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Service Design of Photovoltaic Solar Energy Storage Systems

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Master Thesis

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To my parents.

Abstract

Environmental sustainability is one of the main concerns of society nowadays. How we will be able to stop or decrease global warming and greenhouse gas emissions became a focal point in most of the political agendas, such as in companies' strategy and work ethics.

As a contribution for this goal, important system creations were made in the energy sector, making it possible for the big industries, as well as the residential consumer to produce his own energy, through renewable sources, such as the sun or the wind.

As new products and improvements to the existing ones arise in the market, the Service Design to support selling these products is not always made at the same time. This leads to selling the product alone, what may not be the best way to address customers who don't have so much knowledge on these products' innovations and are used to improved services designed to enhance their satisfaction.

Through this project, it was intended to design the service of Photovoltaic Solar Energy Storage Systems, adjusting such design to the reality of the company in which the study was made. For this to be achievable, a survey was answered by customers and potential customers, interviews were made to key elements of the company, and a final discussion took place with the CEO, in order to conclude how to design the service.

Finally, with the goal of designing the Service, the Multilevel Service Design method was employed, which allowed us to represent the different stages of the process and to properly characterize the proposal of service to be delivered to the customer.

Resumo

A sustentabilidade ambiental é uma das maiores preocupações da sociedade atual. De que forma seremos capazes de parar ou diminuir o aquecimento global e a emissão dos gases com efeito de estufa tornou-se um dos focos da maioria das agendas políticas, bem como da estratégia e ética de trabalho nas empresas.

Por forma a contribuir para este objetivo comum, o setor energético tem criado importantes sistemas que possibilitaram à grande indústria, bem como ao consumidor residencial a produção da própria energia, através de fontes de energia renováveis, tal como o sol ou o vento.

Apesar de novos produtos e melhorias aos existentes surgirem frequentemente no mercado, nem sempre o Desenho de Serviços que apoiam a venda destes produtos é desenvolvido em simultâneo, algo que leva a que o produto seja vendido de forma independente. Esta poderá não ser a forma mais viável de chegar aos clientes que não têm tanto conhecimento relativamente a estes sistemas e inovações, mas que estão habituados a melhorar serviços desenhados para aumentar a sua satisfação.

Pretendeu-se, através deste projeto, desenhar o serviço de Sistemas de Armazenamento de Energia Solar Fotovoltaica, ajustando este desenho à realidade da empresa no qual o mesmo foi desenvolvido. Para que tal fosse possível, um inquérito foi distribuído por clientes e potenciais clientes, entrevistas foram feitas a elementos chave da empresa e ocorreu uma discussão final com o CEO, de modo a concluir qual a melhor forma de desenhar este serviço.

Finalmente, de modo a que o desenho do Serviço pudesse ser representado, o método Multilevel Service Design foi aplicado ao tema em estudo, o que possibilitou a representação de diferentes fases do processo, bem como a caracterização adequada da proposta de serviço a entregar ao Cliente.

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CEM Customer Experience Modelling

CEO- Chief Executive Officer

EES- Electrical Energy Storage

MSD Multilevel Service Design

PHS Pumped Hydroelectric Storage

PV Systems- Photovoltaic Systems

RES- Renewable Energy Sources

ROI Return of Investment

SSA- Service System Architecture

SSN- Service System Navigation

1 Introduction

The following dissertation aims to analyse how the Photovoltaic Solar Energy Storage Systems Service can be designed, in the most appealing and valuable-to-consumer driven way, with the prospect to be profitable for the company PH Energia, Lda. and a future asset in the services range that are provided by it.

This project was developed in cooperation with PH Energia, Lda., and arose in the context of the Dissertation of the Master in Services Engineering and Management, in the Faculty of Engineering of the University of Porto.

1.1 Project background and Problem Description

National and international energy market have suffered a notorious and necessary evolution throughout the last decades. Due to environmental impacts, caused by the growing and unsustainable increase on energy production and consumption, all business and industry activities have experienced change and evolution, and the energy market wasn't an exception, due to its strong influence within the issue.

Regarding this, new sustainable energy sources have been explored, so that non sustainable ones may be substituted and, progressively, abandoned. Simultaneously, new solutions to make consumption more efficient have been created. One of these solutions are the well-known photovoltaic energy production systems (PV systems), which worldwide use has been increased. These systems are characterized by their low price, adaptability and scalability, considering the possibility to install them on buildings or fields and sell them on Business-to-Business or Business-to-Consumer markets.

By selling PV systems to the household sector, storage systems have also been identified as a necessary addition to guarantee the minimum energy waste, aligned with the sustainable use of energy major goal. According to Abdin, G., et all. (2018), the installation of energy storage systems arises due to the recently created need to optimize the profits from users' photovoltaic systems, providing an upgrade to those.

The relevance of this Master Thesis arises in this context, considering that even though the product is available in the markets worldwide, there is a great lack of information on the service potentialities created by it. Therefore, understanding how this Service can be designed to best fulfil Customer needs and expectations and create the most value constitutes a great benefit.

1.2 Research Questions

This Master Thesis aims to Design the Service of Photovoltaic Solar Energy Storage Systems, to fulfil the company PH Energia's need to develop a way to offer this product to the market with the best value. To properly understand what the Customer needs and expectations are, an analysis of how the energy consumption customer experience occurs when having one of these systems.

It is also an objective to analyse which products or services can complement the offer of energy storage in PV systems service to best satisfy the Customer.

Regarding this, the main Research Questions to be answered within the scope of this study are the following:

- What are the reasons for the Customer wanting to acquire an energy storage PV system?
- How is the Customer Experience characterized when having an energy storage PV system?
- How can new services be designed to be linked to the energy storage PV system product and use?
    - What are the most important service characteristics / what are the business limitations regarding these?
- How can this service be commercialized with a better chance of success?

In order for these answers to be answered, the Multilevel Service Design method was applied, based on data retrieved from an online survey answered by customers and potential customers, followed by interviews made to key elements on the development of new products and services in the company, that ended with a final discussion of the information generated by the prior steps with the CEO, with the ultimate goal of deciding which way to go in the service design.

1.3 Report Outline

This report was divided into 6 parts: Introduction, Knowledge Background, Problem Characterization, Methodology, Results and Conclusion.

In the Introduction, the project is presented, such as the company in which it took place. In the Knowledge Background, a review on the information available about the main topics that will be addressed in the Dissertation is made, addressing themes related to Services and Service Design, the Photovoltaic Solar Energy Storage Systems, such as the legal context related to what is addressed.

The Problem Characterization presents the company in greater detail, such as the service's proposal mission statement, main stakeholders, business goals, assumptions and constraints, so that the scope if the project could be properly presented.

Regarding the Methodology, the Mixed Methods Research methodology is explained, such as the Multilevel Service Design method, which was chosen as the method to design the service.

Considering the Results part, it presents all the main findings that occurred thanks to the surveys and interviews and what came out of the final discussion of results with the company's CEO. Besides this, the Multilevel Service Design method diagrams are presented, which represent the service design proposal.

In the final part, the Conclusion, the relation between the Research Questions and the study that was performed is presented, informing on the concrete answers that came out from this process. A Future Research option and the contribution on the literature are also addressed.

2 Knowledge Background

2.1 Services

Vargo and Lusch pinpoint the initial period of service to be approximately 1950-1980 with a theory being established at that point: services could be defined as everything that didn't include goods (Rathmell, 1966). This definition has persisted: "services marketing refers to the marketing of activities and processes rather than objects" (Solomon et al., 1985); services are "a process of performance rather than a thing" (Lovelock & Wirtz, 2011)

Vargo and Lusch state that this idea was abandoned, and argue that goods and services are not mutually exclusive and that services can't be defined by contradistinction from tangible goods, since it limits the understanding of both services and goods. Therefore, the authors present their definition: services are "the application of specialized competences (skills and knowledge), through deeds, processes, performances for the benefit of another entity or the entity itself (self-service)". In a broader view, the authors point that "economic exchange is fundamentally about service provision", being "service" an inclusive concept.

According to Lovelock and Wirtz (2011) services can be defined as "economic activities offered by one party to another. Time-based performances often bring about desired results to recipients, objects, or other assets for which purchases have responsibility. In exchange for money, time, and effort, service customers expect value from access to good, labour, professional skills, facilities, network, and systems; but they do not normally take ownership of any of the physical elements involved".

Further on this document, Lovelock and Wirtz's definition will be considered, due to its greatest completeness according to the current reality.

Both authors point out that "services often include important tangible elements (…). However, (…) as the non-ownership perspective and our definition of service implies, it is the intangible elements (…) that dominate the creation of value in service performances" and also that "when buying a service, customers rarely acquire ownership of the elements that create most of the value".

SERVICE DESIGN

Service design is concerned with systematically applying design methodology and principles to the design of services (Holmlid & Evenson, 2006). From the authors' perspective, Service Design has its starting point on the customer/user into a service and through the use of creative, human-centered and user-participatory methods models the service. That also integrates the possibilities and means to perform a service with the desired qualities, within the economic and strategic intent of an organization.

According to Patrício and Fisk (2013), design service offerings require the integration of service elements down through the different levels of service design:

- The concept level, in which the value proposition is designed and the service offering is positioned in the costumer value constellation;
- The service system level, that requires the design of frontstage interactions, backstage processes and supporting technologies;
- The service encounter level or touchpoint, that requires the detailed design of the interactions between customer and service provider.

