GRID VALUE AND DEFECTION: A DEMAND PERSPECTIVE

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ABSTRACT

This paper highlights the value that home owners and renters place on the gas- and electricity grid is substantially above current grid costs. In addition there is a relatively high willingness to spend money to become self-sufficient and independent.

INTRODUCTION

Energy expenditures amounts to about ~6% of gross domestic product in the Netherlands [1], a figure that is representative of most European countries. Expenditure on the electrical and gas grid amounts to 1% of GDP, around 6 billion EUR in 2015 [2]. This amount is set to increase due to grid extensions, especially for the electrical grid. Electric and gas asset value amounts to ~ 29 billion EUR for the electrical and gas grid assets combined in the Netherlands, amounting to 1.750 EUR per inhabitant, or about 0,8% of total wealth in the country [3].

RESEARCH QUESTION

With these large income and wealth effects, how do individuals value the service provided by the electrical and gas grid? And more importantly, how do they expect to change their usage of these grid assets? This paper seeks to outline a first answer to these questions. A first answer as not much research has focussed on how people value the grid services and its reliability.

METHODE

The method used is a large-scale survey of the Dutch home owner and renter population. The home owners and renters are drawn from a representative distribution the Netherlands, where 52% of homes are home owners and 48% of renters. Survey size is 1000 and completed surveys reached 550, meaning a 55% completion rate.

The survey used a paid-for panel, so as to ensure a high-participation and motivation and control for other factors such as living location in the country, age, sex, education and type of home. The sample obtained from the population is a sufficient representation.

Sample results

The sample from the population of home owners and renters are provided below:

Sample	Unit	Outcome
Education	[highest achieved]	2% elementary school 22% high school 39% vocational 30% higher vocational education 8% university
Age	[years]	52 average 56 median 27 10%-percentile 70 90%-percentile
Gender	[male-female]	48% - 52%
House ownership	[ownership, renting]	49% ownership 51% renting (11% private sector)
House age	[year of construction]	8% before 1930 28% 1930 - 1970 35% 1970 - 1990 21% 1990 - 2010 8% after 2010

The survey questions are added at the end of this paper.

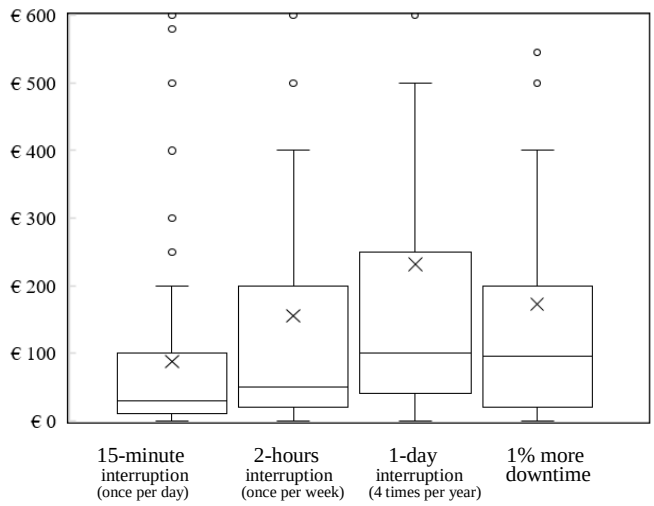
RESULTS

The results can be summarized in three categories: reliability value, grid value and grid defection value.

Reliability

How do people value reliability? We've defined reliability as grid interruption and probed this perceived value using four questions. All questions represent 1% reliability.

Figure 1: perceived grid reliability value



Note: current grid reliability stands at 99,99% in 2015.

People indicated that they we're willing to go without electricity for 15 minutes, once per day, if they received 88 EUR per month on average. The median value is much lower at 30 EUR per month. This highlights that there is a small group that requires a very large amount. Indeed, the 90-percentile is 200 EUR and the 95-pecentile stands at 500 EUR per month.

