibility.

5.4 Robustness Check Using Logarithms

As a robustness check for the results in Chapter 5.1 and 5.2, I use the logarithms of the kWh values and study what happens to the difference-in-difference and the synthetic control results. Another benefit of this is that it will return a percentage estimate of the behavior change of electricity consumption.

Here, I make use of the daily peak hour data described in Chapter 4.1, and take the (natural) logarithm of the kWh consumption. 13 missing values are reported since the hourly kWh consumption is zero for 13 hours. These missing values are found for three different apartments (with 11, 1, and 1 missing value(s), respectively). To make the panel balanced, these observations are dropped, and the new dataset consists of 145 apartments (14 treated and 131 control apartments).

The result from the difference-in-difference regression using logarithms is presented in Table 5. With both robust and bootstrapped standard errors, a significant effect is found where the treated group reduced their electricity consumption during peak hours. The peak hour reduction of electricity consumption is estimated to be 11.4 %.

Table 5 Difference-in-difference results using logarithms

VARIABLES	(1) lnkwh	(2) lnkwh
Treatment	-0.114**	-0.114**
	(0.053)	(0.047)
Observations	13,050	13,050
Number of id	145	145
Robust	Yes	No
Bootstrap	No	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Graphs using logarithms corresponding to Figure 1 and Figure 2 are found in Appendix. The tests for parallel trends do not reject the null hypothesis, indicating the parallel trends assumption holds for the logarithms too. These test results are found in Appendix.

Also the synthetic control results using logarithms strengthen the robustness of the results. A figure corresponding to Figure 3 can be found in Appendix. As seen in Table 6, the effect is significant and estimates the electricity consumption reduction to be 18.4 % during peak hours.

Table 6 Synthetic control results using logarithms

VARIABLES	(1) lnkwh
Treatment	-0.184***
	(0.064)
Observations	13,050
Bootstrap	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From the regression results using logarithms, I conclude that the significance of the treatment effects from Table 1 and Table 2 seem to be robust. See Chapter 6.1 for further comparisons and discussions of the regression results of data in levels and logarithms.

6 Conclusions and Discussion

In this chapter, the results are discussed and contextualized by a hypothetical upscale of the nudge to Eksta's entire housing stock as well as to Swedish national level. Finally, suggestions for future research are presented.

6.1 Conclusions and Discussion of Results

The coherence of the peak hour data results from the two methods (difference-in-difference and synthetic control) is promising. Since the control group consists of apartments similar to the treated apartments, it is not very surprising that the difference-in-difference and the synthetic control results are similar. In fact, the control group used in the synthetic control method is in practice quite similar to the control group in the difference-in-difference method in which all control apartments are assigned equal weights. This may be seen as a sign of a robust model specification.

However, as discussed in Chapter 4.1, the reported peak hour reductions may be exaggerated by limitations of the studied data. For example, the 14 apartments that received the nudge may be more prone to respond to environmental arguments than other tenants. This should be kept in mind when the results are further discussed.

When electricity consumption is aggregated into daily and weekly means, no effect of the treatment is found. This indicates that the nudge actually had an effect on the demand-side flexibility, rather than a general reduction of electricity consumption. This result is satisfying since impacting flexibility was the main aim of the nudge.

I also note that the daily and weekly aggregates in Table 3 and Table 4 report not only insignificant effects, but also smaller point estimates. The point estimates of the treatment in the aggregate daily and weekly collapsed data regressions range between reductions of 0.003-0.011 kWh, which can be compared to the peak hour effects of 0.050-0.078 kWh reductions. This strengthens the conclusion that the tenants have reacted to the nudge with demand-side flexibility rather than a general reduction of their consumption.

Now, the significant results will be given some context. The mean of the two estimates (in levels) gives $\frac{0.050+0.078}{2} = 0.064$ kWh as an average reduction of electricity consumption in the peak hours for the treated apartments. The average peak hour consumption prior to treatment (i.e. January and February) for the treated households is 0.46 kWh. Since $\frac{0.064}{0.46} \approx 0.1399 \approx 14$ %, this is the percentage reduction of peak hour electricity consumption according to the regression results performed on the peak hour data in levels. The mean of the effects when logarithms are used gives $\frac{0.118 + 0.184}{2} = 0.151 \approx 15$ %. Notably, these estimates are similar to the 13.5 % reduction in annual peak event consumption found by Wylie Pratt and Erickson (2020), and also fall within the 10-35 % range found by Newsham, Birt, and Rowlands (2011) presented in Chapter 3. I conclude that the treatment effect, i.e. the peak hour electricity consumption reduction, is about 14-15 % as a response to the environmental nudge.

6.2 Implications for Eksta

The mean peak hour consumption for the treated and control apartments in January and February 2024 is 0.41 kWh. Although this number may not be representative for the entire year, it gives an approximate hourly mean kWh consumption in peak hours. Assuming the apartments in this study are representative for Eksta's housing stock of 3 000 apartments, their total peak hour consumption is 1 230 kWh. Reducing daily peak hour consumption in all the Eksta's apartments by 14 % would reduce the daily peak hour consumption by 172.2 kWh. Since the nudge did not encourage the tenants to shift their electricity consumption to any specific hour, some tenants may have shifted it one or a couple of hours earlier or later, while others may have shifted it to a completely different hour, such as in the night. If the reduction of peak hour consumption is on average distributed evenly over the day, the average price for these kWh would be the average price of that day[15]. The average peak hour price during March 2024 was 91 öre/kWh. The average difference between the peak hour price and the average daily price in March 2024 is 32 %.

This implies that if all tenants would react as the nudged tenants at the demonstration site at Humlevägen, Eksta could reduce their costs by $0.32 \times 91\ \text{öre/kWh} \times 172.2\ \text{kWh} \approx 5014\ \text{öre} \approx 50\ \text{SEK}$ per day if the nudge were to be implemented for all of Eksta's apartments. Assuming this average daily cost reduction is representative for the entire year, this means the yearly savings correspond to $50\ \text{SEK} \times 365\ \text{days} = 18\ 250\ \text{SEK}$[16].

