



The Electrical Industry in Portugal: A strategy formulation analysis

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Abstract

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This study intends to give an overview of the Portuguese electrical industry. The approach was based on the strategy concept, which conducted the analysis. The analysis done of the strategy concept had its focus on both the nature of this concept and its applicability within the economic world. This thesis concluded that strategy is a plan for the future. The study of the concept leads to the creation of models of analysis for business realities. The models used in this work were SWOT analysis, PEST analysis, and Porter's Five Forces. These were the tools used in this work to approach the electrical industry in Portugal. The report concludes that government policies will have great importance in the industry's future. It is assumed that the future of the industry will involve an investment in renewable energy, in the development of the grid, and in sustainable mobility, mainly through electrical energy. The main trends identified are decarbonization, decentralization, and digitalization.

Sumário

Título: A indústria elétrica em Portugal: uma análise de formulação estratégica

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Palavras-chave: Indústria elétrica Portuguesa; Estratégia; PNEC 2030; Energia renovável.

Este trabalho pretende dar uma visão geral da indústria elétrica Portuguesa. A abordagem foi feita com base no conceito de estratégia, que guiou a análise. O conceito estratégia foi analisado numa tentativa de perceber o que é e qual a sua aplicabilidade no mundo empresarial. A conclusão é que estratégia é um plano para o futuro. O estudo do conceito levou à criação de modelos de análise para a realidade empresarial. Os modelos usados foram: análise SWOT, análise PEST, análise das cinco forças de Porter. Foi com estas ferramentas que abordei a indústria elétrica Portuguesa. As conclusões da análise foram que as políticas do governo serão muito importantes no futuro da indústria. É assumido que o futuro da indústria passará por um investimento na energia renovável, no desenvolvimento da rede e na mobilidade sustentável, através da energia elétrica. As principais tendências são descarbonização, descentralização e digitalização.

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Introduction

Background

The electrical industry is a large and complex industry where many and different players interact with each other. Since the time I was in my bachelor's in engineering, where I had the opportunity to take many courses around this sophisticated reality, I grew an interest in learning more about it. Its high level of complexity makes it challenging to have an overview of this industry, and so I thought of trying to look into the sector in this master thesis. The energy industry is currently facing a transition. It is easy to assume that the electrical industry will have an essential role in the energy transition, mainly because of its ability to be low in carbon emissions. Climate change is a hot topic on the political agenda, and the energy sector has a significant role in this matter. With these factors, the electrical industry will be the subject of a severe transformation.

Problem statement

The electrical industry is a broad topic. The initial objective, when I started doing this thesis, was to understand this industry better. I already knew some concepts of electricity and energy, but I didn't know how this industry works, who are the players in it, how the industry is organized, etc. On the other hand, strategy is a sound word that I felt would give me the right point of view to face the challenge of analysing this industry. The purpose of this thesis is to offer an extensive analysis of the electrical industry explained from a strategy formulation point of view. The questions I tried to answer with this thesis are:

RQ1: What are this industry's characteristics?

RQ2: What are the main challenges in this industry?

RQ3: What is happening at this moment changing this industry?

RQ4: What may be the future of this industry?

All these four questions are quite broad. The first research question intention is to send me into an overall understanding of the primary process of the industry and its value chain. The second will make me aware of the obstacles the industry is facing today. The third presents what is happening in the industry; what everyone thinks the industry should be doing now. The fourth question will imply speculation, i.e., this question will have me thinking about the problems the

industry might be facing in the future and what kind of solutions would be the most relevant to resolve them.

Relevance

This thesis pretends to take a holistic approach to the whole electrical industry in Portugal. The purpose for creating a macro analysis is to be able to present the connections between the various aspects of this industry. Instead of focusing on one point and make a more in-depth analysis, the thesis intends to give a general image that will provide the main gateways of opportunities to be explored.

Dissertation outline

The structure of this thesis starts with this introduction, where I give the main reason why I chose this topic and some general aspects of this industry I already knew prior the start of this work.

The second chapter consist in a literature review, where the strategy concept is explored in five areas: Introduction, Definitions, Theories, Instruments and Application. Firstly, it is explained through an introduction why the strategy concept is used in this thesis. This is followed by a section on definitions, giving the fact that it is always crucial to clarify the issue being studied. As many other topics, the strategy concept does not have only one meaning, and so a presentation and analysis of some alternative meanings is done. Thirdly, a section on the theoretical approach intends to clarify the concept of strategy by offering some theoretical views on it. In a fourth section, three analyses, methods, or frameworks that arise from the strategy concept are presented. The fact that these instruments are useful when formulating a strategy, makes it essential to include them when conducting an analysis that seeks a general interpretation of the industry from the point of view of strategy. The fifth section is on the application of the strategy concept in this thesis.

The third chapter outlines the methodology used. This chapter is about the method used to collect data from primary and secondary sources. It is also where it is explained how the interviews were carried out and the way the interviewees were reached.

The fourth chapter concerns the discussion part. This is considered the core of this thesis. It is composed of five parts: Introduction, Characteristics, Swot Analysis, PEST Analysis, and Porter's Five Forces Analysis. In this introduction, one explains the primary process of the electrical industry and its players. The part focusing on characteristics is used to describe the

primary electrical production sources. In the sections regarding SWOT analysis, PEST analysis, and Porter's Five Forces, an analysis of the electrical industry is done with each framework.

The last chapter consists on a conclusion, where the main findings and conclusions of this thesis are presented. In this final chapter, it is also mentioned the limitations and future research of this thesis.

This work also includes appendices presented at the end where one can find some of the data that supports the analysis done in the discussion chapter.

Literature Review

Introduction

This thesis is an industry analysis of the electrical industry in Portugal. A possible way of carrying out this analysis is by using strategy instruments like Porter's Five Forces, SWOT, or PEST. Strategy is a broad concept that is vague for most people. Despite this, it is commonly used. In every company, a strategy for a particular year or for a more extended period of time is often defined. Companies associate strategy to vision, statement, objectives, etc. It's a way of identification of the company itself. In order to reach an overview of the industry, the main goal of this work, the strategy concept seemed able to do the job. Its presence in the day-to-day of companies makes this industry analysis more complete if one includes it in the process.

The structure of this literature review consists in this introduction, where the reason to use strategy for the analysis is addressed; followed by the definition of strategy. It is vital to define the concept in order to have a clear understanding of what is addressed here. After this, some approaches to the concept are presented. These are useful to understand the dynamics of strategy and why companies use it. The following section talks about the instruments. Here one can find a description of the tools used for the industry analysis during the discussion chapter and the reasons why were chosen in the context of this thesis. In the end, it is outlined the applicability of the present chapter to the whole thesis, after it completes its purpose of presenting the strategy concept and increase one's depth of understanding of its crucial role.

Definitions

To clarify the concept of strategy, I decided to introduce three definitions from two theorists and another from a dictionary. The purpose of this section is to familiarize the reader with the idea of strategy. Although the reader probably has its own idea of it, the fact is that strategy is a broad concept that has many interpretations. It is useful then to understand more clearly which meaning will be used throughout this work. The two theorists considered for this point are Michael Porter, famous for his Porter's Five Forces instrument, and Alfred D. Chandler Jr, known for *Invisible Hand*, alongside with many other articles. The dictionary used is the online Oxford Learner's Dictionaries. The reason for including a dictionary definition is to consider a standard definition, free from any analysis the theorists could implement in their definitions.