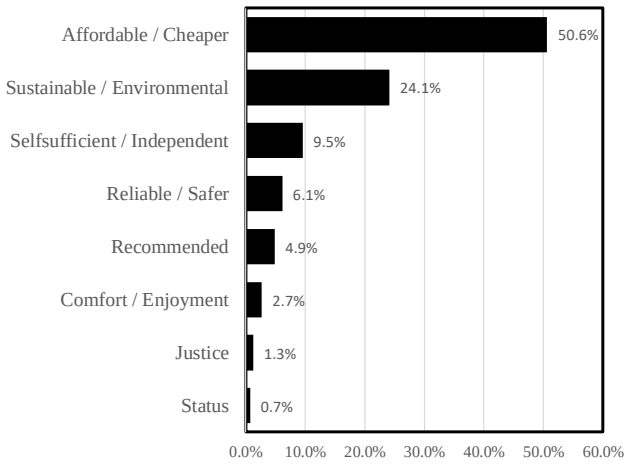
In addition, people in the survey indicated that they require a higher amount when the amount of time without electricity increases. For a two hour interruption, once per week, they require 155 EUR ± 269 EUR on average and for one day per quarter it increases to 232 EUR ±334 EUR.

Interesting, there is a small group, roughly 10% of the sample, that would accept a 1% reliability decrease for only 5 EUR per month. The reason could be part of the driving motivation of the different individuals.

Individual motivations for a grid alternative

To start to understand the driving motive to consider an alternative to the existing grid(s), the survey participants we're questioned into their main driver to consider an alternative. The main occurring driver was better affordability and a cheaper alternative at 51% of respondents. More surprisingly, the sustainable / environmental share was 24% and 10% for self-sufficiency / independence. This group of self-sufficiency / independence might provide an explanation for the low value observed in the grid reliability. Obviously, more research is needed regarding this point.

Figure 2: main reason to consider an alternative to the current grid



Reliable and safer was the fourth category mentioned as main driver at 6% with the other categories taking smaller shares. One striking observation is the very low percentage which indicates status as main driver. The reason for this is unclear, but might be related to the fact that energy supply is not a status good or that this is considered an non-socially acceptable answer.

Grid value

How to Dutch home owners and renters value the electrical and gas grid? What would they be willing to spend to go without? These are relative difficult question to ask and to consider, mostly because the service is so taken for granted service. Therefore, we first introduce the questions asked after which we proceed to the results:

1. Suppose you are moving to a house which has a gas/electrical grid connection and you obtain an offer to forgo the gas/electrical connection. How high would this amount have to be for you to accept this?
2. How much are you willing to spend to be self-sufficient in energy? While maintaining gas and electricity.
3. How much are you willing to spend to be independent in energy? Without maintaining gas and electricity.

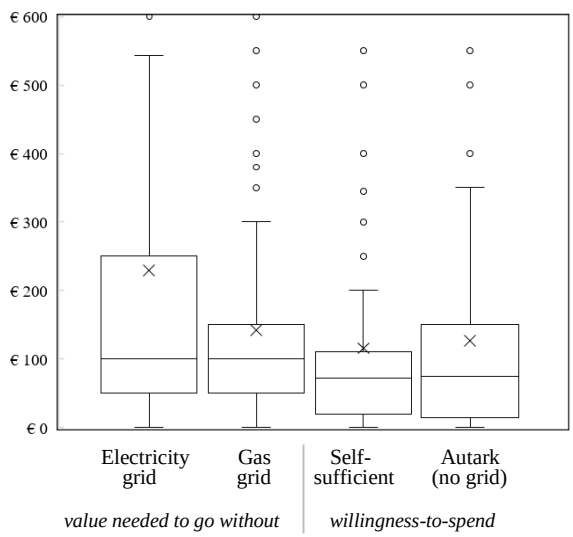
Gas grid value perceived at 142 EUR per month

The gas grid is valued at 142 EUR ± 192 EUR per month on average while the median value stands at 100 EUR. Both values are high when compared to costs and household income. Gas grid expenses amounted to 14 EUR per month per household, an order-of-magnitude smaller than the indicated value. Compared to income, the 142 EUR per month amounts to ~4% of average individual income. Now, let's look at the electrical grid value in turn.