[15] Here, the peak hour is part of the daily average, meaning 1/24 ≈ 4 % of these 14 % are not moved from the peak hour. This choice was made to not make the calculations unnecessary complicated.
[16] This number does not consider any costs for administrating the nudge.

6.3 Implications for Sweden

According to Statistics Sweden, there are about 2 million households with a yearly consumption of 5 000 kWh or less. This number may be used as an approximation for the number of apartment households in Sweden. The majority of these, namely 1,5 million, are located in SE3 (Statistics Sweden n.d.).

To get a rough estimation of the effects of a hypothetical national upscale of the environmental nudge implemented at Humlevägen, I assume the 2 million apartment households in Sweden have the same peak hour consumption as the studied Eksta apartments, i.e. 0.41 kWh. This means a daily peak hour consumption of $0.41 \text{ kWh} \times 2\,000\,000 \text{ apartments} = 820\,000 \text{ kWh}$ during peak hours. 14 % of this is 114 800 kWh, i.e. the number of kWh that would be shifted from peak hours and instead evenly distributed over the remaining hours of each day.

Using the same numbers as in Chapter 6.2, i.e. that these non-peak hours are on average 32 % cheaper than the peak hours, this would mean a potential cost reduction of $0.32 \times 91 \text{ öre/kWh} \times 114\,800 \text{ kWh} = 3\,342\,976 \text{ öre} \approx 33\,430 \text{ SEK}$ per day. Over a year, this translates to $33\,430\, SEK \times 365\, days \approx 12\,202\,000\, SEK$ per year.

Worth noting is that the price facing apartment households is higher than the Nord Pool spot prices. Konsumenternas Energimarknadsbyrå estimated the average markup on monthly variable price contracts to 28 öre/kWh in January 2023. Also, an additional 25 % VAT is added to the price the end-user pays (Konsumenternas Energimarknadsbyrå n.d.). Hence, the welfare increase potential for consumers may be higher than the estimation above.

This upscale of the environmental nudge effects considers a ceteris paribus case, i.e. a scenario with “all else equal”. In other words, any general equilibrium effects are excluded from this analysis. However, a few general thoughts on additional effects should be mentioned. For example, lower peak hour consumption presumably gives lower peak hour prices, as well as higher prices during non-peak hours since demand is shifted to these hours. Furthermore, lower peak hour demand likely lowers the need for fossil electricity since these electricity sources are dispatched mainly when the demand is high. Also, a national reduction of peak hour electricity consumption would likely lead to a more efficient use of the electricity grid. Hence, the benefits of a 14 % kWh reduction during peak hours are likely not limited to a cost reduction, although quantification of these additional effects are beyond the scope of this thesis.

6.4 Suggestions for Future Research

The results from this thesis show that an environmental nudge in the form of information through daily text messages reduces tenants' electricity peak hour consumption by about 14-15 %. For future studies, it would be interesting to study whether such effects remain if the nudge period is longer than a month, such as up to a year or even longer. This type of study would aim to capture whether tenants react with fatigue over time, where the interest in responding to the nudge could decrease, or if they get used to the nudge and to adapting their behavior and thus respond with increasing intensity. This could be studied if the nudge, or a similar test, were implemented for a longer time period.

7 Acknowledgements

This thesis would have been very difficult, not to say impossible, to write without support from some extremely competent and helpful people. Thank you Per Lidbom at Stockholm University for helpful methodological discussions and "aha moments", both during the work with this thesis and in your Econometrics classes. Thank you Nathalie Fransson and Dmytro Romanchenko at IVL Swedish Environmental Research Institute for taking on an Economics student to the ENFLATE project and for sharing your expertise on energy systems. Thank you Eksta Bostads AB for providing valuable practical insights and data, and for trusting me to perform this nudge study on your tenants.

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9 Appendix

A I: Additional Econometric Tables and Graphs

Table 7 Parallel trends test results

SE	Test statistic	P-value	Null hypothesis	Specification
Robust	F(1, 147) = 0.03	Prob > F = 0.873	H0: Linear trends are parallel	kwh
Bootstrap	chi2(1) = 0.05	Prob > chi2 = 0.821	H0: Linear trends are parallel	kwh
Street cluster	F(1, 7) = 0.45	Prob > F = 0.524	H0: Linear trends are parallel	kwh
Robust	F(1, 144) = 0.25	Prob > F = 0.619	H0: Linear trends are parallel	lnkwh
Bootstrap	chi2(1) = 0.19	Prob > chi2 = 0.661	H0: Linear trends are parallel	lnkwh

Figure 4 Synthetic control group weights (used in Figure 3)