The first definition is taken from Porter in *What is strategy?* (Porter, 1996): “Strategy is creating fit among a company’s activities”. This definition assumes a particular view of strategy. A view that is linked to the antonymism between strategy and operational effectiveness, the preliminary point of Porter’s article. In the article, Porter says that strategy is not about doing better, with fewer costs and higher quality than the opposition, but doing differently. Strategy is introduced as the decision to go in different paths. It is choosing various activities to deliver different things from one’s rivals and with these provide something that has more value. An acquired value due to the simple reality that one possesses a product that the client cannot find elsewhere. Porter reinforces that strategy implies a different choice and not a better choice. It is not about choosing the best of everything but make a trade-off between what the company values and what it does not value. The characteristic of the company influences this choice. Every company is different, it has, at least, different people working on it, which means that different companies will always have different qualities and flaws from each other. The role of strategy inside the companies would then consist in choosing the direction that enhances the assets of the companies and minimizes the weaknesses. This strategy is responsible for adjusting the pieces inside the company to create the perfect match. One could apply this definition of strategy to a chess game. In this game, each player selects an approach, an ongoing plan that enhances the fit within its pieces in order to create a robust system. A system where every piece is irreplaceable and should be in the right place at the right time to perform its duty and lead one into victory.

The second definition is given to us by Chandler “[Strategy is] the determination of the basic long-term goals and objectives of an enterprise and the adoption of courses of action and the allocation of resources necessary for carrying out these goals”, from *Strategy and Structure* (Chandler, 1962). This definition originated from a reflection about organisations. The author hypothesizes that if the goal of an organisation is to grow, and one calls ‘strategy’ to the planning and execution of that plan, then the definition of strategy is the one presented above. This definition prescribes a two-step formula to create a strategy. Firstly, one has to define the goals and objectives; secondly, one establishes the path, a series of measures to be followed that are supported by the resources of the company. This definition shows us a different perspective regarding what influences the strategy of a company in comparison with the first definition. In one hand, Porter considers the company ‘in action’, its activities. On the other hand, Chandler looks at the static situation of the company. Chandler also assumes that strategy is about long term goals. This statement means that it is not the challenge that determines the

strategy, i.e., it does not make sense to make a strategy against a momentaneous obstacle. A strategy is made to achieve long term goals in time.

The third definition englobes many interpretations of the concept, as it is usual from a dictionary definition. According to the Oxford Learner's Dictionaries, strategy is: 1 - “a plan that is intended to achieve a particular purpose”; 2 - “the process of planning something or putting a plan into operation”; and, 3 - “the skill of planning the movements of armies in a battle or war”. The first interpretation addresses the concept of goals by including the word purpose. The difference between this two, however, is that purpose is more generic. Purpose can be seen as a positive achievement, in the same ways as when one as a goal does everything to achieve it, but can also be linked to a negative accomplishment, which in contrast one would avoid an obstacle, for example. Furthermore, the concept of time is not issued in this interpretation. The second interpretation approaches the methodology of making a strategy, concretely the conceiving phase and the execution phase. The third interpretation contemplates the human ability to conceive a strategy applied to a specific context, a war or a battle. This interpretation can be seen as quite narrow because of its limited applicability to the military context. Nevertheless, one can use still make use of it and apply it to other more general situations. In the case of an industry, for example, one could assume that companies are at war with each other in the pursue for the highest return. In this scenario, a battle could be considered as a short duration interaction between two or more firms for the success linked to a concrete objective, such as market share, higher sales, better quality end product, etc. It is worth noticing that this dictionary definition, consisting of the three interpretations presented, does not agree with Chandler's definition when it comes to the application of strategy. Chandler assumes that strategy only deals with long term goals, while the Oxford dictionary concedes that sort term disputes can be the object of strategy.

For this thesis, one will assume the Chandler's definition alongside with Porter's. Although the Chandler's definition can be considered more fitting for the mindset of this dissertation, both definitions end up complementing each other.

Theories

This section of the literature review intents to dig deeper into the strategy concept. A definition has already been established, but there is a world around strategy that the reader should be also introduced to. Two articles were chosen as guidelines to tackle this challenge. The first is *The Strategy Concept I: Five Ps for Strategy* (Mintzberg, 1987) from Henry Mintzberg, where the

concept of strategy is approached looking at what it means. One could wonder why this article was not presented in the previous section regarding definitions of strategy, ... (It could be analyzed in the definitions section if it had a single definition.) The second article is *What is strategy again?* (Ovans, 2015), a report that can be found on the Harvard Business Review magazine. The report states that all the articles about strategy explore one of three big groups of strategies: creating something new, exploring from what you have, or reacting to the market opportunities. Following this statement, the author suggests some articles that cover the topic and dig deeper into each group and outlines the examples of strategies found in these other articles. For each group of the three groups of strategy mentioned, there are subgroups. A focus on these subgroups will now be done. This analysis will include an explanation of how one can conclude that the subgroups follow the Chandler definition when contrasting these with Mintzberg's article.

Mintzberg states that strategy is a concept that has many interpretations. He classifies the concept into five types. The first type is strategy as a plan. The manoeuvres that will lead the army/company to victory. The second type is strategy as a ploy - a manoeuvre design to distract the opposition and gain an advantage. The third type is strategy as a pattern. Here the author suggests that strategy is the name given to the consistency of behaviour. In this way, the next action is in harmony with all previous actions, intentionally or not. The fourth type is strategy as a position. This interpretation is in harmony with the plan interpretation. A plan can take into consideration the initial positionings, as the positionings can take into account the actions that follow from a plan. Lastly, the fifth type is strategy as a perspective. This interpretation of the concept suggests that strategy is linked to the company's relationship with its environment.

As it was already mentioned above, there are three categories of strategies discussed in *What is strategy again?* (Ovans, 2015): creating something new, exploring from what you have, and reacting to the market opportunities. Each category has subcategories or subgroups. When it comes to the first category, creating something new, one can find two types of approaches. One can either enter in a new market strategy type of their own creation or transform one's enterprise in order to become different from everyone else.

Concerning the new markets approach, the main idea is that a company should attempt to make a unique offer to the customer, eliminating any competition. When companies compete, their target is often being able to achieve better prices, better quality, or a better ratio between the two. However, competition also often leads to lower profits. A typical belief is that one should

bet in innovation in order to create value and surpass the competition. But the concept of innovation as a mere change it is vague. Value innovation is a concept that aims to overtake this challenge. Through a new mix of characteristics, the companies would land in a no-man land, and so face none direct competition (Kim and Mauborgne, 1999). The theory is developed into the concept of Red oceans and Blue oceans. Red oceans are today's industries and are characterized by fighting over the market share of the companies. Blue oceans are the industries that are not yet discovered and therefore have no competition. A trade-off between value for customer and cost, and so, price, is assumed in Red oceans companies. Meanwhile, Blue oceans companies are characterized by giving better value to the customer and, at the same time, a reduction of the costs/price (Kim and Mauborgne, 2004). Creating value for the customer is not only about technology, nor about the product or the service. It is about the whole package, i.e., the business model. The business model is the key to create a competitive advantage (Johnson, Christensen, and Kagermann, 2006).

The main idea to hold on to when it comes to the transformation strategy type is that differentiation can be made in every point of contact with the customer. Finding and implementing differentiation involves mapping the customer chain and ask the right questions: what, where, who, when, and how (MacMillan and McGrath, 1997).

