KUBE 2023

The value of Elhub's data

Effect of price on electricity demand in Norwegian households – A study of differences in two price areas

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Abstract

This paper explores how the spot price affects electricity consumption in otherwise similar households. Through a geographical discontinuity design, we analyze the development in consumption among households on each side of the border between two price areas. This research design allows us to utilize the detail of the Elhub data, and control for other factors affecting electricity consumption without necessarily including more variables. Specifically, we analyze results from the two Norwegian towns Otta and Vinstra in the period of August 2020 to December 2022. During this period, Vinstra, located in the NO1 price zone, experiences an extreme price increase, compared to Otta in NO3. The analysis is focused on two topics: reduction in total consumption and load shifting. We investigate the topic using descriptive statistics and an ordinary least squares (OLS) regression.

Our findings are to a large extent consistent with current research within the field. We find a clear change in the consumption of the high-price area (Vinstra), while the low-price area (Otta) shows only small changes. The price elasticity is –0.18. We observe no clear trends in load shifting.

Understanding trends in electricity consumption is important for the management of and future investments in the electricity grid. A good understanding of these trends is only attained through reliable analysis. Elhub's data makes a great foundation for such analysis. Thus, we wish to shed light on three specific aspects: 1) data storage, 2) data quality and 3) data sharing.

Content

1. Introduction

This paper presents the results from the KUBE 2023 project. The purpose of the project is to demonstrate the value of Elhub's data. Our analysis shows an example where the level of detail in the data is utilized. Here, we investigate implicit demand side flexibility; how consumers adapt their demand when faced with increasing electricity spot prices. Our analysis is thus twofold: First, we investigate if an overall reduction in consumption has taken place. Second, we investigate if this has happened through a reduction in total consumption or through load shifting. We do this by looking at two towns located in different pricing zones, but are otherwise similar, namely Otta and Vinstra.

How and when people consume electricity increasingly affects how Statnett manages the electricity grid. This has happened simultaneously as the activity on the grid has increased, in line with the electrification of society. Understanding demand flexibility is important for making the right grid investments. According to NVE (2022), flexible consumption can be a decisive factor in ensuring the national power balance in 2030. Statnett (2023) also stresses the importance of flexible consumption for grid capacity and future grid investments and considers renewable production and flexibility to be the options of lowest costs for reaching our emissions targets. Further, NVE highlights that the greatest uncertainties and knowledge gaps are related to flexible consumption, such as how consumers respond to high prices.

1.1. Why do we care about load shifting?

The second part of the analysis is concerned specifically with the issue of load shifting. Previous studies (e. g. Hofmann 2023) have shown that consumers tend to reduce their total consumption instead of moving their demand from peak hours to non-peak hours. This was part of the reasoning behind the effect-based tariff model that was introduced July 2022. According to NVE, peak demand has had a stronger growth than overall energy consumption in Norway, meaning that more of the demand is concentrated on hours of peak demand, raising issues of grid capacity (NVE 2022). This is concerning, because the grid needs to be able to handle this load, even in the case that it is needed only very occasionally. Effect balance will also become increasingly important as the energy market becomes more dominated by renewable energy production and increasing electrification. Facilitating demand-side flexibility should thus be a top concern in order to not further strain grid capacity . If households are able to be flexible during peak hours, future expansion of the grid may be avoided, or capacity can be freed up for other uses, such as further electrification of industry.

Historically, we have assumed the flexibility of demand is close to zero, taking the option of flexibility out of the discussion. However, in later years changing market situations (providing better information to consumers and making them stand across the marginal cost of using electricity) have altered with this opinion, with articles showing consumption is more flexible than first assumed.

1.2. What makes our project unique

Three aspects make our project unique: 1) the highly detailed data set we have access to, 2) the events that have unfolded in the past few years, and 3) the features of the energy system and market in Norway.

1) This paper uses the highly detailed data from Elhub. The data is unique in its level of detail, providing hourly data on every metering point in the electricity system. Much metadata is collected on each metering point, enabling us to locate the observation geographically and find its consumer group.

2) As the Norwegian market typically has had low prices, there has been a lack of empirical data with high prices to investigate, until now. That makes the timing of this study crucial, as the past three years have consisted of several interesting events unfolding within the energy system. Most remarkably, the electricity prices have risen to unprecedented heights, the fluctuation in prices have been larger than before, and the differences between the price areas have also been substantial. The starkest contrast can be found on the southern border of NO3. While NO3 has had relatively low prices during the energy crisis, the southern pricing zones, NO1, NO2 and NO5, have experienced high prices. The differences between all zones have been small for the past thirty years, whereas in 2022, NO3 had prices close to zero over longer periods, while NO1 had over 5 NOK/KWh at times (Energikommisjonen 2023).

The high prices have prompted policy responses such as a power price subsidy where households are compensated for the high prices. Further, an effect-based tariff model was implemented July 2022 to better reflect the real costs in the grid. Additionally, the energy crisis has made electricity a big topic in the media and possibly made the population more conscious about their energy consumption.

3) Several features make the Norwegian market especially interesting. Norwegian industry and households are highly electrified in comparison to other countries, with a high share of electrical cars and residential heating based on electricity. Further, the typical Norwegian consumers pay their electricity bills based on spot price. Lastly, the electricity market is split into five pricing zones, where the prices within the zones are determined by supply and demand within any given hour, as well as the transfer capacity between the zones.