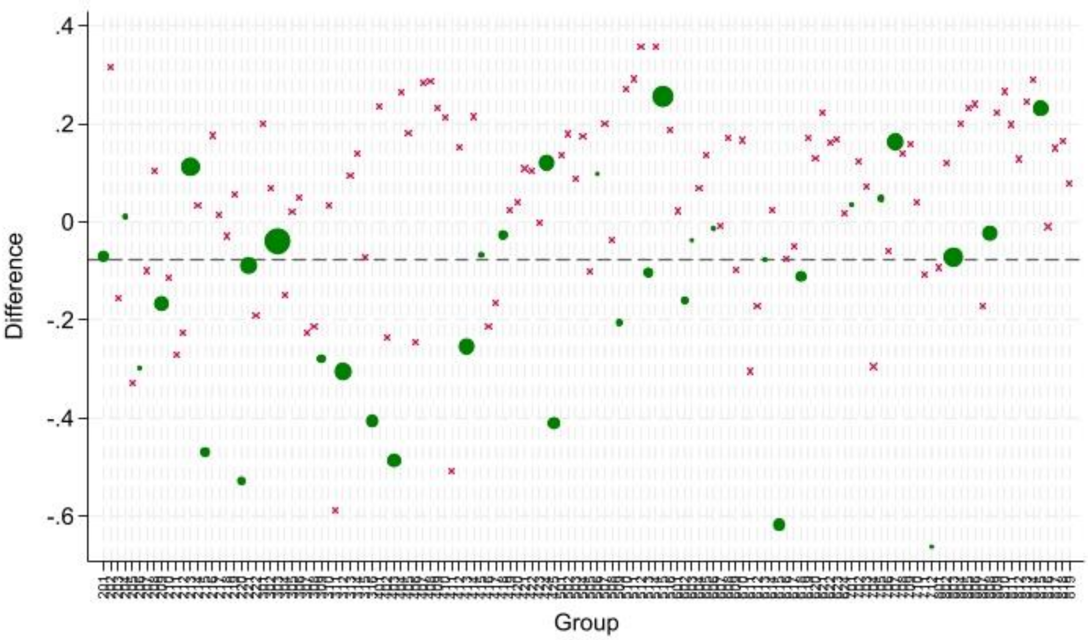


Figure 5 Observed means using logarithms of kWh consumption in peak hours for the treatment and the control group

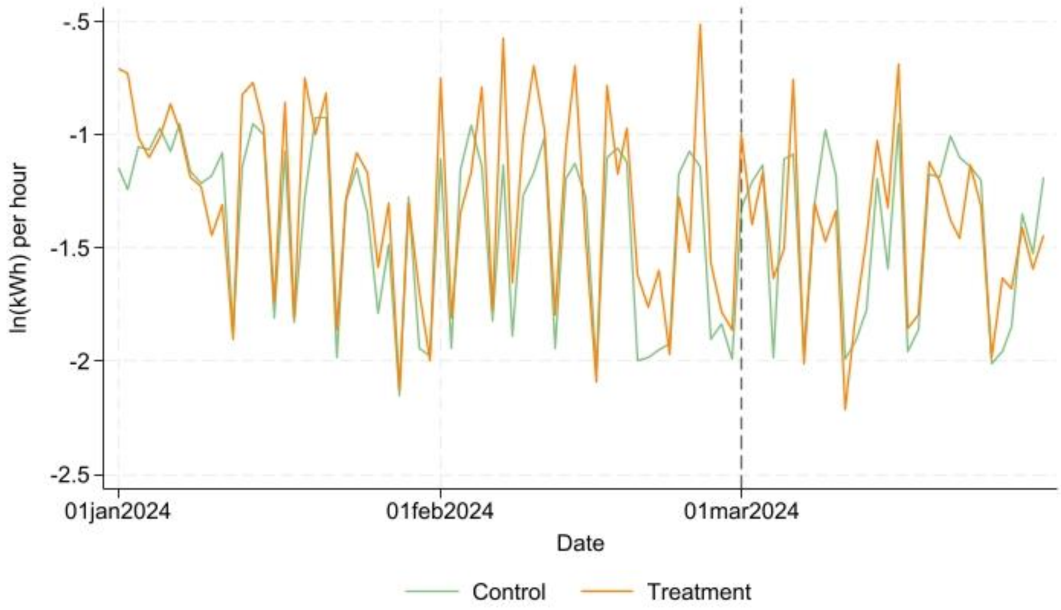


Figure 6 Differences of mean kWh consumption using logarithms in peak hours between treatment and control group. Mean difference before and after treatment are displayed as dashed green lines

