Measuring the elasticity of the demand considering the PVPC regulation changes in Spain

Master's Degree in the Electric Power Industry (MEPI)

Annex A

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1. Introduction

The electricity landscape is rapidly evolving due to technological improvements, regulatory changes and policies driven by the European policies towards achieving net zero emissions by 2050. Moreover, electricity prices have been affected by major global events in recent years, such as COVID-19 or the Ukrainian War, which have generated indirectly high volatility in electricity prices. The introduction of more renewable energies in coming years may also create high differences in prices when the renewable production is high and when its scarce. Those fluctuations must be coupled with generation changes of other technologies like hydroelectric and CCGTs. In Spain, the electricity market has witnessed significant transformations over the years.

In particular, the retail electricity market consists of a variety of retailers who purchase energy from the wholesale electricity market and sell it to end-users, offering different types of contracts and tariffs. To adjust the Spanish regulation to the European Directives, Royal Decree-Law 1/2019 was approved to establish the differentiation between tolls and charges in the access tariff. Tolls are regulated costs intended to recover the costs from the transmission and distribution networks. These are established by the CNMC. Charges are regulated costs intended to cover other regulated costs, such as renewable financing or the additional costs of energy generation on the islands and are established by the government [1]. This reform allowed the creation of six access tariffs for companies, depending on their connection and power. This segmentation will be necessary to classify the consumers in the analysis.

Another essential milestone was the introduction of the Voluntary Price for the Small Consumer (PVPC) regulation, which aims to promote transparency in electricity prices and offer consumers a tariff based on the hourly electricity prices. The PVPC regulation was revised in 2023 and came into effect the 1st of January 2024, changing the methodology for the calculation of the electricity prices for consumers subscribed to this regulated tariff. Given the great number of consumers that contracted this tariff, it is relevant to study whether it has made an impact on the way consumers behave. Understanding the elasticity of the demand under these circumstances is relevant to analyze market dynamics and implement efficient energy policies.

2. State of the art

The retail electricity market has implemented several reforms and changes in recent years. As discussed previously, Royal Decree-Law 01/2019 set the differentiation between tolls and charges in the access tariffs. Consequently, six different tariffs were created for companies, depending on the connection and power:

- 2.0TD: applicable to businesses with low voltage supply (under 1 kV) and power ratings lower or equal to 15 kW.
- 3.0TD: applicable to businesses with low voltage requirements (under 1 kV) and power ratings greater than 15 kW.
- 6.1TD, 6.2TD, 6.3TD and 6.4TD: applicable to companies connected to higher voltage supplies (greater than 1 kV) [2].

Later on, the PVPC reform entered into force. The Voluntary Price for the Small Consumer (PVPC) regulation entered as a substitution of the Last Resort electricity Tariff (TUR) in 2014. The voluntary prices for small consumers are defined as the maximum prices that retailers can charge their customers that meet the requirements for them to be applicable. The PVPC model supposed a significant change, from a model where the estimated cost of electricity was calculated by a mechanism based on future prices to a new methodology where consumers would pay the price that the energy had on the market during that period. This new PVPV was supposed to reduce prices for customers, who would not have to deal with the insurance costs in the price of a product traded on a futures market and to ensure transparency in electricity pricing, as well as giving price signals to consumers, promoting efficiency [3].

The regulatory authorities have a significant role on the implementation of the PVPC regulation. Retailing companies are obligated to inform consumers entitled to be covered by the PVPC. The Spanish National Markets and Competition Commission (CNMC) is in charge of the supervision of retailing companies and the implementation of complementary measures to facilitate consumers the access to information and knowledge of the electricity system.

The escalation of electricity prices from the second half of 2021 onwards called into question some of the regulatory pillars on which the regulatory framework for the electricity sector were based at a wholesale and retail level, sharpening the debate on whether the actual regulation was the best way to implement the ambitious renewable objectives on national and international energy markets, giving consumers the opportunity for benefitting from the affordable renewable energy and distributed energy resources. Consumers with supply contracts indexed to the wholesale electricity market have suffered from the spike of the electricity prices, since the final price of electricity passed on by retailers to customers with these contracts is a pure reflection of the marginalist electricity prices closed on the markets [4].

Nonetheless, this competitive environment has come with a downside: the risk of exposure of market participants to the day-ahead market has grown. This phenomenon has reduced the willingness to hedge risks through forward hedging instruments, by which weakness becomes clear, in turn, because of the points of leverage to the natural gas that have been formerly serving as the electricity price determinant.

The volatility of the day-ahead market has considerably reduced the liquidity in the forward markets. In addition to the measures introduced in Royal Decree-Law 6/2022, of March 29th to promote forward contracting as a response to the economic and social consequences of the Ukrainian War, the Royal Decree-Law 446/2023, of June 13th was introduced, which includes a forward price signal in the calculation of the PVPC that encourages the contracting of hedging instruments on the demand side by retailers, which enables liquidity to enter the forward markets.

The approval of the Royal Decree-Law 10/2022, of May 13th, introducing the "Iberian Exception" caused a notorious decrease on the prices of forward products traded on the Iberian Electricity Market (MIBEL) following the trend of the day-ahead and intraday markets. This context is ideal for the PVPC reform, establishing forward signals. The modifications introduced in this Royal Decree-Law adapted the PVPC structure to the principles established on Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity, amending Directive 2012/27/EU [4].