To the extent of our knowledge, this is the first study to truly exploit the advantages of the unique features of the Norwegian markets with such detailed data and at a point in time when the energy system has gone through major changes simultaneously. The next sections of this paper first summarize the relevant literature, then it gives a description of the methods used for analyzing the topic and an overview of the data as we have so profoundly told the value of. We go on to give the main results from the analysis, and end the report with a discussion and conclusion.

2. Literature Review

While price elasticity of demand and reduction in total consumption has been a hot topic, the literature is rather sparse when it comes to load shifting. We provide here a brief review of the articles we find the most relevant for our analysis.

Fabra (2021) looks at consumers responsiveness to nation-wide rollout of real-time pricing in Spain in 2015 and finds that consumers do not respond significantly to real-time pricing. This confirms findings from other studies with large empirical evidence. Compared to the Norwegian situation, Spain is less electrified, and there is likely less use of information. The potential for saving is too low and the incentives are not strong enough, as the range between highest and lowest price is quite s

mall. The paper suggests that awareness, access to information, the ability to adapt one's consumption as well as substantial price differences are necessary for consumers to respond to price incentives. This might be indicative of our analysis giving different findings.

Ito (2014) uses a geographical discontinuity design similar to ours, but investigates the effect of a different type of price scheme: average vs. marginal price. By investigating demand in zones with different price schemes, he finds that consumers respond to average prices more than marginal prices. Similar to Fabra (2021) the author suggests that this suboptimal behavior comes from the information cost – it may be harder for consumers to understand non-linear prices. This highlights the importance of awareness and information to make consumers respond to price incentives.

Hofmann (2023) finds through a pricing experiment in Norway that consumers mainly reduce their overall consumption, rather than moving their demand to hours of the day with lower prices. He finds that consumers are elastic in hours with high prices, but consumers do not react significantly to the magnitude of the price increase.

Patrick and Wolak (2001) analyze five industries in England and Wales and their potential for intertemporal substitution in electricity consumption, i.e. load shifting. The industry is subjected to a demand charge, very similar to the newly introduced effect based net tariff on Norwegian consumers. They find a very heterogeneous response across industries.

3. Methods & Data

This section introduces the research design used in our analysis, and the foundations of which this design was chosen. Secondly, we give an overview of the data used in the analysis, and where it is retrieved from. Lastly, we explain the process of filtering our data and the statistical methods for analysis.

3.1. Research design

For this analysis we have chosen a geographical discontinuity design as it fits well with our detailed data and allows us to isolate the effect of price, while holding other factors constant. In other words, by utilizing the detail of the Elhub data we can control for other factors affecting electricity consumption without including more variables. Specifically, we will compare two areas on each side of a border between two price zones.

When deciding on what prize zone border to investigate we were particularly interested in the southern border of NO3, because this is where we have seen the largest variations in price over the past few years. While NO3 has stayed relatively constant, with low and stable prices, the southern regions, NO1, NO2 and NO5 have all experienced soaring and very fluctuating prices. We deem it unlikely that any long-term effects of the differences between the pricing zones have arisen at this point, and thus we can assume that we observe the effect of price on consumption.

We settled on investigating the towns of Otta and Vinstra, as they are close to each other and share many demographic characteristics, but on each side of the border of NO3. This was decided partly because the area along the border is more sparsely populated, making this the main area where we can obtain a large number of observations. The location of the five different price areas and the location of Otta and Vinstra is shown in the figure below.

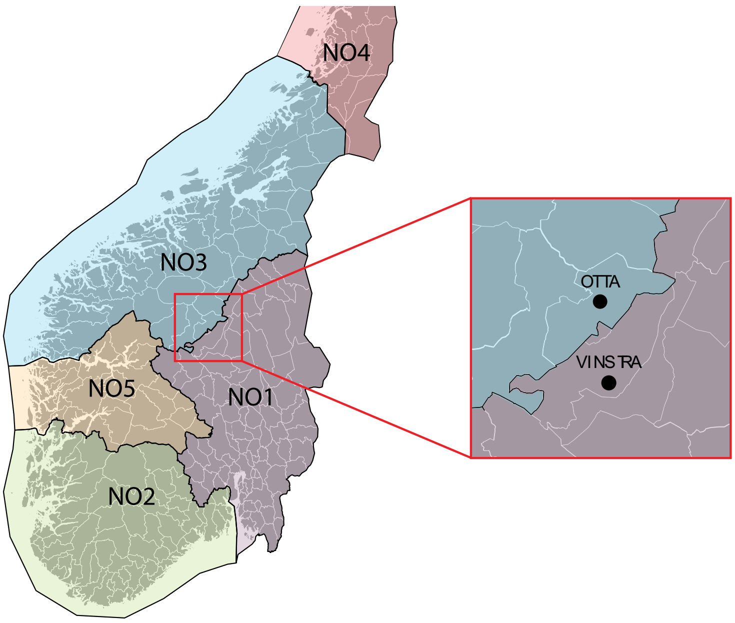

Fig. 1. Map of price zones with zoom-in on the area of analysis.

