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PASSTHROUGH OF EMISSION COST IN ELECTRICITY MARKETS IN GREECE

An econometric Analysis

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ΠΑΝΕΠΙΣΤΗΜΙΟ
ΠΕΙΡΑΙΟΣ ΤΜΗΜΑ ΟΙΚΟΝΟΜΙΚΗΣ ΕΠΙΣΤΗΜΗΣ

ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ ΤΜΗΜΑ ΒΙΟΛΟΓΙΑΣ

ΤΜΗΜΑ ΒΙΟΟΙΚΟΝΟΜΙΑΣ

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Planning and drafting a dissertation that attempts to do an extensive analysis on a current matter of importance for the society, the state and the academia alike is a complex task. From material collection to synthesis and analysis of data, the researchers must be able to interpret material properly and carefully to end up with results that are up-to-date, accurate and useful for the academic discussion on the subject under study.

In this process, I have been supported in every possible way by my supervisors and colleagues. The teaching staff of the University guided me in selecting and discussing a matter that would have been interesting for my future career and professional life. Also, the library staff of my home University have been more than qualified and willing to resolve problems and help me with the location and acquisition of data and literature works that have been essential for my dissertation.

At the same time, as the research focuses on Greece and the Greek electricity market, it was considered vital for me to gain insights from an internal level. The use of databases and factsheets from the EU resources has been achieved with the support of fellow students who have been more acquainted with the task at a primary level and, later on, I have contacted members of local organizations that are entitled to inform the public on contemporary matters with regard to the EU and national policies.

In this respect, the staff of Europe Direct in Thessaloniki have supported me by informing me about the availability of data and the most recent changes that have taken place at a European level.

Last but not least, I would like to thank my family for their unending support and understanding.

ABSTRACT

The purpose of this dissertation is to conduct an empirical analysis on the cost pass - through of emission of the Greek electricity market, this analysis shows the impact of the emissions cost raise in the price of electricity in Greece, and how the policy of the EU interferes with that.

These calculations are very important in the business world because they can predict with accuracy, the fluctuation of the production cost and the profit. This dissertation includes both a

theoretical review and an empirical analysis on the subject, all references come from official sites of the Greek Government and European Union, as well as high prestige academic and economic sources.

Despite the fact that many researches have been conducted on the subject, none of them has deepen enough on the real - life impact of these policies and changes in prices. There will be a reference on the subject of the problems that these changes cause on the customers and citizens of the state, as well as sensitive groups, such as people with disabilities, people who need life - support machines etc.

There will be a reference on a theoretic level, on the fundamental elements of economics that govern all of modern economic views and theories, and an analysis of the opportunity cost that lies behind these factors. The data and the conclusions of this analysis has shown that, if not any immediate measures are taken, the cost of electricity in Greece will rise highly, even at the first months of 2019. The simulation conducted used as an example the upcoming law that stops the standard CO_2 price/kWh in the country and trading with a fluctuation clause that will depend on the ETS price of CO_2 allowances. The data and calculations examined under three scenarios, the first one stated that in an event of a stricter environmental regulation, how the prices will be affected, the second one does the opposite, that in case the environmental regulations that are now in effect loosen, then how this will affect to the price of electricity. There is room for further research on this sector, especially in countries that have low natural resources and are still using old technology in order to generate electricity.

Keywords:

Electricity market; costs; CO2; pollution; pass through; environment.

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INTRODUCTION

The pass - through cost regards the quantity that may or may not affect the economy either at state level or globally (Sijm, Neuhoff, & Chen, 2006). It is one of the most important factors in Economic analysis, since it's impact can cause a great and irreversible amount of damage in economy, and, depending the occasion, usually cannot be measured accurately, because of the many different variables that surround it (Hooper & Mann, 1989). In international scale it's important to define the pass - through costs, in order to determine the exchange rate to the prices of the imported goods (Taylor, Low inflation, pass-through, and the pricing power of firms., 2000). In state scale the pass - through cost is important to be calculated for the determination of the tax incidence [CITATION Mar11 \l 1033].

The economic theory is based on the assumption that there are activities in the market that are conscious and that a process of buying, selling and producing products takes place. These products can be goods, either tradable or not, or services [CITATION Car14 \l 1033].

In capitalist states operating on the basis of the free market, there is a distinction between public and private organizations. However, in both cases, the aim is to better manage the resources at the lowest possible cost and the greatest possible benefit. Pollution and emission costs fall into the category of risks in the production process and, as a result, businesses aim to limit them to the greatest possible extent [CITATION Ala01 \l 1033].

This need became clear after fines were adopted by European and national operators in the public and private industries and the productive units that systematically contaminated soil, subsoil, water bodies and the atmosphere. This study examines the case of the management of the transport of pollutants in power generation, with an emphasis on carbon dioxide and greenhouse gases [CITATION Joh11 \l 1033].

The calculation of emission costs in energy markets is important because, it gives both the state and the energy industry, a tool, in order to determine the sales cost to the customers, it also gives the ability to quantify and qualify a situation, that can have both economic and environmental impact [CITATION Zac08 \l 1033].

In order to reduce greenhouse emissions, EU has implemented a policy of emission trade, which gives the company the right to buy or sell emission allowances, which is the equivalent of a ton CO_2 or a ton of nitrous oxide (N_2O) and perfluorocarbons (PFCs) (European Union, 2018). Each allowance can be used only once, and if a company emits more than it has been reported, then it has to pay a heavy fine [CITATION Eur18 \l 1033].

In order to calculate the passthrough of emission costs, a number of variables are used which aim at predicting the price with the highest possible precision. For this reason, prices are used which require the least possible assumptions about demand, and prices on the company's tactics to achieve profit. Electricity companies are ideal for this calculation as their organization and the technique in which they produce and distribute electricity is structured in such a way that it allows the analyst to include in its calculations both production and the demand for the product. Moreover, the calculation of marginal costs can be achieved with great accuracy, because there is a link between the cost of emissions, the quantity of pollutants and the selling price of the electricity [CITATION Fab14 \l 1033].

The cost of a passthrough can cause a huge impact on an economy, for that reason emission prices is a good example, as opposed to other costs, because the impact it induces can vary from different time and technology. Also, emission costs are a caused from an exogenous factor, because of the different countries and firms that participate on the Emissions Trading Market [CITATION Ell07 \t \l 1033].

The literature review has been a challenge since almost the entirety of the available material is related to the EU policy on green energy and climate change and there were only limited data available on the electricity market in Greece and the current situation in the country. However, there was a plethora of information published on the important of emission costs for the study of economics, information assessed and included in the analysis [CITATION Man01 \l 1033].

In order for one to understand the magnitude of the emission costs, he has to understand the impact these emissions have on the environment and well - being of the citizens and workers, who live in close proximity of these installations [CITATION Bro02 \l 1033]. These installations have, over the years, caused such a damage in the areas they are based, that it will take almost 50 years for the environment to recover [CITATION Nor07 \l 1033].

In Greece, the biggest electricity production facility, is located in the city of Ptolemaida, in the region of Macedonia, this facility has caused one of the biggest environmental destructions in the history of the country [CITATION Tsi04 \l 1033]. It produces almost 10 times more emissions than the allowed levels and is the cause of the many cancer related deaths in the region [CITATION Geo101 \l 1033].

Electricity production can produce emissions that can have either immediate impact on the surrounding area, or intermediate impact on both human health and the environment [CITATION

Geo101 \l 1033]. Emissions can be produced in different density by all types of energy producing technologies, even the "green" types, such as renewable energy technologies [CITATION Amp14 \l 1033].

The most harmful of emissions are considered to be those produced in electricity production facilities, these are carbon dioxide, carbon monoxide, nitrous oxides, sulfur dioxide, particulate matter and heavy metals. These emissions all have negative impact on both the environment and organic life. Of course, they are not only produced by the electricity production facilities, but from agriculture, human activity and transportation etc. [CITATION Bro02 \l 1033].

Carbon Dioxide (CO_2)

The most common pollutant , and the most harmful of them, in small quantities carbon dioxide is useful for the production of oxygen by the plants through the photosynthesis process. But in higher levels it cannot be processed by the remaining plants of an area that has been cleared [CITATION Sol09 \l 1033].

In order to construct a facility, a company has to fully clear the area around it, and also, it has to build roads, railways and pipelines that connect the facility with the supply distributors, in addition, most of these facilities also contain personnel housing programs, which creates the need for further ground cleansing. All of these result in the reduction of the plantation and wild life in an area and has a huge environmental impact [CITATION Haa06 \l 1033].

Carbon Monoxide (CO)

Carbon monoxide is usually connected to vehicle emissions and is overlooked from other human activities, but electricity production facilities have a fair share of carbon monoxide emission, which is usually higher when the main fuel of production is coal [CITATION Wea02 \l 1033].

It is well established that carbon monoxide is the cause of most of the immediate health issues that can be found around an area with high pollution levels. It can cause higher blood toxicity which results to immediate poisoning that can be fatal, it blocks blood's ability to carry out oxygen through the body [CITATION Rau00 \l 1033].

Sulfur dioxide (SO_2)

Sulfur dioxide is known to be emitted by various installations that use fossil fuel, in higher concentration it can cause permanent lung damage in humans and it can form new types of chemicals when it comes in contact with water and ozone, the most dangerous chemical reaction that it forms is sulfuric acid (H_2SO_4), which causes chemical burns in humans and can destroy both plantation and wildlife [CITATION Wes56 \l 1033].

Nitrous oxides

Nitro is an element that already exists in great levels in earth's atmosphere, mostly it comes from natural processes such as lightning, photosynthesis, etc. Nitrous oxides are the most dangerous byproduct of Nitro, it can reduce the mental ability of a human making him incapable of functioning by himself. In higher concentration, if it is inhaled by someone without adequate amounts of oxygen, it can even cause a heart attack, due to the reduction of blood pressure [CITATION Eic90 \l 1033].

Particulate matter and Heavy metals

Particulate matter comes in smoke form, which comes as a byproduct from fossil fuel burn, it contains small quantities of microscopic solids and liquid drops, that can easily be inhaled and cause lung and heart problems to anyone that lives or works around such areas. The problem with PM is that both the solids and the liquid it contains can be breathed and enter the bloodstream of an individual, they also can't be metabolized by anyone because of the size and chemical contains. If a person is healthy, they are being extracted by natural processes, if he is not, they can cause asthma or decreased lung function [CITATION Gar00 \l 1033].

Heavy metals are a group of metals that have an atomic weight greater than iron's, these metals already exist in various forms in nature and the human body and in small quantities they are harmless, but it has been recorded in areas where various facilities operate, higher concentrations of these metals and their oxides. Most of these metals can easily form chemical bounds with other elements, the result is the new chemical to be a corroded version of the previous and in that form, it can cause cancer, poisoning, lung problems etc., it can also poison water, soil and air and it is extremely costly to remove from an area [CITATION Pac07 \l 1033].

CHAPTER 1.

Basic economic terms and analysis

1.1. Supply and Demand and the electricity market

The theoretical view of pass - through analysis, can be broken down into the very fundamental parts of economics, and economic theory. The spirit of this analysis is to determine whether the cost of the emission will result in a raise on the price that the customer has to pay, and what kind of impact will it have in the company [CITATION Tay00 \t \l 1033].

There are two forms the pass - through cost can take:

- Absolute pass - through: which can be explained in absolute changes in cost will produce an absolute change in price, e.g. if a 1 euro raise in the cost of production, and the price raises by 2 euros then the pass - through cost equals 2 (200 %).

- Pass - through elasticity: it describes a percentile raise in cost that will cause a percentile raise in the price, e.g. if pass - through elasticity equals 1, that means that a 1% raise in the cost of production, will cause a 1% raise in the price, respectively if it equals 2 a 1% raise in cost, will cause a 2% rise in price.

The connection between the two may seem that they are equal, but if someone sees closer, then it will be clear that the elasticity is always smaller than the absolute, e.g. if the elasticity is 1, like the example above, and the cost equals with 100, then the price will form from 200 to 202, but the absolute will be 2 because a one euro increase in cost, caused a 2 euro increase in price. The second connection is that if a firm, keeps a steady percentage margin on its price, then the margin will always be equal to the first, e.g. if the percentage margin is 50% then, (200 - 100) / 200 =50 %, after the pass - through cost it will be (202 - 101) / 202 =50 %.

The pass - through cost of emissions can be calculated with either way, because of the system of trading allowances in the EU, firms have to place daily new bids in order to acquire these allowances, this causes a higher price raise, since the number of the available allowances is controlled from the EU and a reduction in the number can cause a raise in prices. Most of the companies analyze the prices two predict the most effective day to acquire them.

Most of the theoretical reviews about pass - through costs are focusing on the absolute pass - through, but in order for to understand in depth, what is the impact of this cost, there have to be a further expansion on the pass - through elasticity, which depicts the modern economic reality more realistically.

The first and most fundamental components on every economic analysis is the supply and demand. Demand refers to the will of a customer to acquire a product, depending on the price of the product, the customer may choose to acquire a bigger quantity of it. Supply is a measure of the ability of the market to respond to demand, if the price is satisfying for the seller, he may decide to address the demand on its full scale. The bond between the two is the price, both the customer and the market will respond on the level of the price regarding a product, if the market is able to supply the product at low price then the demand will rise, on the contrary if the demand rises about a product but the market is not able to respond, then the price will rise since the product will be desired by more customers [CITATION Dal13 \l 1033].

The connection between the two can also affect the distribution of the resources. Most of the economic theories state, that the allocation of the resources, must be at the most productive way possible [CITATION Arr72 \l 1033].

Of course, there is more theoretical background in calculating the pass - through costs of emissions, firstly one must take into account the unique system that is the power market. Electricity is necessary for everyone, and cannot be considered as a product that someone can surpass in order to save money, it is necessary for the function of the state mechanisms and basically, after 19th century all modern world activities and functions are built around the use of electricity [CITATION Ela14 \l 1033].

The right for having electricity at home, is protected by every constitution in the world, and several governments, have introduced laws that protect that right, furthermore, in most of the Western World countries governments are takin financial measures to ensure that. This is the reason why power production, still remains under state controlled in many countries. This system may have worked the previous years, but it is a slow - moving system, where technological advances move fast.

Privatization of the sector allows private companies to produce and distribute electricity to their customers, this measure allows the sector to advance faster, due to the fact that there is competition between the companies, and the client list contains all of the people in the world. Private companies, driven by the will to earn more, will try to top the competition, by improving the production process, changing to “greener” energy techniques and try to view themselves as the best, mostly by reducing the prices (Lampropoulou, 2018).

But, in order for a company to be able to reduce the prices, on a level that allows it to earn more money than the competition, it must optimize its production process and find a way to avoid unnecessary costs. The system introduced by EU, for reduction of the emission in the Union, drives companies to raising their prices, thus having a bad public image, or leads them to move their production process to countries that have “softer” boundaries about the emissions (Gali, 2015).