According to these authors, service design has become, through the years, an interdisciplinary field that integrates different contributions into a holistic approach to creating new services. Within this contributions, service marketing is pointed out as responsible for designing the value proposition and how the organization will deliver its promises across the different service encounters; interaction design is the contributor that designs the frontstage interactions between customer and service provider; operations management is referred to as the designer of the backstage system and processes that enable service offerings to be efficiently delivered; finally, service engineering is identified as the developer of technology-enabled solutions that provide crucial support for service provision.

Regarding the Service Design Process, the authors identify the exploration of participants' needs, dreams and behaviour as a starting point. This process is then characterized by several stages:

1. Inspiration: studying the stakeholders who will be involved in the project, such as their experience, behaviour and context;

2. Ideation: process of generating and developing new ideas that may lead to service solutions (the main stakeholders shall work with the team at this point),

3. Reflection: includes prototyping previously created service concepts and testing them with potential customers;

4. Implementation: planning, implementing and reviewing the changes necessary to operationalize the new service concept and offer it to customers.

CUSTOMER EXPERIENCE

Customer Experience, according to Lemon and Verhoef (2016), was initially addressed in a narrow way, by "recognizing the importance of emotional aspects of decision making and experience". Later, broader approaches have emerged, with Schmitt, Brakus and Zarantonello suggesting that "every service exchange leads to a customer experience, regardless of its nature and form (…) incorporating the customer's cognitive, emotional, sensory, social and spiritual responses to all interactions with a firm (as cited in Bolton et al. 2014; Gentile, Spiller, and Noci 2007; Lemke, Clark, and Wilson 2011; Verhoef et al. 2009).

Lemon and Verhoef also state that there are multiple definitions but the most accepted are: the multidimensional view by Schmitt (1999) that identifies "five types of experiences: sensory, affective, cognitive, physical and social-identity experiences"; Brakus, Schmitt and Zarantonellos's view, that conceptualizes "brand experience as subjective, internal consumer responses and behavioural responses evoked by brand-related stimuli that are part of a brand's design"; and the De Keyser et al. (2015) description of customer experience as "comprised of the cognitive, emotional, physical, sensorial, spiritual and social elements that mark the customer's direct or indirect interaction with (an)other market actor(s)".

The authors also point out the roots of customer experience study and identify seven specific developments that have emerged since 1960 and that culminate in the Customer engagement, developed in the 2010s, that recognizes the customer's role in the experience.

Regarding the customer experience construct, the authors state that it is also related to:

- Customer satisfaction (cognitive evaluation of the experience);
- Service quality (an antecedent to customer experience);

- Trust (just like the firm's reliability and benevolence, it doesn't directly influence the customer experience, but a good experience may build trust);
- Commitment (measure of a customer's connection with a company);
- Customer engagement (the extent to which the customer reaches out and initiates contact with the firm - it constitutes various touch points along the customer journey).

VALUE IN SERVICE

Vargo et all. (2008) state that, through Vargo and Lusch's (2004) definition of Service as an application of competences by one entity for the benefit of another, understanding the economic phenomena gained a new perspective, in which value is created collaboratively. According to the authors, the nature of value has been discussed, and, as a consequence, two possible meanings were identified: "value-in-use" and "value-in-exchange". The traditional view is the goods-dominant logic and is based on the "value-in-exchange" meaning of value: the value is created by the firm and distributed to the customers. Value here is usually defined by the exchange transaction of money for a good. The service dominant logic is based on the "value-in-use" meaning of value: the roles of consumer and producer are not distinct and value is co-created through the integration of resources and application of competences.

In the table below, the main differences between the two approaches are pointed out by Vargo et all., for a better understanding on the topic.

Goods Dominant Logic vs Service Dominant logic in value creation		
	Goods-Dominant Logic	Service-Dominant Logic
Value Driver	Value-in-exchange	Value-in-use or value-in-context
Creator of Value	Firm, often with input from firms in a supply chain	Firm, network partners, and customers
Process of Vale Creation	Firms embed value in ‘‘goods’’ or ‘‘services’’, value is ‘added’ by enhancing or increasing attributes	Firms propose value through market offerings, customers continue value-creation process through use
Purpose of Value	Increase wealth for the firm	Increase adaptability, survivability, and system wellbeing through service (applied knowledge and skills) of others
Measurement of value	The amount of nominal value, price received in exchange	The adaptability and survivability of the beneficiary system
Resources used	Primarily operand resources	Primarily operant resources, sometimes transferred by embedding them in operand resources-goods

Role of firm	Produce and distribute value	Propose and co-create value, provide service
Role of goods	Units of output, operand resources that are embedded with value	Vehicle for operant resources, enables access to benefits of firm competences
Role of Customers	To 'use up' or 'destroy' value created by the firm	Co-create value through the integration of firm provided resources with other private and public resources

Table 1- Goods Dominant Logic vs Service Dominant logic in value creation

The authors point out that to perceive value as value-in-use, consists on basing it on processes that integrate resources. On the service systems perspective, value is generated whenever an improvement in system well-being occurs and the measurement is possible through the system's adaptiveness or ability to fit in its environment. To these authors, service systems are defined as the value-creation configurations. These service systems exist in an interdependence basis with other service systems: they are *connected through the proposition, acceptance and evaluation of value*. Each of these systems propose value in the market based on their competences and capabilities. This proposition is accepted, rejected or unnoticed by other service systems, which can be the potential consumers for example, who will accept the value proposition or not.

2.2 Legal Context

In order to support the relevance of this Master Thesis, it is important to look through the recent legislation that was published both by the European Union (2018/2001 Directive) and that lead to the 162/2019 Decree-Law published by the Portuguese Government.

In the European Union 2018/2001 Directive, regarding the promotion of renewable energy sources (a reformulation of the 2009/28/EC), sustainability friendly measures were announced, which represents bigger advantages for companies that were already seeking sustainability and energy efficiency as goals (considering these Directives pave the way for countries to support legally and financially individual or enterprise initiatives towards the common goal of having a better planet to live in).

This Directive points out, in Article 3 (1), that the Member States shall ensure a share of energy from renewable sources of 32% by the end of 2030, and on (5) that the Commission shall enable funds use for "developing (…) storage facilities and interconnections (…)".

In Article 21(2)(b), Renewable self-consumers are addressed, a major point of interest regarding this Master Thesis, and it is established that those are entitled "to install and operate energy storage systems (…) without liability for any double charge, including network charges, for stored electricity remaining within their premises". Further on, on (2)(d), it is required that these consumers receive remuneration (…) for the self-generated renewable electricity that they feed into the grid (…)"

As required through Article 21(4), "Member States shall ensure that renewables self-consumers located in the same building (…) are entitled to engaged jointly (…) and are permitted to arrange sharing of renewable energy that is produced on their site or sites between themselves,

without prejudice to the network charges and other relevant charges, fees, levies and taxes applicable to each renewables self-consumer."

2.3 Photovoltaic Solar Energy Storage Systems

According to Haisheng Chen, et. all (2009), Electrical Energy Storage (EES) systems origin started in the turn of the 20th century, "when power stations were often shut down overnight, with lead-acid accumulators supplying the residual loads on the direct current networks (…). The author states that after a period of interest related to Pumped Hydroelectric Storage (PHS), such interest fell down due to environmental concerns and deregulation. According to the author, the interest in EES systems regrew because of new regulation, a reliance on electricity in industry, commerce and home, the growth of renewable as a major new source of electricity supply, more environmental requirements, many technological developments in emerging EESs and the anticipated unit cost reductions.

According to the International Renewable Energy Agency "Electricity Storage and Renewables: Costs and Markets to 2030" report, "the challenge facing governments now has shifted from discussing what might be achieved t how to meet the world's collective goals for a sustainable energy system. (…) The increased need for system flexibility as the share of variable renewables grows, the importance of electric vehicles to decarbonise the transport sector; and the important inter-linkages between sectors (…) all serve to highlight the potential contribution of electricity storage systems (EES)- and energy storage more generally- as an important part of the energy transition".

This report also informs us that Battery Storage Systems show an improvement on their performance, while the price is decreasing. This tendency is following the priority in decarbonising the electricity sector by 2050, with predictions of an increment of 23% in 2015 to 82% in 2050 on the share of renewable energy in electricity generation. The expected increase in solar photovoltaic and wind power capacity and generation are two contributors to the predicted increased need of electricity storage systems.

The document also reports that renewables are a key factor in providing energy to those without access to the grid, through solar home systems, solar PV mini-grids. In Asia, for instance, these systems that provide electricity to over 300 million people, also include batteries. The predictions of the report, specifically regarding electricity storage power capacity, point to 1000 GW by 2030 that split into 175 GW from stationary battery storage.

As pointed out in the report, residential and commercial PV owners represent a growing application for battery storage systems. Their market shares may be underestimated because of a potentially high number of unreported small projects. It is pointed out that in Germany, through financial support, approximately 40% of small-scale PV systems with battery systems have been installed.

This document separates 3 main segments in which electricity storage systems can be used:

- Grid Services: helping to control grid's frequency for instance;
- Behind-the-meter applications: used to "increase the local self-consumption" of decentralized generation. As such, the amount of power obtained from the grid can be lowered, resulting in a decrease of the electricity bill Although currently not economically profitable for most private users, a general interest in new technologies

and the increasing demand for local green electricity supply is driving many people to invest in small storage systems."

- Off-grid applications: Diesel generators are used to power consumers with no access to electricity grids. Considering the diesel prices fluctuation, more enterprises have integrated renewable energy technologies. When added electricity storage systems, the amount of renewable energy on these systems can grow up to 100%.