Gas grid value perceived at 229 EUR per month

The gas grid is valued at 229 EUR ± 320 EUR per month on average while the median value stands at 100 EUR, which is similar to the gas grid. Which implies that the electrical grid is valued 60% higher than the gas grid. The higher value is mostly explained by a small group which requires a very high sum to go without the electricity grid. This is represented by the 90-percentile which stands at 500 EUR and the 95-percentile at the 100 EUR per month amount.

Figure 3: perceived grid value



Next, let's look at the result when the question is inverted. How much are you willing to spend? Instead of what would you want to obtain to forgo use of the grid.

Self-sufficiency is valued at 116 EUR per month
Self-sufficiency, meaning producing as much energy as is used, while maintain the gas and electrical grid connection, is valued at 116 EUR ± 224 EUR per month on average while the median value stands at 73 EUR. Interesting, the spread in the indicated value is smaller than in the earlier two questions.

Independence from the grid is valued at 127 EUR per month
Independence from the grid, or autarky, meaning being self-sufficient without using the grid is valued slightly higher than with a grid connection. Independence is valued at 127 EUR ± 239 EUR per month on average while the median value stands at 75 EUR.

It seems logical that the first set of questions yields a higher value, what do you want to obtain, compared what are you willing to spend. However, the values are not very different in magnitude.

What do the DSO's expect

From a grid distribution perspective, the grid defection possibility is the most relevant and valuable. Since 2011 the amount of grid connections has grown by about 1,5% amounting to about 100.000 for electric connections slightly less gas connections [4], [5], [6]. Despite the growth, a growing number of DSO's expect the number of gas connections to decrease or decrease quite rapidly [5].

How to interpret these values? We come to this in the conclusions, let's first look at the intention of using heat pumps, solar panels and electrical vehicles. All three are technologies that would have a large impact on grid use.

Electric cars expected to become widespread

A third of respondents expects to buy or lease an electrical car. When asked when they expect to start buying or leasing the following results are obtained for the indicated third: 2% indicated to already own an electrical car, 4% indicates within 2 years, 5% indicates within 2 to 5 years, 6% between 5 and 10 years and 16% indicates not to know when.

The effect of such a switch would amount to 18% indicating to switch within 10 years which would amount to 1 million cars by 2026. In case a third will switch to electric vehicles, this would amount to 2 million vehicles.

When asked if respondents expect whether to charge the electrical vehicle from their home, they indicate the following: 53% expects not to charge from their home, 47% indicates charging at home. Corresponding quite well with the split in home ownership and renters.

Finally, a quarter of the people expect to charge more than 50% of the required amount of electricity, while a fifth expects to charge less than 50% at home. The remaining three-fifth does not know how much they will be charging at home. If these finding are correct, this implies that only a quarter of electricity consumption of the electric vehicles might be charged from the home.

When asked how the they would want to charge the vehicle, a third responds that they want to start charging when arriving at home to fill up the as quickly as possible. Another third indicates they would charge the vehicle more flexible as long as the battery charge is sufficient for the next journey. The final third hints that they would charge flexibility, and the home could use the electricity as long as they would save money by doing so.