The similarities between the two towns are the main reason for choosing them as part of this analysis. The figure below shows statistics collected from **SSB** on demographic data for the two towns. Otta and Vinstra have a similar share of electric vehicles (EVs). Additionally, we can observe that Otta and

Vinstra typically have the same temperatures, which is typically the main factor affecting electricity consumption in households in Norway. When it comes to housing, they both have a very low share of apartments – only 1 % and 3 % of all households. There is, however, a small difference in construction year, with a larger share of houses built prior to the 1970`s in Otta compared to Vinstra.

Sadly, we do not have any data on household sizes, the number of people in a typical household, nor the average size of housing in square meters. Neither do we have information on income or more socio-economic factors. This can potentially be factors affecting our analysis that we are not able to control for, leading to omitted variable bias in our analysis.

As an alternative to Otta and Vinstra we also considered Høyanger (NO3) and Balestrand (NO5). These areas were not chosen mainly because the population size in the two areas is different. Also, Høyanger is the place of a university, meaning the demographics of the two towns are not as similar as Otta and Vinstra. We urge others to apply our analysis onto the areas of Høyanger/Balestrand and other places to analyze whether the same results hold.

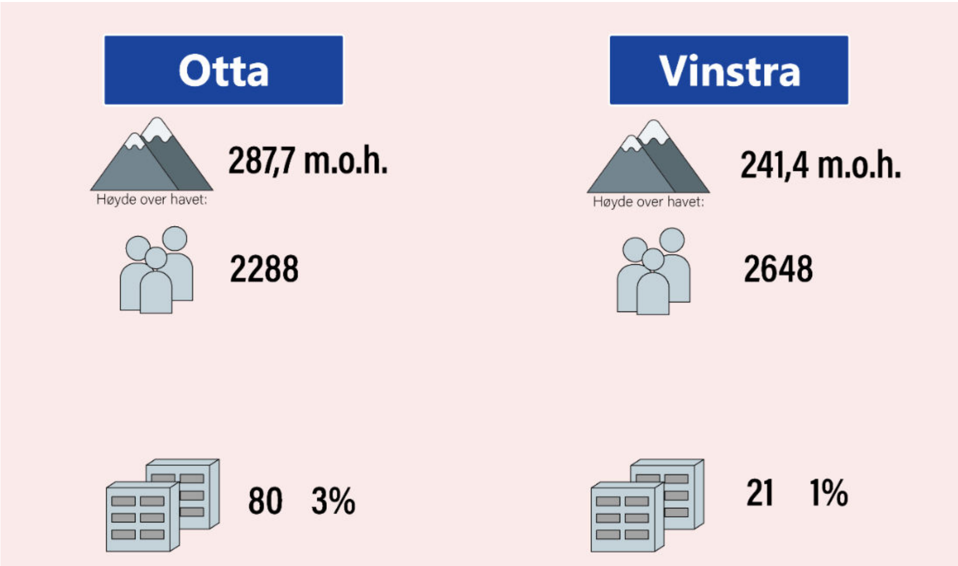

Fig. 2. Characteristics of the towns of Otta and Vinstra.

A common difficulty with this type of research design is the danger that effects from other factors follow the same border. That is often the case when one observes borders that follow administrative borders, like counties or municipalities. In general, that is not the case with the borders of the pricing zones, as these have been drawn after what is sensible according to the existing electricity grid. This reduces the threat of compound treatment effects and allows us to assume that all other factors can be held constant. However, the large part of the population in our two areas of interest are in separate municipalities, but the border does not one-to-one overlap with the price zone border. We were not able to find any factors that could have a significant effect on our outcome of interest connected to municipality administration.

It is worth noting that the areas chosen are not large cities, but rural towns. This has the implication that our findings might not be generalizable to more urban areas. As Hofmann (2022) has noted earlier, charging of electric vehicles are typically the most common option for load shifting in Norwegian households. Given that it is more common to own EVs in larger cities this may give us different findings to what one could expect for more populated areas. Also, one would expect the characteristics of the housing and population in Otta/Vinstra to vary from that of the entire population. We expect the housing in Otta/Vinstra to be more dominated by houses than in larger cities where apartments are more common. Lastly, the temperature and weather conditions in Otta/Vinstra might create a disparity between how they are affected by price changes as compared to the country as a whole. To summarize, the result from this survey might have limited external validity without further analysis.

3.2. Data & time-period

For the analysis we have included data from multiple sources. We have gathered data on both electricity consumption, electricity price and temperature for the chosen area.

The main data source for the analysis is Elhub's own data. Elhub gathers data on both consumption and production of electricity from 3,3 million metering points through Norway. The metering values has a time resolution of one hour, and each metering point contains metadata about location, grid company, and consumer code for each metering point. The data is given in kilowatt-hours (kWh) used per hour. The data is collected by advanced metering system (AMS) readers placed on the consumption/production unit - and reported to Elhub by the respective grid company. Due to regulations and privacy concerns, Elhub is only allowed to store data for a maximum of three years. Also, because of time constraints the data available to us ends about half a year before our project starts. This means that the analysis is being conducted on data collected in the period between 1. August 2020 and 31. December 2022.

Temperature data is retrieved from the Norwegian Centre for Climate Services. From here we have obtained data from three different temperature measuring points: central Otta, north of Otta and halfway between Otta and Vinstra. The temperature is given in degrees Celsius.

Data on the electricity price is retrieved from Elhub. The data gives us the spot price for electricity per hour, per price area. The spot price is given in Norwegian kroner (NOK) per kWh and is known the day before the actual consumption happens. This means that there is time for the consumer to adapt its use of electricity to the price curve throughout the day. Information on price for NO1 - Southeast Norway (Otta) and NO1 - Central Norway (Vinstra) is retrieved from this source.