Regarding the analysis of the cost-of-service per electricity storage application, which results are presented in the report, for self-consumption systems, which are used in residential applications, Lead-acid batteries and Li-ion batteries are referred to as the usual options. The comparison between both is made and the second are stated as "having a higher lifetime, no maintenance, no gassing, easier to install, being possible to install hanging to a wall, higher efficiencies and lower total cost of ownership due to lifetime and efficiency".

In the analysis of the cost and prediction to 2030, it is referred that Li-ion batteries have the advantages (when compared to other storage systems) of being high energy and power density, high rate and high-power discharge capability, excellent round-trip efficiency, a relatively long lifetime and a low self-discharge rate". There are, although, concerns regarding its thermal stability, considering that under certain environments, cells may catch fire. This problem is being addressed through an effort on improving thermal management and monitoring processes on the system.

Another advantage of these systems, that is also pointed out, is the fact that these batteries are used in our portable electronics and electromobility markets, which leads to the cost reduction of the product.

The cost of the systems, by the time of the report, varied between 473 USD and 1260 USD/kWh . Regarding the lifetime of the system, it can vary between 500 and 20 000 equivalent full cycles (being the temperature a highly impacting feature on such analysis). Considering the goal of reducing the battery cost, it is possible to verify, based on the conclusions of 5 studies, the composition of the equipment's final price. It may be divided into material-based costs and the other costs: labour, rest, profit margin and overhead. It is also stated that the cost component distribution per storage size is characterized and it is verifiable that as bigger the system size is, the relevance on cell cost is lower.

3 Problem Characterization

In recent decades, global warming and climate change are an issue of global concern, with carbon dioxide emissions being considered one of their main causes. To mitigate these problems, finding new renewable energy sources (RES) and utilizing energy in an efficient way with the integration of RES and energy storage systems have been identified as ways to achieve carbon dioxide reduction. (Dinh, H. et all., 2020)

This project was developed in PH Energia, Lda., a company based in Porto that was funded back in 2014, basing its activity in business ethics, environmental sustainability and energy efficiency. Customer's satisfaction is the priority, so its conduct is driven by the principles of transparency, saving and innovation. By the time of September 2021, the company had 30 employers, 5000 customers and an energy volume of about 300 GWh/ year, spread across the region of Portuguese mainland.

The company is an electricity and natural gas commercialization player that only provides renewable sourced energy, with internal procedures compliant with environmental sustainability and with 100% digital processes in the relationship established with customers and other agents involved. The vision is to lead the Iberian market in self consumption and renewable carbon neutral energy production solutions. The mission is to help customers to target carbon neutrality by the end of 2035.

In 2021, the message that is communicated to the market through a marketing strategy, is "Queremos Zero CO2"- We want zero CO2, in an effort to contribute in a broader way in the influence on residential and business markets to make what is possible to save our planet, trying to achieve carbonic neutrality, having the company as their partner in this effort. This slogan, that was used more than as a sales strategy, as the tone to drive the companies' employers' actions, has a connection to this master dissertation: as the service proposal that is presented contributes directly to decarbonization, by allowing residential and business energy consumers to store renewable energy to spend later, therefore reducing the amount of non-renewable energy that is consumed from the energy grid.

The mission statement identified for the quorum of this work to be developed consists of delivering the most suitable electrical energy storage system service to the customer, regarding their needs and requirements. As the mentioned service brings an important improvement towards decarbonization and to an existent renewable energy product- photovoltaic energy production system s- it gains a greater importance for companies in the industry to transform these products into exciting and appealing consumer services, fulfilling their needs and preferences. The primary target market that is pointed out for directing this service is the Portuguese residential market, with the financial ability to acquire the product and, thus, enjoy the service offered, and also with the possibility to install it in one of the properties owned. A secondary market is also identified as the residential market with the will to acquire such systems and associated services but without the financial ability to do it at prompt payment. For the purpose of this study, the population in analysis was defined as PH Energia's customers within this market, due to the companies' current reality of reaching and acquiring a new customer: residential consumers are mainly reached through special campaigns launched online and by getting to know the company as a company energy provider - the owners and employees become interested in having PH Energia providing energy for their residential homes. It was thus, deemed more accurate to consider a smaller range of customers as the real population and target of the study, including also people from the "bigger" market to obtain data from customers that already have energy storage systems in their homes.

In order for the service to be correctly delivered to the customer, the following business goals were identified:

- To specify the market target for the service to be presented to;
- To understand what are the customers' needs and preferences in the context of the service being provided to them;
- To design a service that is suitable for the customer group interested in acquiring the service;
- To implement the service in the company's offerings portfolio with adequate margins and profit;
- To keep up with the industry's innovations and deliver it to customers, as has been done through the years;
- To keep up on increasing the company's contribution to environmental sustainability and representing a bridge for consumers to participate in this common goal.

Our main assumptions are that it is identifiable that the suppliers will keep their electric storage systems' stock availability constant enough, and that the relationship of the company with their existing installer partners will continue strong and the service level will be maintained at its high standards.

As the main constraints to deliver the service we consider the still high cost of the system and the fact that it is much more likely to be delivered to photovoltaic energy production systems owners.

The identified stakeholders are:

- The Government, considering the ongoing goals to improve environment sustainability in the country and in Europe;
- The Electrical Energy Storage Production System provider;
- The company, PH Energia, Lda.;
- The company's consumers, more specifically Photovoltaic Energy Production System owners.

4 Methodology

4.1 Existing Investigation Strategies

As possible Methodologies to develop the initial phase of this study, a Qualitative, Quantitative or Mixed Method Research could be performed to get to any conclusion and new knowledge on the topic.

Quantitative and Qualitative Research main differences are the framing in terms of words or numbers, respectively. Mixed methods research uses elements of both Quantitative and Qualitative research. (Creswell, 2018)

John W. Creswell (2018: 25) provides a definition of Qualitative research: an approach focused on analysing the meaning individuals or groups ascribe to a social or human problem, characterized by a process that involves questions and procedures, being the data collected in the participant's setting, analysed inductively by the researcher that shall interpret the meaning of such data.

According to Creswell (2018) Quantitative Research tests "objective theories by examining the relationship among variables", which are measured typically on instruments and analysed using statistical procedures.

Mixed Methods Research involves collecting quantitative and qualitative data, "using distinct designs that may involve philosophical assumptions and theoretical frameworks. The core assumption of this methods is that qualitative and quantitative research together can provide greater results than each could give by itself.

According to Alan Bryman (2012), Qualitative Research and Quantitative Research are differentiated according to the following parameters:

- Orientation to the role or theory in relation to research: Quantitative follows a Deductive one, testing existing theories; Qualitative uses the Inductive one, generating theories;
- Epistemological orientation: Quantitative uses a Natural science model, in particular positivism; Qualitative uses Interpretivism;
- Ontological orientation: Quantitative is Objective; Qualitative is Constructive.

It is important to understand such concepts, prior to making any decision on what Method to adopt in the study to be developed.

Therefore, according to Bryman (2012), using a Deductive theory, a researcher formulates a hypothesis based on what is known about a topic. This hypothesis is then translated into researchable entities and the researcher may "specify how data can be collected in relation to the concepts that make up the hypothesis". The last step of this theory involves its opposite, induction, considering that "the researcher infers the implications of his or her findings in the initial theory". The inductive approach is defined as the outcome of research, by "drawing generalizable inferences out of observations. The inductive researcher may also use the Deductive theory, as he or she may want to "collect more data in order to establish the conditions in which a theory will and will not hold" (an iterative strategy).

Regarding the Epistemological considerations, Positivism is difficult to define according to the same author, but there are five principles that can describe it:

- "Only phenomena and hence knowledge confirmed by the senses can genuinely be warranted as knowledge (…) (phenomenalism);

- The purpose of theory is to generate hypotheses that can be tested and that will thereby allow explanations of laws to be assessed (deductivism);

- Knowledge is arrived at through the gathering of facts that provide the basis for laws (inductivism);

- Science must be conducted in a way that is value free (objective);

- There is a clear distinction between scientific statements and normative statements and a belief that the former are the true domain of the scientist."

Interpretivism is a term born due to the discordance of some authors with Positivism. applied to the study of the social world, due to the differences of both fields' requirement of a different logic. Interpretivism "is predicated upon the view that a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires to gasp the subjective meaning of social action". (Bryman, 2012).

Finally, defining the contrasting existing ontologies, Objectivism "implies that social phenomena confront us as external facts that are beyond our reach or influence" and Constructionism "asserts that social phenomena and their meanings are continually being accomplished by social actors", not only being produced through social interaction but also being in a constant state of revision (Bryman, 2012)

After considered all perspectives, it was decided that a Mixed Method Research would take place. In order to perform a Quantitative Research, an online survey would be answered by customers and potential customers. After this, semi structured interviews would be done to key elements, that are, usually, involved in the service design in the organization. After gathered all the data previously mentioned, a conversation would take place with the CEO, in order for a final decision regarding the way to go on designing the service to be made.

It was identified that Multilevel Service Design method would be the most appropriate one to design the solution to the problem presented. This interdisciplinary method integrates interaction design, service science, management and engineering, enabling integrated design of service offerings at three hierarchical levels with a strong focus on the customer experience: designing the organization's service concept; designing the organization's service system and designing each service encounter. (Patrício and Fisk, 2013)

This method consists of 4 main steps that are performed:

- Step 1: studying the customer experience through the value constellation experience, the service experience and the service encounter experience;
- Step 2: the service concept design is possible at this point, based on the study of customer experience and on the value constellation model;
- Step 3: the firm's service system is designed through the service system architecture (SSA)- in which the structure of the service system is defined- and service system navigation (SSN)- that maps the alternative paths customers may take across different service encounters in the service experience;
- Step 4: service experience blueprint is used to design each concrete service encounter. (Patrício and Fisk, 2013)

It is also divided into 4 phases: inspiration, in which the customer experience will be understood; ideation, when the service offering will be designed; reflection, where the service experience is prototyped and finally, implementation.