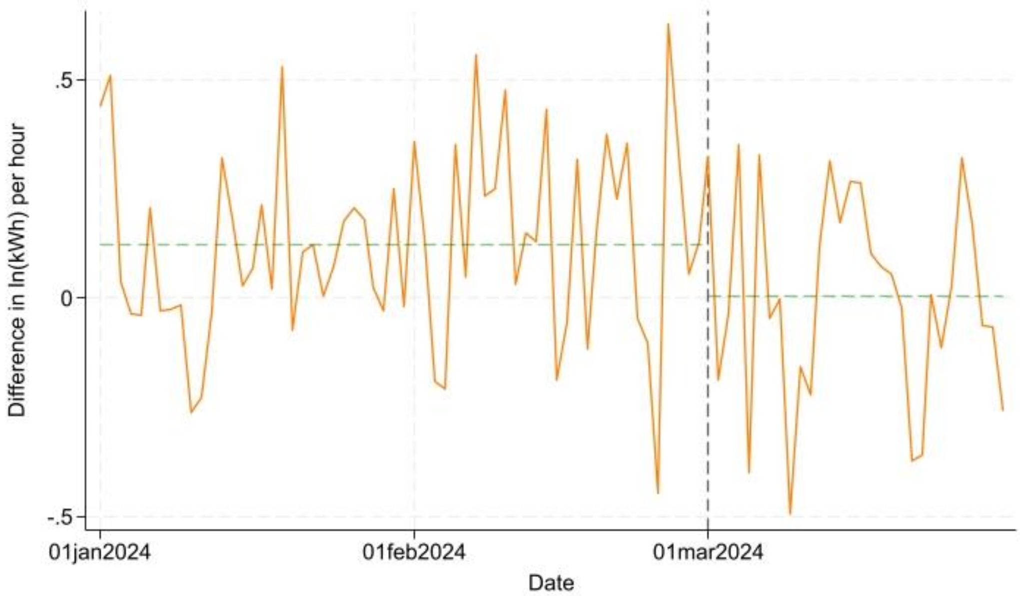


Figure 7 Synthetic control using logarithms

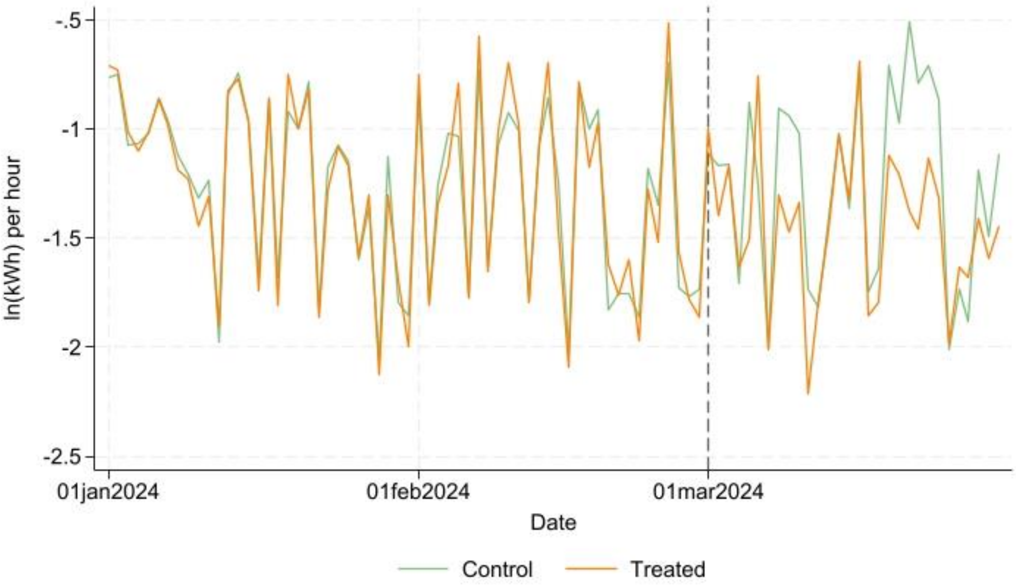
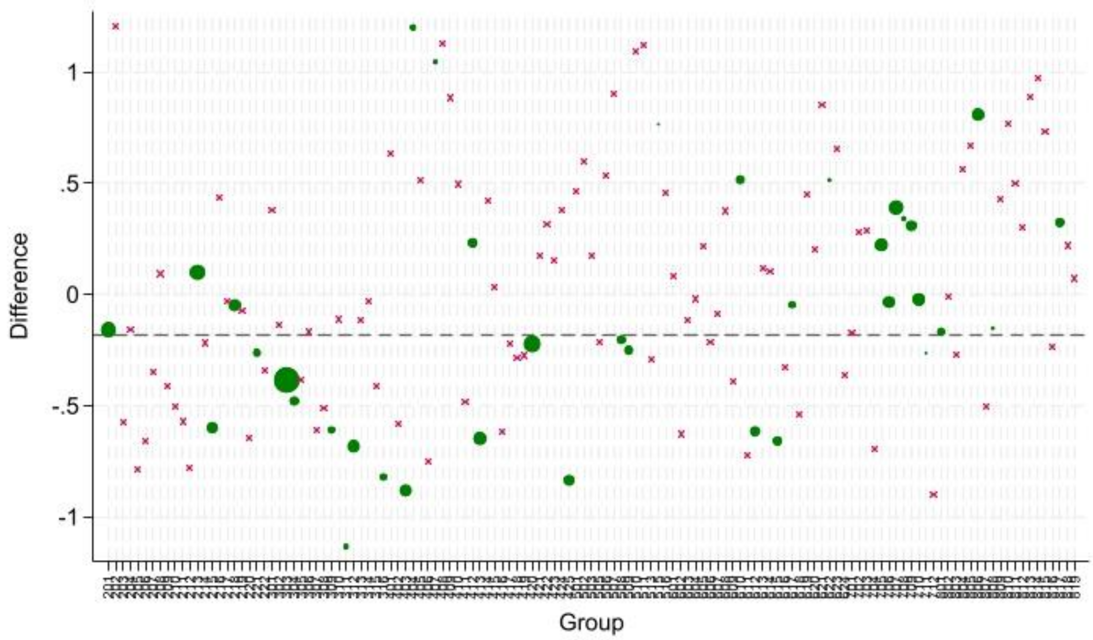


Figure 8 Synthetic control weights (used in **Error! Reference source not found.**)



A II: Nudge Details

Table 8 Text messages

Date	Text
Friday March 1st	Hej Namn Imorgon är det den 1 mars och testet för Humlevägens elförbrukning startar. Presentation från infomötet finns på https://minasidor.eksta.se. Mellan 17-18 imorgon är det många som behöver el. Undvik denna timme och underlätta för mer förnybar el! Mvh Eksta
Saturday March 2nd	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Gör som dina grannar på Humlevägen och vänta lite med att t. ex. starta tvättmaskinen! Mvh Eksta
Sunday March 3rd	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Låt t. ex. diskmaskinen gå lite senare och minska risken för att behöva aktivera fossil elproduktion! Mvh Eksta
Monday March 4th	Hej Namn Imorgon mellan 08-09 är det många som behöver el. Flytta t. ex. din elbilsladdning till senare (eller tidigare) och bidra till mer förnybar energi! Mvh Eksta
Tuesday March 5th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Undvik denna timme och bidra till mer förnybar energi! Mvh Eksta
Wednesday March 6th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Minska elanvändningen då och minska risken för att behöva aktivera fossil elproduktion! Mvh Eksta
Thursday March 7th	Hej Namn Imorgon mellan 07-08 är det många som behöver el. Undvik att t. ex. tvätta då så kan fler använda elnätet. Miljön tackar dig! Mvh Eksta
Saturday March 9th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Gör som dina grannar och använd mindre el under denna timme! Mvh Eksta
Sunday March 10th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Minska din elanvändning då, för ett bättre klimat! På https://minasidor.eksta.se hittar du mer om fördelarna med att flytta sin elanvändning och andra lästips. Mvh Eksta
Monday March 11th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Undvik t. ex. att ladda bilen denna timme, för en bättre miljö! Mvh Eksta
Tuesday March 12th	Hej Namn Imorgon mellan 08-09 är det många som behöver el. Tillsammans kan vi minska elanvändningen under den timmen, för en mer förnybar elproduktion! Mvh Eksta