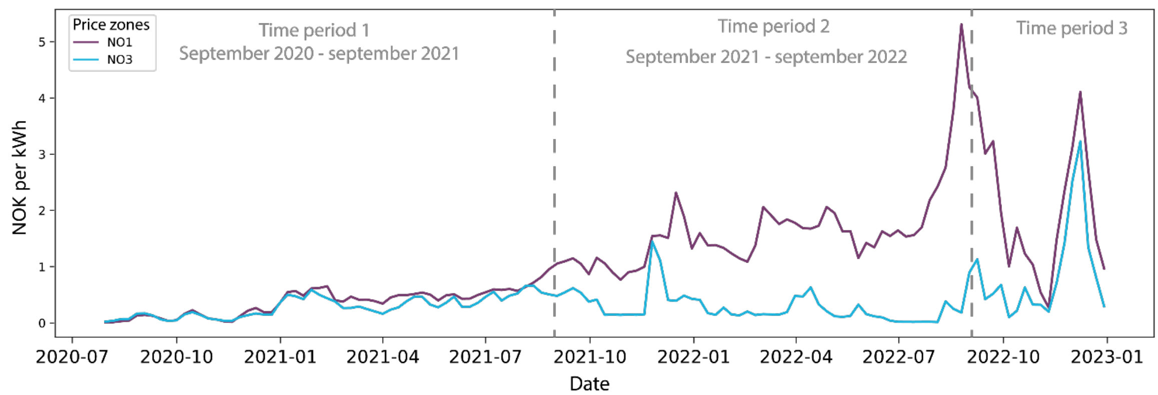

Fig. 3. Price development through the period for NO1 (Vinstra) and NO3 (Otta)

Based on trends in the spot price (hereafter referred to as price) we have split our data set into three main time periods. The specific dates of the periods are outlined in table 1 and shown graphicly, along with the price in the figure above.

Table 1. Exact dates of chosen time-periods

Period	Start	Stop
1	3. August 2020	31. August 2021
2	1. September 2021	31. August 2022
3	1. September 2022	7. December 2022

One shortcoming in this study is that the data only goes back to august 2020. 2020 was by no means a normal year, with the pandemic and abnormally low electricity prices. This makes it difficult to determine a sensible baseline. Thus, it is important to take results with a pinch of salt when we compare the different time periods in our data set.

3.3. Data treatment

The quality of the data has been a challenge through this analysis. Some metering points were categorized as households but turned out not to be. These were detected by comparing the data from Elhub with data from grid-owners, containing estimated annual consumption and installation description of each metering point. Filtering out missing description and description containing apartment or residence made it easier to find metering points that were not classified correctly in Elhubs data. After manually going through and filtering out metering points that could potentially be a household, the remaining points were a list of mainly farms, cabins and business facilities, and was removed from the original dataset.

Removing outliers were done in two ways. The first thing was removing metering points with an annual consumption above 50.000 kWh in 2021. The reasoning behind this removal was because the average annual consumption in Norway is approximately 16.000 kWh according to SSB. Old houses may consume more due to poor insulation, so a threshold below 50.000 kWh could remove important information.

We also removed metering points with a large deviation from estimated annual consumption. 97 metering points had a deviation above 60% and could impact the general impression of change in consumption and therefore removed. The last removal was a metering point with a consumption of 29.98 kWh for one hour. This was done by the assumption that the AMS meter for this metering point might be defective.

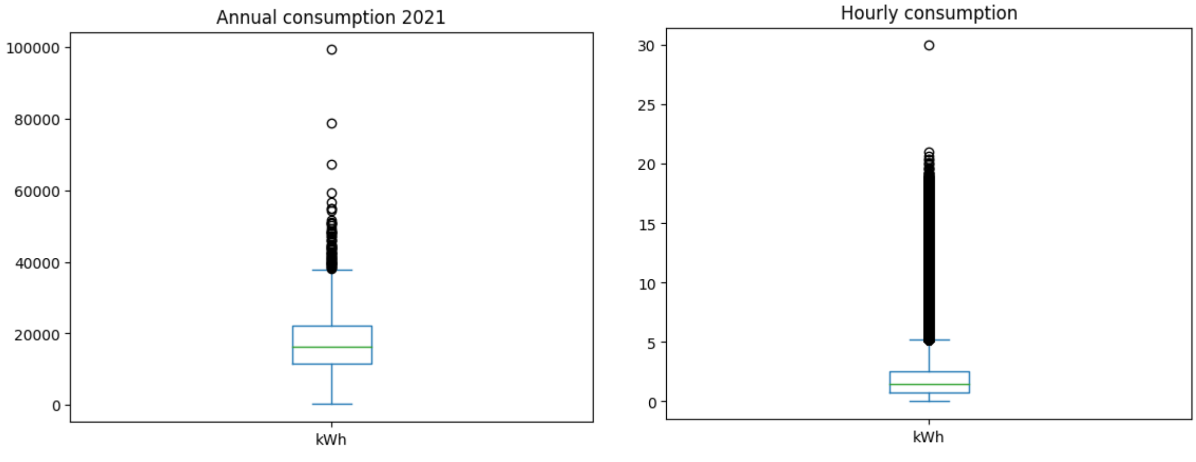

Fig. 4. (left) Boxplot of annual consumption for metering points in Otta and Vinstra for the year 2021. (right) Boxplot of hourly consumption for Otta and Vinstra between 01.08.2020 and 01.01.2023.