4.2 Method used in the project

As previously mentioned, Multilevel Service Design (MSD) was the Method chosen to develop this project as it seemed to be the most adequate based on the existing goals.

The logic that is followed by this Method was developed *according to a design research approach*, uniting contributions from different fields and designing the service offering through different levels of customer experience. In fig. 1, the 4 main steps of the model are represented: Studying the Customer Experience; Designing the Service Concept, Designing the Firm's Service System and, finally, Designing the Service Encounter. (Patrício, L., et al. 2011)

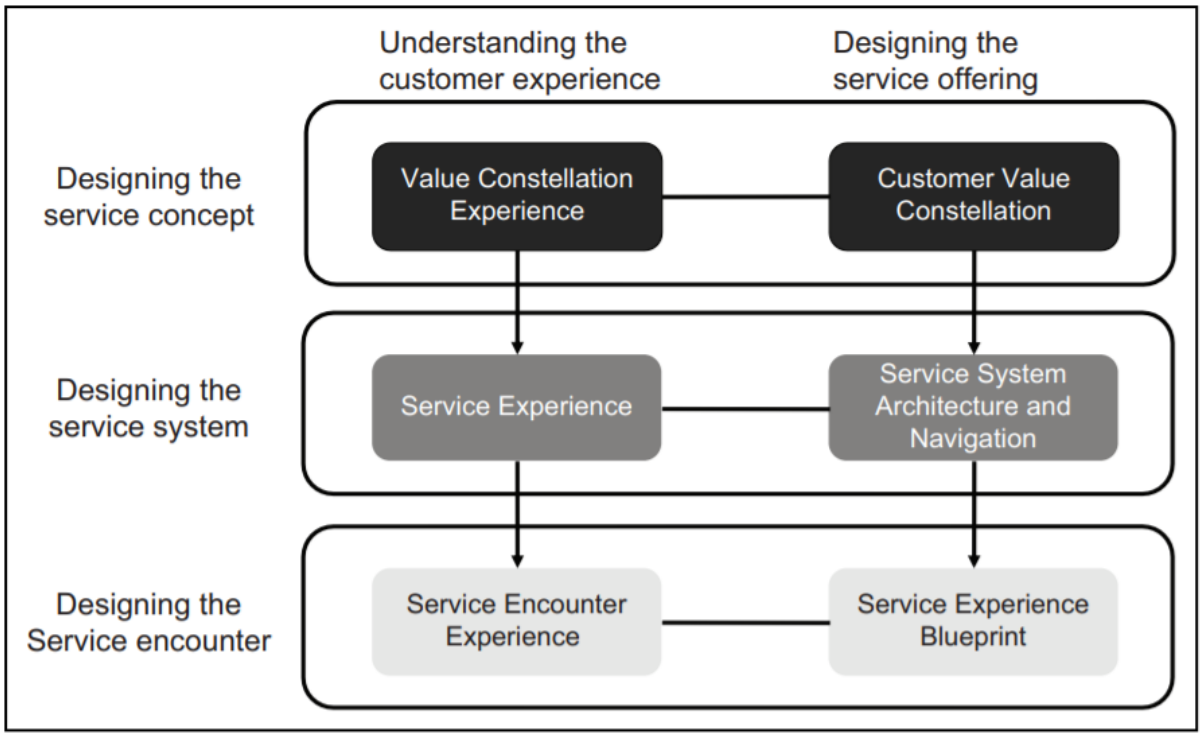

Figure 1- Multilevel Service Design Model (Patrício, L., et al. 2011)

As a first step, after analysing data that was collected through the questionnaires and interviews, the Customer Experience was studied and analysed. As Service Design is a multidisciplinary field that involves marketing, human resources, operations, organizational structure and technology disciplines (Ostrom et all., 2010), it must consider service elements, as the physical environment, people (customers or/and employees) and the service delivery process itself in order to help customers co-creating their experiences. (Teixeira, et all., 2012)

The Customer Experience Modelling was applied in order to capture all the elements that are part of the experience, as it is a modelling tool that enables a manageable abstraction of a complex reality and facilitates the creative transition to service design solutions, which is the ultimate purpose of this project. This method includes contributions from Human Activity Modelling (as the conceptual grounding and notation for CEM), Customer Experience Requirements (as a way to express customer desired attributes and assess how each service element influences the customer experience) and Multilevel Service Design (connecting

customer experience and service design through three hierarchical levels: service concept, service system and service encounter). (Teixeira, et all., 2012)

In order to be possible to model the Customer Experience, it is firstly needed to study customer as deeply as it can be done. In the context of this study, the data needed to model the Customer Experience was collected through an online survey, in which customers/ potential customers had the possibility to identify what was mostly required for the service that this project is proposing to develop.

Through this method, the Value Constellation Experience was defined- all the interactions between the customer and all service organizations needed to perform a given customer activity, in this case, the Value Constellation of Renewable Electricity Consumption was defined. As the second level, the Service Experience- focusing on a single service provider service system was defined: Stored Electricity Consumption. At last, the Service Encounter Experience was defined, identifying Pre-Production Service and Post-Production Service Experiences as the ones that include all the experience requirements identified by customers at the inquiries for the service in study, specifically.

After modelling the Customer Experience, Designing the Service Concept was the next step. To complete this task, the firm's positioning in the customer value constellation is defined, *including the services offered and the links and partnerships established with other organizations in the network to enhance the firm's value proposition* (Patrício, L., et al. 2011). As the Customer Value Constellation was designed in the Customer Experience Modelling diagram, the step was completed.

The 3rd step consists on Designing the Firm's Service System. This step is performed, in order to operationalize the value proposition, based on understanding the service experience. Service System Architecture is the first part of this phase, in which the main tasks performed by the customer are identified in the top row. In the column, the service interfaces are represented, divided by service interfaces and backstage activities. In the matrix, the service interfaces and backstage activities that support each customer task are shown, therefore identifying the touchpoints or service encounters of the service in analysis. The sequence of these touchpoints or service encounters defines the customer journey. (Patrício and Fisk, 2013)

Through the matrix that is defined, it is possible to map different customer journeys, which form the Service System Navigation, in which the implications in terms of backstage processes and technologies can be analysed (Patricio and Fisk, 2013).

On the final step, the 4th, the Service Encounter is designed. Service encounters are the moments of interaction between the customer and the firm and may take place in multiple interfaces. (as cited in Patricio L, et al. 2011). In- depth studies with customers enable mapping the process customers use to cocreate their experiences for each service touchpoint or encounter and identifies important experience factors. (Patrício, L. et al. 2011)

The MSD method uses Service Experience Blueprint diagrams in order to represent the service encounter design. This diagram maps the actions of the different participants in the service encounter, frontstage and backstage. (Patrício, L.et al. 2011)

5 Results

In order to apply the Multilevel Service Design method to this specific case, the first step that was taken was to understand the Customer Experience.

Regarding the survey that was answered by customers and potential customers, the study developed had a direct approach, in which the main goal was to find out what are the characteristics that these people would rather find in the electrical storage system service, such as how much they would be willing to pay for the system or the motivations to acquire the product in the first place.

In order to define the appropriate sample size, considering a population of 4000 residential customers, which energy provider is PH Energia, Lda., a confidence level of 90% - how confident we are on the actual mean falling within the margin of error- and a margin of error of 7%- the difference allowed between the mean number of the population and the sample- were considered, which resulted in an ideal sample size of 134 people.

129 answers were collected and the main findings for this study are pointed out next. It was found that only 6,2% of the sample owns an Electrical Energy Storage System and the reasons pointed out by those for having acquired them are money saving (75%) and environmental sustainability (62,5%). The services offered by their service provider that were identified were 10 years warranty, a monitoring app and free installation. As the main improvements those people would suggest to their service provider, better technical assistance, more efficiency on the periodical verification and more teams to assist customers were identified.

Considering the inquired that don't own an Electricity Storage Systems, 49,6% considered Most Likely (11,6%) or Likely (38%) they would acquire one of these systems in the future and 50,4% considered it to be Very Unlikely (21,7%) or Unlikely (28,7%) for this decision to happen in the future. Regarding the motivations that would lead these potential customers to acquire the product, money saving was the main one (82,2%), followed by environmental sustainability (59,4%) and a greater energetic independence (51,5%).

Regarding the amount that those would be willing to pay for the system, 59,4% considered the range between 1500€ and 3000€ and 17,8% considered 3000€-4500€ to be their price limit. Considering return of investment times, 4-6 years was the period identified by the majority (66,3%), followed by 6-8 years (23,8%).

Referring to which services the sample would prefer, the results were the following:

- Free equipment installation: 32 found it crucial and 29 considered it very important;
- 10 years warranty: 60 found it crucial and 37 very important;
- System's performance monitoring app: 26 considered it crucial and 51 very important;
- Specialized Customer Support Service: 41 considered it crucial and 32 very important;
- Related Products Discount Program: 17 considered it crucial and 37 very important;
- Detailed Study on Return of Investment time: 34 identified it as crucial and 39 as very important.

In a final open question, in which it was allowed for the respondents to share ideas or opinions that couldn't be shared previously, several aspects were mentioned, such as the possibility of reusing car batteries to store energy at home, which has been done abroad but isn't a possibility

in Portugal yet, and the dependence on the systems and energy price for these to be sold to a more significant amount of customers.