Wednesday March 13th	Hej Namn Imorgon mellan 08-09 är det många som behöver el. Låt t. ex. tvättmaskinen gå under en annan tidpunkt och minska risken för att behöva aktivera fossil elproduktion! Mvh Eksta
Thursday March 14th	Hej Namn Imorgon mellan 11-12 är det många som behöver el. Gör som dina grannar och undvik att slå på t. ex. diskmaskinen då, för ett bättre klimat! Mvh Eksta
Friday March 15th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Undvik att t. ex. använda tvättmaskinen då och främja förnybar energi! Mvh Eksta
Saturday March 16th	Hej Namn Imorgon mellan 10-11 är det många som behöver el. Gör som dina grannar och minska din elanvändning under den timmen så används elnätet bättre och mer förnybar el får plats! Mvh Eksta
Sunday March 17th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Undvik att t. ex. slå på diskmaskinen då, för en bättre miljö! På https://minasidor.eksta.se hittar du mer om fördelarna med att flytta sin elanvändning och andra lästips. Mvh Eksta
Monday March 18th	Hej Namn Imorgon mellan 08-09 är det många som behöver el. Flytta din elanvändning till senare (eller tidigare) och bidra till mer förnybar energi! Mvh Eksta
Tuesday March 19th	Hej Namn Imorgon mellan 08-09 är det många som behöver el. Tillsammans med dina grannar kan du minska elanvändningen då och bidra till en bättre miljö! Mvh Eksta
Wednesday March 20th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Har du möjlighet kan du förbereda middagen tidigare och främja förnybar el! Mvh Eksta
Thursday March 21st	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Gör som andra på Humlevägen och minska din elanvändning då – för ett bättre klimat! Mvh Eksta
Friday March 22nd	Hej Namn Imorgon mellan 19-20 är det många som behöver el. Undvik denna timme och bidra till mer förnybar energi! Mvh Eksta
Saturday March 23rd	Hej Namn Imorgon mellan 19-20 är det många som behöver el. Välj att t. ex. ladda bilen tidigare eller senare i stället – för en bättre miljö! Mvh Eksta
Sunday March 24th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Undvik att t. ex. tvätta då så kan fler använda elnätet. Miljön tackar dig! På https://minasidor.eksta.se hittar du mer om fördelarna med att flytta sin elanvändning och andra lästips. Mvh Eksta

Monday March 25th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Flytta din elanvändning till senare (eller tidigare) och bidra till mer förnybar energi! Mvh Eksta
Tuesday March 26th	Hej Namn Imorgon mellan 07-08 är det många som behöver el. Gör som dina grannar och undvik att slå på t. ex. diskmaskinen då – för ett bättre klimat! Mvh Eksta
Wednesday March 27th	Hej Namn Imorgon mellan 08-09 är det många som behöver el. Minska din elkonsumtion under den timmen, för en ökad förnybar elproduktion! Mvh Eksta
Thursday March 28th	Hej Namn Imorgon mellan 09-10 är det många som behöver el. Gör som andra på Humlevägen och minska din elanävndning då – för ett bättre klimat! Mvh Eksta
Friday March 29th	Hej Namn Imorgon mellan 17-18 är det många som behöver el. Undvik att t. ex. använda tvättmaskinen då och främja förnybar energi! Mvh Eksta
Saturday March 30th	Hej Namn Imorgon mellan 18-19 är det många som behöver el. Flytta din elanvändning till senare (eller tidigare) och bidra till mer förnybar energi! Mvh Eksta
Sunday March 31st	Hej Namn Imorgon mellan 19-20 är det många som behöver el. Tillsammans minskar vi elanvändningen då - för miljön! Stort tack för ditt deltagande! På https://minasidor.eksta.se finns info vad som händer nu och hur du kan fortsätta använda el vid smarta tidpunkter. Mvh Eksta

Figure 9 Leaflet about informational meeting

EKSTA Kungsbacka

INFORMATION

VÄLKOMMEN PÅ INFORMATIONSMÖTE

Kan vi på Eksta tillsammans med er hyresgäster på Humlevägen bidra till att EU blir mer förnybart?

Sedan cirka ett år tillbaka är vi med i ett EU-finansierat projekt som heter ENFLATE (ENabling FLexibility provision by all Actors and sectors through markets and digital TEchnologie).
Ett projekt som pågår under fyra år (2023–2026) med målet att hitta lösningar för att minska EU:s behov av fossila bränslen. Vi vill nu bjuda in till ett informationsmöte för att berätta mer.

Humlevägen - ett framgångskoncept

Flera länder är med i projektet och i varje land testas olika lösningar. Tillsammans med IVL (Svenska Miljöinstitutet) och NODA Intelligent Systems driver vi en testdatabas där vi testar olika tekniska lösningar - på just Humlevägen. På Humlevägen finns vårt uppmärksammade likströmsnät som vi nu ska utöka genom att studera och testa hur flexibiliteten mellan fjärrvärme och el kan nyttjas på bästa sätt.

Är det möjligt att ha flera olika energikällor och välja varifrån energin ska tas beroende på tillgång?

Vad har vi gjort än så länge?

Vi har under det första året utfört massor av mätningar för att ha något att jämföra med. Inne i undercentralen har vi nu installerat en elpanna för att vi framgent ska kunna välja om energin ska komma från fjärrvärme, solvärme eller el.

Vi behöver er hjälp – vill du delta i studien?

Vad kan få våra hyresgäster att ändra sitt beteende när det gäller energiförbrukning? Det är en fråga som vi vill diskutera med er. Kan vi tillsammans hjälpas åt att undvika att förbruka el när topplasten är som högst (dyrast) och istället använda el när det finns stor tillgång?