Passing on to Ovans' second category, exploring what you have, one can find three different strategy subcategories or subgroups. One may either move to an adjacent territory (industry), respond competitively, or make surviving disruptors moves. On the subcategory where one would choose moving to an adjacent territory the main idea behind it is that companies should use their capabilities in new ways that prove to be more valuable to the customer. No core business endures forever. Therefore, every company will, sooner or later, face two key questions: when to change and where to go? There are five areas the manager should analyse to know when to do this type of move: customers, differentiation, industry, capabilities, and culture. With these parameters, the manager will get an idea of the status of their current core business and will be able to assess if the company needs a shift into a new core business. For greater success, the transformation should be gradual, pass through investing in hidden assets (assets that were not producing at its maximal potential), becoming industry leaders, and leaving the industry within the right timing (Zook, 2007). The process of moving to an adjacent industry can be converted into a repeatable formula but takes great discipline and customer knowledge (Zook and Allen, 2003). Strategy is about managing resources to produce the best result possible. These company resources can be physical assets, intangible assets, or

capabilities. The key is to test, invest, and upgrade the resources (Collis and Montgomery, 2008).

For the subcategory concerning competitive responses, the main idea is that one should “play” hard if one wants to survive in the business world. There are two types of players in the business world: the softball players and the hardball players. The softball is the one who avoids confrontation and will try to keep the status quo. The hardball is the one that wants to be the best they can be and makes use all legitimate forces, even when they are controversial, to reach this goal (Stalk and Lachenauer, 2004). Controversial measures can be effective, but eluding your adversary is also a good strategy to gain a competitive advantage. By getting the competitors to do something dumb or prevent them from making a good move, one’s company will get an advantage (Stalk, 2006).

When it comes to the last subcategory, making surviving disruptors moves implies that one’s strategy lies in the already existent power of the established companies in order to prevent and obstruct the success path of disruptors. Revolutions seem to be very effective when in fact, they are not. When a revolution that does not work it is simply called rebellion, riot, or some other word with a prerogative meaning. This can give an optimistic view about the idea of revolutions. In the business world, the same thing happens. People may be led into thinking that start-ups are better than incumbents. However, start-ups only work if the incumbents let them work. The power is in the hands of companies already in the market. They already possess the network, the distribution channels, the suppliers, etc. (D’Aveni, 2002). On the other hand, one can respond to this by creating disruption. One should, however, take into careful consideration the consequences this move will originate (Wessel and Christensen, 2012).

Lastly, one needs to consider reacting to market opportunities, Ovans’ third category. This category encompasses three types of strategies: discovering planning, continuous planning cycle, and start-ups planning style. Discovery planning has to do with the idea that a strategy should not be a plan made at the beginning of the year, or the project, and that would not change with time. In the practice of the Japanese martial art of judo, one must use the weight and strength of their opponent to one’s advantage. This strategy uses the principles of judo to get a competitive advantage. It is called the judo strategy and has three basic elements: rapid movement, flexibility, and leverage. The first element is about exploring new business areas through the launch of new products or entering new market space. The second element of flexibility is about avoiding sumo matches. That is, confronting head-to-head a more powerful

adversary. The third element is leverage. In every judo match, one does not play infinitely, they want to win, and so they need to finish the match. Leverage is about this. When there is a successful company, other companies will be suffering. These can become one's allies and can be used to reach one's goals (Yoffie and Cusumano, 1999).

Concerning the continuous planning cycle, the concept is that every plan should be adjusted as time passes by. Strategy planning is important in every company. Nevertheless, to make the most of it there is a new approach that changes the game completely. The traditional way has two main characteristics: the plan is annual and is business unit based. This type of strategic planning is about "review and approve", review what the unit has been doing and approving its budget. The calendar effect is bad for two reasons. Firstly, because of problems that arise in time, deciding once a year does not resolve the problem. Secondly, the timing at which the decisions appear is not feasible with the traditional approach. The new way is about "debate and decide". It consists of deciding about the main path the company has to take while considering the main criteria and decisions the company has to follow. By combining decision making with plan making, it is possible to focus on a few but key decisions that will guide the rest of the other decisions and align them with the plan (Mankins and Steele, 2006).

To conclude, there is the concept of start-up management style which consists in being simplistic and testing hypotheses. It is a new method for dealing with new ventures. Firstly, the business plan is no longer a perfect business plan that must be followed no matter what, but it is instead a summary of hypotheses that are necessary to be confirmed. For that it is necessary to collect information among all parts of the market in order to test those hypotheses, discarding the false ones and keeping the true ones. The objective is to create a "minimum viable product". In other words, a product that has the minimum features, but all of them are known to be within what the market wants. The most important thing is that the product is what the customers want (Blank, 2013).

The presentation of the concept of strategy and theoretical application based on the articles mentioned above can serve as an introduction to the next section on instruments. Instruments which are no more than formulations of the concept of strategy and that can be used to perform the industry analysis intended in this work.

Instruments

The three instruments that will be considered in this dissertation are SWOT (Heeri and Noon, 2008), PEST (Heeri and Noon, 2008), and Porter's Five Forces (Porter, 2008). Each one of

these seeks to offer different points of view over the same matter, in this case, the electrical industry in Portugal. These instruments will be used in the discussion section as frameworks to understand the dynamics behind this industry.

The SWOT analysis is a technique that faces four aspects of any company: strengths, weaknesses, opportunities, and threats. This technique is beneficial because it approaches inside and outside elements of the company. The strengths and weaknesses are inside aspects of the company and have a crucial role in determining its strategy. This approach reflects Chandler's definition of strategy. The resources of the company have their qualities and flaws. This analysis should give an image of the true colours of those resources and introduce the manager into the right path to success. Those resources can be physical like an asset, accountable in the balance, but also an intangible resource, such as a brand, a supplier network, or the workforce that cannot be measure by numbers. The outside aspects are opportunities and threats. These aspects are essential, and, although they are not under direct control of the company, they can be manipulated to the company's benefit. Simplistically, the opportunities must be seized, and the threats must be avoided. This is certainly more difficult to do than to say. The first step to work with external factors is to recognise them, and that is what this technique intents to help on doing. Sometimes the difference between an opportunity and a threat is thin. On top of that, these external factors can be happening at a present moment or be expected in the future. Aspects as economy, legislation, other companies' actions of today can change in the tomorrow. The SWOT analysis can give clues to decide the direction of the company. It is used to expose the various aspects of the industry and provide a basis from where conclusions about the industry's future are extrapolated.

The PEST analysis focuses with a greater amplitude on the external factors. It is a framework that allows to expose the main external factor that influences a company's future. The name is an acronym for political, economic, socio-cultural, and technological analysis. Instead of classifying the external factors as opportunities or threats, this analysis intends to describe the environment in which the company finds itself. It focusses on four primary areas that for this dissertation are enough by the author. Even though there are some variants to this framework with the addition of some other areas such as ecological, legal, intercultural, and military, some of these can be considered contained within the initial frame for this dissertation analysis. For example, legal factors, which are important in this industry, can be approached in the political factors, while ecological factors, another critical issue, can be presented in the socio-cultural aspects or under the political elements, depending on the point of view. In the primary

framework, political elements refer to the government influence over the economy. The economic elements relate to the health of the economy and can be considered both from a global point of view or a narrower perspective. The socio-cultural aspects include demographic trends, population characteristics, the population's health, etc. These are aspects that will influence the company directly or indirectly. Lastly, the technological elements influence the workforce qualifications demand, the cost of the companies, etc. Technological aspects focus on technology as an indirect force in electric industry companies that plays a role not only in its interactions with clients and suppliers but also within their workforce and overall structure.