Therefore, by Royal Decree-Law 10/2022 a price signal is introduced for forward products. This price signal is created as a combination of forward products linked to the forward market managed by OMIP. It is distributed between the monthly, quarterly and annual products. This distribution enables the partial indexation of PVPC to long-term price signals. The monthly product accounts for the 10%, the quarterly product accounts for a 36% and the annual product accounts for the remaining 54%.

Additionally, a transitional framework has been set where the weight of the forward signal will increase between 2024 and 2026, so that, for the first year, the forward signal will represent the 25%, the 40% in 2025, reaching a 55% in 2026, leaving the remaining 45% for the day-ahead and intraday signals.

3. Motivation

The electricity sector is one of the most decisive sectors that leads the transition towards a more sustainable and efficient system. In Spain, the implementation of the Voluntary Price for the Small Consumer (PVPC) regulation represents a key point for the achievements of these objectives. With the introduction of the dynamic prices linked to the wholesale market, the PVPC aims to protect consumers from the volatility of the day-ahead and intraday markets while promoting energy efficiency and the integration of renewable energy resources.

The main factor for the success of energy regulation, including the PVPC, is understanding consumer behavior and market dynamics. The elasticity of demand is particularly important, as it represents the variability of the electricity consumption to changes in electricity

prices. Thus, analyzing the elasticity of the demand seems primordial to determine efficient market optimization and policy implementation.

Although there are many studies regarding the analysis of the elasticity of the demand with respect to different products, no other has addressed the elasticity of the demand analysis prior and after the PVPC reform in 2023 [5]. This thesis seeks to shed light on the response of consumers to the new PVPC and how their behavior has changed. Furthermore, this research intends to provide insights for policymakers, regulators, energy companies and consumers.

4. Project objectives

The objective of this Master's Thesis is to perform a statistical analysis to determine the elasticity of different consumer groups by electricity tariffs groups. Based on the results of this analysis, an evaluation of the behavior of consumers in different years is going to be performed, seeing if recent regulatory changes have had an impact on the consumption habits of consumers.

5. Alignment with the Sustainable Development Goals

This Master's Thesis is intended to make an impact and face the challenges that will be relevant in the coming years in the energy sector. Consequently, it aligns with some of the Sustainable Development Goals established by the United Nations to promote and work on peace and prosperity for everyone from now into the future:

- Goal 7: Affordable and Clean Energy

This goal aims to ensure the access of affordable, sustainable and up-to-date energy for everyone while also improving energy efficiency [6]. With the electricity prices on the rise in recent years, it is essential to look for alternatives that enhances energy efficiency and reduces prices for end-users. This thesis aims to examine the changes on the elasticity of the demand to energy prices, in order to understand consumer strategies against prices and implement regulation that contributes to the integration of clean energy with more affordable prices.

- Goal 10: Reduce Inequality within and among Countries

This goal aims to combat the inequalities in income, opportunity and access to basic services by promoting measures that reduces the differences within and among countries [7]. This thesis intends to acknowledge the effects on consumers of the regulations that have been implemented in Spain, looking to provide more stability and affordability for everybody, reducing the differences among consumers.

- Goal 12: Responsible Consumption and Production

This goal advocates for and attains a more sustainable and efficient management of resources while enhancing consumption patterns [8]. This thesis intends to analyze and understand the behavior of consumers based on the electricity prices, which act as responsible consumers trying to adapt their consumption minimizing their costs.

6. Work methodology

The methodology adopted to address the activities encompasses several steps.

1. Research the electricity market and the PVPC regulation and the effects on consumers that led to the revision and changes on this regulation.
2. The execution of a regression analysis:
    a. Linear regression to analyze the relationship between demand and price by using statistical software to estimate the parameters of the regression. Different variables will be considered such as: temperature, labour calendar, among others.
    b. Clustering techniques to classify the dataset into different segments to examine the dynamics within each cluster.
    c. Sensitivity analysis to evaluate the strength of the results when modifying the model inputs, data assumptions and outliers.
3. Results discussion and conclusions formulation based on the previous results.

The timeline of the Master's Thesis is represented in the following Gannt Chart:

TASK ID	TASK TITLE	START DATE	DUE DATE	DURATION IN DAYS	PCT OF TASK COMPLETE	MONTH 1				MONTH 2				MONTH 3			
						1	2	3	4	1	2	3	4	1	2	3	4
1	Intro + Theoretical Context	17/04/24	08/05/24	21	25%	■	■	■									
2	Analysis of the Data	08/05/24	12/06/24	35	0%				■	■	■	■	■				
3	Results	12/06/24	26/06/24	12	0%									■	■		
6	Conclusions	26/06/24	10/07/24	12	0%											■	■

Table 1 Gannt Chart

7. Resources

The necessary data for this Master's Thesis are taken from the Spanish National Markets and Competition Commission (CNMC), the Spanish regulator. This data consists of the hourly demand (in kWh) for different years. They are divided according to the different tariffs.

To perform the regression analysis, different programs that may be used. One of the most common is MATLAB, which includes a dedicated toolbox for statistical analysis called "Statistics and Machine Learning Toolbox" that allows the performance of this type of analysis [9]. Alternatively, Phyton may be used.

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