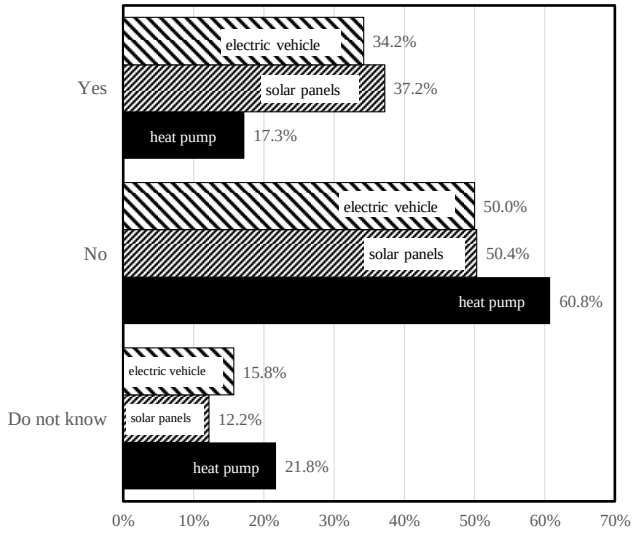
Combining the above results, indicates that a full third of the 1 to 2 million electrical vehicles would create a non-flexible demand, adding to the grid load. Assuming a 10 kW_{el} charger, this would imply a potential worst-case 10 to 20 GW_{el} non-flexible demand. The highest number being similar to the current available production capacity in the Netherlands. And this would probably at a time when no or much less solar production is available.

Solar panels expected to become even more widespread

Solar panels, meaning photovoltaic cells, are indicated in the sample to be put up/installed in 37% of all cases. This divides into 10% which indicates to already have solar panels, 8% expects to put up panels within 2 years, 6% between 2 and 5 years, 2% between 5 and 10 years and 11% doesn't know when.

For the 7.8 million Dutch households this would translate into 2.8 million who expect to put up solar panels. For illustration of the potential impact, let's assume 8 panels of 255 $Watt_{peak}$ which would add ~6 GW_{peak} to the grid, all of it in the local grid. This would increase solar-PV capacity six-fold. More importantly, it indicates a faster adoptation than current national and DSO energy planning and modelling expects [1].

Figure 2: electric vehicle, solar PV and heat pump expected adoption



Heat pumps expected to remain a niche

Heat pumps have a lower expected uptake as 17% of respondents indicates to apply/install a heat pump, and 61% expects not to. This is markedly lower than for the electric vehicles and solar panels.

Hydrogen would be acceptable if the price is similar

When asked if hydrogen would be acceptable, provided at equal costs as natural gas, 55% of respondents indicates a yes. But, as expected, there is not a lot of knowledge available to answer the question which is indicated as 39% does not know yet. The remainder 7% indicates no and would not accept hydrogen.

Smart thermostat already adopted by a quarted

One of the final survey questions considers the use of a smart thermostat. A quarter of respondents indicates to use such a thermostat (28%). It would be interesting to follow up this finding with more detailed questions and over time to be able to follow the adoption.

CONCLUSIONS

How to interpret these values? First, the reliability of the grid is valued at 88 – 232 EUR depending on the duration. This highlights that reliable energy access is observed as much more valuable than the grid costs which are an order of magnitude lower.

Second, the self-sufficiency and independence are Values that are given a high willingness-to-pay judging from the stated amounts. If the willingness-to-spend is correct, there could be a swifter deployment of technologies that would increase self-sufficiency and independence that now expected.

Third, the utility of foregoing the gas and electricity grid is quite a bit higher than the current costs, and higher than the perceived value of 1% reliability, which is logical and increases validity in the outcomes. It might be acceptable for the population to expend more on the grid, something that is bound to happen as renewable sources are integrated.

Fourth, the electrical grid is valued higher than the gas grid, which could hint at which grid might be first to see a drop in the number of connections. Especially when viewed from the identified group who put sustainability and independence before affordability and costs.

Fifth, there is a relatively large group who is not mainly costs driven. The sustainability and self-sufficiency part of the sample indicates a full 34% within this group. A high number, even more so, when one also considers that there is a relatively low amount of higher educated people and a large number of renters of social housing within the sample. This group would naturally be expected to be the first group to go off-grid. DSO's could consider to start working with a segmentation of customer groups to improve modelling and anticipate demand shifts.

Sixth, the adaptation for solar panels and electric vehicles is indicated to go relatively rapidly if the respondents follow through with their stated intentions. Heat pumps lag behind solar panels and electric vehicles. This support the observation that the adaptation of new and renewable energy technology will occur most rapid in the electric technologies and less rapid in the heating technologies. DSO's might want to review and update their expectation for solar and electric vehicles.

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