The third tool of analysis being taken into consideration is the Porter's Five Forces. This type of analysis focuses more on the near environmental aspects of a company. A cross with a circle in the middle and in each end is often used to represent the five forces. In the middle, there is competitive rivalry force. It is the representation of the aggressiveness between the companies that are in the same industry. The vertical part of the cross represents the interaction of the company with other industries. Here is where the suppliers and clients are taken into account. The forces behind these players are the bargaining power of the suppliers and the bargaining power of the clients. Each one has the potential to increase the cost of supply material or decrease the price of the final product, and so reduce the profit of the company. The horizontal part of the cross represents the challenges within the industry. These can be presented as the substitutes and the new entrants. The companies that propose new products/services that meet the same end in this industry are in competition with each other, and must, therefore, be taken into account when planning the company's actions. The companies that may enter in the industry also influence the company's decisions, as they will be a threat to the company's power in the market. This analysis is commonly used to predict the profitability of an industry: both incumbents and start-ups benefit from this analysis. The former benefit because it helps to create a plan to keep market power. While the latter benefit because it helps understand if it is profitable to enter the market.

These three instruments of analysis will overlap because the reality that is being analysed is the same for all three. Nonetheless, it is essential to do it. The use of the three instruments ensures a more complete view of the industry, in comparison with a scenario where only one these instruments would be used the analysis.

Application

The applicability of the concept will be patent in the discussion chapter. The discussion chapter will be guided by the instruments introduced above. Instruments that were showed to be the concretization of the strategy concept defined in this chapter. Each instrument will be used to analyse the industry. and support any conclusions about the industry made by the author.

Methodology

The methodology used in this work complements primary data with secondary data. For primary data, interviews were conducted to collect empirical data. These were guided interviews with four questions, which were followed by one or more extra questions aimed at clarifications of the answers to the first four questions. The four questions used were the questions trying to be answered with this thesis: what are the characteristics, challenges, present solutions, and future of the electrical industry in Portugal? The complexity of this industry and the broadness of the questions asked affected the answers given by the interviewees. Sometimes, there were cases where a straight answer about what was being asked was not given. It seems important to also notice that the quality of the interviews increased alongside the author's growth in knowledge about this industry as this thesis was being developed. The contact with the interviewees was arranged through LinkedIn and the author's personal network. The interviews were not recorded due to confidentiality, but notes were taken.

A total of four people were interviewed, all of which are specialists in some areas of this industry. The first person interviewed works in Voltalia. Voltalia is a company founded in 2005, and specializes in power-producing with renewable sources, mainly from solar, wind, hydro, and biomass energies, and in providing complementary services. The person in question is the current chief technology officer (CTO) in Portugal. The second person approached works in Neoen, where they currently hold the position of managing director in Portugal. Neoen is specialized in power-producing with renewable sources and related services. The third interview was conducted with a director at EDP Comercial. EDP Comercial is an EDP company branch. EDP is at the moment the most significant player within the energetic sector in Portugal. Lastly, an interview was carried out with a professor from the Instituto Superior Técnico from the Universidade de Lisboa. This professor is an expert in this field, to the point of having been called to intervene in the energetic national debate related to PNEC 2030.

The secondary data was collected mainly through internet websites and news. Most entities associated with this sector supply information about it, even if at times this data is dispersed.

Discussion

Introduction

The purpose of this introduction is to describe the main characteristics of the electrical industry. To do this, it is useful to remember that the electrical industry is related to many other industries and sectors. This is mainly due to its link with the big energy industry: production of energy and its usage are present in all industries, including the energy and the electrical industries themselves. Another point one needs to take into consideration is the consumer. These are divided into two categories: small and big consumers. The big consumers, such as energy-intensive industries, have a unique role in this industry. Another part of the industry that plays a big role are the suppliers of non-renewable energy sources.

The framework of the discussion starts with this introduction, where the main characteristics of this industry are summarised. For a matter of simplification, Portuguese terminology is used due to the fact that the objective of this work is to analyse the Portuguese electrical industry. The introduction will be followed by a presentation of the active players in this industry and highlight some connections with other industries. The last part of this chapter is made of three analyses of this industry, with SWOT, PEST, and Porter's Five Forces frameworks.

In the analysis, it was decided to use the insights from the interviews as a whole. This industry is quite broad, and the information received in the interviews perceives the industry from a particular point of view. In this chapter, the information obtained with the interviews presented has already been processed. But one can find raw summaries of the interviews in the appendix. The contribution of each interview won't be visible in the discussion, although it is possible to check the contribution of each interview in Appendix 1.

The energy industry englobes the electrical industry. In the electrical industry the end product is energy in its electrical form. Electricity has two distinctive features from other energy forms: it must be consumed when it is produced, and it must be transferred through conductors' wires. On the other hand, it follows a quite straightforward production process. One only needs any form of energy and an adequate mechanism to transform the energy in the primal form to the electrical form of energy. On top of that, the device of electricity production in itself, i.e., without considering the primary energy source, is environmentally friendly. This characteristic makes this industry very important to the achievement of carbon neutrality goal.

As in any other industry, the value chain in this industry involves some players. Let's start with the producers. The electrical industry has two types of producers: PRO, ordinary regime producers (produtores em regime ordinário), and PRE, special regime producers (produtores em regime especial). The PRO includes the producers in the standard regime, i.e., those who produce electricity making use of traditional ways. The non-renewable sources present in Portugal's electrical industry reality are mostly coal and natural gas. Due to their environmental impact, this type of producers does not participate in government subsidies like PRE. Regarding renewable energy, wind and hydroelectricity account for most of its production. Solar production participates at a lower scale, but it is foreseen to have a more significant participation in the future.

Following the production comes transportation. Unlike other forms of energy, electricity is not transported in tanks by a vehicle, but by wires. For higher voltage, this process is called transportation. The entity responsible for it in Portugal is REN, energetic national grids (redes energéticas nacionais). For lower voltage, the process is called distribution. The entity responsible for this in Portugal is EDP Distribuição, EDP Distribution. Transportation is followed by an intermediary between the distributor and the consumer called the retailer. And finally, there is the consumer. Alongside this value chain, ADENE, an Energy Agency, is responsible for the operation of exchanging between retailers and consumers. One also needs to take into consideration MIBEL, Iberian Electric Market, which is the market for electricity in Iberia. Last but not least, the other missing players are ERSE, Electric Sector Regulator Entity; DGEG, Energetic and Geological General Office; ENSE, Fuel Market National Entity, which are responsible for regulation, licensing, and inspection, respectively.

Characteristics

The players of this industry responsible for electricity production can be divided into renewable energy and non-renewable producers. In fact, a producer can produce electricity from both renewable and non-renewable sources. Regarding renewable energy, there are many possible sources of electricity production: hydroelectricity, wind, solar photovoltaic, biomass, geothermic, concentrated thermal solar, and waves. Within non-renewable energy, sources include: coal, natural gas, fuel oil, oil shale, and nuclear.