This effect, further raises voices in a change of economic and environmental policy from EU. The fact that these companies will move their facilities to a state that allows them to emit pollutants, but continue their economic activities within the EU, finds both economists and environmentalists against it. Economists state that the fact that this company moved to another countries, reduces taxes, jobs and in general reduces the economy of the state, on the other side environmentalists state that this tactic doesn’t change anything because the air pollution is a worldwide problem [CITATION Cal16 \l 1033].

This policy has the modern monetary theorem in its basis, according to which, the companies are trading something like money that it is not money, in a system that was forced by foreign government, in this case EU. EU by controlling the number of the available allowances, and by forcing companies to bid in an auction that raises furthermore the production cost, is working in a way that drives companies away, because most of them cannot control their emissions. Also, in those member states, where the state controls the power production and distribution, this cost is being paid by the state, which as referred earlier, slow in changing the system that has built. This policy gives these states two choices, either privatize the sector or change the system [CITATION Kni13 \l 1033].

1.2. Basic concepts

A. The Law of Demand

This law states that, if all factors remain equal, the higher the price of the product, the lower the demand, this means that a customer will reduce the quantity of the purchased product. The amount of a product that a customer is willing to pay to acquire must be on a level that it will not force the customer to choose between the product and something else he needs [CITATION Chu17 \l 1033].

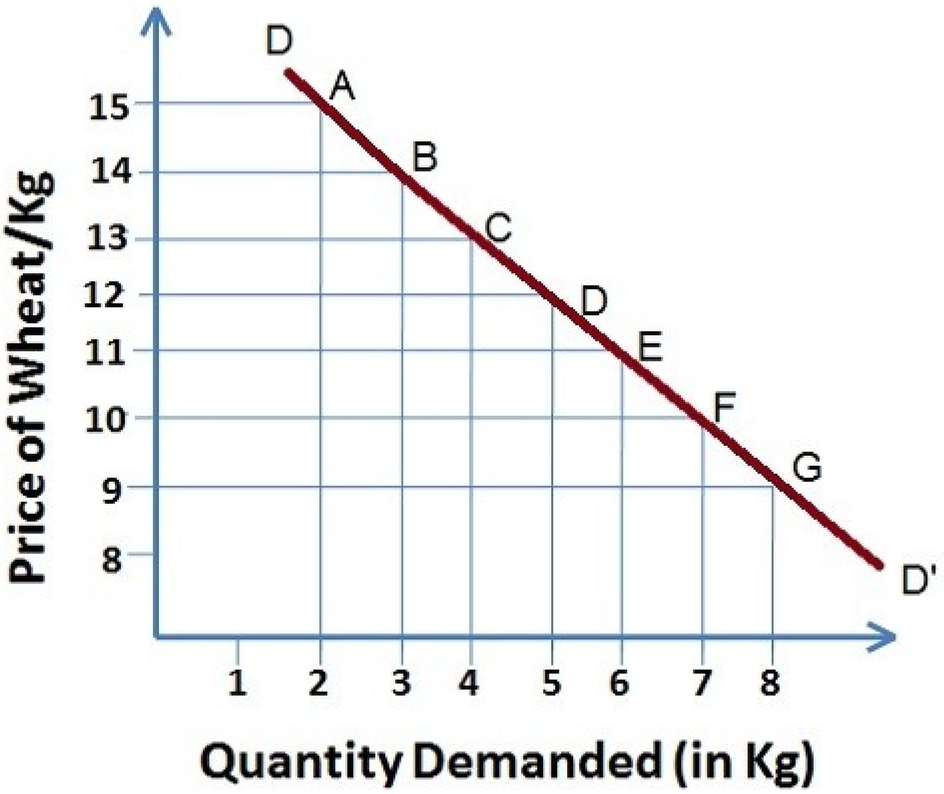

Figure 1 The law of Demand, [CITATION Gui05 \l 1033]

A, B and C are points on the demand curve, each point is a connection between price and quantity. The demand relationship curve shows that this function works negatively, as the price rises the quantity reduces [CITATION Chu17 \l 1033].

B. The Law of Supply

It's practically the same as the law of demand, but the function, instead of working negatively, it works positively, because the higher the price, the higher the quantity [CITATION Llo15 \l 1033].

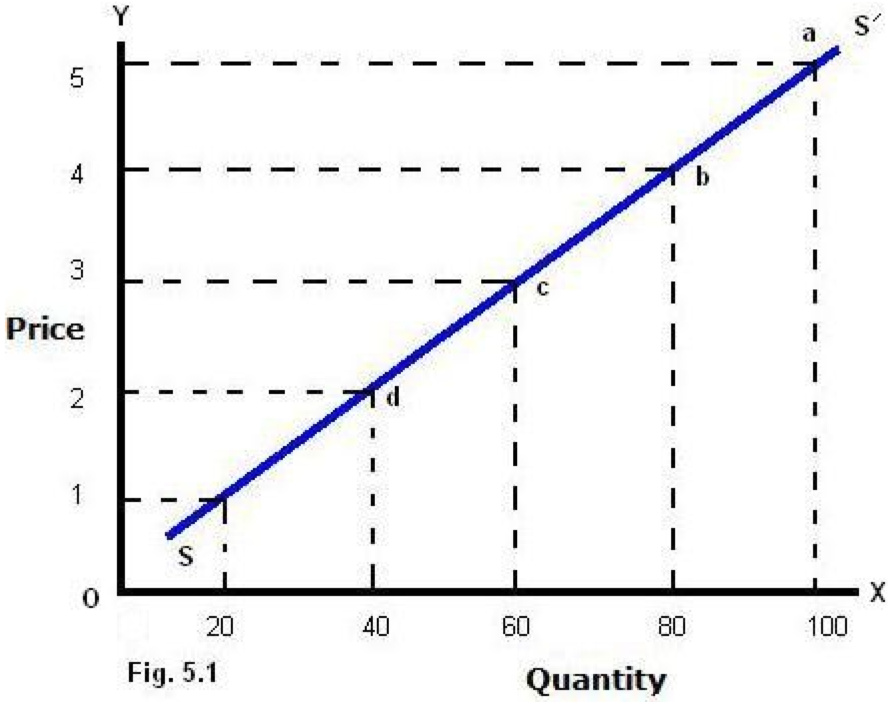

Figure 2 The law of Supply [CITATION Gui05 \l 1033]

As the diagram shows, there is positive connection between price and quality, since the supplier will earn more if he provides more to the customers. Unlike demand, supply has a factor of time, the supplier has to provide quickly his product in order to satisfy the demand, because there is always the chance that the competition will provide a better to cheaper product to satisfy the demand [CITATION Llo15 \l 1033].

C. Equilibrium

When supply and demand are equal, that means that all the produces goods are being bought by customers, this state of the economy is called an equilibrium, it is the point where demand meets supply. This state means that everyone involved in the process, suppliers, customers, countries, etc., are satisfied since everyone is getting what he demands and everyone sells what he produces [CITATION Ace15 \l 1033].

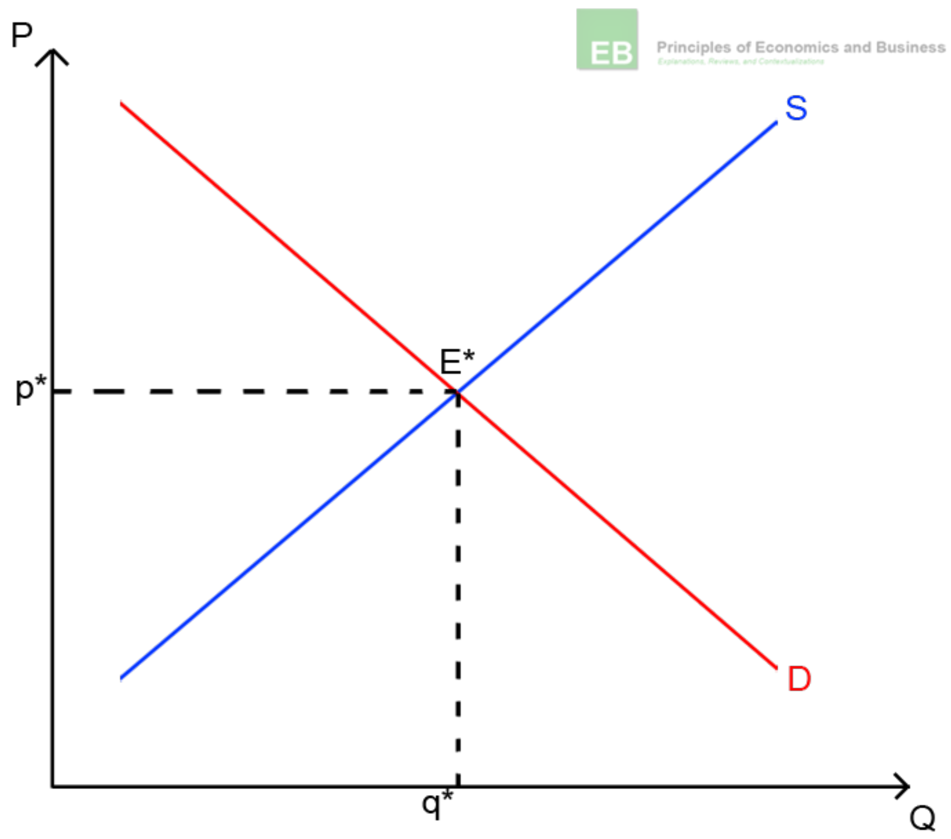

Figure 3 The equilibrium state of a theoretical economy, [CITATION Gui05 \l 1033]

It is clear from the chart that the equilibrium is the point where the two functions intercept one another. The specified price and quantity that refer to this point are called, equilibrium price and equilibrium quantity. Equilibrium is more of a theoretical state of an economy, due to the fact that in reality, price and other factors that affect supply and demand, are changing in such pace, that the equilibrium state cannot be achieved [CITATION Ace15 \l 1033].

D. Excess Supply

Excess supply refers to a state of an economy, when the price is set very high and the demand falls respectively, at this state the market works insufficient because of the excess quantity and the low inflow from the sales [CITATION Bas16 \l 1033].

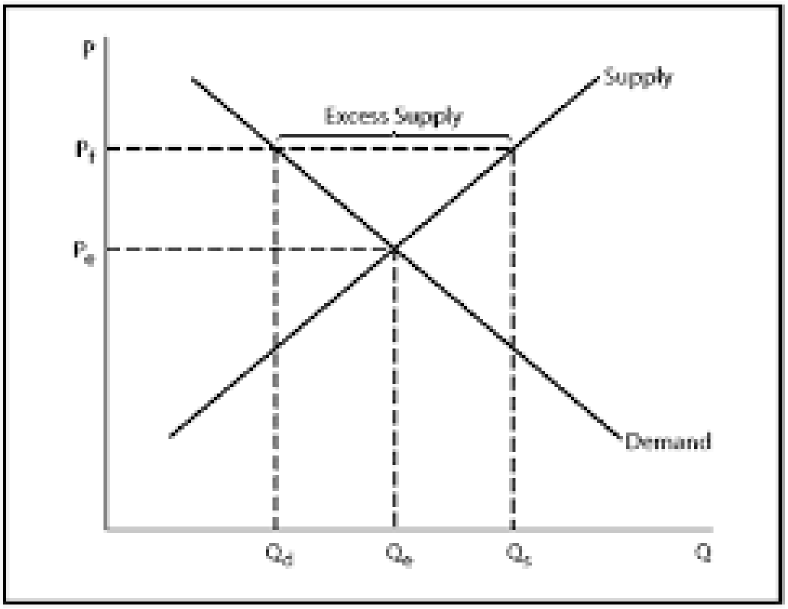

Figure 4 *Excess supply state of an economy, [CITATION Gui05 \l 1033]*

E. Excess Demand

Excess demand means that the price of a product is set so low, that created a level of demand higher than the that the market is able to provide [CITATION Xie15 \l 1033].

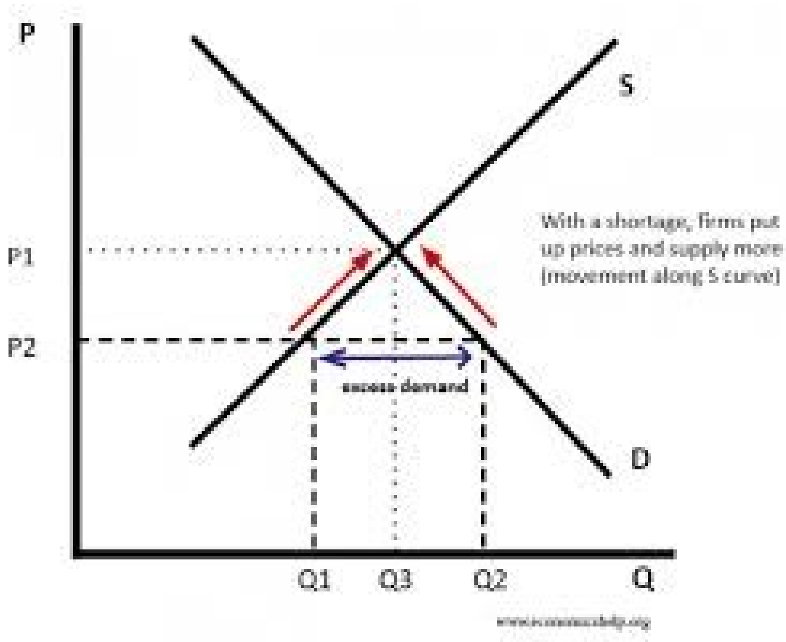

Figure 5 Excess demand state of an economy, [CITATION Gui05 \l 1033]

F. Shifts and Movement

1. Movements

A movement refers to a change along a curve. In the case of the demand curve, the movement is referring to a change in quantity and price. This means that the demand curve remains consistent. A movement happens when a change on the price leads to a change in quantity. In other words, a movement occurs when a change in the quantity demanded is caused only by a change in price, and vice versa [CITATION Gho16 \l 1033].