3.4 Econometric methods

The main part of our analysis is retrieved from descriptive statistics. What factors are portrayed and what filtering is applied to each analysis is explained in the figure text under the respective figure.

For investigating total reduction in consumption, we have applied an ordinary least squares (OLS) method. The OLS is fitted for each separate household. OLS is used to model the relationship between a dependent variable and one or more independent variables, this analysis use kWh as the dependent variable and price per kWh (NOK_KWH) as the independent variable.

The natural logarithm of the kWh (usage per hour) and NOK_KWH (cost per kWh) variables were taken. The log transformation is often used to handle data with a skewed distribution and can help to stabilize the variance and make the relationship between variables more linear. The OLS regression is specified with the formula,

$$\log(kWh) \sim 1 + \log(\text{NOK\_kWh})$$

Here, kWh is the usage per hour, representing the outcome of interest, and NOK_KWH is the cost per kWh for the corresponding hour, also known as the predictor variable. The formula indicates that we want to model kWh as a function of a constant term (the intercept, denoted by 1) and the variable NOK_KWH.

The statsmodels.api library from python is used to perform this analysis. The OLS model assumes a linear relationship between the dependent variable kWh and the independent NOK_KWH and aims to find the intercept and coefficient for NOK_KWH that minimize the sum of squares between the observed kWh values and the predicted kWh values from the model. The estimated coefficients represent the effect of NOK_KWH on the kWh values. A positive coefficient would suggest that an increase in NOK_KWH is associated with an increase in kWh, while a negative coefficient would indicate a negative relationship. The model is applied to each household and plotted in a frequency plot to get the distribution of both Otta and Vinstra for different time periods.

The electricity price is jointly determined by demand and supply of electricity. In the spot price market, the price is settled the day before consumption happens. Consequently, investigating the effect of price on demand could introduce simultaneous causality bias. That is, the price affects demand, but the demand also affects the price. To reduce this bias, we used actual total load data instead of day-ahead load. However, consumers are often themselves not involved in market transactions, making them price takers. Also, our analysis investigates only the consumer group households and only the areas of Otta and Vinstra. Thus, our sample makes up only a small share of the consumption in each price area while it is the load for the entire price area that contributes in determining the price. Still, there may be some bias due to the strong correlation between actual total load and day-ahead demand. In addition, our sample generally follows a similar load trend as that of the entire price area. Because of these issues, we should in our analysis not focus on the exact numbers themselves, but rather the difference in effect between Otta and Vinstra.

The model includes only a few variables due to time constraints. Other variables not included in the model might have an impact on hourly demand. If this is the case, we might have a presence of omitted variable bias in our coefficient estimates.

4. Findings

This section describes the central findings from our analysis. We start off with reduction in total consumption, then we move on to load shifting. Descriptive methods and statistical inference will here be explained in the section for which it best fits according to its topic.

4.1. Total reduction

The overall trend in total consumption is important primarily for the energy balance, i.e., the balance between production and consumption over a longer period of time. In comparing the overall development in Otta and Vinstra, we do not control for temperature over time, so we will primarily focus on the difference between the two areas, as variations over longer periods of time could easily be due to differences in temperature.

The figure below shows hourly consumption per metering point, averaged over each town and month. The time aggregation is carried out to remove unnecessary noise from the results. We see that consumption shows a clear pattern of following the temperature. The red line is connected to the next figure.

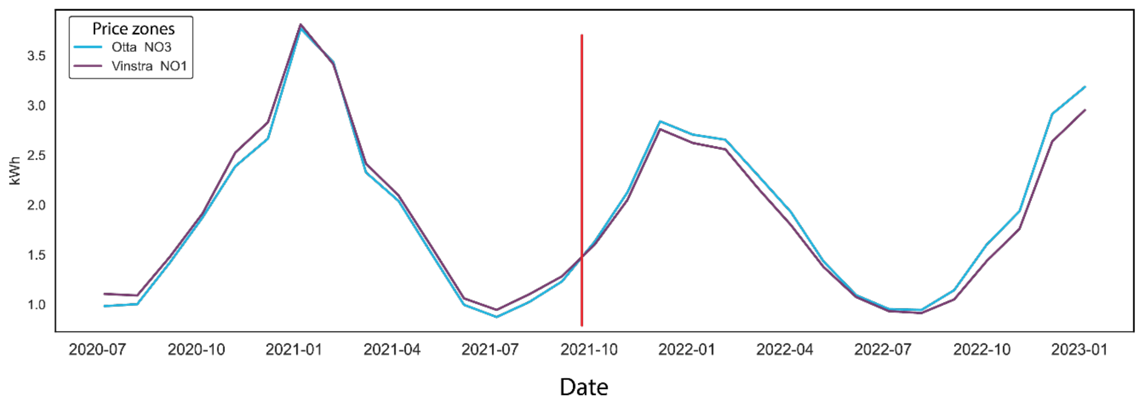

Fig. 5a. Historical consumption in Otta and Vinstra.

