

Residential Energy Communities: How to minimize the investment risk from an investor perspective

Complementary notes

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Abstract—This note is the complement of the article “Residential Energy Communities: How to minimize the investment risk from an investor perspective”. The objective of this note is to explain the methodology and rationals used in the mentioned article to determine the prior-knowledge of the investor.

Index Terms—Bayesian Game, Distribution System Operator, Grid tariffs, Residential Energy Community

I. INTRODUCTION

We will describe how the investor could infer the following information:

- the repartition of consumer’s types in the neighborhood, although it is not known with specific customer belongs to each type θ_x
- for the type θ_i , the distribution of the values of β_{x,θ_i}
- for the type θ_g , the distribution of the values of factor ξ_x that intervenes in the determination of β_{x,θ_g} .

Our example will be based on the Belgian situation, though we will explain our approach in order that investors active in other countries may find their way.

To do so, we have to estimate the proportion of each consumer’s type and their respective β as well. We will start with θ_i (consumer type not concerned by their electricity bill (inelastic)) and secondly the proportion of the θ_g consumer types (green oriented) and finally θ_c .

II. ANALYSES OF THE FUNCTIONING OF THE RETAIL MARKET REGARDING ENERGY PRICE

At the end of the 20th century, European Union and other part of the world (e.g. New Zealand, Australia, etc.) switched from a centrally-run-system of providers of generation, transmission, distribution, and retailing to competitive markets. This market can be seen as a functional split between the different here-above mentioned roles with new roles been added: Regulation, administration, and market clearing. Transmission and Distribution System Operator (TSO and DSO) considered as natural monopolies are controlled by regulation agencies that are independent from market and from government.

On the wholesale market, generators can make offers to supply electricity at grid injection points, while retailers and some major industrial users make bids to withdraw (“off-take”) electricity at grid exit points. The market uses a locational

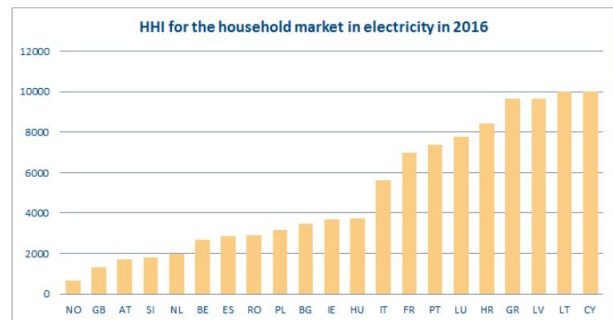


Fig. 1. HHI for the household market in electricity for selected countries.

marginal pricing auction which takes generators’ offers and retailers’ bids and computes final prices and quantities at each node.

Retailers (also named energy suppliers) purchase electricity from this wholesale market, and on-sell it to final consumers. Final consumers are free to change their retailer (action called Supplier switch) and have the option of choosing a (dynamic) electricity supply price contract.

One can argue that the proportions between the different types of consumers are directly influenced by the maturity of the competition in the energy market. At the extreme, in a monopolistic framework, the sole provider does not have an interest in offering highly differentiated offers and therefore consumers are pushed to be broadly of the type θ_i .

The Herfindahl-Hirschman Index (HHI) ([10]) is used by regulatory agencies as an indicator of the amount of competition among electricity suppliers. An HHI index equal to 10 000 is corresponding to a monopoly market and the lower the index, the fiercer the competition.

Figure 1 shows the HHI index for some regions in Europe after more than ten years of liberalized retail market [9].

Another useful indicator measures the rate of supplier switches. In Belgium, following [14] where the HHI index is low, the rate of supplier switches is also high with 20.1% in Flanders / 16.5% in Wallonia per year (12.2% at federal level to be compared to 6.2% at European union level / Germany 9.6% / France 5.4%). One can think that these Belgian markets are very highly competitive.