Hydroelectricity is electricity produced by hydropower. This method of producing electricity is present in Portugal since the beginning of electricity production (Maria Fernanda Rollo, 2015). It is one of the most significant sources of renewable energy in Portugal, accounting for 23%

of electricity production in 2018 (REN, 2018). Hydroelectricity is very important in the energy transition because it allows the producer to choose when to produce electricity. It is fair to say that the producer does not have total freedom, because the dam must have water stored to produce electricity, but it is still a process that allows the producer to balance renewable production with consumption. Although, renewable energy production is usually not controlled by the producer, there is a technology that enables a dam to store energy. This process is done by using electricity to pump water up from a second reservoir to the first reservoir of the dam and store energy. When needed, the dam can then release the water stored and produce electricity. This storage system is useful to balance electricity production with demand.

Wind power is also used to produce electricity. Electric windmills can be installed onshore and offshore. The majority of the electricity produced by wind power in Portugal comes from onshore windmills. The current capacity in Portugal is 23% of electricity produced in 2018 (REN, 2018). It is a cheap way of producing electricity, although it has some disadvantages, such as visual and sound pollution. The current situation of this source of renewable energy production has two aspects. On the one hand, the actual wind power farms are becoming too old. On the other hand, there is still a lot to be explored in this field. It is also useful to know that there are two current solutions concerning the end of useful lifetime guaranteed by the manufacturer: extending the lifetime of the wind turbines or substituting the turbines by new ones, taking advantage of the structure already present on the site. The latter process is called repowering (IEP, 2019).

Solar photovoltaic is a method of producing electricity using the sun's energy in its light form. In 2018, the capacity of this source of renewable energy was 1,5% of the total electricity produced (REN, 2018). There was even a campaign, in 2009, from the government promoting the installation of such technology, but it failed. Now this industry is much more attractive because its cost has lowered significantly, due to the maturity of the technology. The government has been, with great success, promoting an auction for PPAs, power purchase agreements. This financing system enables the investors to have a guarantee that the electricity produced will be sold at the agreed price. Together with the PPA, the meteorological forecast of solar energy that will focus on the solar photovoltaic power plant, and the guarantee of the manufacturer about the efficiency of the solar panel, the risk of such a project can be considered as small. This has attracted investment in this area. One of the remaining difficulties, however, is the access to the grid. This is a problem that the government will try to solve by allowing the

producers to develop the grids alongside the grid operators (REN or EDP Distribuição) so that the grid capacity can be increased in that area.

Biomass consists of organic or animal products used to generate energy. It can improve the forestry sector value. For the electricity industry, it is not a solution due both to its low efficiency and the low rentability, which forces the government to give out subsidies to these companies in order for them to survive (PNEC 2030, 2019).

Geothermal energy is energy generated by using the heat from the Earth. In the Azores, it already has a significant presence, producing 19% of all electricity there (azores.gov, 2017). There is still unexplored potential, and it is expected for its capacity to be increased to its maximal potential. Geothermal energy must be high to be able to produce electricity. Otherwise, the energy can only be used in some industrial processes or to residential use. This source of renewable energy is considered cheap (Pedro Reis, 2017).

Concentrated solar power is a source of energy that uses heat from the sun to generate electricity. The heat is used to produce mechanical energy that is then turned into electrical energy. Its presence in Portugal is not significant, even though Portugal's metrological conditions are suitable for the implementation of this technology (Manuel Collares Pereira).

Waves power is another source of renewable energy that uses the movement of the waves to generate electricity. This source is in development, and it is not a solution yet.

Coal plays an essential role in electricity production in Portugal, producing almost 20% of the total electricity in 2018 (APREN, 2019). The process of producing electricity with coal consists of burning coal to produce heat that is converted into electricity through a mechanical process that involves turbines. Coal is now facing an opposition from European policies because of its greenhouse gas emissions and CO₂ gas emissions. The Portuguese government decided to shut down the two power plants in Portugal, which is foreseen to occur in 2021 for one, and 2023 for the other (PNEC, 2019). This measure makes part of the governmental plan to achieve the goals stipulated in PNEC, which are influenced by the EU environmental policies. The shutdown of these two power plants will have several consequences in the energetic, social, and economical sectors. This will be approach again in the analysis.

Natural gas is a source of energy derived from fossil fuel. It has various uses, one of them being its use to produce electricity. One of the benefits of this source of energy is its flexibility and higher energy density when compared with coal. The Portuguese government's intentions

toward this energy source are to maintain its use as backup support to renewable sources. In the long term, the goal is to reduce its use and convert the power plants into green gas power plants, such as hydrogen. The goal aligns, once more, with the reduction of greenhouse gas emissions and CO₂ gas emissions (PNEC, 2019).

This description of the various forms of electricity production is vital to understand what are the options available and where can the electricity producers invest.

Concerning transportation, the entity responsible is REN. REN is very dependent on DGEG because the revenue is a percentage of the value of the assets. The company profit is, simplistically, the difference between the revenues from DGEG and the interest payments to invest in the grid. It is important to highlight that REN is responsible for other grids other than the electrical grid, such as the natural gas national grid. The understanding of the DGEG's goals is crucial to understand where to invest, from a producer perspective.

Distribution is the responsibility of EDP Distribuição. Like REN, EDP Distribuição is dependent on DGEG. EDP is a private company that encompasses EDP Distribuição. The reason why EDP Distribuição is responsible for the distribution while being a private company, is due to the process of privatization of EDP. Until 2004, EDP was a public company controlled by the government (EDP, 2020). This process was not instantaneous; it started in 1997 and ended in 2004.

Retailers are responsible for providing electricity to the consumer. They buy electricity and sell it to customers. By paying a fee, they get permission to access the grid. The usual contract stipulates a fixed and a variable cost of electricity, dependent on the power the client requires.

SWOT Analysis

Strengths

The electrical industry has some characteristics in its favour. The first one is the end product it offers. Electricity is a basic need in the majority of European countries. The reality is that no one in Europe can conceive living in a world without electricity. Every sector uses it to some degree. It is well seen by society and it is linked to its future. These make the electrical industry more predisposed to be recognized by investors. Moreover, renewable energy has been the subject of technological developments, which has contributed towards the electrical industry's growth.

Weakness

On the other hand, the electrical industry is a very complex industry with many players. It is also very dependent on government policies. The fact that electricity is considered a basic need makes the government conduct a careful supervision with the society's protection in mind. This industry has, also, the instability of commodity price changes. Part of the electric energy is produced with imported goods, such as coal, natural gas and fuel. The fluctuation of these goods influences the cost of producing electricity.

Opportunities

The industry is facing a changing period. There are new trends that everyone agrees that will become the standard. The main trends are decentralization, decarbonization, and digitalization. Each one can be an opportunity for the industry to revolutionize itself and grow. The governmental policies can help the industry to reinforce its investments in renewable energy, which is crucial to meet the trend of decarbonization. Mobility, which has been suffering a change in renewable energy consumption, is an opportunity to grow the utilization of electricity in society. There is a clear bet by the Portuguese government in electrifying the economy. The increase of renewable energy in the electrical production mix will present opportunities to reinforce the national grid, involve the consumer in the process and create a higher awareness of the industry.