Vi kommer att skicka ut ett sms per dag med information om vilken timma elen, kommande dag, är som dyrast och även som minst förnybar. Syftet är att ändra beteendemönster och undvika att använda el när den är som dyrast och minst miljövänlig. Testet pågår under mars månad 2024 och som tack för att du deltar under hela testperioden får du ett presentkort på Kungsmässan på 300 kr.

Ett medgivande krävs

Vill du vara med i testet? Då behöver vi ditt medgivande. Godkänn genom att fysiskt skriva på under informationsmötet eller signera digitalt via Scrive som skickas ut via mejl. Mejla oss om du vill vara med men inte kan medverka. Du kan när som helst dra tillbaka ditt medgivande om du inte vill ha sms längre. Då utgår inget presentkort.

Informationsmöte

Varmt välkomna på informationsmöte 20 februari klockan 18.00. Mötet beräknas ta cirka 40 min och hålls inne på Måhaga äldreboende. Gå in via huvudentrén och sedan är det skyltat.
Anmälan behövs inte. Kan du inte vara med på plats? Meddela oss så skickar vi länk digitalt.

Information på Mina sidor

Framöver kommer vi att skicka ut och lägga upp dokumenterad information på nya Mina sidor.
Du loggar enkelt in med BankID på **minasidor.eksta.se**.

Har du några frågor?

Kontakta Karin Gustavsson på Eksta på karin@eksta.se eller telefon 0300-356 00.

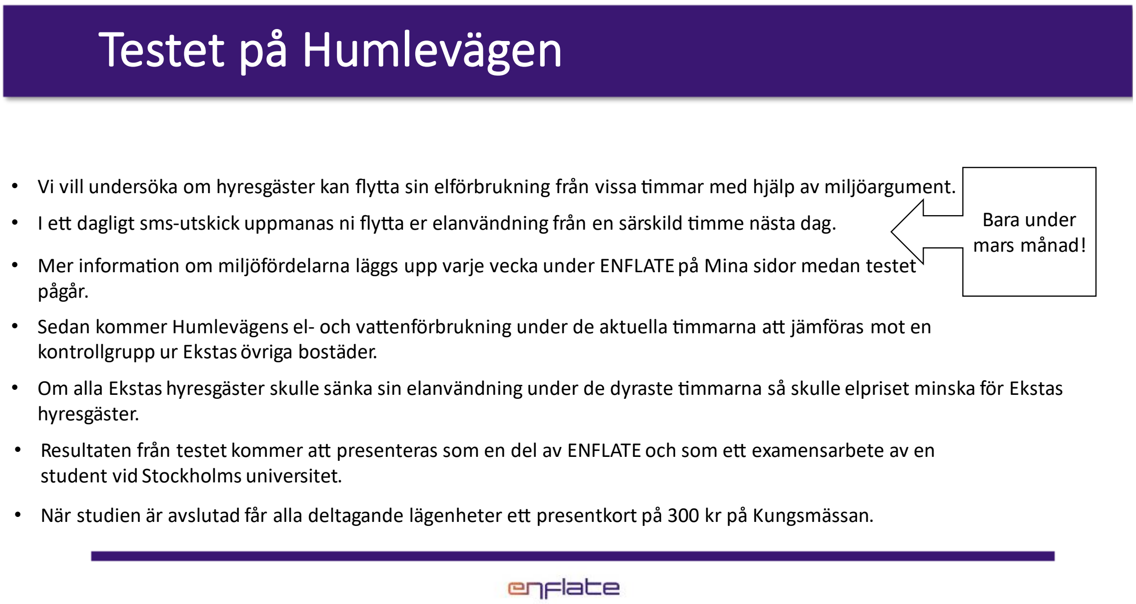
Med vänlig hälsning,
Eksta Bostads AB

Eksta Bostads AB
Box 10400
434 24 Kungsbacka

telefon: 0300-356 00

e-post: info@eksta.se

Figure 10 Presentation at informational meeting before nudge start



Varför flytta sin elanvändning?

Om vi använder våra resurser mer effektivt bidrar det till mindre miljöpåverkan och minskade utsläpp.

Inte krångligare än så.

enflate

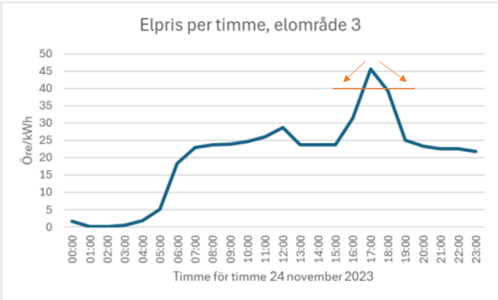
Hur uppstår miljöfördelarna?

- Om vi flyttar vår elanvändning från de dyraste timmarna kan vi undvika att aktivera fossil elproduktion.
    - De billigaste energislagen aktiveras först. Dessa är förnybara (vind, sol, vatten med mera).
    - När elbehovet är som störst behövs ibland även den fossila elen.
    - Elbehovet är sällan så stort under en lång tid, utan oftast under specifika timmar.
    - Därför kan en minskad användning under just de timmarna leda till att de fossila kraftslagen inte behöver aktiveras.

enflate

Hur uppstår miljöfördelarna?

- Timmarna med högst elbehov är ofta även de timmarna då priset är som högst.

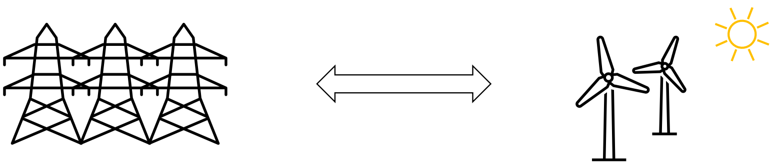


Källa: Nord Pool.