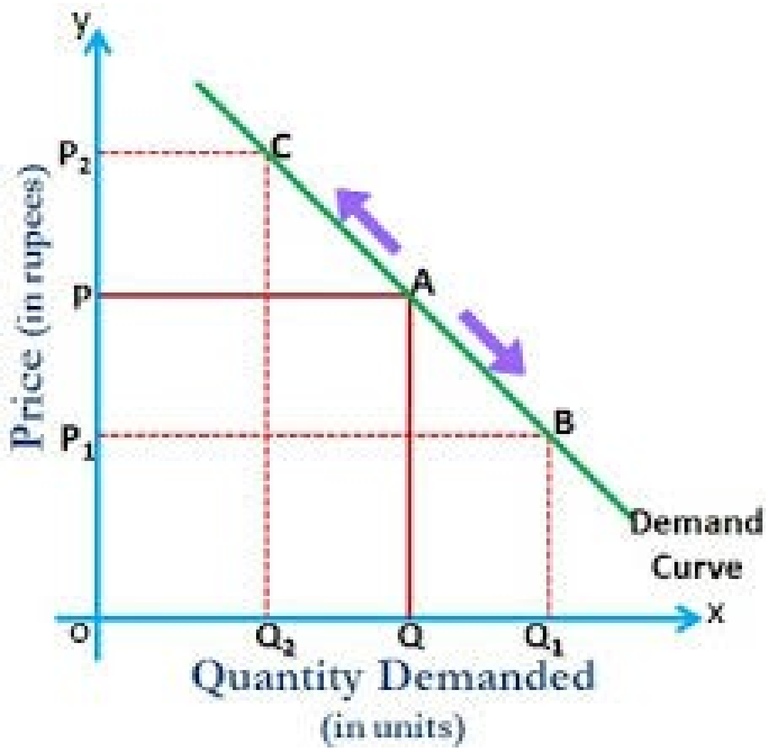

Figure 6 Movement along the demand curve, [CITATION Gui05 \l 1033]

Like the previous occasion, a movement on the supply curve means, that the curve is consistent, and any change on the price will have the according change in quantity [CITATION Gil14 \l 1033].

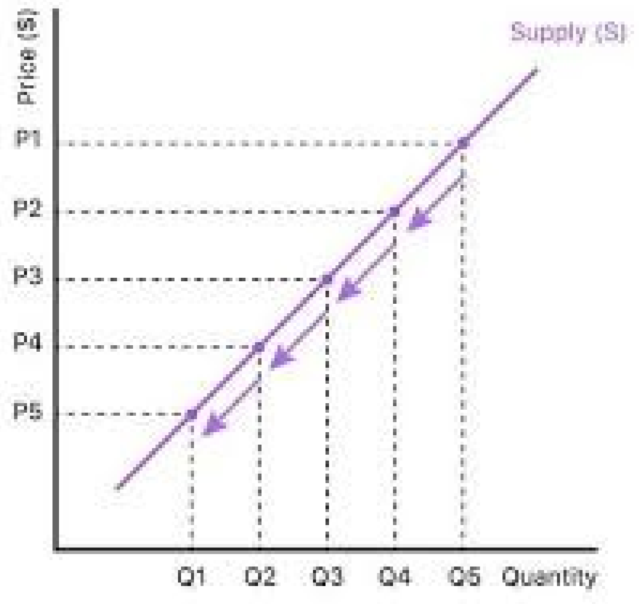

Figure 7 Movement along the Demand Curve, [CITATION Gui05 \l 1033]

2. Shifts

A shift means that the quantity has changed but the price remains steady, when this occurs, the whole curve shifts position, and the relationship between price and quantity changes. This can happen when quantity has been affected by a factor other than the price [CITATION Gho16 \l 1033].

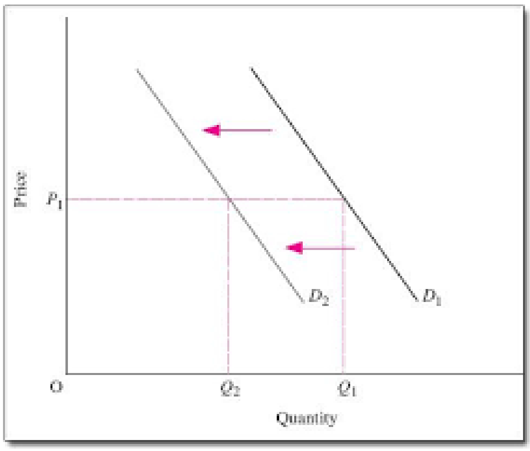

Figure 8 Shift on the Demand Curve, [CITATION Gui05 \l 1033]

Respectively, the same happens with the supply curve, if a supplier keeps the price as it is, but, changes the quantity of the product, then the supply curve will shift and the relationship between the two will change [CITATION Gho16 \l 1033].

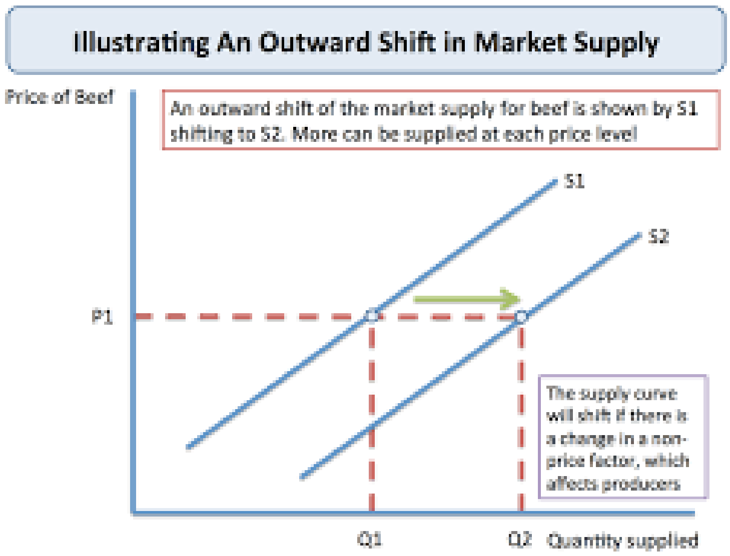

Figure 9 Shift in supply curve, [CITATION Gui05 \l 1033]

1.2. Financial Sources

As analyzed in the introduction to the present study, the competitive market operates on the basis of profit-seeking. Within it, businesses want to produce as much as possible and sell it at the best possible price. As a result, the supply law is applied. It is noted that the supply curve is negative [CITATION Jon18 \l 1033].

Even public sector production units are aimed at maximizing their profits and gaining a competitive advantage over existing and potential competitors. The purpose is that total revenue be greater than the total costs and that the amounts collected by the company are higher than the amounts spent on purchasing the necessary inputs for the production of the goods or services they market [CITATION Kah86 \l 1033]. The profit is calculated as:

$$Profit = total\,revenue - total\,cost$$

The cost of manufacturing an enterprise includes the costs of pollutant and waste management. These costs are both direct and indirect, as companies are called upon to improve their infrastructure and to protect the environment and, on the other hand, if they exceed the emission ceilings, to pay fines in the state and the EU.

The production function expresses the relationship between the amount of inputs of the enterprise that has been used to produce the product of the enterprise [CITATION Tee10 \l 1033].

With Q the quantity of the product is denoted by P the value and with C the cost. Correspondingly, with d the demand is denoted by a factor affecting demand, while b the slope of the demand function.

Based on these figures, the production functions are calculated.

The P and Q are associated with a linear formula that, in its simple form, is given by the formula

Alongside those figures, the estimation of the costs of production is necessary:

- with TP being the total product produced by the company,
- TC the total cost of production,
- AP the average product.
- AC the average cost.
- L as labour:

The marginal product or MP of each input is an additional input for the enterprise and is attributable to the increase in output of each additional variable rate unit [CITATION Geo15 \l 1033]. Therefore

$$MPL = \frac{\Delta TP}{\Delta L} = \frac{\Delta Q}{\Delta L}$$

Production costs are either fixed (FC) or variable (VC). Fixed are the costs that are not altered by the change in the quantity produced and respectively, variables, those affected by this change.

M average cost obtained by dividing each cost category in quantity and are representative of the unit produced [CITATION Dia18 \l 1033].

On the other hand, the marginal cost increases, as the quantity produced increases as the product is declining. In most businesses there is a separation of FC from VC which is determined by whether these costs are short-term or not [CITATION Cul17 \l 1033]

CHAPTER 2.

Methodology

The analysis of the Greek electricity market, follows the steps of an empirical analysis based on available public data and creates scenarios that will be examined under the assumption of the price fluctuation. Because of the established system in the Greek electricity market, some assumptions must be made in order for the calculations to proceed, these are assumptions, are based on previous researches on the subject and data collected from other European countries [CITATION Sha17 \l 1033].

The system that is established the country is state - driven, which means that even though the sector is privatized, the prices are under a form of control by the state, in order to regulate the transition from a state - controlled electricity production system, to a privatized electricity market [CITATION Nep15 \l 1033].

These guidelines by the government dictate several limits in the pricing of several parts of the electricity bills, emissions costs included, until 2019 when some of these regulations are programmed to be canceled, and the companies will be able to form the price. One of these limits is the emission cost, which is to depend on the price that is formed at the ETS [CITATION Cui14 \l 1033].

The analysis that follows predicts the price fluctuation, by using the available data on the prices and an estimation made by the Energy Regulation Authority for the period from September 2017 to September 2018, in order to show how the prices will be formed, and how this will affect the customers [CITATION YuZ15 \l 1033].

After these calculations there will be an examination of three scenarios, depending on whether the cost pass - through rises, whether it reduces or whether it remains on the same level[1], with a change in pass - through elasticity. The predictions made in these scenarios are based on the assumption that the law already in effect from 1/1/2019, was in effect from September 2017, the law states that from now on, the prices of emission costs that were fixed on the electricity bills, will, from now on, depend on the prices of the ETS. The purpose of these predictions is to evaluate the way these prices will affect both the electricity bills and the electricity market in Greece.

1 Which means that is can be set within a limit of $\pm 20\ \% \pm 20\ \%$

These scenarios will be examined under the available data and will lead to the final conclusion, which is a probability factor. Of course, these scenarios are theoretical and based only on public data, and previous fluctuations on the emissions pricing [CITATION Spr16 \l 1033].

The analysis will examine three electricity companies for a period of a month, and the summary of the Greek market on a yearly period. The cost pass - through will be calculated on the summary of the Greek market, which is the point of this dissertation, but the monthly examination of three of the companies is necessary, in order to understand the system that is forming on this sensitive market [CITATION Pap17 \l 1033].

Furthermore, several factors that may affect the outcome of the calculations, will either be taken into account, or if possible bypassed, in order to achieve further accuracy in the predictions. Also, the fact that Greece has not yet achieved full privatization of the sector, will be considered, due to the fact that it is possible for the EU to put pressure on the Greek government in order to achieve full privatization within the first quarter of 2019 [CITATION Pap15 \l 1033].

It is clear from the collected data that a big rise in the prices of allowances will cause a further rise in the prices, even if the regulations are not cancelled, because of the huge debt that PPC has.

Firstly, there will be a presentation of the general state of the Greek electricity market, regarding demand and supply capabilities along with the production of emissions, secondly an examination on the client list size that every company has will occur, thirdly there will be a presentation of the current billing form, under the state regulations. On the next step of the analysis, an examination of a period from September 2017 to September 2018 regarding the prices of the allowances will show a model of how these costs can affect the prices of electricity [CITATION Mar14 \t \l 1033].

The examination of the scenarios will be at the end of the analytical procedure, the data will be inspected under the three referenced assumptions, in order to create the figures and compare them with the calculations and between them.

CHAPTER 3.

The Greek system

3.1. The European energy policy

European Union has an established environmental policy, since its creation. This policy aims of the greenhouse footprint reduction and in developing further energy efficiency. As a start level, the union uses the 1990 emission levels, its goal is to reduce the emissions by 20 % by 2020 and increase the use of renewable energy sources and energy efficiency by 20 %on the same time. On the long - term EU aims on reducing its emissions by 90 % compared to 1990 levels by 2050. This policy is a combination of funding “green” programs and regulate the member states that do not comply with this policy [CITATION Van17 \l 1033].

The EU Emissions Trading Scheme (ETS) can be used as a model for countries wishing to develop their activities in different sectors and become more competitive. The successive phases of EST are as follows [CITATION Kle16 \l 1033]:

- Two marketing phases that took place by 2012, one from 2005 - 2007, with a view to implementing pollution reduction strategies and one from 2008 to 2012, when Member States were called upon to fully implement the Kyoto Protocol.
Under the EU ETS, the EU ETS functions as a market for the production of one tone of carbon dioxide. This license is not marketable and should only be granted to companies that meet the requirements for controlling and limiting pollutant emissions on their premises [CITATION Zak15 \l 1033].

Initially, in phase 1 (2005-2007), the ETS covered only certain industries and units, which included:
- High power plants with a thermal input exceeding 20 MW (input value),
- High energy installations, including coke ovens, steel production and so on.

The ETS covers a total of more than 50 % of annual CO_2 emissions and 40 % of GHG emissions in the EU. The rights are set on the basis of price caps and national allocation and, on an annual basis, are provided free of charge after EU approval. distribution is: Standard,
- such as the Cap-and-Trade system, where a national authority imposes a certain threshold and auction for the acquisition of rights and,

- Initial, one-off allocation to some existing installations.
- By benchmarking

Depending on the market, an equilibrium value is defined which defines the emission standard and the source of cost minimization. The market system is not completely structured and therefore the investment decisions of each workshop can have a significant impact on the market. Systems vary depending on the state. While free auctioning does not differ greatly, the role of management is of great importance in the analysis. Depending on the needs and aims of each Member State, different strategies and methods may be chosen if they are in line with the European strategies and the Kyoto Protocol. The possibility of auctioning up to 5 % of phase 1 emission allowances and 10 % in 2 caused problems because free allocation would be based on historical emissions in non-competitive sectors, such as electricity generation [CITATION Fre14 \l 1033].

There are serious shortcomings in the mechanism with regard to the management of new entrants and the problems associated with adherence to deadlines, control procedures and trade.

The main objectives of the European Union and the European Trade Market in relation to the pass - through of emissions and pollution management in the EU concern, in addition to the distribution systems and the development of the European market, the overall performance of the internal market and the energy economy The data used by the EU comes from a decentralized system and the financial analyses made are mainly aimed at the issue of resource allocation rights and the cost - effectiveness of investment [CITATION Leh13 \l 1033].

The EU has also established the emission trade market and the allowance system. The allowances system is a license - based system that gives the owner the right to emit a certain amount of pollutants by industrial procedure [CITATION Ell07 \t \l 1033]. Depending of the industrial activity of each country, EU gives a standard number of allowances to each member - state, which then auction them to the companies that emit pollutants. If a company emits more than it’s licensed to, it has to pay a heavy fine to the EU or the member - state that sold the licenses [CITATION Ell16 \t \l 1033]. The emission trade market is relatively a stock market but instead of stocks it buys and sells allowances in order for the companies to avoid the fines. This system has been around since 2005 and it has contributed in the reduction of the greenhouse pollutants from EU’s member - states [CITATION Ell07 \t \l 1033]. However, this policy has a negative impact on the operation of power companies as many of them prefer to be transferred to non - member countries and to continue to supply electricity to countries using the European Transnational Network [CITATION Cha17 \l 1033].