Though, the Belgian federal regulatory agency (CREG) published in its market comparison an index called sleeping contracts. These are old contracts signed for several years and which kept the price level of gas and electricity of the time. In December 2018, for a 3500 kWh consumer type, the yearly cost of these contracts was 882 € to be compared to the cheapest offer at 631 € [11]. This difference is, in fact, huge because the commodity (energy) is only a part of the total bill (between 25% to 30%). The share of taxes and levies is the most significant part of households electricity price (36% at European level / 33.9% at Belgian level/41.7% for Wallonia). Then follows the DSO cost (26.3%) and TSO cost (0.5%) (see [12] and <https://www.ores.be/particuliers-et-professionnels/facture>).

These numbers indicate that, even in this very high competitive markets, there is a significant percentage of customer for which electricity bills is not a concern and that they are not interested in this market. Following the CREG, it is 18% of the customers who have never changed from supplier [11]. To these consumers, we have to add those with a social contract, i.e. consumers that have been dropped by their suppliers because they have difficulties to pay their energy bills. It is not a matter of choice but, for the purpose of this paper, they cannot take any actions to join the community. their proportion is around 2.5% (numbers from the same sources).

III. ASSESSMENT OF THE θ_i CONSUMERS AND THE DISTRIBUTION OF β_{x,θ_i}

From these data, we can assess that the proportion of θ_i consumers is 20.5%. For the distribution of β in the space \mathcal{I} , we will assume that it is a normal distribution with 250 € as the mean (i.e. the difference between the costs of "sleeping contract" and cheapest contract) and zero is equal to three time the standard deviation.

IV. ANALYSES OF THE FUNCTIONING OF THE RETAIL MARKET REGARDING "GREEN APPETITE"

Another interesting aspect of the retail market is to look at the products and contract types proposed to customers. Beside the duration of the contracts, suppliers are offering special green energy contracts with electricity mostly generated from renewable sources (or compensated by a green label Guarantee of Origin following Directives 2001/77/CE, 2003/54/CE, 2004/8/CE, and 2009/28/EC). Table I shows the prices of this product compared to the cheapest product for some countries/region based on [8] and for Australia use of <https://www.energymadeeasy.gov.au/>, for 3500 kWh consumer without PV and any discount)

The aim of this table is not to compare prices between countries because the price structure is not the same (Belgium and Netherlands only commodity price, for other countries some DSO components already included). Nevertheless, it can be observed that, generally speaking, green products are more expensive than a classical product. That indicates there are customers, concerned by environmental issues, ready to pay more in order to use renewable energy. We can use these

TABLE I
ILLUSTRATION OF THE *green appetite* (IN €).

Country	Green product	Cheapest product
Belgium	284.50	223.85
France	527.25	479.70
Germany (Bayernwerk Netz)	1005.10	877.99
Netherlands	225.15	224.15
Australia (Sydney)	1420.00	1390.00

TABLE II
PROPORTION OF *green appetite*

Supplier	Green Score	Market share	% of \mathcal{G}
Engie	6/20	41.61%	12.5%
Luminus	2/20	17.66%	1.8%
Eneco	16/20	14.91%	11.9%
Lampiris	7/20	8.81%	3.1%
Essent	5/20	6.70%	1.7%
DSO	0/20	2.89%	0.0%
Elegant	7/20	2.52%	0.9%
Octa+	8/20	1.43%	0.6%
Mega	17/20	0.69%	0.6%
Others	18/20	2.68%	2.4%
		Total	35.4%

numbers to approximate the $\xi_x < 0$ in the relation ?? by considering that ξ_x is a normal distribution with a mean equal to 0.017 €/kWh (i.e the difference between cheapest price and green contract for Belgium divided by 3500 kWh) and zero is equal to three time the standard deviation.

Regarding the proportion of consumer in the space θ_g it is not possible to have a clear numbers of green contract as these data are confidential. Anyway, we can use some sources to approach this. On one hand, in Belgium, Greenpeace published a scoring (on 20) for every supplier [15]. This score give how green is the supplier beyond the commercial announcement. On the other hand, the federal regulator published the share of the residential market for each supplier [16]. To infer the proportion of consumer type θ_g , we multiply these two numbers. The rational behind this approach is that consumer who really care about environment could consider such scoring mechanism done by a (for them) trusted third party. The data are shown on table II.

Complementary, the proportion of θ_c is equal to 44.1%(i.e 100%-20.5%-35.4%).

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