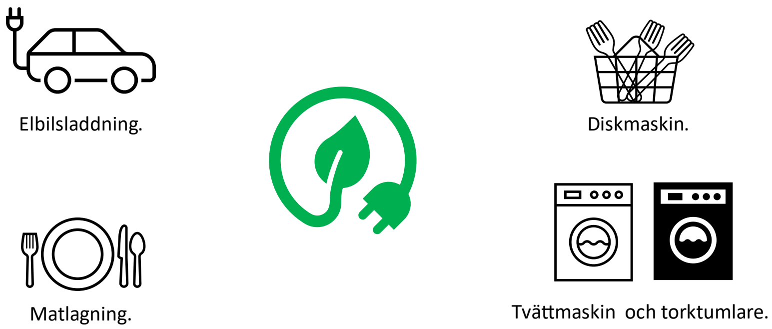
- Risken för att behöva aktivera fossil elproduktion minskar om toppen kapas.
- Även priset minskar.

Varför flytta sin elanvändning?

- Om vi använder elnäten mer effektivt underlättar vi för utbyggnaden av förnybar energi, grön industri med mera.
  - Det är även bra för miljön att inte bygga ut elnät i onödan/där det inte behövs.



Vilken elanvändning kan flyttas? Allt! T.ex.



Vecka 1

Hej alla boende på Humlevägen!

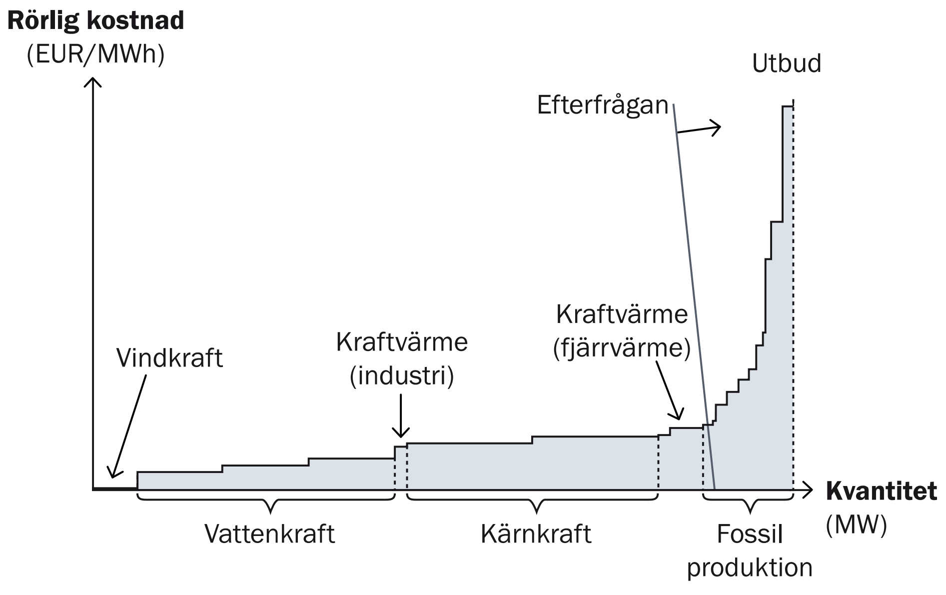
Nu har första veckan av testet gått. Bra jobbat – nu är vi igång!

Som tack till er som tar emot dagliga sms under hela testperioden i mars kommer ett presentkort per lägenhet på Kungsmässan på 300 kr delas ut efter testets slut.

Under veckan hade vi ett mindre tekniskt problem med utskicken men vi hoppas ha löst problemet och att smsen ska skickas ut en gång om dagen under resten av mars, under eftermiddagen eller kvällen.

Genom att kapa toppen på elförbrukningskurvan hjälps vi åt att undvika att fossil elproduktion aktiveras. Bra va?!

De förnybara energikällorna som vind, sol med mera aktiveras nämligen först eftersom de är billigast. Om behovet av el ökar slås även andra energikällor igång. Dyrast är den fossila elen och den aktiveras bara om behovet är väldigt högt. Bilden visar vilken ordning de olika energikällorna aktiveras.

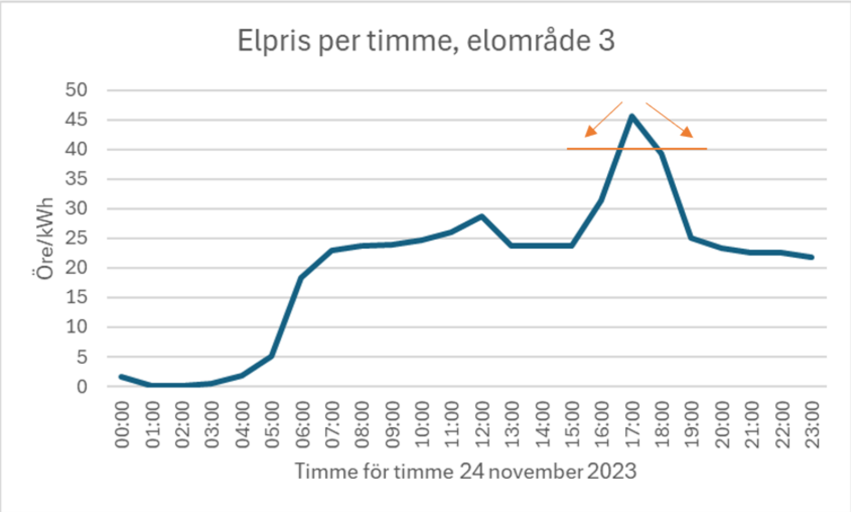


Källa: Energimarknadsinspektionen.

Kolla in på Energimarknadsinspektionens hemsida för att läsa mer om hur det fungerar: https://ei.se/konsument/el/elmarknaden#h-Dagenforemarknaden

Det går även att se hur priserna varierar över dygnet. Oftast är de dyraste timmarna samma timmar som elnätet är som mest belastat och även samma timmar som risken för att fossil elproduktion aktiveras är som störst. Kan vi plana ut elanvändningen under timmarna som det är som dyrast kan vi både få ner priserna och förbättra användningen av elnäten – och underlätta för mer förnybar energi.