Until 2015, the performance of emission trading systems was significantly lower than expected, and investment in research, development and technology did not deliver. However, the EU has achieved significant work in the field. Greece uses EU networks, draws resources from the European funds and promotes cohesion policy with an emphasis on energy [CITATION Haa11 \l 1033].

The main EU objective, as analyzed, is to reduce CO_2 emissions in two bases according to SEN; in the first phase, in 2005 - 2006, there was a relative improvement in energy efficiency while market infrastructure was developed. Also, due to the expansion of available networks and cooperation between states in the framework of regional policy, progress has been made in improving the current situation [CITATION Thi16 \l 1033].
Stakeholders are complying with EU requirements, both because there is increased interest and a shift towards green energy and environmental protection, and because, according to the ETS, the fines for environmental pollution are high [CITATION Lab11 \l 1033]. The EU also plays an important role in the process of progressive development of competing energy production methods, which also covers the power sector.
Industries are required to provide full and reliable information on emission prices and whether they are in breach of the EU's long - term cap with the ETS.
In the second phase of the implementation of the strategy for the reduction of pollutants from industrial production, until 2008 there were no substantial indications that the ETS has a negative impact on the economic development and competitiveness of the energy companies [CITATION Dem08 \l 1033].

The subsidy for renewable energy programs is through funding programs from the European Central Bank and the NSRF Regional Development Program. The programs aim at the further development of renewable energy sources (RES) technologies and their further use by all member states of the Union [CITATION Cha17 \l 1033]. The target is for the Union's total electricity production from RES to be 20 % by 2020. Europe's average is currently at 17 % and the 2020 target seems achievable, and there is the hope that the 2030 target of 27 % will also be accomplished [CITATION EEA17 \l 1033].

According to the European Environmental Agency (EEA) report on the Member States' annual emissions, the Union's environmental objectives are very close to achieving, as all Member States report a reduction in air pollutants. The power generation sector has a share of 9 % in the emission of gaseous pollutants with the main pollutants nitrogen oxides, sulfur dioxide and carbon dioxide [CITATION EEA17 \l 1033].

While the targets are very close to achieving, the European Union has reduced the number of pollutant emission allowances, resulting in a 300 % increase in price compared to 2017 [CITATION Per18 \l 1033]. Based on this data, electricity prices to consumers, whose suppliers still use lignite and other fuels that produce polluting substances, are expected to be affected [CITATION Tos18 \l 1033].

Greece is one of those countries that are going to be affected the most, since a large portion of the electricity production processes still uses lignite as the main fuel. According to the Intergovernmental Panel on Climate Change (IPCC), using fossil fuel, produces 910 gr /kWh of CO_2 or CO_2 equivalent. The combination of this number, with the total energy production of a firm, e.g. PPC, and the price of a CO_2 emission allowance price, will give the total price of the emission [CITATION IPC18 \l 1033].

3.2. Electricity market

Despite the fact that Greece has a huge capacity for renewable energy production, the main production method remains lignite at 55 %. As a result, the country is constantly subject to fines from the European Union, while the country's electricity generating companies are generating electricity at fairly high costs due to the old technology used. The main power producer in the country is the state - owned PPC, which is in the process of privatizing, with its subsidiary, DEDDIE, to control the lignite mining and electricity production plants [CITATION Tig15 \l 1033].

Electricity generation in Greece is an important aspect of the national economy. In general, electricity generation in the country can be done in two main ways [CITATION Tig15 \l 1033]:

- the conventional ones

- by using renewable energy sources.

Conventional means and methods of electricity production in Greece include the use of fossils, fuels, minerals or solid materials such as oil and lignite. When using fossil fuels, there are serious environmental consequences. In addition to water and soil / subsoil pollution, atmospheric pollution from CO 2 gas or greenhouse gases is not a complex phenomenon [CITATION Bro02 \l 1033].

On the other hand, there is also the prospect of generating electricity using RES. The main sources of energy in power generation are solar and solar energy. Greece is often also the use of hydroelectric power stations [CITATION Ang18 \l 1033].

Unlike RES, fossil fuels can yield results and their use generates gains in electricity generation, but coal and lignite cannot be reused in the production process. on the contrary, both water and the sun and the wind are economically accessible alternatively and can reduce production costs and compensation costs [CITATION Bas16 \l 1033].

The main reasons that industrial plants appear convincing to fully replace their existing production structures using conventional renewable energy sources are economic and practical. RESs have a low inflow into the Greek market and there are problems related to the cost of the expenditure required to invest in development projects [CITATION Bau88 \l 1033].

Although investment projects have a life span of over thirty (30) years, investments are costly and state support is required in the effort. The existence of funds from European funds is not enough to support policies that encourage industries to move towards a complete replacement of conventional energy with green energy [CITATION Eur18 \l 1033].

The low efficiency of lignite combustion results in maximizing the cost of electricity generation and excessive use of raw material. The cost of producing electricity is also directly influenced by the EU's environmental policy, the fines of which the Greek state bears due to its absolute control of production [CITATION Fre15 \l 1033]. One of the prerequisites of Greece's economic program was the privatization of electricity production, as up until 2017 the establishment of electricity generating and distribution companies was not allowed [CITATION Ang18 \l 1033]. While lignite electricity generation was state - controlled, individuals were able to build and maintain wind farms and solar parks whose energy production was however bought by the state at a pre - agreed price and did not allow the same use [CITATION All14 \l 1033].

Greece. pays a total of 7 billion euros a year for fines for non - compliance with EU environmental policy, both in the power generation and air pollution sectors, with the result that a change in policy is necessary in order to determine financially the sustainable production of electricity in Greece [CITATION Ang18 \l 1033]. Since the liberalization of the energy market in Greece, many new electricity generators have emerged, most of which are private initiatives to produce electricity from renewable sources, but a large part of them use oil or natural gas and are therefore under the same regulations with other European companies [CITATION Cha17 \l 1033]. Today, several private electricity companies operate, the total installed capacity of the country reaches 7 GWatt, three of them were selected for the purpose of the project [CITATION Bac18 \l 1033].

These companies were selected because of the use of lignite as a fuel for the production process, their gaseous pollutant data comes from the official data published by the companies, there will, however, be a calculation of the theoretical quantity of their emissions, in order to test the accuracy of the official data. Prices on the Emissions Trading Scheme were selected based on last year's prices from December 2017 to December 2018 [CITATION EEX18 \l 1033].

The taxes and fines set by the Greek state for emissions of pollutants in industry are commonly called " Pigovian taxes " and concern the compensation paid by producers for the environmental damage they cause through them. The purpose of introducing these taxes is to reduce the abuse of available resources and to further develop strategies for the use of "green energy" [CITATION Bau88 \l 1033].

Under Greek law, polluters are called upon to compensate the state by paying an amount that will be channeled to remediate the problems caused by pollution. The economic benefits of this process are of a different nature, but extremely important.

Also, green policy, through the imposition of fines, also aims at redistributing wealth, as the negative effects of pollution and the state revenues increase. on the other hand, there may be particularly negative consequences, notably in the form of barriers to free competition and the market [CITATION Raf06 \l 1033].

The Pigonian taxes are considered part of a policy in which the tax is used to estimate the cost of an activity and to offset costs by an economic policy measure. The main objective of the State is to determine a coefficient used as the basis for calculating the operating loss resulting from the activity in a region or a sector. It is essential to emphasize that such taxes and fines should not distort producers but encourage them to develop research and technology and find equivalent alternatives. The reduction of the production of gaseous pollutants is part of the Europe 2020 Strategy and, therefore, of key importance for Greece (Metaxas & Tsavdaridou, 2012).

At the same time, in the country, there are problems related to the economic downturn. Greece, having ratified the Kyoto Protocol, must "honor" its commitments to the international community and its citizens. Therefore, the payment of fines should not be regarded as a negative measure necessarily of a disciplinary nature.

Based on the economic analysis, environmental fines are an additional cost (PMC) of the company and may lead to an increase in this performance and optimization of production. Especially in the case of power plants, the additional social cost curve (SMC) can be used to estimate the benefits of citizens in relation to the company's costs (Whalley & Walsh, 2009).

By doing so, through an estimate of the cost-benefit ratio, it is estimated that, in practice, the imposition of measures to limit climate change is a measure consistent with the objectives of the common market. However, the negative impact of the process of imposing tax rates and fines on producer companies should also be noted.

Focusing on the case study of work and assessing the effect of imposing an environmental tax on PPC, one can assess the social, economic and political effects of this action (Diakoulaki & Karangelis, 2007).

1. First, because the demand for the commodity "electricity" is inelastic, the increase in production costs by imposing fines leads to an increase in the price of the good.

2. The economic crisis has already hit producer companies and the public, and the further increase in the cost of buying, producing and distributing a social commodity like electricity can create barriers to the state and restrict growth.

3. The state does not expect economic benefits from services of general interest to the extent that it can be demanded by individuals.

4. The success of government measures is judged by whether the production curve changes.

5. The imposition of measures hampers the competitiveness of businesses.

The first of these companies is PPC, whose lignite - based production units account for almost 30 % of the country's total power output at 2.040 GWatt. The second is Heron SA with a total installed capacity of 0.460 GWatt, while the third is GEK TERNA SA. with an installed capacity of 0.187 GWatt (RAE (Energy Regulator Authority), 2018).

3.3. Supply

In addition to lignite, other energy production methods are used in Greece. The second largest fuel in use is natural gas at 20 % of total production, although it has an increased cost because Greece does not carry out natural gas and oil extraction, but it remains a fairly economical method due to the high combustion efficiency and the low - level emissions. This method seems to be the predominant among private power companies, as the low cost of pollutants and the ability to provide consumers with natural gas and electricity at the same time helps to develop the sector and is an excellent advertisement for the newly funded firms (Marques, Fuinhas, & Menegaki, 2016).

The third most common method is by using renewable energy sources, Greek islands are perfect for the installation of wind parks and the almost 300 sunny days in Greece, make it perfect for the installation of solar power panels. There is an attempt by a portion of the academic world in Greece, to pressure the government in funding research and development programs regarding renewable energy technologies, such as tidal energy, geothermal etc. There are also several hydroelectric installations, in large rivers in the country, all of which are mainly controlled by DEDDIE (Santamouris, Cartalis, Synnefa, & Kolokotsa, 2015).

Greece is also importing electricity from Bulgaria and Serbia, especially during the summer when the demand is at its peak, however the government has been criticized for this tactic, because of the availability and capacity of Greece's natural resources in order to further expand its electricity production capacity (Karanfil & Li, 2015).

3.4. Data

This analysis will show the amount of the pass - through cost of emissions, and how it can affect customers. The analysis will be conducted by comparing three of the biggest energy companies in Greece, PPC included, and the data are being collected from the official annual reports of the companies.

	Private Companies			Public Company	Greek Electricity Market		
Variables	Mean	Total	Median	Total	Mean	Total	Median
Clients	22,276	311,869	9,083	6,319,123	3,315,496	6,630,992	3,315,496
Growth Rate		103.30%		-103.30%	0	0%	0
Electricity Produced/year (MW)	361.0084	6137.142	435	8,650	7,394	14787.14	7,394
Price/kWh €	0.073			0.0946	0.0838		

Table 1 Table of Descriptive Statistics of the Greek Electricity Market,[CITATION RAE18 \l 1033]

The econometric model used to conduct the analysis is based on the exploration of the positive and negative effects on the electricity market of the liberalization of the carbon price and its formation on the basis of the carbon prices of the European pollutant market.

The variables used for the analysis are based on data from the Regulatory Authority for Energy, the Hellenic Statistical Authority and the Polymers Market. The empirical method of developing a model based on the hypothesis that the Greek Electricity Market, in operation since 2018, with the law of releasing the pollutant value in force, was used for the analysis.

The equations used in this analysis are:

- The rate of cost pass-through is calculates from:

$$\left(\frac{dP}{dAC}\right) = -\left(\frac{Dq}{Dq - Sp}\right) \leq 1$$

Where Dq and Sp are the Demand and Supply, respectively

P is the price of carbon per ton

AC is the current allowance price

3.4.1. Cost per Company

Each of these companies are using the allowances system of the EU about emission and they are not entitled to any of the free allowances, those that EU provides to member - states in order to cover non - industrial emissions (Kopidou, Tsananikas, & Diakoulaki, 2016).

Firm	Total energy output	Total CO_2 emission	Total $CO_{2\,(eq)}$ emissions	Cost in ETS for 20 euros per Mt of emission
	MWh	gr/kWh	gr/kWh	Euros
PPC	104.880	127.902	127.902	268.287.23 5
Enelco Inc.	21.456	26.125	26.125	11.210.760
Elpedison Inc.	9600	11.707	11.707	2.247.744

Table 2 Theoretical view of the yearly cost of emissions per company, (RAE (Energy Regulator Authority), 2018)

The above table shows the yearly amount of money, a firm has to pay, for an average price of ETS allowance. In order to calculate both the cost to the customer, and the actual cost of the emissions, there have to be certain admissions. First, the cost will be calculated based on September 2018 costs of the allowances, Second the companies under analysis will be considered to work for a 365 days period, on a single 8 - hour shift. And last the demand of energy will considered to be the average demand in Greece, during the Autumn months[2] (Founda & Santamouris, 2017).

The following diagram shows the price for a metric ton of CO_2 or $CO_{2(eq)}$ in the Emissions Trading Scheme.

2In Greece most people are using electric heaters and means to warm during the winter, and for cooling during the summer, also during the spring and summer months, the demand is higher due to the tourists that come to the country.