After this had been done, semi-structured interviews were performed with key people from PH Energia, Lda., that are usually involved in the product and service design in the company: two Commercial Agents, the Marketing director and the Commercial director.

In these interviews, the results of the previously mentioned inquiry were presented and it was intended for these key employees to share the way they would design the service, based on what they know and the new data generated in the inquiries.

In these interviews, several perspectives were presented to some questions and there was agreement in some others.

The main finding that can be identified as a common agreement from these specialists is the difference existing between the amounts that potential customers are willing to pay for these systems and the real price those are currently being sold for. The return of investment periods that were identified by respondents were also considered unlikely to be possible at the moment, by the average residential customer in Portugal. In spite of this fact, it is pointed out that the return of investment is directly connected to the consumption profile of each customer, which means that lower power levels will have a bigger return of investment time than bigger power levels (the consumption profile is usually proportional to the power) This can be used to segment the market and the service that will be designed. Also, the energy price has a great influence in this indicator, considering that if energy markets are now selling energy at 40% higher prices than before, and the tendency continues, the return of investment time will decrease a lot, making Electricity Storage Systems more appealing to customers not willing to be dependent on these market variations and on speculation.

Besides this, an important element was pointed out by all interviewed elements: considering the gap between the price of Electricity Storage Systems and what respondents were willing to pay, financing solutions are the main obstacle for this service to be provided to consumers and to represent a proper share on the company's revenue. For this problem, several solutions were pointed out: to present customers with the possibility of using governmental funds that were created to give an incentive on the usage of renewable energy; to contact bank entities to verify if it would be possible to build a credit product for this purpose, building a partnership with PH Energia Lda. to achieve this goal; to integrate a credit for the system in the housing credit.

Considering the service features that were presented to respondents and the data that came out of such questions, in which the preferred features were identified, the interviewed elements informed that there wouldn't be limitations on implementing any of those, based on the assumption that the app would be developed by the system provider, as it currently happens. Through this app, it was also pointed out that it wouldn't be difficult to integrate the info of the return of investment time in real time - with a calculation that would consider the invested amount, the energy produced in the photovoltaic production system, stored in the battery, used for self-consumption and the price of the energy at such moment (to calculate how much the customer would be paying if consuming directly from the grid).

All the elements agreed that the company should position itself as a service provider rather than only a product provider, keeping up with the energy commercialization tendency nowadays (these aren't only the company that provides energy at a price for its customers but a service provider that tries its best to monetize the customers' money, at the same time as it contributes to an improvement on environmental sustainability).

Addressing specifically how these individuals considered the service could be designed, 4 different options were presented:

- The service could be provided to the customer with all the features at 100% of the cost and, if some of those were discarded, the price would decrease (the values for these would have to be calculated by the company);
- Personas should be defined and only the adequate proposals should be presented to each of those: a customer with a low consumption profile should receive a proposal with a financing solution, but for a higher consumption profile customer, a proposal with prompt payment could be sent. The payback time should be kept out of the communication strategy, due to the lack of knowledge customers currently have on the topic.
- The warranty and technological features are considered more important, so these should be offered immediately and the remaining would be introduced further on;
- Presenting the complete solution would be the best, considering that the amount invested is big, so the customer must have access to all features and support possible and the company should be prepared to offer those.

After the interviews were made and analysed, the results were presented to the company's Chief Executive Officer, in order to design a final solution on how the service should be designed and presented to the market.

From this discussion, there was a general agreement with the answers given by the interviewed elements. Financing customers were agreed as being the most critical element to make it possible to unlock a higher scale sale of these systems in Portugal, such as has already happened with photovoltaic production systems. Until that solution is found, the product can only be addressed to around 20% of the sample that answered to be willing to pay higher amounts for the system. It was also agreed that the return of investment time is directly connected to the consumption profile of each customer and that the offer should be differentiated between different target markets.

Some findings came from this conversation: integrating the system credit within the housing credit would be hard, considering the way in which credit conceiving is done in Portugal, only for construction, acquisition or renewing purposes and not for extra elements of the household. Even though the market isn't considering this already, this could also be a solution beneficial to both the service provider and the credit entity.

As the main service design conclusion, it was defined that the way to go should be: the existing customers of the company (the population of the study) should be segmented according to their consumption profile. After this is done, a different offer should be sent to each segment, as suggested by one of the elements interviewed previously: to the lower consumption profile segment, an offer based on external financing would be sent and for the higher consumption profile segment, an offer with or without financing would be sent. Regarding the service features, it was agreed that there wouldn't be limitations that would preclude the offer of such benefits to customers.

After the definition with the CEO of how the service should be designed, the Multilevel Service Design method could be implemented, in order to translate how de different elements of the service would interact and how the service would be designed, performed and experienced.

As explained in the last chapter, the first step of this method is to perform a deep analysis and study on what characterizes the customer experience. This shall be made by representing the value constellation experience, the service experience and the service encounter experience.

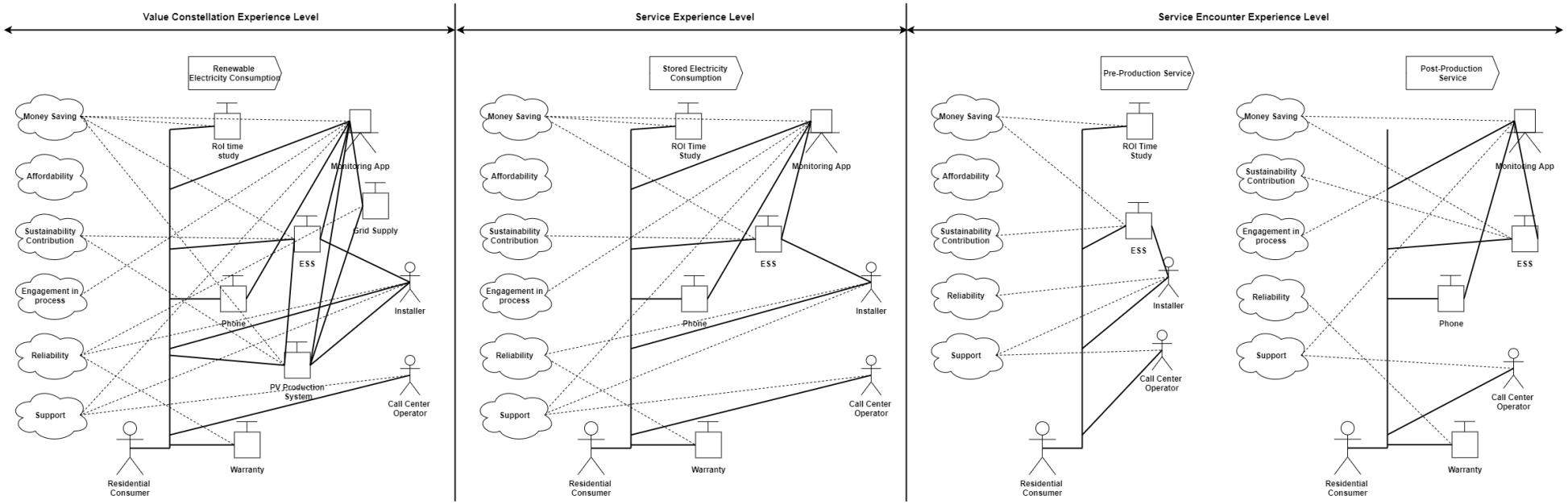

Figure 2- Customer Experience Modelling

Fig.2 represents the 3 elements pointed out above, through Customer Experience Modelling, a method described in the previous chapter. This method represents the interconnections that exist between the Customer, other actors, artifacts, technology-enabled systems and artifacts that are involved in the activities that are performed for the service to be provided, in order to fulfil customer experience requirements. All these elements are represented in fig.2 and the logic that precedes such representation is better understood by analysing fig.3. An artifact is any artifacts employed within an activity, the technology- enabled system is any non-human system interacting with the customer. Actors are activity participants that interact with the customer, and the customer itself. Customer Experience Requirements are perceived attributes of the interaction with a service provider that contribute to satisfaction and usage of the service. Finally, an activity is a collection of actions or tasks undertaken for some purpose. (Teixeira et all., 2012)

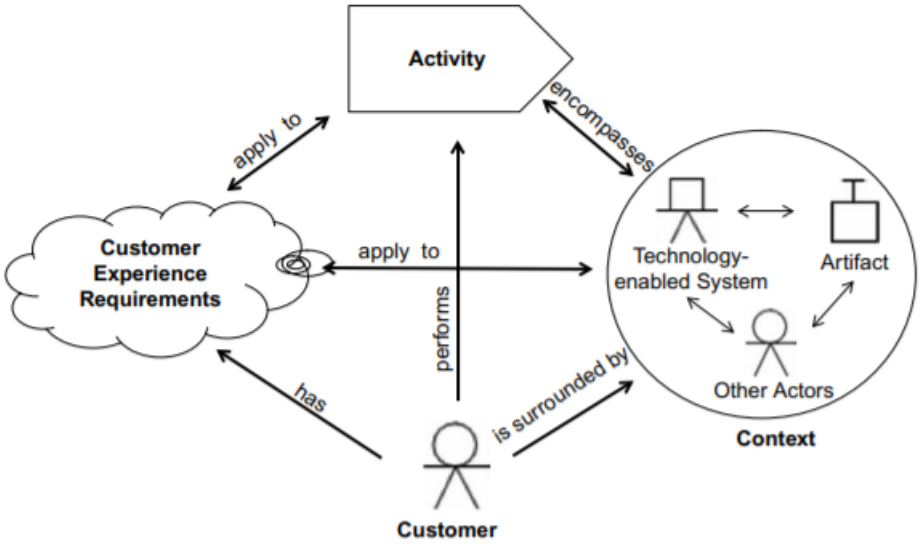

Figure 3- Customer Experience Modelling elements and their relationships (Teixeira, et all., 2012)

Analysing the Customer Experience Modelling in greater detail, the Customer Value Constellation represented Renewable Electricity Consumption, as it was understood as the broader activity in which this service can be integrated in. The main requirements identified based on the information gathered in the survey and the interviews are represented on the left. The actors involved in the experience are the Call-Centre Operator, such as the Installer. The only technology- enabled system identified is the Monitoring App. The identified artifacts were the Return of Investment Study (ROI Time Study), the Grid Supply, the Electricity Storage System (ESS), the Phone, the Photovoltaic Production System (PV Production System) and the Warranty. The connections between the customer and the other elements are represented by the black lines and the connections between each customer experience requirement and the other elements is represented through the dotted lines.