Nedan är ett exempel från i november förra året. Vi kan se en tydlig topp i elpriset klockan 18. Troligtvis är denna timme även den timme då risken för att fossil elproduktion aktiveras är som högst. Kan vi minska toppen (genom att använda mindre el just mellan klockan sex och sju på kvällen i detta fall) kan vi få ned priserna och minska risken för att vi behöver slå igång fossila energikällor. Om tillräckligt många av Ekstas hyresgäster minskar sin elanvändning under perioder med höga elpriser skulle det resultera i ett lägre elpris för alla boende.



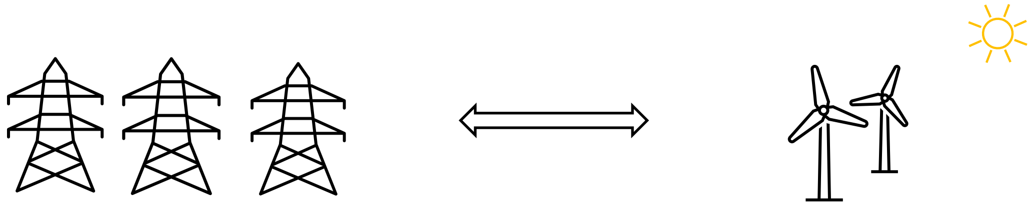
Källa: Nord Pool.

Vecka 2

Hej!

Nu är vi halvvägs igenom projektet! Du och dina grannar gör ett fantastiskt jobb. Genom att sprida ut elkonsumtionen hjälps vi åt att bättre utnyttja den kapacitet som finns i elnäten. Tack vare det underlättar vi för mer förnybar el i ledningarna. Snyggt jobbat!

Hur använder vi elnäten mer effektivt genom att kapa topparna då? Elnäten tar lång tid att bygga ut, och om vi tillsammans hjälps åt att använda befintliga elnät på ett smart sätt kan vi underlätta för utbyggnad av industrier, bostäder och infrastruktur för elbilar. Det kan i sin tur skapa jobb och välfärd.



Du kanske har hört att Pågen och andra företag i södra Sverige har behövt avstå investeringar och utbyggnader eftersom elnätet inte har räckt till. Elnätet behöver byggas ut i stora delar av Sverige, men det tar tid. Tillsammans kan vi hjälpas åt att sprida ut vår elkonsumtion för att använda elnätet mer effektivt – och skapa förutsättningar för företagande och välfärd.

Hos SVT Nyheter kan du läsa mer om skånska företag som flyttar investeringar: https://www.svt.se/nyheter/lokalt/skane/brist-pa-el-gor-att-skanska-foretag-flyttar-investeringar

Hos SVT Nyheter kan du även läsa om en solcellspark i Laholm som försenas på grund av kapacitetsbrist i elnäten: https://www.svt.se/nyheter/lokalt/halland/trots-okat-elbehov-natet-saknar-kapacitet-for-planerad-solcellspark-i-laholm

Gör som dina grannar på Humlevägen – kapa eltopparna!

Som tack till er som tar emot dagliga sms under hela testperioden i mars kommer ett presentkort per lägenhet på Kungsmässan på 300 kr delas ut efter testets slut.

Vecka 3

Hej!

Som du känner till vid det här laget kan vi undvika fossil elproduktion genom något så enkelt som att sprida ut vår elkonsumtion och styra den bort från de dyraste timmarna. Under timmarna med högst efterfrågan ökar risken för att behöva aktivera fossil elproduktion, eftersom de billiga och förnybara energikällorna inte alltid räcker till.

Oljeeldade Karlshamnsverket är en del av Sveriges så kallade effektreserv. Under den kallare delen av året behöver mycket av deras elproduktion finnas tillgänglig för att kunna hålla elsystemet i balans, ifall elbehovet plötsligt ökar. Hos Svenska kraftnät kan du läsa mer:
https://www.svk.se/aktorsportalen/bidra-med-reserver/om-olika-reserver/effektreserv/

I januari höjde Karlshamnsverket sin beredskap för att aktiveras. Om fler gjorde som ni kan vi minska risken för att behöva aktivera fossil elproduktion! Hos Sveriges Radio kan du läsa mer om Karlshamnsverkets beredskap:
https://sverigesradio.se/artikel/karlshamnsverket-i-hojd-beredskap-smugit-igang-produktionen

Som tack till er som tar emot dagliga sms under hela testperioden i mars kommer ett presentkort per lägenhet på Kungsmässan på 300 kr delas ut efter testets slut.

Vecka 4

Tack för din medverkan!

Efter den 31 mars är testet för Humlevägens elförbrukning över. Resultatet av testet kommer att presenteras som en del i en rapport om ENFLATE, och som ett examensarbete av en student vid Stockholms universitet.

Rapporterna och resultaten är inte sammanställda ännu men vi vill rikta ett stort tack till er för er medverkan och för ert engagemang. När examensarbetet och ENFLATE-rapporten är färdiga lägger vi ut länkar till dem här under ENFLATE-fliken på Mina sidor.

Vill du fortsätta styra din elanvändning bort från de dyraste timmarna för att bättre använda elnäten och underlätta för mer förnybar energi?

På Nord Pools hemsida hittar du information om priserna i ditt elområde (Elområde SE3). Timmarna då priset är som högst är oftast samma timmar som elnätet är högst belastat och risken för att aktivera fossil elproduktion är som högst. Från klockan 13:00 varje dag kan du gå in och titta på priserna för följande dag, för att veta när du kan hjälpa till att avlasta elsystemet.

Se länk: https://data.nordpoolgroup.com/auction/day-ahead/prices?deliveryDate=2024-02-07&deliveryAreas=AT,SE3&currency=SEK

Till er som har deltagit under hela testperioden genom att ta emot SMS kommer ett presentkort per lägenhet på Kungsmässan på 300 kronor delas ut.