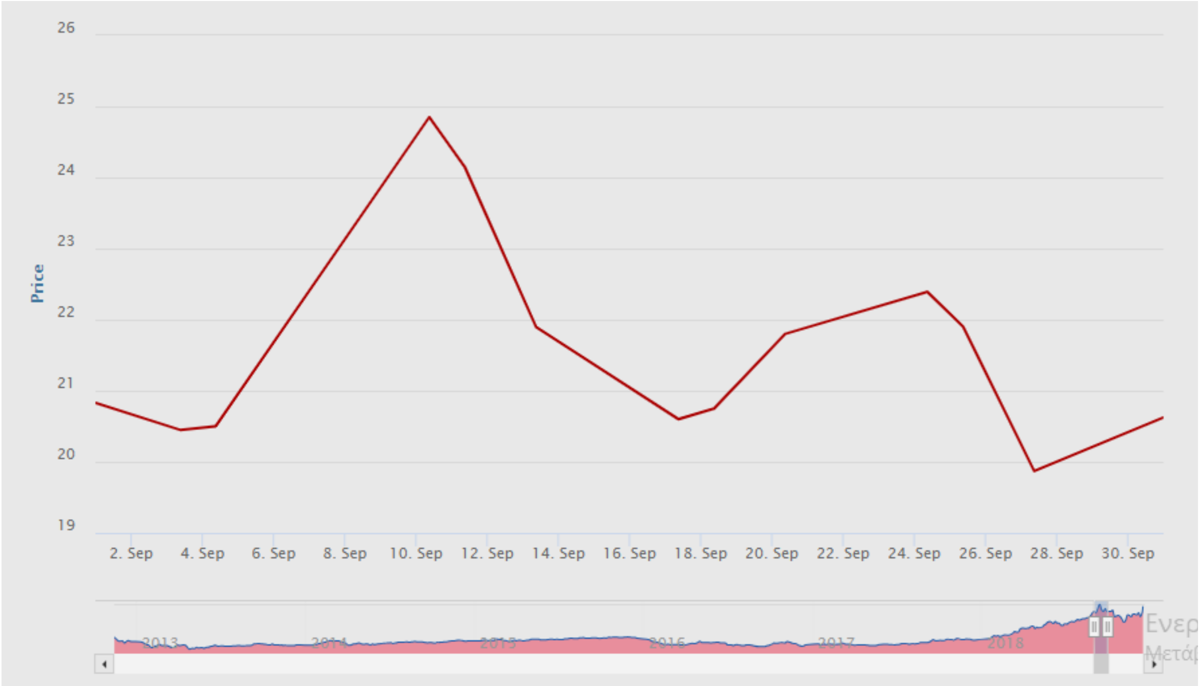

Figure 10 Price of CO_2 emissions allowances at ETS, (EEX Group, 2018)

The price ranged mostly but, during the second week of September reached its peak at 24,85 euros per permit. This resulted in a rise in prices of electricity by 20 %, also during this month, especially in the southern parts of the country, where the temperature is higher, most people are still using cooling devises which result in a bigger demand, and therefore a higher cost both in production and the customer (EEX Group, 2018).

The following table shows the daily emission cost, for PPC, for September 2018

Date	KWh per day	Emissions gr / kWh	gr / kWh to gr / kW	gr to tons	price (euro)	Daily cost
1/9/2018	3.496.000	127.902	5329,25	5,3292 5	20,8	110,85
2/9/2018	3.496.000	127.902	5329,25	5,3292 5	20,6	109,78

3/9/2018	3.496.000	127.902	5329,25	5,3292 5	20,45	108,98
4/9/2018	3.496.000	127.902	5329,25	5,3292 5	20,5	109,24
5/9/2018	3.496.000	127.902	5329,25	5,3292 5	21	111,91
6/9/2018	3.496.000	127.902	5329,25	5,3292 5	21,5	114,58
7/9/2018	3.496.000	127.902	5329,25	5,3292 5	22,3	118,84
8/9/2018	3.496.000	127.902	5329,25	5,3292 5	23	122,57
9/9/2018	3.496.000	127.902	5329,25	5,3292 5	24	127,90
10/9/201 8	3.496.000	127.902	5329,25	5,3292 5	24,85	132,43
11/9/2018	3.496.000	127.902	5329,25	5,3292 5	24,15	128,70
12/9/201 8	3.496.000	127.902	5329,25	5,3292 5	23,5	125,23
13/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,9	116,71
14/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,5	114,57
15/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,3	113,51

16/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21	111,91
17/9/201 8	3.496.000	127.902	5329,25	5,3292 5	20,6	109,78
18/9/201 8	3.496.000	127.902	5329,25	5,3292 5	20,75	110,58
19/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,2	112,98
20/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,8	116,17
21/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,9	116,71
22/9/201 8	3.496.000	127.902	5329,25	5,3292 5	22	117,24
23/9/201 8	3.496.000	127.902	5329,25	5,3292 5	22,4	119,37
24/9/201 8	3.496.000	127.902	5329,25	5,3292 5	22,39	119,32
25/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21,9	116,71
26/9/201 8	3.496.000	127.902	5329,25	5,3292 5	21	111,91
27/9/201 8	3.496.000	127.902	5329,25	5,3292 5	19,87	105,89
28/9/201 8	3.496.000	127.902	5329,25	5,3292 5	20	106,58

29/9/2018	3.496.000	127.902	5329,25	5,32925	20,4	108,71
30/9/2018	3.496.000	127.902	5329,25	5,32925	20,5	109,24
					Total	**3459,00**

Table 3 Data on the cost of emissions for every day of September 2018 for PPC, these Data is combination from (EEX Group, 2018), (RAE (Energy Regulator Authority), 2018)

The same data are available for the other two companies in the following tables.

For Enelco Inc.:

Date	KWh per day	Emissions gr/kWh	gr/kWh to gr/kW	gr to tons	price (euro)	Daily cost
1/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,80	22,64
2/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,60	22,42
3/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,45	22,26
4/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,50	22,32
5/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,00	22,86
6/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,50	23,40

7/9/2018	715.200,00	26.125,00	1.088,54	1,09	22,30	24,27
8/9/2018	715.200,00	26.125,00	1.088,54	1,09	23,00	25,04
9/9/2018	715.200,00	26.125,00	1.088,54	1,09	24,00	26,13
10/9/2018	715.200,00	26.125,00	1.088,54	1,09	24,85	27,05
11/9/2018	715.200,00	26.125,00	1.088,54	1,09	24,15	26,29
12/9/2018	715.200,00	26.125,00	1.088,54	1,09	23,50	25,58
13/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,90	23,84
14/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,50	23,40
15/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,30	23,19
16/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,00	22,86
17/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,60	22,42
18/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,75	22,59
19/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,20	23,08

20/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,80	23,73
21/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,90	23,84
22/9/2018	715.200,00	26.125,00	1.088,54	1,09	22,00	23,95
23/9/2018	715.200,00	26.125,00	1.088,54	1,09	22,40	24,38
24/9/2018	715.200,00	26.125,00	1.088,54	1,09	22,39	24,37
25/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,90	23,84
26/9/2018	715.200,00	26.125,00	1.088,54	1,09	21,00	22,86
27/9/2018	715.200,00	26.125,00	1.088,54	1,09	19,87	21,63
28/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,00	21,77
29/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,40	22,21
30/9/2018	715.200,00	26.125,00	1.088,54	1,09	20,50	22,32
					Total	**706,53**

Table 4Data on the cost of emissions for every day of September 2018 for Enelco, these Data is combination from (EEX Group, 2018), (RAE (Energy Regulator Authority), 2018)

And for Elpedison Inc.:

Date	KWh per day	Emissions gr/kWh	gr/kWh to gr/kW	gr to tons	price (euro)	Daily cost
1/9/2018	320.000,0 0	11.707,00	487,79	0,49	20,80	10,15
2/9/2018	320.000,0 0	11.707,00	487,79	0,49	20,60	10,05
3/9/2018	320.000,0 0	11.707,00	487,79	0,49	20,45	9,98
4/9/2018	320.000,0 0	11.707,00	487,79	0,49	20,50	10,00
5/9/2018	320.000,0 0	11.707,00	487,79	0,49	21,00	10,24
6/9/2018	320.000,0 0	11.707,00	487,79	0,49	21,50	10,49
7/9/2018	320.000,0 0	11.707,00	487,79	0,49	22,30	10,88
8/9/2018	320.000,0 0	11.707,00	487,79	0,49	23,00	11,22
9/9/2018	320.000,0 0	11.707,00	487,79	0,49	24,00	11,71
10/9/201 8	320.000,0 0	11.707,00	487,79	0,49	24,85	12,12
11/9/201 8	320.000,0 0	11.707,00	487,79	0,49	24,15	11,78

12/9/2018	320.000,00	11.707,00	487,79	0,49	23,50	11,46
13/9/2018	320.000,00	11.707,00	487,79	0,49	21,90	10,68
14/9/2018	320.000,00	11.707,00	487,79	0,49	21,50	10,49
15/9/2018	320.000,00	11.707,00	487,79	0,49	21,30	10,39
16/9/2018	320.000,00	11.707,00	487,79	0,49	21,00	10,24
17/9/2018	320.000,00	11.707,00	487,79	0,49	20,60	10,05
18/9/2018	320.000,00	11.707,00	487,79	0,49	20,75	10,12
19/9/2018	320.000,00	11.707,00	487,79	0,49	21,20	10,34
20/9/2018	320.000,00	11.707,00	487,79	0,49	21,80	10,63
21/9/2018	320.000,00	11.707,00	487,79	0,49	21,90	10,68
22/9/2018	320.000,00	11.707,00	487,79	0,49	22,00	10,73
23/9/2018	320.000,00	11.707,00	487,79	0,49	22,40	10,93
24/9/2018	320.000,00	11.707,00	487,79	0,49	22,39	10,92

25/9/2018	320.000,00	11.707,00	487,79	0,49	21,90	10,68
26/9/2018	320.000,00	11.707,00	487,79	0,49	21,00	10,24
27/9/2018	320.000,00	11.707,00	487,79	0,49	19,87	9,69
28/9/2018	320.000,00	11.707,00	487,79	0,49	20,00	9,76
29/9/2018	320.000,00	11.707,00	487,79	0,49	20,40	9,95
30/9/2018	320.000,00	11.707,00	487,79	0,49	20,50	10,00
					Total	**316,61**

Table 5 Data on the cost of emissions for every day of September 2018 for Elpedison, these Data is combination from (EEX Group, 2018), (RAE (Energy Regulator Authority), 2018)

Of course companies are not buying the allowances every day, but yearly, usually through auctions at the ETS.

3.4.2. Demand per Company

Another important factor is the number of customers every company has, that information is the most valuable because is the factor that determines if the company will absorb the cost of the emissions, or if it's going to put it in their customers' bills.

Until 2017 PPC had the 100 % of the electricity market, but since the law that allowed private companies to produce and distribute electricity that number has been reduced to 80,78 % of the market. That number can be explained by two things. Firstly, in 2012 there was a big chaos, when the government tried to introduce the private energy system, several private companies appeared, but a few months after the law, the government withdrew it and most of the customers that tried to change electricity provider, had a problem (Tselepis, 2015).

That had an impact on the Greek people trust against this system, since for almost 70 years they knew only PPC as their provider. Secondly, these companies that were created after 2017 are still trying to organize and they trying to do so by copying the PPC's system for production and distribution. Also, it is well known in Greece that the reduction of PPC's part of the market, was one of the terms introduced in the Stabilization Program, after the 2009 economic crisis (Polemis, 2016).

The following table shows the number of the customers per company:

Company	Customers	Percentage of the Greek market, %
PPC [3]	6.319.123	80,78
Enelco Inc. [4]	81.796	4,1
Elpedison Inc.	76.161	3

Table 6 Customers per company, (RAE (Energy Regulator Authority), 2018)

According to the Greek Statistic Authority (ELSTAT), in average a greek household will consume 3.750 kWh per year, of course that number depends on the month, the weather and the region of the country. The stradegy of the company, reggarding billing, will take into account if the company is able to produce enough electricity to provide the customers, or if it has to purchase that electricity from other companies (Greek Statistic Authority, 2018).

3.4.3. Billing

In order to examine the cost of pollutants, the pricing procedure must first be followed. Most companies in Greece aim to increase their clientele through lower billing, which usually reaches 70 %compared to PPC. This tactic means that a private company is more likely to absorb some of the production costs in order to increase the number of customers (RAE (Energy Regulator Authority), 2018).

3 The Stabilization Program that was signed by the Greek government, stated that by December 2018, PPC had to drop its portion of the market to 62.24 %but that target was not achieved.
4 Enelco Inc is the production company of the corporation Protergia.

Typically, the pricing that arrives to the customer is monthly, and includes taxes, additional municipal fees and the cost of pollutants. From these extra costs, the variable, ie the cost of pollutants, is what companies choose to absorb in order to view and increase customers (Zhang, Cai, & Feng, 2017).

Company	Price per kWh	Additional cost	Emission Costs
PPC	0,08761	0,005	0,020
Enelco Inc.	0,00527	0,0042	0,02267
Elpedison Inc.	0,08925	0,00435	0,02267

Table 7 Prices per company, [CITATION RAE18 \l 1033]

The above table shows that PPC, due to the larger client list and the state funding, has a lowered emission cost to their clients. But, on the contrary the private companies try to absorb some of the production costs in order to keep their price lower than PPC's.

CHAPTER 4.

Analysis and data synthesis

4.1. Descriptive Statistics

Greece until recently had a standard carbon price, in energy bills, which was paid by all of the customers and was regulated by the Energy Regulator Authority, but as of 2019, the cost of carbon emissions in the electricity bills in the country, will depend on the price that the company has paid in the Emissions Market, this will give the ability to the companies to induce this cost into their clients, and on the same time, it will allow them to surpass the competition, and further their image, by choosing to bill less for the carbon to their customers.

In order for this analysis to continue, there have to be several assumptions, about the energy market in Greece, firstly the cost pass - through will be calculated by taking into account the raise in carbon price in Greece that happened on 1/1/2018 and calculating the absolute pass - through and pass - through elasticity from that data, and using it for every change in price happened during 2018.

On December 31st 2017 the companies in Greece paid 2,5 euros per MWh for emissions, on January 1st 2018 they paid 12 euros per MWh. The cost pass - through calculations will be conducted for both forms of pass - through.

In order to begin the calculation MWh must turn to kWh so:

31/12/2017 = 2.5 € / MWh = 0,0025 € / kWh

1/1/2018 = 12 € / MWh = 0,012 € / kWh

The prices of the emission allowances were:

31/12/2017 = 7,4 euros per allowance

1/1/2018 = 7,6 euros per allowance

The difference between the two is equal to 20 cents and caused an almost 5 times increase in the price. The calculations have to include the amount of kWh this allowance cover. In average there is 0,62 kg of emissions per kWh, because every allowance covers a ton of emissions it means that there are 1.612,90 kWh per allowance which leads to a cost of 0,004712 € / kWh at 7,6 euros price, at 7,4 euros that cost is 0,004588 € / kWh.

Which means that for a raise of the marginal cost of 0,000124 € / kWh, the customers paid an extra 0,0095 € / kWh, these amounts may seem small but in a yearly period of time, with an average demand of 3.750 kWh per customer, it translates in a 35,625 € raise in the price of electricity.

This is a minimum raise, calculated for a single change in the price of the allowance. On a larger scale this raise can cause serious problems to the customers budget. The absolute pass - through in this case can be calculated as:

$$\frac{0.0095}{0.000124} = 76.61 \ = 7661 \ \%$$

The absolute pass - through in this case came as a factor of 76.61 but, this is a theoretical calculation, based on estimations, that predicted the raise of the allowances price. In order for more accurate results there have to be a further analysis of the cost pass - through and the prices at the ETS.