Threats

There are explicit threats to this industry, and although they do not seem definitive, they are dangerous. The threat that seems most dangerous is the lack of cooperation between all stakeholders involved in the process. The electrical industry cannot work if one of the players does not do their job. So, for example, if renewable energy producers decide to increase their capacity, and the grid is not prepared to receive it, the project cannot go forward. Moreover, the fluctuation between demand and supply can be especially dangerous when the renewable energy percentage in the mix is increased. It creates an energy security obstacle to the implementation of renewable energy. The green gases are part of the strategy of the government to reduce emissions and can compete in some areas with electricity. When it comes to the decentralization of the electricity industry, the consumer is empowered to produce energy in electric form and supply the grid. The producers, but also the retailers, will be damaged by this situation. The shutdown of the coal power station will also affect the industry because it will force the industry to invest actively in more capacity in renewable energy sources.

PEST Analysis

Political

The electrical industry is strongly influenced by government action. In December 2019, the Portuguese government released a strategical plan concerning energy and climate policies. That plan is available for public consultancy and is called PNEC. The analysis of this category of factor will be based on this document.

PNEC 2030 is a product of the Paris Agreement in 2015. In this document, it is agreed between almost all the countries the world that they would take the necessary measures to assure an ambitious goal: the decrease of global average temperature to plus 2°C above the preindustrial level, and seek the 1,5°C mark. This objective compelled the participants to create a plan to achieve that goal. Portugal, as one of the participants, started to elaborate their own. However, because it is a European country, it receives guidelines from the European Union. The result was a number of plans that include the RNC 2050 and the PNEC 2030, among others. The RNC 2050 is the plan that intends to reduce the carbon emission and it is designed till 2050. The PNEC 2030 is the plan that materializes the guidelines established in the RNC 2050, with concrete measures in each area of action. The PNEC also focuses more on the energy industry, relating it with the other sectors. There are five areas that this plan approaches: Decarbonization, Energetic Efficiency, Supply Security, Internal Market of Energy, and Investigation, Innovation, and Competitiveness. The program approaches each one of these dimensions with specific measures, some very concrete and other more general. It is assumed that the energy transition will pass by the electrification of the economy. The document also highlights that Portugal has special conditions for the implementation of the energetic shift. The goals of PNEC 2030 are listed in the table below:

Table 1 - Goals of PNEC 2030

Emissions (relating to 2005)	Energetic efficiency	Renewables	Renewables in transportation	Electric interconnections
-45% to -55%	35%	47%	20%	15%

Eight objectives that support these goals. These are: decarbonization of the national economy; prioritize energetic efficiency; reinforce the renewable energy investment and reducing the energetic dependency; guarantee energetic supply; promote sustainable mobility; help to promote sustainable agriculture and florestal activity, while working towards carbon emissions;

develop an innovative and competitive industry, assuring a fair, democratic and cohesive energetic transition. The goals and the objectives are both interconnected. One can see through the goals and the objectives that the main big goal is not promoting the electrical industry for itself, but that all actions are framed into the reduction of climate change problems while trying to take advantage of the situation. It is assumed that the challenge for the next years is the implementation by the national authorities, the private sector, and society, of the necessary compromises for reducing the greenhouse gases while increasing the percentage of renewables in the energetic mix, the energetic efficiency and the interconnection capability (PNEC 2030, 2019). This plan shows a clear direction of the government's intentions.

There are some measures in the program that the author considers essential for the future of the electrical industry. An extended overview of the list of measures can be found in appendix 2. The actions related to the electrical industry are the closure of electrical coal production until 2030. It is predicted to close by 2023. With the closing of coal power plants, the goal is to transform those power plants into renewable source power plants. A carbon emission tax will be maintained and it will be promoted the electrification of buildings as an attempt to increase renewable energy usage of infrastructures and promoting the use of renewable energy in the industry. This can be seen as an opportunity for the industry. Renewable sources are renewable electricity or renewable gases. Managers in all sectors of the industry should evaluate if this opportunity is worth it. Digitalization is an objective of the government towards this industry and so it will be promoted. The grid access auctions for renewable sources are a powerful and essential instrument in the whole process. At the moment, it seems that the hybrid systems will be supported because they are a good compromise between efficiency and ecological goals.

The wind power plants face the challenge post by asset maturity. It is being analysed the possibility of repowering or over-equipment. Cogeneration systems will be promoted alongside ocean renewable energy. In the Azores, geothermal energy will be reinforced. Regarding the decentralization, distributed production and auto consumption will be encouraged as well as the energy communities that are fundamental in this goal. The legal framework of the national electric system has to be reviewed to promote renewable energy. The plan for transport and distribute electricity will be adapted to renewable energy. Concerning communication, the interaction with the market will change in order to increase the knowledge of the market and its interactions, from a consumer point of view. The bus fleet will be renewed, promoting green gas and electric vehicles. Electrical mobility will be supported by physical structure and taxes (IRS, IRC, IVA, and others). Equipment substitution and better management are also in the

front line of government measures. The energy storage systems will have a legal framework supporting them. This measure is essential because their existence will become more valuable with the increase of renewable energy in the electric system. Alongside the legal aspect, the association between renewable energy producers and storage centres will be promoted. The digitalization of the sector by introducing smart meters and smart grids will be encouraged. Regarding energy transition, a national plan will be developed, with a risk contingency plan of the electrical system. Natural gas will be the energy back up and the intercountry electrical grid connections will be reinforced. The aggregator market will benefit from regulation as it evolves in the future as consequence of energy transition. The demand aggregator concept will be studied. From a social view, the government will elaborate a strategy to promote a fair energy transition. Lastly, they will encourage investigation in Universities and companies in areas concerning renewable energy sources, energy efficiency, and others.

All these measures point out that the electrical industry will be influence by the government in order to seek renewable energy sources for electricity production. It will help to face the question of demand and supply management. On top of this, an overall investment from the government to develop this industry while at the core of the energy transition is fundamental to meet the Paris Agreement 2015 goal. Each measure should be studied individually to understand the opportunity or challenge it represents, but that analysis would scope out of the propose of this thesis.

Economical

When considering a larger period of analysis, the ten years period predicted in PNEC 2030, the results regarding the economic impact are very generic. The main conclusion is that DGP will decrease its growth rate but will continue to grow.

Table 2 – PNEC 2030 DGP and population preview

	2020	2025	2030
DGP (variance) (JANUS model Times model) for PT	1,7% 2,0%	1,3% 1,6%	1,0% 1,5%
Population (millions) (JANUS model Times model) for PT	10,18 10,25	10,00 10,14	9,84 10,00

Looking into a shorter term, the Banco de Portugal released an economical paper that helps predict the future of the Portuguese economy. The paper analysis the period between 2020 and

2022. As in the PNEC 2030, it is predicted that DGP growth will slow down from 2,4% in 2018 to 1,6% in 2022. One of the factors conducting this trend is worse global economic conditions due to protectionism measures, political uncertainty, and economic cycle maturity. The activity growth in Portugal is increasing, but it has been supported by internal demand and it is not expected to continue. Importations will rise more than exportations. Employment will continue to rise, decreasing unemployment, although at a slower pace. Inflation should stay moderate until 2022. From a global perspective, DGP should recover from the last years. The reasons for this recovery will be less stimulus from economic policies at the end of 2022, gradual transition of the Chinese economy to lower growth, and the recovery capacity of some emergent economies like India, Brazil, Mexico, and Turkey. The petrol price has increased in the last year but is predicted to decrease. Interest rates should stay low.