In the Service Experience Level, the activity represented is the Stored Electricity Consumption. In this activity, the Grid Supply and PV Production System artifacts are no longer a part of what is represented.

At the Service Encounter Experience Level, two activities were represented, since performing this service can't consider only the Pre-Production Service or the Post-Production Service: both of those are really important for the customer to be well informed and to feel supported by the company, in the first activity, and for this support to be given when needed, in the second activity. In the first, the Return of Investment Time Study, the Electricity Storage System are the artifacts kept and the Installer and Call-Centre Operator are the actors that participate in such activity. In this activity, the customer experience requirement Engagement in process is taken, considering the engagement is perceived as starting only in the second activity. Regarding the second activity, the Monitoring App is represented, as it will keep the customer informed of the system's performance throughout its lifetime. For this to be possible, the artifact Phone is required and the ESS is always mandatory, so those are also represented. Finally, the Warranty is also part of this activity, as an artifact that will be kept to increase security for the customer in the upcoming years after the buy itself. In this activity, Affordability no longer is a part of the representation, as it is considered a requirement only relevant before the purchase.

In fig.4, the first part of designing the service system is represented through the Service System Architecture. In the top row, the main tasks customers perform to acquire and enjoy the service in study:

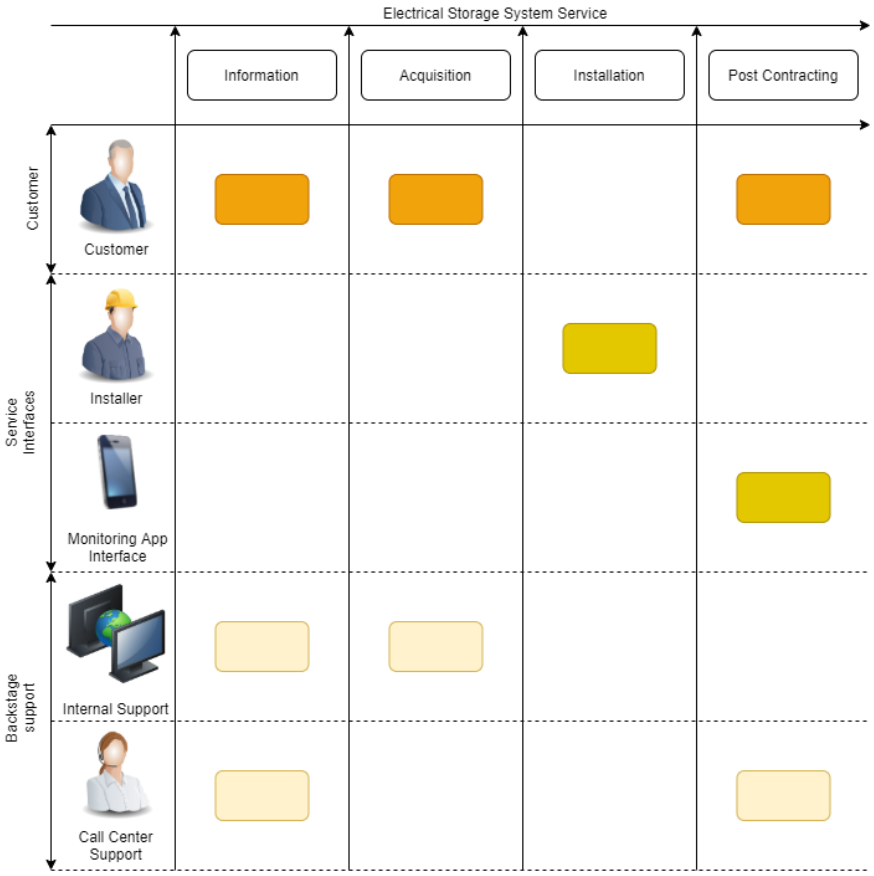

Figure 4- Service System Architecture

information, acquisition, installation and post-contracting. In the column, the service interfaces (frontstage)- installer and monitoring app interface- and the support processes and technologies (backstage)- internal support and call-centre operator are represented, representing these

interfaces what enables the customers to co-create experiences. In the body of the matrix, the connection between which interface or support process/ technology supports each customer service task is represented in each cell. These cells are the service encounters or touchpoints.

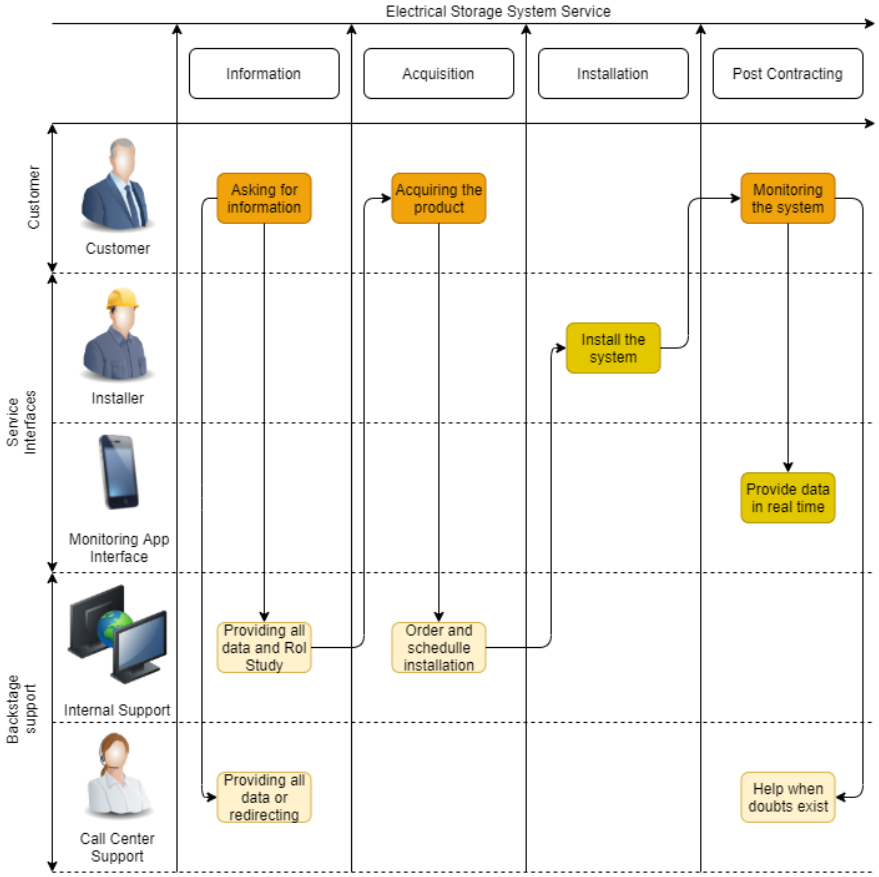

Figure 5- Service System Navigation

Based on the Service System Architecture, it became possible to create the Service System Navigation, which represents the customer journey that exists in this service. By following the rows represented in fig.5, it is possible to verify the path that is followed by the customer and the other actors involved to make the service a reality that is satisfactory for the customer, considering the data previously gathered. Considering this representation, it is possible to verify the interconnections between the customers' tasks, the backstage support processes and technologies, such as the service interfaces, which allows the company to understand what would be the direct implications of this service in its operations. Therefore, it is understood that the Call Centre team will have to receive the proper information on how to solve any doubts that customers may have during pre-contracting or post-contracting service, about installation, warranty or the app or systems' functioning (something that was pointed out during the interviews - the importance of this team to be able of answering every question so that the customer feels properly supported). Considering the internal support interface that is mentioned, the company can conclude that the elements involved in this interface will be the interconnection between the product supplier, the installer and the customer, so this communication channel must flow in accordance to quality standards that the company already works with, so that customers still receive the same quality treatment as they are used to. The Monitoring App is a service feature that will be developed by the product's provider, it is also important for key elements in the company to get the proper training on how it works, in order to be able of explaining it to consumers if needed. The Installer's role is crucial during the

process, as this team of professionals represents the first contact point of the customer with the product, so it is also important to assure that scheduled times are respected and that the team is properly prepared with the information needed, so that the customer gets positive feedback from this experience.

In fig. 6, the service encounter is designed, through the service experience blueprint. Service encounters are the moments of interaction between the customer and the firm and may take place in multiple interfaces, such as the internet or a physical store (Bitner et al., 2000). At this level, the interaction setting, interaction process and the role of each participant is properly designed.

Considering Multilevel Service Design was the method chosen for this project, the diagram used to represent this information was the service experience blueprint (Patricio et al. 2008), so that each concrete service encounter could be designed.