The cost of emissions will be calculated according to the average price per month for the period from September 2017 to September 2018.

Month	Avg price per allowance	Production per month	Emissions	Allowances	Cost of Allowances
	euros	MWh	Mt		euros
September 2017	5,50	2.730,10	1.692,66	1.693,00	9.311,50
October 2017	7,86	2.850,00	1.767,00	1.767,00	13.888,62
November 2017	7,68	3.286,50	2.037,63	2.038,00	15.651,84
December 2017	7,89	3.108,80	1.927,46	1.928,00	15.211,92

76bvcb	7,63	3.139,70	1.946,61	1.947,00	14.855,61
February 2018	8,70	2.853,60	1.769,23	1.770,00	15.399,00
March 2018	9,64	2.781,10	1.724,28	1.725,00	16.629,00
April 2018	13,82	2.122,40	1.315,89	1.316,00	18.187,12
May 2018	15,05	2.469,90	1.531,34	1.532,00	23.056,60
June 2018	15,44	2.898,70	1.797,19	1.798,00	27.761,12
July 2018	16,99	3.378,50	2.094,67	2.095,00	35.594,05
August 2018	18,20	3.213,80	1.992,56	1.993,00	36.272,60
Septembe r 2018	24,85	2.936,00	1.820,32	1.821,00	45.251,85
Total		37.769,10	23.416,8 4	23.423,00	287.070,83

Table 8 Monthly cost of the allowances, [CITATION EEX18 \l 1033]

Figure 11 Cost fluctuation of the ETS, [CITATION EEX18 \l 1033]

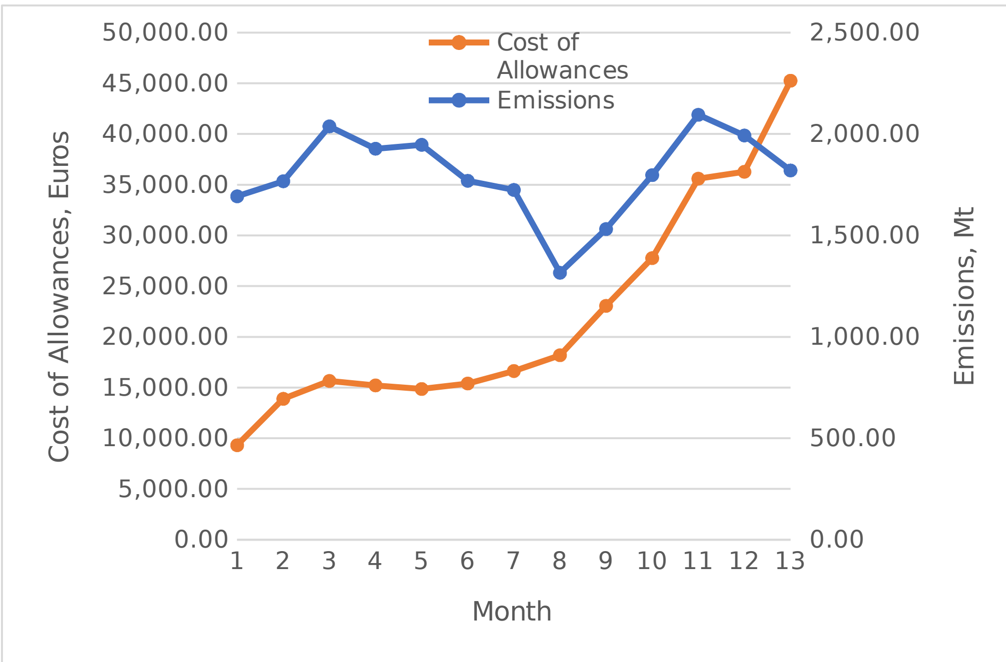

Figure 12 Relation between emissions and cost, [CITATION RAE18 \l 1033]

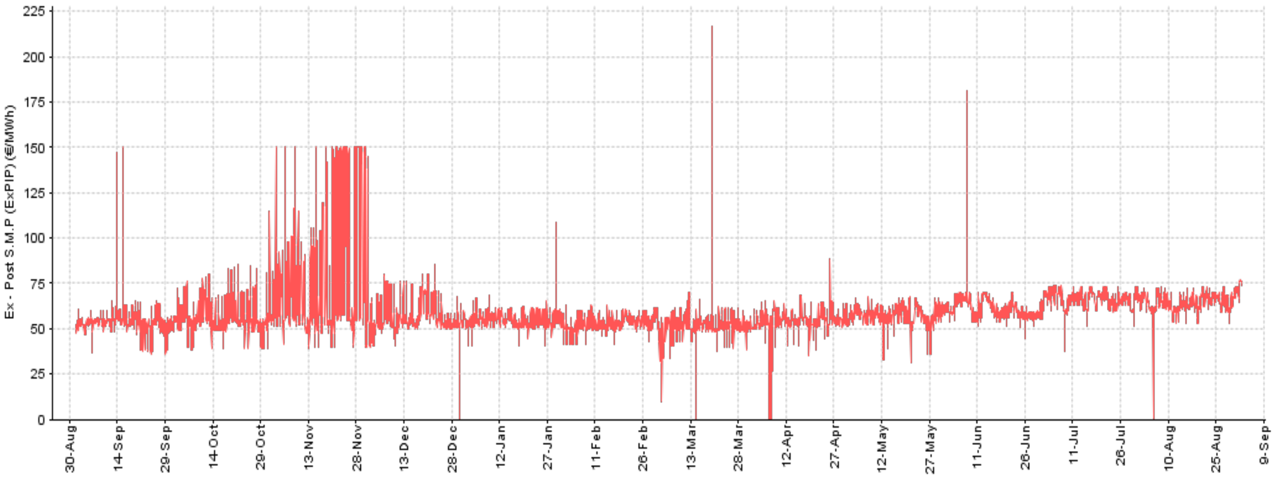

Figure 13 supply prices of electricity per MWh in Greece, [CITATION EEX18 \l 1033]

4.2. Cost pass - through

The difference in the cost of production and the electricity price can be seen in the next table. The data are collected from official governmental sources.

Month	Avg price per allowance	Production per month	Emissions	Allowances	Cost of Allowances	**Emission cost in production**		**Avg price of emission costs in electricity**	
	euros	MWh	Mt		euros	Euros / MWh	Euros / kWh	Euros / MWh	Euros / kWh
September 2017	5,50	2.730,10	1.692,66	1.693,00	9.311,50	3,410681	**0,003411**	53,510531	**0,053511**
October 2017	7,86	2.850,00	1.767,00	1.767,00	13.888,62	4,873200	**0,004873**	56,628976	**0,056629**
November 2017	7,68	3.286,50	2.037,63	2.038,00	15.651,84	4,762465	**0,004762**	79,980213	**0,079980**
December 2017	7,89	3.108,80	1.927,46	1.928,00	15.211,92	4,893181	**0,004893**	57,320875	**0,057321**
January 2018	7,63	3.139,70	1.946,61	1.947,00	14.855,61	4,731538	**0,004732**	54,991647	**0,054992**
February 2018	8,70	2.853,60	1.769,23	1.770,00	15.399,00	5,396341	**0,005396**	52,816766	**0,052817**
March 2018	9,64	2.781,10	1.724,28	1.725,00	16.629,00	5,979289	**0,005979**	51,442555	**0,051443**
April 2018	13,82	2.122,40	1.315,89	1.316,00	18.187,12	8,569129	**0,008569**	53,453381	**0,053453**
May 2018	15,05	2.469,90	1.531,34	1.532,00	23.056,60	9,335034	**0,009335**	57,372466	**0,057372**
June 2018	15,44	2.898,70	1.797,19	1.798,00	27.761,12	9,577093	**0,009577**	61,070154	**0,061070**
July 2018	16,99	3.378,50	2.094,67	2.095,00	35.594,05	10,535460	**0,010535**	66,192488	**0,066192**
August 2018	18,20	3.213,80	1.992,56	1.993,00	36.272,60	11,286514	**0,011287**	64,499726	**0,064500**
September 2018	24,85	2.936,00	1.820,32	1.821,00	45.251,85	15,412755	**0,015413**	72,652542	**0,072653**

Total		37.769,10	23.416,84	23.423,00	287.070,83

Table 9 Table 6, including the cost of production and the emission costs in electricity, [CITATION RAE18 \l 1033]

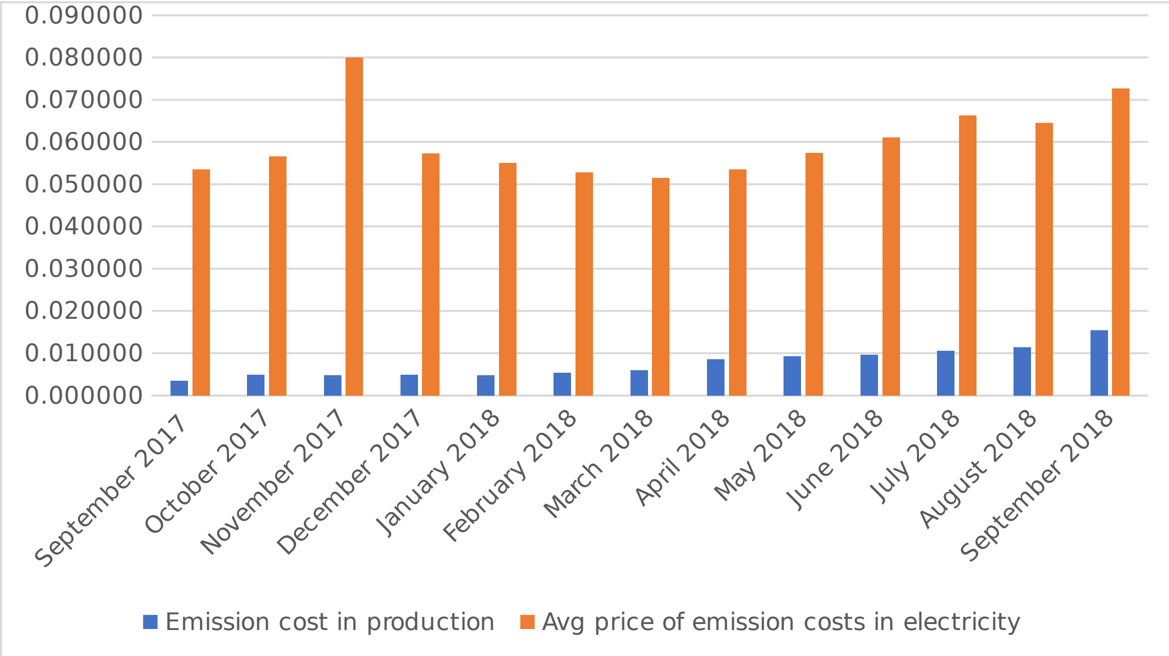

Table 10 Diferrence between cost and price, [CITATION RAE18 \l 1033]

The cost pass - through can be seen in the next table.

Month	Emission cost in production		Avg price of emission costs in electricity		cost pass - through of emissions	
	euros/MWh	euros/kWh	euros/MWh	euros/kWh		%
September 2017	3,410681	0,003411	53,510531	0,053511	15,69	1568,91
October 2017	4,873200	0,004873	56,628976	0,056629	11,62	1162,049
November 2017	4,762465	0,004762	79,980213	0,079980	16,79	1679,387

December 2017	4,893181	0,004893	57,320875	0,057321	11,71	1171,444
January 2018	4,731538	0,004732	54,991647	0,054992	11,62	1162,236
February 2018	5,396341	0,005396	52,816766	0,052817	9,79	978,7514
March 2018	5,979289	0,005979	51,442555	0,051443	8,60	860,3457
April 2018	8,569129	0,008569	53,453381	0,053453	6,24	623,7901
May 2018	9,335034	0,009335	57,372466	0,057372	6,15	614,593
June 2018	9,577093	0,009577	61,070154	0,061070	6,38	637,669
July 2018	10,535460	0,010535	66,192488	0,066192	6,28	628,2829
August 2018	11,286514	0,011287	64,499726	0,064500	5,71	571,476
September 2018	15,412755	0,015413	72,652542	0,072653	4,71	471,3793

Table 11 Cost pass - through calculations on the electricity prices, [CITATION RAE18 \l 1033]

4.3. Scenarios

4.3.1. Raise in emissions price, raise of absolute pass - through by 1.

In the previous subsection the calculations showed several values of the absolute pass - through, the fact that the prices in ETS could rise further, is a real scenario, due to the fact that EU is trying to push further in order to achieve the goal for reduction of the emission levels. In this scenario EU, trying to implement "greener" technologies in the industrial sector, reduces the number of the available allowances causing a rise in the prices of the emissions costs, which leads to a rise of the pass - through factor by 1. The scenario will examine the period between September 2018 and September 2019 based on the available data of the previous calculations.

Month	**Emission cost in production**		**Avg price of emission costs in electricity (Sc1)**		**Scenario 1**		**Total cost per customer**
	Euros / MWh	**Euros / kWh**	**Euros / MWh**	**Euros / kWh**		**%**	**euros**
September 2018	**3,410680927**	**0,003410681**	**56,92121148**	**0,056921**	**16,69**	**1668,910481**	17,78788
October 2018	**4,8732**	**0,0048732**	**61,50217581**	**0,061502**	**12,62**	**1262,049081**	19,21943
November 2018	**4,762464628**	**0,004762465**	**84,74267713**	**0,084743**	**17,79**	**1779,387014**	26,48209
December 2018	**4,893180648**	**0,004893181**	**62,21405565**	**0,062214**	**12,71**	**1271,444079**	19,44189
January 2019	**4,731538045**	**0,004731538**	**59,72318455**	**0,059723**	**12,62**	**1262,236169**	18,6635
February 2019	**5,396341463**	**0,005396341**	**58,21310783**	**0,058213**	**10,79**	**1078,751377**	18,1916
March 2019	**5,979288771**	**0,005979289**	**57,42184388**	**0,057422**	**9,60**	**960,3457214**	17,94433

April 2019	**8,569129288**	**0,008569129**	**62,02250984**	**0,062023**	**7,24**	**723,7901047**	19,38203
May 2019	**9,335033807**	**0,009335034**	**66,7075002**	**0,066708**	**7,15**	**714,5930222**	20,84609
June 2019	**9,57709318**	**0,009577093**	**70,64724735**	**0,070647**	**7,38**	**737,6689985**	22,07726
July 2019	**10,53545952**	**0,01053546**	**76,72794743**	**0,076728**	**7,28**	**728,2828742**	23,97748
August 2019	**11,28651441**	**0,011286514**	**75,78624021**	**0,075786**	**6,71**	**671,476042**	23,6832
Septembe r 2019	**15,41275545**	**0,015412755**	**88,06529712**	**0,088065**	**5,71**	**571,3793189**	27,52041
						Total	275,2172

Table 12 Cost pass - through of First scenario.