There is an ongoing pandemic affecting almost every country in the world, and it will have repercussions in the global economy. However, because it is a rather recent and ongoing event, its consequences to the economy and the electrical industry will not be considered in this work.

Social-cultural

To illustrate the social-cultural factor in Portugal, data from the INE (Instituto Nacional de Estatística), the Portuguese national statistic centre, are presented in the table below.

Table 3 – INE statistical indicators

Indicator	Last update	Value
Resident Population	2018	10.276.617
Average annual liquid monetary revenue per adult	2017	11.063€
Basic education rate	2020	74,6%
High school rate	2020	54,8%
University education rate (25-64 years)	2020	26,3%
Unemployment rate	2020	6,7%
Migratory balance	2019	11.570
Poverty intensity rate	2019	22,4%
Electric energy consumers	2020	6.518.194

The most critical indicators seem to be the average annual liquid monetary revenue per adult, education indicators, and unemployment rate. They give the idea of a country that is still

developing with a lot to progress on. Migratory balance is also high and may indicate that many citizens find other countries to have better conditions to live and work.

Technological

In some ways, the technological factor is already considered in the political element, once PNEC 2030 approaches all the challenges. There are two types of technological factors that seem to have a bigger influence. One is digitalization and the other is the service quality expected. The companies are promoting digital transition, with industry 4.0. The risk of not keeping up with this innovation process is to lose competitiveness. The other factor is service quality expectancy. Today, the client expects electricity to not fail, be charged at a low price, and receive excellent customer service. Offering the whole package is difficult, but the path passes through digitalization that allows reducing costs while supplying the customer with a fast response to their needs.

The technological aspects that have a high impact in the industry are: decreasing renewable production costs, grid digitalization, and electric mobility. One of the most important elements that will revolutionize the industry is the cost of solar electric energy, which is now expected to be under the market. In fact, it was sold under the market price in the last auctions for grid access. Grid digitalization through smart meters and smart grids is an ongoing work that has already been started, although it has yet to be concluded. The crucial consequence of this process is the improvement of grid efficiency. Lastly, we have electric mobility. Electric mobility is as environmentally friendly as the electrical energy supply is. As the government decided to invest in this resource, the industry is already moving towards it. The great challenge is to predict its impact: will it substitute the fuel vehicles completely? What will be its relationship with renewable gas vehicles?

Porter's Five Forces Analysis

In this analysis, it is essential to divide the industry into its leading players: the producers that use non-renewable sources, the producers that use renewable sources, the transporter, the distributor, and the retailers.

Transporter and distributor

For both these players, the transporter and the distributor, a Porter's Five Forces analysis will not be made. The reason for this is that both of them operate in a monopoly market, which means that there are no threats nor opportunities. It is a strongly regulated market and a national service. The reasons behind the monopoly of this market are the incompatibility of profitability

and the market quantity being higher than one. It is not considered productive to have two electrical lines from different companies to serve the same customer.

Non-renewable Producers

Industry rivalry

There is not much inner competition between non-renewable energy producers. There are only two coal power plants in the country. Natural gas power plants are more numerous. The reality is that non-renewable producers do not compete with each other but with the electric market, and that includes every form of production. Here the lowest final price wins. Taxes influence the final price, and the electricity produced by coal has higher fees than natural gas because it releases more carbon emissions.

Power of suppliers

Suppliers have robust control over producers because they are framed in the global market that is influenced by geopolitical events. At the same time, the energy source price, of coal or natural gas, represent the majority cost for producers, giving the fact that without them they cannot produce electricity. At the same time, natural gas can be substituted by renewable gases. This possibility is being developed and could give greater power to the producers.

Power of consumers

Consumers also have a great influence over producers. MIBEL gave power to retailers. Enlarging the market makes it more competitive. At the same time, the product producers' offer is the same for non-renewables and renewable electricity.

New entrants

The threat of new entrants is considered small. For coal power plants, it is certain that it will not happen because the Portuguese government wants to close all coal power plants. For natural gas, the entrance is challenging because the government's plan is not to increase natural gas electricity production capacity but to maintain it while renewable energy is developing its position in the market. However, the possibility of a new entrant with a hydrogen power plant is more likely and represents the main threat of a new entrant in this group.

Threat of substitutes

The risk of substitutes is high. On the one hand, we have the government's intention to introduce renewable sources in the market. On the other hand, natural gas electricity producers have the opportunity to be a backup of the electrical system when the renewable sources increase its

share in the electric mix. This is important as natural gas can be fully controlled and, in contrast, renewable sources only can be predicted.

Renewable Producers

Industry rivalry

Renewable producers, contrary to non-renewable producers, have intense competition. Two main factors are to blame for this increase in competition: the grid access and the price competitions. As the end product is the same, every producer must assess if their technology/energy source is the most adequate.

Power of suppliers

The suppliers of this group are just maintenance supply related since the energy source is free. The power of the supplier is weak since the contribution to the end product price is small and declining.

Power of consumers

The power of the consumer is the same as in non-renewable producers, i.e., considered as strong. The consumers are the same for both groups.

New entrants

The new entrant's threat is the highest risk of this group. The renewable electricity production capacity is rising, and new producers want to enter this industry. At the same time, there is not grid capacity for everyone. The investment in most renewable sources is low risk, as the profit estimative for an annual period is very accurate. Moreover, the government's help towards entering into the market increases the threat for the already established companies. At the time, it is part of the government's plan to allow the renewable producer to invest in the grid with the transportation and distributor agents in order to increase grid capacity and enable more producers to enter the market.

Threat of substitutes

The risk of substitutes is weak. These producers face the opposite situation of the non-renewable producers.

Retailers

Industry rivalry

This group, which represents an industry inside the electrical industry, faces high competition. This is mainly due to the fact that there are many companies: some for big consumers, some for

domestic consumers, and others for both. The end product can be differentiated with a different package. By offering differentiated customer services, and complements to the main product, retailers can differentiate from each other.

Power of suppliers

Suppliers have a weak influence over retailers, giving that MIBEL regulates the supply. The more the market grows, the more it reduces the suppliers' power.

Power of consumers

The consumer, on the other side, has medium strength. They can change from one retailer to another without any significant physical change. On top of that, consumers are price sensitive.

New entrants

The easiness of entry is another obstacle to this group. While the end product is the same, the service behind it may be more sophisticated in some companies than in others. Also, there is not a significant investment in physical assets.

Threat of substitutes

There seems to be no real threat regarding substitutes. The alternatives of retailers are consumers that are producing their electricity or use other forms of energy. In today's world, not using electricity is very uncommon. People producing their own electricity may be the future, as decentralization is a hot topic in this industry. However, living isolated from the national electrical grid has many inconveniences. The main problem is the irregularity of electricity by renewable sources and high prices of non-renewable sources.