The figure below shows the difference between Vinstra and Otta from the above figure. It shows the difference between Vinstra and Otta in monthly average of hourly consumption per metering point. The x-axis represents time. The red line marks the transition from positive to negative values. The same point in time is shown in the graph above. We observe that starting out Vinstra (high price) has a higher consumption than Otta (low price), although varying. From October 2021 there is a clear shift, with Otta taking over as the largest consumer. As we observed a large price increase starting from August/September 2021, this can point in the direction of consumers in Vinstra reacting to the price increase with some delay. Considering that power bills are often charged after the end of the month, this is a reasonable result. We note that this figure does not show any clear seasonal pattern.

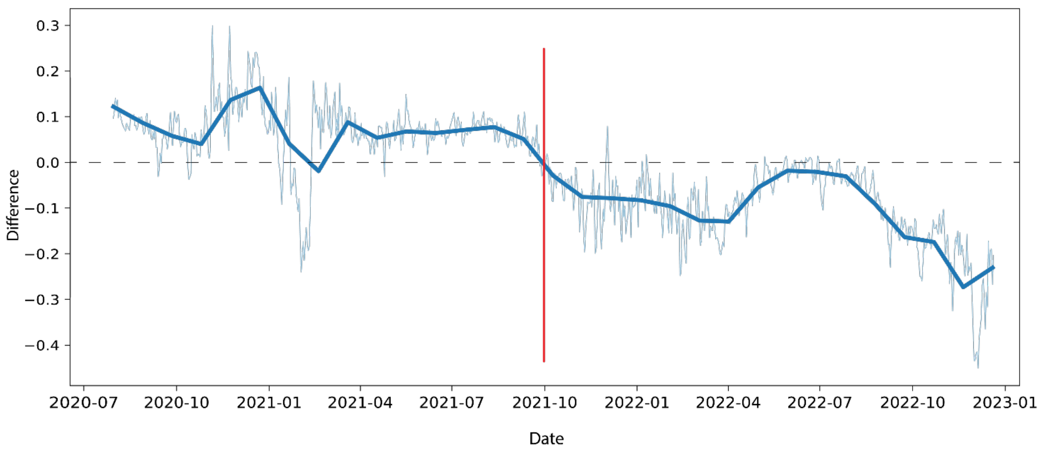

Fig. 5b. Difference in consumption between Otta and Vinstra.

Taking a multiple linear regression approach (as explained in the method & data section) we investigate the price elasticity of consumption. Elasticity is defined as the percentage change in consumption per percentage change in price. The figure below shows the distribution of the elasticity per household. That is, a broader curve indicates more variation among households in how elastic they are to price. We find that throughout the period all curves become sharper, showing less variation than initially.

Second, we observe that Vinstra distinctly reacts in the high-price period, while Otta stays relatively similar. In fact, the hourly price elasticity for Vinstra in Period 2 (which has a significant increase in price) is –0,18. One interesting point to notice is the positive average of the coefficients in Otta through the entire period. This is likely due to the simultaneous causality bias, or reverse causality, as earlier mentioned. People are more likely to use electricity during hours with higher prices, but not *because* of the higher prices. This effect is most likely present in both Otta and Vinstra, thus the graph could look different in both if it were possible to control for this effect. Note that the graph shows the hourly elasticity, i.e. how consumers react to the price within the same hour.

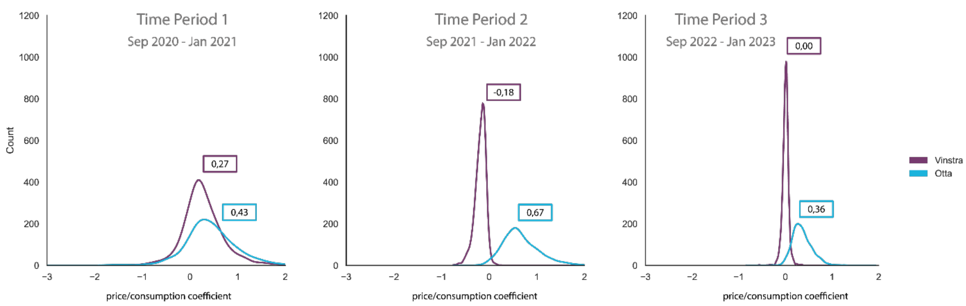

Fig. 6. Distribution of elasticities.

4.2. Load-shifting

While total demand is important for the energy balance, peak demand is important for the electricity grid, and especially for future grid investments. The detailed data from Elhub allows us to break down the data to hourly demand and investigate to what extent consumers respond to prices by shifting their demand to different hours of the day. This is particularly important for estimating the need for future grid investments.

This section starts by giving an overview of the daily load. The figure below shows the hourly consumption through the day for different time-periods, averaged for Otta (left) and Vinstra (right) respectively. The figure shows only parts of the full time period we have available. This is done to make each line-plot show the same time of the year, and make the intuition clearer. The plot filters away weekends. We observe that consumption follows a clear pattern through the day, depending on people's habits. Also, there is a striking difference between Otta and Vinstra.