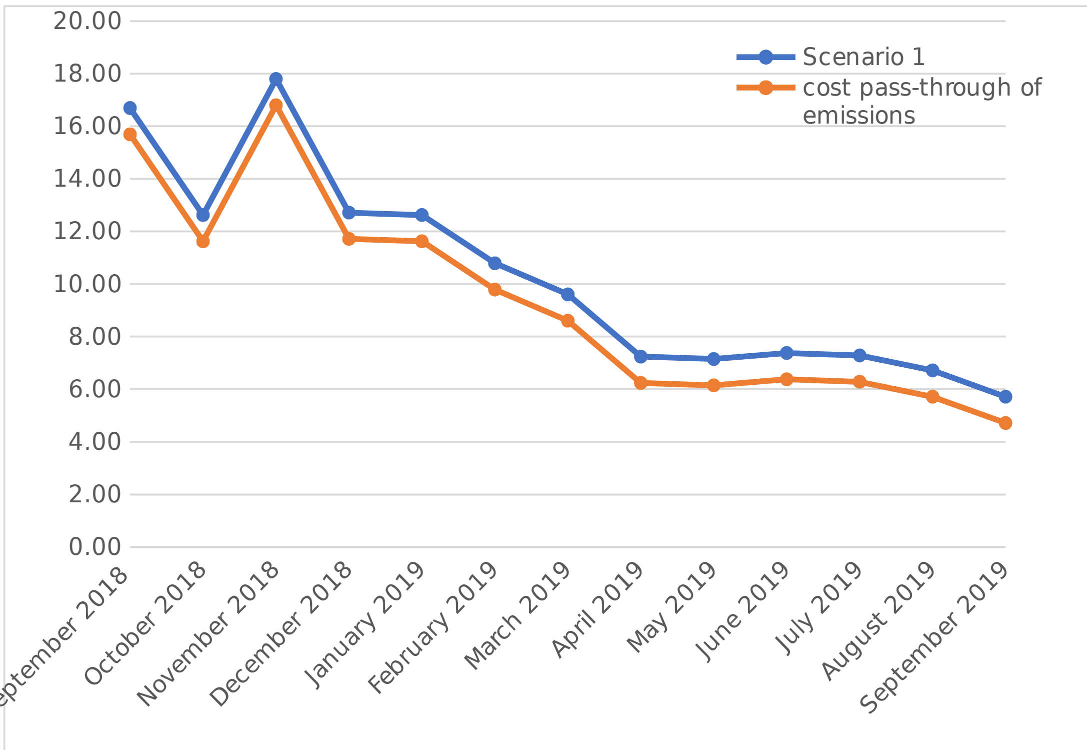

Figure 14 Comparison between the actual data and the first scenario

According to this scenario, a small shift on the price curve, caused a 36 euros raise on the annual bill of the customer, the amount of money may seem small, but this amount refers only to the emissions costs, which may or may not cause further raises on other factors. The possibility of this scenario is high due to the fact that EU puts pressure and effort in achieving the goals of 2020, and in the long run the goals of 2030.

4.3.2. Emissions prices reduce, reduction of pass - through factor by 1.

This is a part of possible, but unlikely scenario, that in case of a satisfying level of the goals of 2020, EU will release a larger number of allowances causing the prices to fall. The logic of this scenario states that most of the member - states have achieved their necessary enviromental targets, and EU is trying to bring back those companies, that took their business in third countries, in order to avoid these regulations. As in the previous scenario the prices will be compared to the ones that were given previously and the period under examination remains the same.

Month	**Emission cost in production**		**Avg price of emission costs in electricity (Sc2)**		**Scenario 2**		**Total cost per customer**
	Euros / MWh	**Euros / kWh**	**Euros / MWh**	**euros**		**%**	**euros**
September 2018	**3,410680927**	**0,003410681**	**50,09984963**	**0,050100**	**14,69**	**1468,91**	**15,6562**
October 2018	**4,8732**	**0,0048732**	**51,75577581**	**0,051756**	**10,62**	**1062,049**	**16,17368**
November 2018	**4,762464628**	**0,004762465**	**75,21774787**	**0,075218**	**15,79**	**1579,387**	**23,50555**

December 2018	**4,893180648**	**0,004893181**	**52,42769435**	**0,052428**	**10,71**	**1071,444**	**16,38365**
January 2019	**4,731538045**	**0,004731538**	**50,26010846**	**0,050260**	**10,62**	**1062,236**	**15,70628**
February 2019	**5,396341463**	**0,005396341**	**47,42042491**	**0,047420**	**8,79**	**878,7514**	**14,81888**
March 2019	**5,979288771**	**0,005979289**	**45,46326634**	**0,045463**	**7,60**	**760,3457**	**14,20727**
April 2019	**8,569129288**	**0,008569129**	**44,88425127**	**0,044884**	**5,24**	**523,7901**	**14,02633**
May 2019	**9,335033807**	**0,009335034**	**48,03743259**	**0,048037**	**5,15**	**514,593**	**15,0117**
June 2019	**9,57709318**	**0,009577093**	**51,49306099**	**0,051493**	**5,38**	**537,669**	**16,09158**
July 2019	**10,53545952**	**0,01053546**	**55,65702838**	**0,055657**	**5,28**	**528,2829**	**17,39282**
August 2019	**11,28651441**	**0,011286514**	**53,2132114**	**0,053213**	**4,71**	**471,476**	**16,62913**
September 2019	**15,41275545**	**0,015412755**	**57,23978622**	**0,057240**	**3,71**	**371,3793**	**17,88743**
						Total	**213,4905**

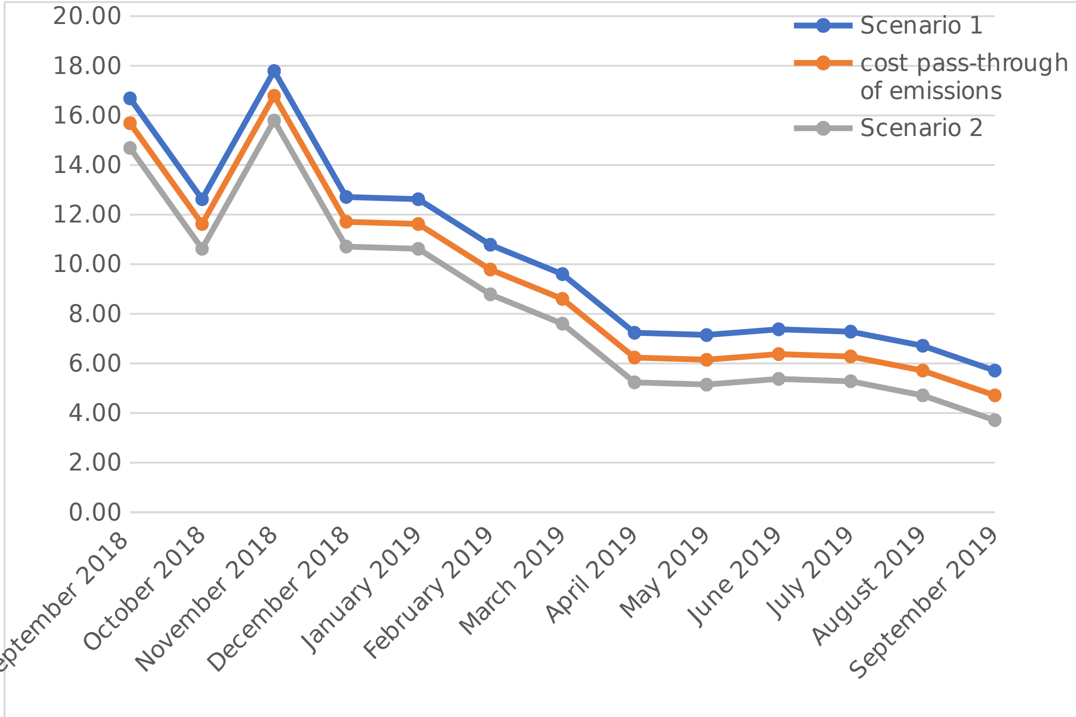

Figure 15 Comparison of the first two scenarios and the original prices

As in the previous scenario, there was a linear shift in pass - through curve, this shift caused a reduction on the annual cost of a customer by 31 euros. One can easily conclude than any unitary change in the absolute pass - through, will cause a linear shift on the price curve.

4.3.3. Elastic change in pass - through.

The last, and most likely, scenario is that Greek electricity market will have to face several percentile changes in emissions cost, these changes will cause a non - linear shift in the pass - through curve. This scenario is based on a realistic model of the electricity market in Greece, and the state involvement in the sector. This model investigates what will happen in the market, on a realistic level, because of the fluctuation in the price of emissions allowances and how they affect the prices of electricity bills.

By analyzing the previous data, there can be a calculation of the pass-through elasticity and the prices it generates. On the following table there are the results of the calculations of the previous data.

Month	**Emission cost in production**		Avg price of emission costs in electricity		cost pass-through of emissions		pass-through elasticity
	Euros / MWh	**Euros / kWh**	Euros / MWh	%		%	%
September 2017	**3,410680927**	**0,003410681**	53,51053056	93,62615	15,69	1.568,91	93,62615
October 2017	**4,8732**	**0,0048732**	56,62897581	91,39451	11,62	1.162,05	91,39451
November 2017	**4,762464628**	**0,004762465**	79,9802125	94,04545	16,79	1.679,39	94,04545
December 2017	**4,893180648**	**0,004893181**	57,320875	91,46353	11,71	1.171,44	91,46353
January 2018	**4,731538045**	**0,004731538**	54,99164651	91,3959	11,62	1.162,24	91,3959
February 2018	**5,396341463**	**0,005396341**	52,81676637	89,7829	9,79	978,75	89,7829
March 2018	**5,979288771**	**0,005979289**	51,44255511	88,37677	8,60	860,35	88,37677
April 2018	**8,569129288**	**0,008569129**	53,45338056	83,96897	6,24	623,79	83,96897
May 2018	**9,335033807**	**0,009335034**	57,3724664	83,72907	6,15	614,59	83,72907
June 2018	**9,57709318**	**0,009577093**	61,07015417	84,31788	6,38	637,67	84,31788
July 2018	**10,5354595**	**0,01053546**	66,1924879	84,0836	6,28	628,28	84,0836

	2						
August 2018	**11,28651441**	**0,011286514**	64,49972581	82,50145	5,71	571,48	82,50145
September 2018	**15,41275545**	**0,015412755**	72,65254167	78,78566	4,71	471,38	78,78566

Table 13 Calculation of pass-through elasticity regarding the period September 2017-2018

The elasticity results on this table, indicate a big difference between the production cost and the price that reaches the customer, in this scenario the elasticity will determine the number of the price and not the other way around. In order for the scenario to be accurate, the percentage of the difference between the prices of the allowances, will be multiplied by the elasticity of the pass-through cost.

Month	Avg price per allowance	Percentile fluctuation.	Pass-through elasticity	Pass-through elasticity (Sc3)	**Emission cost in production**		Avg price of emission costs in electricity (Sc3)	
	euros	%	%	%	**Euros / MWh**	**Euros / MWh**	**Euros / MWh**	**Euros / MWh**
Septemb	5,5	4,72727	93,6261	98,35342	**3,41068092**	**3,41068092**	3,35452143	0,00335452

er 2017 [5]	0	3	5		**7**	**7**	2	1
October 2017	7,86	30,02545	91,39451	121,42	**4,8732**	**4,8732**	5,917037334	0,005917037
November 2017	7,68	-2,34375	94,04545	91,7017	**4,762464628**	**4,762464628**	4,367260854	0,004367261
December 2017	7,89	2,661597	91,46353	94,12512	**4,893180648**	**4,893180648**	4,605712382	0,004605712
January 2018	7,63	-3,4076	91,3959	87,9883	**4,731538045**	**4,731538045**	4,163199661	0,0041632
February 2018	8,70	12,29885	89,7829	102,0818	**5,396341463**	**5,396341463**	5,508679871	0,00550868
March 2018	9,64	9,751037	88,37677	98,1278	**5,979288771**	**5,979288771**	5,867344701	0,005867345
April 2018	13,82	30,24602	83,96897	114,215	**8,569129288**	**8,569129288**	9,78722989	0,00978723
May 2018	15,05	8,172757	83,72907	91,90183	**9,335033807**	**9,335033807**	8,579066671	0,008579067
June 2018	15,44	2,525907	84,31788	86,84379	**9,57709318**	**9,57709318**	8,31711064	0,008317111
July 2018	16,99	9,123014	84,0836	93,20662	**10,53545952**	**10,53545952**	9,8197453	0,009819745
August 2018	18,20	6,648352	82,50145	89,14981	**11,28651441**	**11,28651441**	10,06190562	0,010061906
September 2018	24,85	26,76056	78,78566	105,5462	**15,41275545**	**15,41275545**	16,26758167	0,016267582

Table 14 Calculation of the emission prices that will occur in Scenario 3

5 For the calculation of the percentage of this month, the price that will be used will be of August 2017, which was 5,24 euros per allowance, (EEX Group, 2018).

These changes in pass-through elasticity cause a change in passthrough absolute values.

Month	**Emission cost in production**		Avg price of emission costs in electricity (Sc3)		pass-through elasticity	Scenario 3	
	euros/MWh	**euros/kWh**	euros/MWh	euros/kWh	%		%
September 2018	**3,410680927**	**0,003410681**	3,354521432	0,003354521	98,35342	0,98	98,35
October 2018	**4,8732**	**0,0048732**	5,917037334	0,005917037	121,42	1,21	121,42
November 2018	**4,762464628**	**0,004762465**	4,367260854	0,004367261	91,7017	0,92	91,70
December 2018	**4,893180648**	**0,004893181**	4,605712382	0,004605712	94,12512	0,94	94,13
January 2019	**4,731538045**	**0,004731538**	4,163199661	0,0041632	87,9883	0,88	87,99
February 2019	**5,396341463**	**0,005396341**	5,508679871	0,00550868	102,0818	1,02	102,08
March 2019	**5,979288771**	**0,005979289**	5,867344701	0,005867345	98,1278	0,98	98,13
April 2019	**8,569129288**	**0,008569129**	9,78722989	0,00978723	114,215	1,14	114,21
May 2019	**9,335033807**	**0,009335034**	8,579066671	0,008579067	91,90183	0,92	91,90

June 2019	**9,57709318**	**0,00957709 3**	8,31711064	0,00831711 1	86,8437 9	0,8 7	86,84
July 2019	**10,5354595 2**	**0,01053546**	9,8197453	0,00981974 5	93,2066 2	0,9 3	93,21
August 2019	**11,2865144 1**	**0,01128651 4**	10,0619056 2	0,01006190 6	89,1498 1	0,8 9	89,15
September 2019	**15,4127554 5**	**0,01541275 5**	16,2675816 7	0,01626758 2	105,546 2	1,0 6	105,5 5

Table 15 Calculations on the absolute pass-through cost.