In fig. 6, the pre-installation service is designed, with the several participants' actions in the service encounter being mapped, both frontstage and backstage. This diagram depicts lines of interaction, lines of visibility, fail points, waiting points and service interface links. The initial task of the Customer asking for information is the beginning of the process that is directed to the Internal Support Team (Backstage support interface). After receiving the information, the customer can decide on acquire the product or not, or ask for a Return of Investment Study prior to make this decision. If after receiving the study or without the study being needed, the Customer decides on acquiring the product, the process flows and integrates a new actor (the Installer), with whom the installation of the product will be scheduled and that will proceed to the installation on the customers' consumption point.

Considering the several diagrams that were designed, it is possible to gain a Service Design view on how different actors, organizations, products and the customer would interact for the last to enjoy the service.

There is one important aspect that was left aside from model: The financing solution for the customer. This wasn't considered as the company doesn't have any partnership that would allow it to be considered in the upcoming months. As the goal was to develop a service that could be delivered to the customer in the moment, financing wasn't considered. Another reason for this is the fact that the financing solution that may arise from any partnership could be very different from each other- it could come from governmental funds, from a banking institution or included in the housing loan, and the way these organizations would interfere in the Customer Experience and in the processes flow would always differ. Even though it was left aside, it isn't less important as agreed by the interviewed members of the company: it may even be the aspect that is keeping customers from being more frequent buyers- the fact that the pricing isn't in accordance to the possibilities of the majority in the Portuguese market.

Considering some future possibilities for the company, the data retrieved from the surveys can be used to gather more data that is identified as valuable in the future: the interconnection between some demographic data and the answers that were given can help in defining marketing strategies or in understanding why a group of people eventually may be acquiring the product less than another one and the survey can be sent to customers again later, so that the information is always up-to-date, for instance.

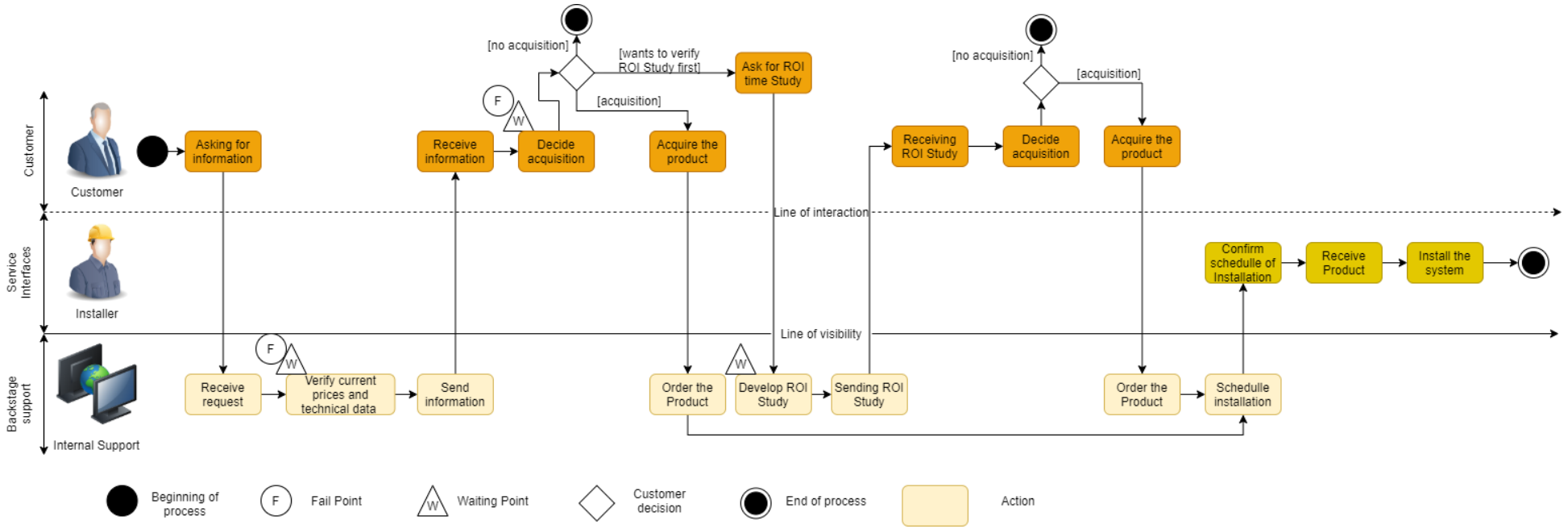

Figure 6- Pre-Installation Service Experience Blueprint

6 Conclusion and future research

6.1 Conclusion

In this Master Dissertation, an in-depth study on how Service Design of Photovoltaic Solar Energy Storage Systems occurred. By using the Multilevel Service Design approach, it was possible to properly assess every aspect of the Customer Experience, considering the several phases that are experienced, the objects involved in it, the actors, processes and tasks and, ultimately, represent the service design that would, according to the data retrieved, work better in the market targetted.

It is relevant to highlight the limitations that occurred during the time the project took place: the time period in which it took place didn't make it possible to perform the final phase of Multilevel Service Design approach: testing. Through this phase, some new ideas would possibly show and the existing ones could be improved.

This study started with the definition of several Research Questions that were answered by the various phases of it. The first one was "What are the reasons for the Customer wanting to acquire a Photovoltaic Solar Energy Storage System, which was answered both in the survey and in the interviews: environmental sustainability and money saving. Based on this question, it is possible for the company not only to verify Customer Experience Requirements but also some Marketing strategy clues on what would capture potential customers' attention.

In the second question, how the Customer Experience is characterized when having one of the mentioned above systems was defined as important to answer. This was characterized in the various Multilevel Service Design steps that took place.

How can new services be designed to be linked to the systems ? followed: as one of the main fingings in the interviews it was stated by all elements that a financing solution would be a key element to improve sales.

What are the most important service characteristics/ what are the business limitations regarding these? was the next identified question. In the survey, customers and potential customers decided on which service features would be more appreciated and those were presented to the company's key elements that were interviewed. Through this process, it was possible to understand that none of the service features identified by the respondents would represent an implementation limitation.

Regarding the question *How can this service be commercialized with a better chance of success*, the answer was retrieved firstly in the interviews and lastly with the decision made in the discussion with the company's CEO: every service feature could be offered to the customers, but the way in which the product would be presented to them would differ: it would have to exist a market segmentation, based on consumption profiles, that would lead if it made sense to present the product without a financing solution or not.

6.2 Future Directions

Considering the contribution on the literature and subject, an existing model was applied to a new topic/ subject- the Photovoltaic Solar Energy Storage Systems Service Design. When the Research phase took place, there wasn't much information available on how to sell this product

or how to generate a service from it. Related to this, there wasn't any data on the customer satisfaction levels or what could be improved, so this study can be a starting point for these energy related innovations to be considered and for more studies to take place having this important subject into consideration.

As testing wasn't done in the end of this study, that would also represent a way to go in order to perform future research base on what was developed.

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APPENDIX A: Results of the survey

Figure 7- "In which district do you live?"

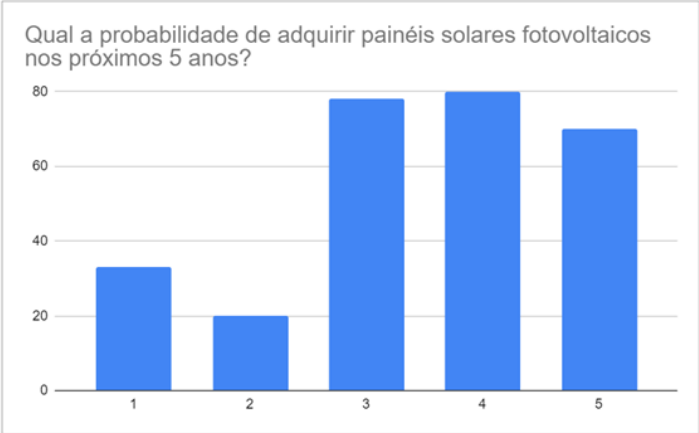

Figure 8- "What is the probability of acquiring Photovoltaic Solar Panels within the next 5 years?"

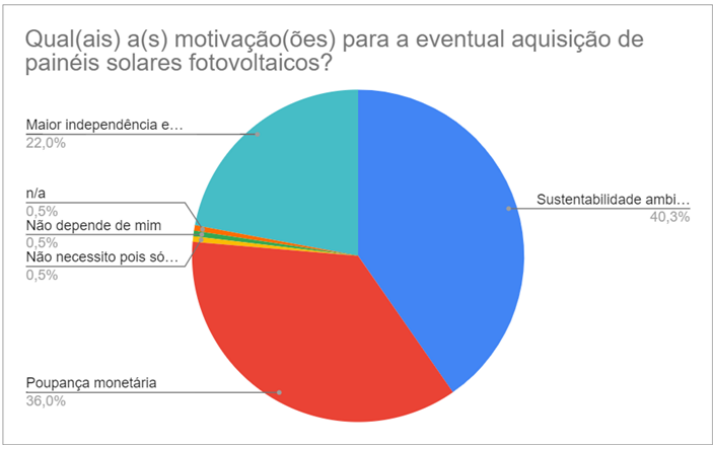

Figure 9- "What is the probability of eventually acquiring Photovoltaic Solar Panels?"