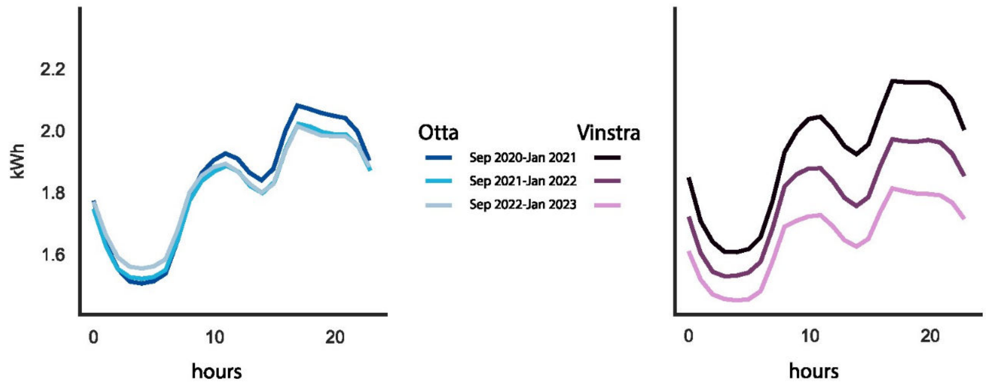

Fig. 7 - Daily load in different periods Otta v. Vinstra

We now dive deeper into the difference in consumption between peak and non-peak hours between the areas, shown in the figure below. Here, the morning peak is defined as 07:00-09:00, while the evening peak is 17:00-19:00 for all days. Data from weekends are not included in the figure. The graph is shown in percentages (using Vinstra as base) to remove seasonal variations. We observe weak indications of load shifting in both places, but not enough to conclude that this is clearly happening.

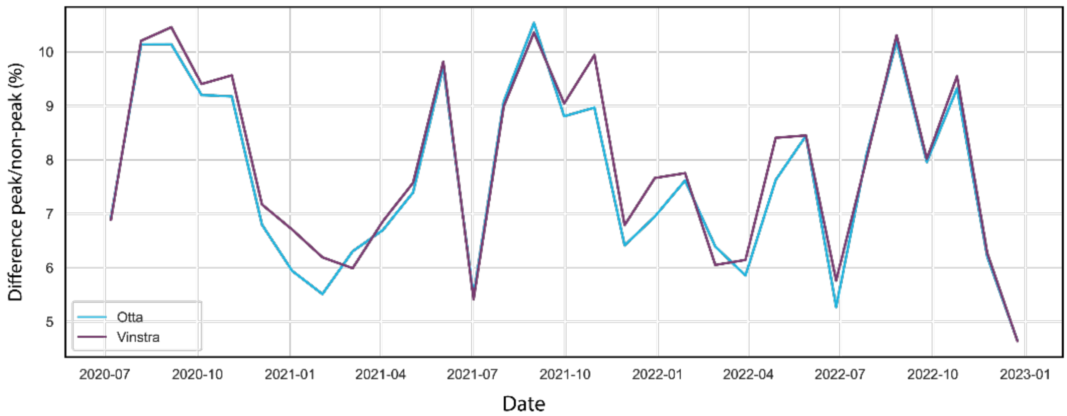

Fig. 8 – Percentage difference in consumption for peak vs. non-peak hours in Otta and Vinstra.

The finding above is also shown statistically by fitting a regression line to the result, as shown in the figure below. The regression line for Vinstra is steeper than for Otta, further reducing the difference between peak and non-peak, which implies that Vinstra has smoothed out the daily consumption more than Otta. However, there is not enough evidence to say that this is the case. The reason is that the confidence interval, the blue shaded area, contains possibilities of both positive and negative slopes on the curve.

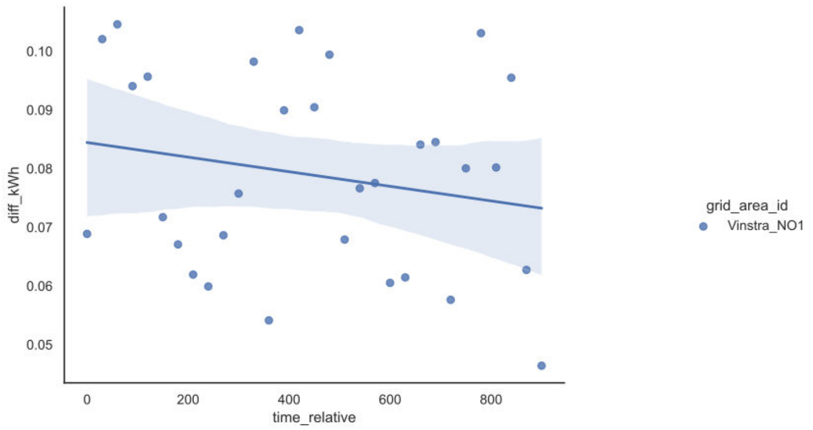

Fig. 9a. Regression line for percentage difference in consumption for peak vs. non-peak in Vinstra

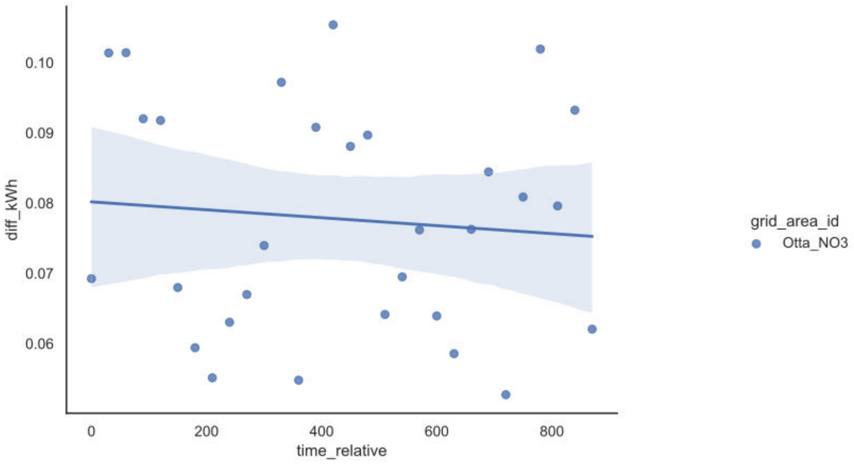

Fig. 9b. Regression line for percentage difference in consumption for peak vs. non-peak in Otta

5. Discussion

In this section, we will discuss the findings of our analysis and possible venues for future research.