The effect that elasticity has on the prices of the emission charges, is smaller than the one of the absolute pass-through. The relation between the prices of the period September 2017-September 2018 and September 2018-September 2019, is shown in the following diagram.

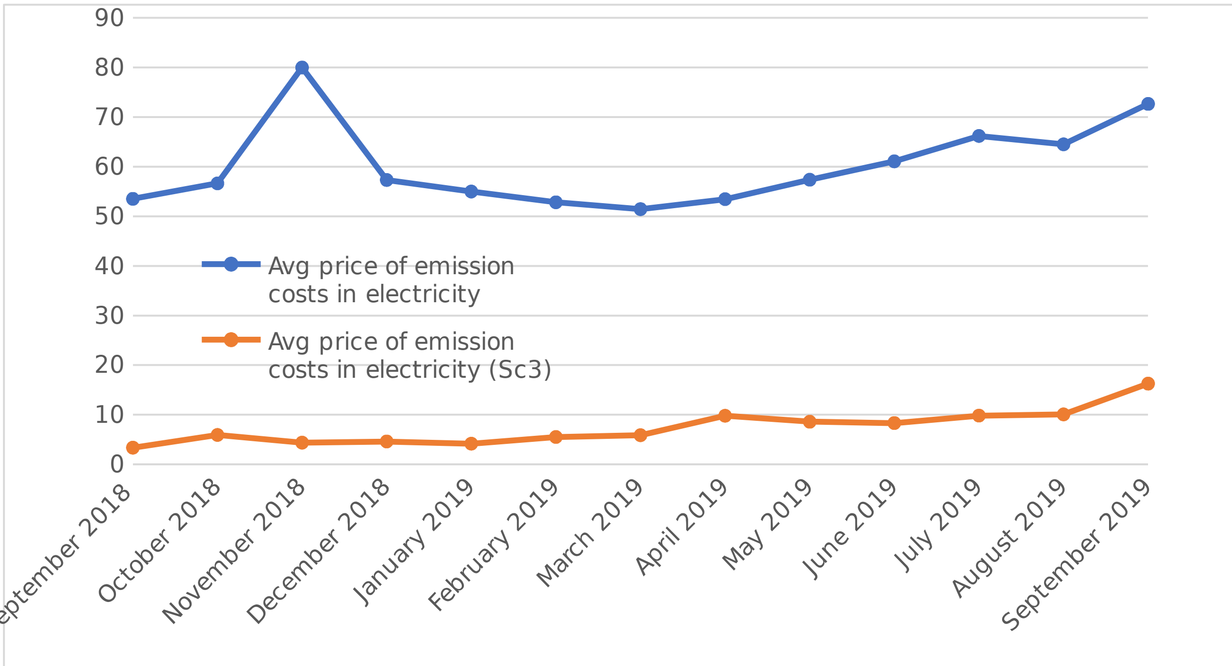

Figure 16 Comparison between the prices of emissions of September 17-18 and September 18-19

As shown in the above diagram, there is serious reduction in the prices of emission costs, this comparison between the prices is a more realistic one for the Greek market, because the companies will try to keep the prices law, even in expense of their profit, in order to increase their client lists.

CHAPTER 5

Conclusions & Policy Implications

The dissertation focused on an analysis of the emission costs in the case of the electricity market in Greece. In the four main chapters of the study, it has been shown that there are both challenges and opportunities deriving from the use and enforcement of a stricter environmental policy in the EU. In European systems and hence in Greece, there is the "the polluter pays" principle present in law. This principle, applied both at the level of citizens and state as well as industry, strengthens the sense of social responsibility and, at the same time, completes the economic objectives of the state (Wilkinson, 1992).

Instead of spending money on consolidating the economy and remediating the problems caused by uncontrolled misuse of resources, the state, by imposing fines on the emissions of the producers, is making revenue from companies that violate environmental and pollution control agreements. Policies for managing pollutants and reducing carbon dioxide and greenhouse gas emissions, however, are judged to be partially successful (Laszlo, 2003).

The environmental tax is imposed for the purpose of supporting the national goals on pollution restriction, but the use of taxation cannot be viewed as a tool of economic policy and, also, the fear of sanctions does not solve environmental issues. On the contrary, fining and restricting production can lead to problems in the supply, demand and consumption of goods, especially when they are in the category of public goods or goods of general interest (Esty, 2001).

Depending on the EU Member State, environmental taxation is changing. Environmental taxes in general range between 0.7 and 8.8 % of total gross domestic product on an annual basis. Types of environmental taxes include:

1) Fuel tax and,

2) The tax on industrial production.

Industrial plants pay fines for waste management and carbon dioxide or greenhouse gas emissions. It is estimated by the OECD that, as a whole, the productive units spend between 1 - 2.5 % of their

GDP on environmental taxes. Under existing law, there is both the system of tradable permits for CO2 emission and a licensing system. This system includes the purchase of licenses entitling the holder to produce a specific quantity of CO2. Environmental permits replace the environmental tax and, as a solution, can be a practice with great benefits for the state and the state. However, in order for the tax to be fair, a social benefit must be produced. In the case of licenses, the state initiative and both internal and external control play a prominent role. For each unit of activity within the power plant, even a minimum marginal net profit must be achieved (Svendsen, Daugbjerg, Hijollund, & Pedersen, 2001).

The implications caused by these measures, are also high, due to the fact that those companies that have the resources to produce more energy, and therefore more profit and taxes, choose to leave the EU, in order to avoid this profit reduction. If this policy doesn't change, the majority of the companies will move their business elsewhere, causing a domino effect that will implicate the tax collection, the electricity prices, the number of jobs etc.

At the moment Greece is still safe from this problem, since the majority of the citizens are using the PPC, as their main electricity provider, but, if this policy causes the private companies to lose more money, they will relocate probably in FYROM, Albania, or Turkey, and by doing so they will further reduce the Greek economy.

The analysis that took place earlier in this dissertation, was based on purely academic and public data available to the public, although the outcome of this analysis may seem indifferent in many, it matters because it represents a realistic model of the electricity market, as it is being formed in EU and Greece. The sole purpose of this analysis was to attempt on a prediction, on what will happen in case of change in emission prices.

The fact that a simple percentile could cause an impact of this scale to the total of the economy, is one to be taken on account, especially in a sensitive economy, such as Greece's.

Firstly, the data collection has shown how quickly the electricity market is changing in Greece, how the privatization has caused a shift on the vary foundations on the Greek market, and how this is affecting the whole of the Greek economy. Private companies, seem to have expanded their client list really quickly within the past year, and they are committed for further expansion, by investing in new production facilities and technologies, and by trying to further their cause by improving their public image.

The second step was the determination of the portion each company has on the Greek market, the conclusion is that in case of lifting the emissions regulations, the private companies will have to further bill their clients, to cover these expenses, while PPC will be able to keep this cost on a low level because of the larger client list.

The collection of the data continued by examining the costs that come in an electricity bill, for every one of the companies, what is interesting is that PPC has a different regulation than private companies by charging 0,002 less than private companies, the reason is because PPC is still state-regulated, managed to keep the cost at its minimum, while private companies charge it at its maximum because of the smaller client list.

During the annual analysis, based on the prices from the previous year, the results lead to the conclusion, that in an event of a price increase of emissions allowances, the Greek electricity market will have to face a huge amount of additional costs, that it won't be able to absorb and not pass to the clients.

During the scenarios examination the results showed a steady shift in the cost pass-through, and the cost, if distributed right, will not cause any big issues on the Greek market, of course in the event of large raise in prices of emissions, that cost will be multiplied and the companies will not be able to keep it under control.

The third scenario, however, has shown different results than expected, the results suggest a drastic drop on the prices of emission costs the customers have to pay, these results seem to be the most realistic, due to the fact that if the regulations on the Greek market be cancelled, the private sector will have the flexibility to adjust the prices, based on their client list limits and the purchase cost, rather than having a minimum and maximum limit, to whit they have to follow.

Of course, if the prices in ETS raise even more, there will be a raise in the emission cost to the customers, but not as big as the pessimists are afraid of. The private sector, has the ability to regulate its profit at will, and by doing so, it can reduce the impact of a raise in ETS prices. The question here is whether EU's or state's policy will allow such initiatives, because it is well known that a larger profit for a company means a larger tax collection by the state, and whether the companies will be willing to reduce their profit in order to reduce the charges to their clients.

The conclusion is that Greek society will not be greatly affected, as on average the cost of electricity increases due to pollutants amounts to 30 euros per year. So, there is no expectation of some kind of social turmoil in the country, at least for that reason. The problem lies within companies that should be able to absorb much of the cost of pollutants in order to stay competitive with other companies.

With customers going out of PPC at a fast pace, private companies will be forced to increase their electricity production to meet demand. In the Greek market there is the possibility of supplying electricity from one company to the other, but the cost in the long run is greatly increased, so companies will have to increase their production in order to avoid a future reduction in their profit.

The answer to that question can be given in one of the fundamental laws of economics, the law of demand, in a system where the customer is free to choose the most beneficial choice, he will always choose a lower price than a large one. The newly funded private electricity companies in Greece have to find the right connection between price and benefit, when they do, they will be able to draw more customers.

Because of the nature of the sector, there will be no potential client that will not eventually choose a firm to power his home or his business. Further research on this subject is sufficed, due to the many potentials that are visible. Such researches can refer to the subject of how emission costs affect fuel and production costs in the process of generating electricity. The geographical on which Greece is located, gives the country many advantages, which it can exploit, in order to reduce both production costs and its greenhouse footprint.

Another field that would be interesting, for research purposes, is the impact emission costs have on the country's economy, which is weaken after many years of crisis. In general, emission costs have an important role in an economy, especially in a European country, who is under the regulation of the EU.

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Appendix

Abstract in Greek

Σκοπός της παρούσας εργασίας είναι η διεξαγωγή μιας εμπειρικής ανάλυσης σχετικά με τη μετάδοση του κόστους της εκπομπής της ελληνικής αγοράς ηλεκτρικής ενέργειας, η ανάλυση αυτή δείχνει τον αντίκτυπο της αύξησης του κόστους εκπομπών στην τιμή της ηλεκτρικής ενέργειας στην Ελλάδα και τον τρόπο με τον οποίο η πολιτική της ΕΕ παρεμβαίνει σε αυτόν τον τομέα.

Αυτοί οι υπολογισμοί είναι πολύ σημαντικοί στον επιχειρηματικό κόσμο επειδή μπορούν να προβλέψουν με ακρίβεια, τη διακύμανση του κόστους παραγωγής και το κέρδος. Το παρόν έγγραφο περιλαμβάνει τόσο μια θεωρητική ανασκόπηση όσο και μια εμπειρική ανάλυση του θέματος, όλες οι αναφορές προέρχονται από επίσημες τοποθεσίες της Ελληνικής Κυβέρνησης και της Ευρωπαϊκής Ένωσης, καθώς και ακαδημαϊκές και οικονομικές πηγές υψηλού κύρους.

Παρά το γεγονός ότι έχουν διεξαχθεί πολλές έρευνες σχετικά με το θέμα, κανένας από αυτούς δεν έχει εμβαθύνει αρκετά στον πραγματικό αντίκτυπο αυτών των πολιτικών και στις μεταβολές των τιμών. Θα υπάρξει αναφορά στο θέμα των προβλημάτων που προκαλούν αυτές οι αλλαγές στους πελάτες και τους πολίτες του κράτους, καθώς και στις ευαίσθητες ομάδες, όπως άτομα με αναπηρίες, άτομα που χρειάζονται μηχανές υποστήριξης της ζωής κ.λπ.

Θα γίνει μια αναφορά σε θεωρητικό επίπεδο, στα θεμελιώδη στοιχεία της οικονομίας, που διέπουν όλες τις σύγχρονες οικονομικές απόψεις και θεωρίες, και μια ανάλυση του κόστους ευκαιρίας που βρίσκεται πίσω από αυτούς τους παράγοντες. Τα στοιχεία και τα συμπεράσματα αυτής της ανάλυσης έδειξαν ότι εάν δεν ληφθούν άμεσα μέτρα, το κόστος της ηλεκτρικής ενέργειας στην Ελλάδα θα αυξηθεί σε μεγάλο βαθμό, ακόμη και κατά τους πρώτους μήνες του 2019. Η προσομοίωση που χρησιμοποιήθηκε ως παράδειγμα για τον επερχόμενο νόμο που σταματά την τυπική τιμή CO_2 / kWh στη χώρα και την εμπορία με ρήτρα διακύμανσης που θα εξαρτηθεί από την τιμή εκπομπών διοξειδίου του άνθρακα στο πλαίσιο του ΣΕΔΕ. Τα δεδομένα και οι υπολογισμοί που εξετάστηκαν σε τρεις σενάρια, ο πρώτος δήλωσε ότι σε περίπτωση αυστηρότερης περιβαλλοντικής ρύθμισης, το πώς θα επηρεαστούν οι τιμές, το δεύτερο κάνει το αντίθετο, ότι σε περίπτωση που οι περιβαλλοντικοί κανονισμοί που είναι τώρα σε ισχύ χαλαρώνουν, τότε πώς θα επηρεάσει αυτό το κόστος της ηλεκτρικής ενέργειας. Υπάρχει περιθώριο για περαιτέρω έρευνα στον τομέα αυτό, ειδικά σε χώρες που έχουν χαμηλές φυσικές πηγές και εξακολουθούν να χρησιμοποιούν παλαιά τεχνολογία για να παράγουν ηλεκτρική ενέργεια.

Λέξεις-κλειδιά:
Αγορά ηλεκτρικής ενέργειας, κόστος, εκπομπές, CO_2, ρύπανση, περιβάλλον.

Abbreviations

EU	European Union
ETS	Emissions Trading Scheme
CO_2	Carbon Dioxide
N_2O	Nitrous Oxide
PFCs	Perfluorocarbons
CO	Carbon Monoxide
SO_2	Sulfur Dioxide
PM	Particulate Matter
FC	Fixed Costs
VC	Variable Costs
RES	Renewable Energy Sources
EEA	European Environmental Agency
IPCC	Intergovernmental Panel on Climate Change
PPC	Public Power Company (i.e. D.E.I.)
PMC	Private Marginal Cost
SMC	Social Marginal Cost
ELSTAT	Greek Statistic Authority (translation)
DEDDIE	Managerial Company of Electricity Distribution Network (translation)
RAE	Energy Regulator Authority (translation)
GDP	Gross Domestic Product
OECD	Organization for Economic Co-Operation and Development