Conclusion

Main findings and conclusions

The main findings of this thesis are the result of the PNEC 2030 analysis alongside the interview feedbacks. From the eight objectives presented on the PNEC 2030, there are four that greatly influence the electrical industry. In essence, these are: decarbonization of the national economy, reinforcing the renewable energy investment and reducing energetic dependency, guarantying energetic supply, and having sustainable mobility. The first objective concerns the reinforcement of renewable energy in the energetic national mix. It is transversal to all sectors, not only electrical production, even though electrical production has a strong influence on the national carbon emission footprint. Reinforcing the renewable energy investment and reducing energetic dependency passes through changing the energetic national mix. Coal and natural gas are mostly imported. Fuel oil is also imported in its primary form and then refined in Portugal. This objective implies that renewable energy sources became the primary source of energy. This scenario is, at the moment, challenging to achieve. This challenge can be track down to the difference between demand and supply. Renewable energy is an unstable source, and its integration in the grid implies serious management challenges. There is a solution to this problem that involves introducing storage capacity in the grid. It can be done using batteries or dams with reversible turbines. The energetic dependency is linked to the following objective, to guarantee energetic supply. Energetic security is fundamental in today's world. This objective will be accomplished with an intercountry grid connection and establishing energetic reserves. According to PNEC 2030, the last objective regarding sustainable mobility will pass by mobility sectors using power obtained through renewable energy. The energy sources responsible will be electrical energy, produced from renewable sources, and renewable gases. For private and small dimensions vehicles, the predicted solution is going electrical. For industrial mobility, and other forms of mobility, such as planes, trains, trucks, the answer is predicted to become hydrogen fuelled.

This thesis extracted some other conclusions about the players in this industry, mainly when it comes to producers and retailers. Regarding producers, the future lies within renewable sources, with natural gas as a demand/supply adjuster while other developments are made concerning this area. The grid access will be allowed through auction. Furthermore, the government will facilitate the association between REN and EDP Distribuição with the producer when it comes

to grid developments concerning increased grid capacity. On the other side, it is acknowledged that grid capacity increase will entail changing to smart grids, redesigning the grid, and empowering the grid with management instruments, such as storage systems among others. The retailers' path will require the digitalization of the process. The keyword is client-focus. This mentality is what supports digitalization and decentralization. Retailers will need to differentiate themselves to survive. The strategy concept theories all point out to this fact. Decentralization is especially problematic, as it involves grid management difficulties.

Limitations and future research

Concerning limitations, this thesis has some. The main one is the broadness of the topic it intends to analyse. The electrical industry involves several players and agents. To make a strategical approach to the topic, one should choose to go deeper into the analysis. On the other side, the geographical region is very narrow. It focusses only on Portugal. When considering a macro view of this industry, one should account for the fact that it is deeply connected to the European context, and even global context. The third limitation of this thesis concerns the interviews. Because of the broadness of the topic, some interviews, in spite of the goodwill of the participants, were proven to not be as useful as they could have been if the questions were more focused on one sector of the electrical industry.

From this thesis, future research can go in many directions. For instance, it can go deeper into any sector of this industry. One can also broaden the geographical spectrum. From the experience of this thesis, the suggestion would be to follow both of these directions: narrowing the industry to producers, or transporter, or distributor, or retailer, and broadening the geographical analysis to a European scale.

There are always actualizations that need to be made continually. In the past weeks, the world started its battle against a pandemic disease that will affect the economy and this industry. The Brexit situation is also something that was not explored in this work that would be convenient, or even necessary, in a European context analysis.

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Appendices

Appendix 1: Interviews

1. João Amaral, Chief Technology Officer at Voltalia, Portugal– 06/12/2019

The first thing to study about this industry is the national plan, PNEC 2030. Some European directives are essential to know if you want to cover the European electricity industry. The government subsidizes the renewable energy market; the conventional, coal, and natural gas, are not.

2. Bernardo dos Santos, Managing Director at Neoen Portugal – 09/01/2020

How does the electrical system work?

Agents, Portuguese government strategy plans, factors for the successful implementation of renewables, PPA (market price, cost price), REN, renewable project (low risk), individual charge for the grid and green energy sources benefits

· What is the importance of batteries?

Grid, differentiation between production (solar, wind) and consumption, use of batteries

· And what about E-mobility?

I think that hydrogen will have an essential role in the future.

3. Filipe Santos, Director at EDP Comercial – 22/01/2020

The industry is coming to a revolution that needs to face two main problems: technological transition and social change. These will enable business opportunities.

On decentralization:

In the next years, utilities will face an energy transition because of the CO₂ problem and the rising of its severity. It will request a technological upgrade, which at the moment is not feasible, and a social change. Decentralization will help economically and technologically. There will be lower energy losses. This will take having to transform the distribution grid from unidirectional to bidirectional, which in turn will take smart meters and AI, Artificial

Intelligence, into the grid. That step is already being done. There are mainly three agents in this reform. The market recognises the necessity of the energy transition and is making pressure upon governments and companies. The governments in the EU are promoting the transition through regulation. Monetary funds and other financial entities are also promoting this transition. Portugal is in the vanguard, especially when it comes to smart grids, although it is behind regarding charge posts. Concerning mobility, hydrogen is part of the solution and will have a unique role in jobs where power or time is essential. For example, trains, ships, planes, factories, auto trucks. For the individual, the electric car is probably the best solution. Regarding the distribution grid, the leading solution is smart grids, followed by the reinforcement/redesign of the grid and, lastly, by installing mechanisms to store energy, such as capacitors and batteries.

4. Teresa Correa de Barros, Professor at IST – 04/02/2020

In the beginning, the electricity was decentralized. It was formed by electric islands where one generator would fuel the entire community. This system was fragile, with many energy interruptions incompatible with the actual demand. The national grid will, in time, be even more necessary. The question of decentralization has two parts: bi-directionality of the grid, which is already possible, in spite of the need for development of the appropriate mechanisms to support it; the non viability for a matter of security of an independence of the grid. The evolution of the grid is depended on the evolution of the rest of the market, producers, and consumers.

Appendix 2: PNEC 2030 measures related to the electrical industry:

1. Cease electrical production with coal, till 2030;
2. Conversion of coal power plants to renewable sources power plants;
3. Maintenance of carbon emission tax, CELE;
4. Electrification of buildings, promoting renewable energy sources and electric energy as the energy source for the infrastructures;
5. Promoting the use of renewable energy sources in the industry;
6. Promoting the electrification of the industry;
7. Promoting the digitalization of the industry;
8. Promoting renewable energy through grid access auction for renewable sources;

9. Promoting hybrid systems, that use both renewable and non-renewable energy sources;
10. Promoting wind power plants, through repowering and over-equipment;
11. Promoting cogeneration systems;
12. Promote ocean renewable energy;
13. Reinforce geothermal energy, with presence in the Azores;
14. Promoting distributed production and auto consumption;
15. Promote energy communities;
16. Review the legal framework of the national electric system, promoting renewable energy;
17. Adapt the criteria for planning the transportation and distribution of electricity, promoting renewable energy;
18. Promote better communication and simplify interaction with the market, from a consumer view;
19. Renew the bus fleet, favor electric and green gas vehicles;
20. Promoting electrical mobility, with a support structure for this reality;
21. Promoting electrical mobility, through taxes (IRS, IRC, IVA, and others);
22. Promoting equipment substitution for more efficient ones;
23. Promote better energy management;
24. Promote the legal framework for energy storage systems;
25. Promote the association between renewable energy and storage centers;
26. Promote energy industry digitalization (smart meters and smart grids);
27. Develop a plan for the national energy system towards energy transition;
28. Develop a national risk contingency plan in the electrical system;
29. Establish natural gas as the electrical energy backup;
30. Promote intercountry electrical grid connections;
31. Promote Portuguese market integration in the energetic European market;
32. Regulate the market aggregator;
33. Study the creation of demand aggregator;
34. Elaborate a strategy to promote a just energy transition;
35. Promote investigation in Universities and companies, in renewable energy sources, energy efficiency, and others.