5.1. Discussion of the results

In our analysis, we find a relatively small indication of load shifting, which is in line with the existing literature. However, Fabra (2021) outlines certain conditions that lack in the case of real-time pricing in Spain for consumers to be flexible – the price incentives are not strong enough, i.e. the price difference between peak hours and non-peak hours are too small, there is not enough potential for saving electricity and there is a lack of information. The authors hypothesize that consumers do not have enough to gain from responding to prices to actually adjust their behavior. All of these conditions are certainly more present in the case from Norway that we have investigated, in comparison to the case from Spain. The price incentives are stronger in the sense that the difference in prices within a single day has at times been very high in NO1, the pricing area encompassing Vinstra. There is most likely more potential for saving electricity as heating is typically electric in Norway, and overall per capita consumption of electricity is the second highest in Europe. There is also, most probably, more widespread information on electricity prices, as it has been subject to much debate in recent years, and being informed on prices and consumption through mobile applications has become more common. Despite our case at least coming closer to fulfilling these conditions, we do not see any substantial degree of load shifting. This could be an indication that implicit demand flexibility is not a substantial alternative to grid expansion, as peak demand will continue to increase, or, at best, stay the same while consumers respond to price signals by reducing their total demand instead of shifting demand.

5.2. Future research

This paper opens several venues for future research. We think a natural first step would be to further investigate load shifting, especially in the context of the recently introduced effect based net tarif. The new net tarif was implemented July of 2022, after being postponed from its intially planned implementation of January 2022. We have chosen not to focus on this in our analysis, as we do not have much data from the time after. Further, there might have been confusion among consumers about the implementation date, which might lead to a distortion of the results.

The net tarif is supposed to be evaluated in the fall of 2024, and a thorough analysis on consumers' peak demand could be a good basis for such an evaluation. The level of detail in Elhubs data would be crucial for such an analysis, as one could look at how individual households have shifted their demand within a day, how this develops over time, and if this coincides with peak demand hours in the grid or not. The issue of load shifting should be investigated further as it is crucial for grid capacity, and this paper, along with other studies, gives clear indications that load shifting rarely takes place. For making recommendations for policy and market design, there are substantial knowledge gaps to fill first.

6. Conclusion

This paper presents the results from the KUBE 2023 project. The purpose of the project is to show the value of Elhub's data. The most striking data attributes are its hourly time resolution and information per metering point, as well as the metadata entailed, such as information on consumer groups and geographical location. Our analysis shows an example where the level of detail in the data is utilized.

In this paper we have explored how the spot price affects consumption in otherwise similar households. Through a geographical discontinuity design, we have analyzed the development in consumption among households on each side of a border between two price areas. This research design allows us to utilize the detail of the Elhub data, to control for other relevant factors affecting electricity consumption without necessarily including more variables. Specifically, we analyze results from the two towns Otta and Vinstra in the period of August 2020 – December 2022. During this period, Vinstra, located in the price area NO1, experiences an extreme price increase, compared to Otta in NO3. The analysis has focused on two topics: reduction in total consumption and load shifting. We have investigated the research questions using descriptive statistics and an ordinary least squares (OLS) method.

Our findings are to a large extent consistent with current research within the field. We find a clear change in the consumption of the high-price town (Vinstra), while the low-price area (Otta) shows only small changes. The price elasticity is however small: -0,18. On the other hand, when it comes to load-shifting we observe no clear trends.

Trends in electricity consumption are increasingly important for how Statnett manages the Norwegian electricity grid. A good understanding of these trends is only attained through reliable analysis, and Elhubs data can make a solid foundation for such analysis with its level of detail.

References

Energikommisjonen NOU 2023: "Mer av alt - raskere"

Fabra, Natalia, David Rapson, Mar Reguant, and Jingyuan Wang (2021): "Estimating the Elasticity to Real-Time Pricing: Evidence from the Spanish Electricity Market." AEA PAPERS AND PROCEEDINGS, VOL. 111, MAY 2021 (pp. 425-29)

Hofmann, Mathias and Karen Byskov Lindberg (2023): "Evidence of households' demand flexibility in response to variable electricity prices – Results from a comprehensive field experiment in Norway"

Koichiro, Ito (2014): Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing. American Economic Review Vol. 104 No. 2 2014.

Norges Vassdrags- og Energidirektorat (2022): Norsk og Nordisk Effektbalanse mot 2030

Patrick and Wolak (2001): Estimating The customer-level demand for electricity under real-time market prices. National Beaurea of Economic Research.

Statnett (2023): Langsiktig Markedsanalyse