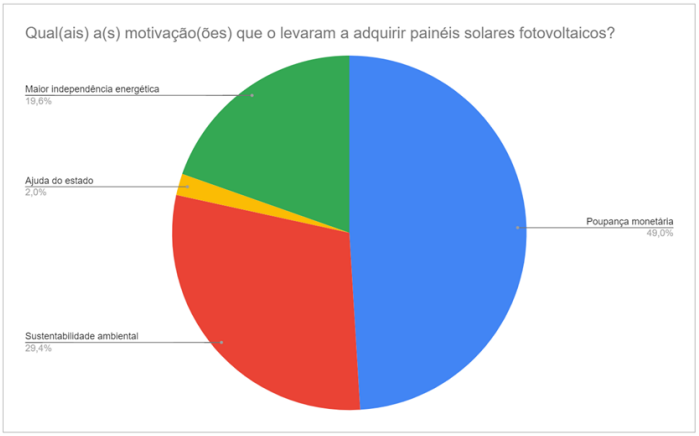

Figure 10- "What are the motivations that led you to acquire the Photovoltaic Solar Panels?"

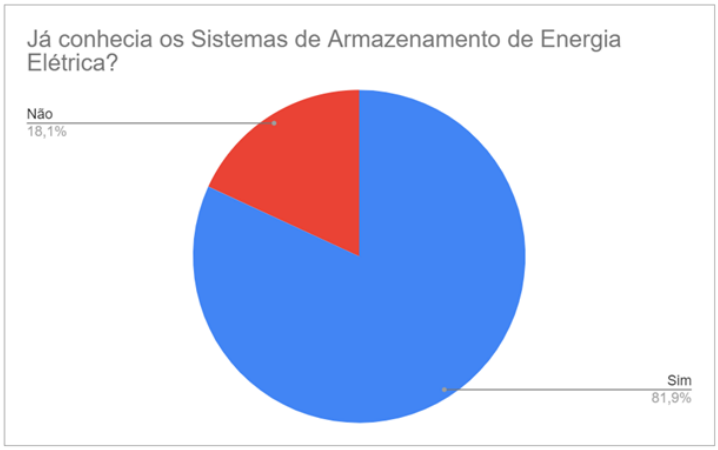

Figure 11- "Did you already know Electrical Storage Systems?"

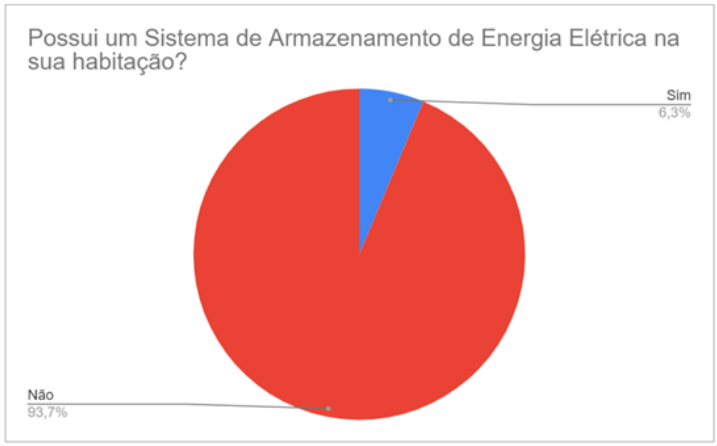

Figure 12- "Do you own an Electrical Storage System in your home?"

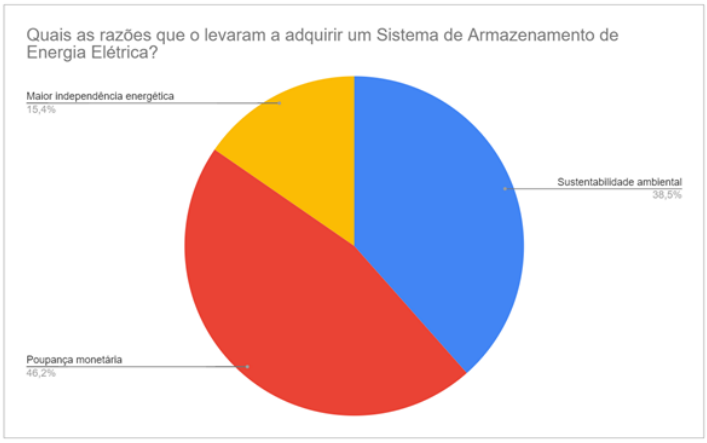

Figure 13- "What reasons led you to acquire an Electrical Storage System?"

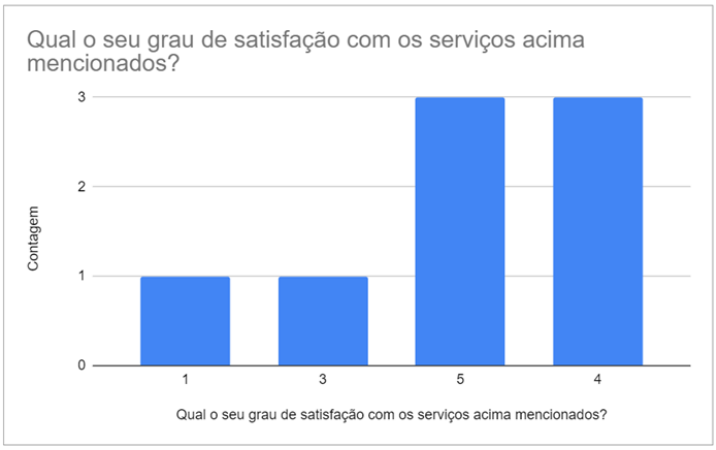

Figure 14- "What is your satisfaction level with the services offered by your system provider?"

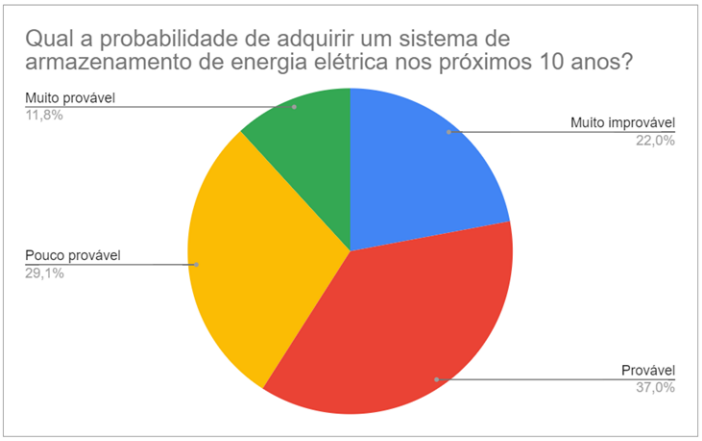

Figure 15- "What is the probability for you to acquire an Electrical Storage System within the next 10 years?"

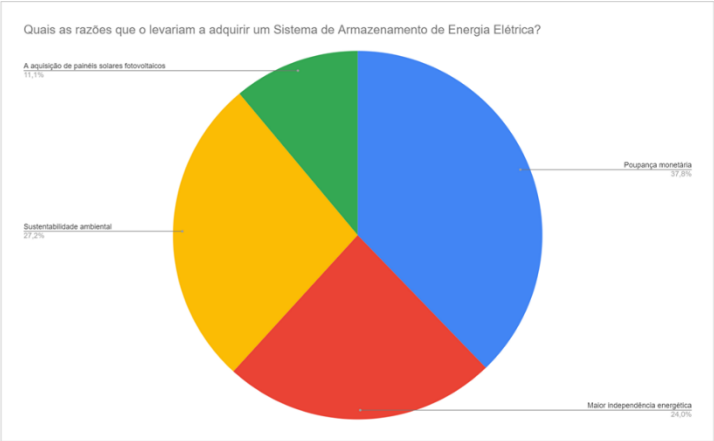

Figure 16- "What were the reasons that would lead you to acquire an Electrical Storage System?"

Figure 17- "What is the amount that you would be willing to pay for an Electrical Energy Storage System?"

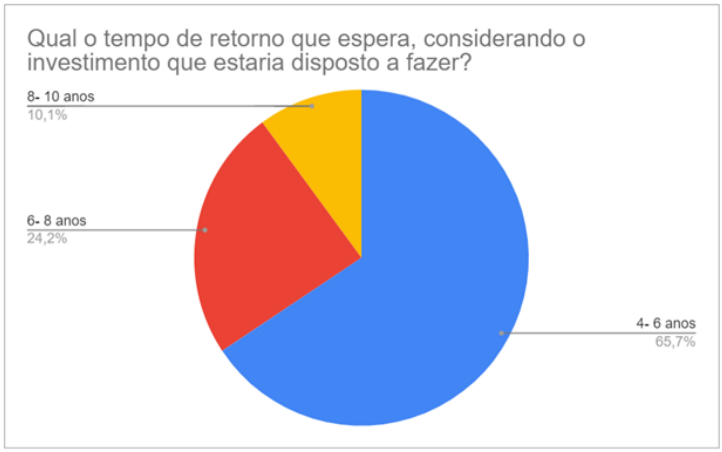

Figure 18- "What Return of Investment Time do you expect, considering the investment you would be willing to make on the system?

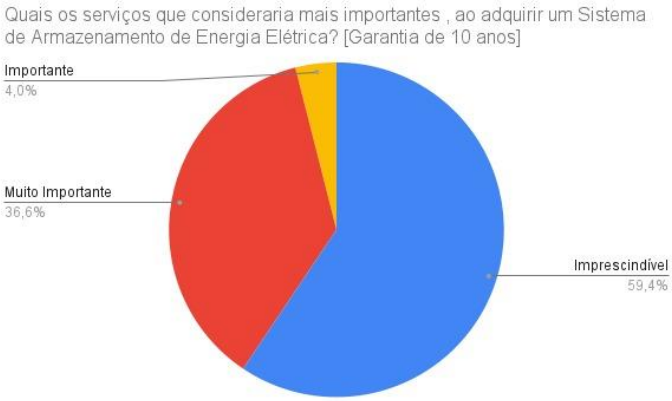

Figure 19- "What are the services that you consider more important, when acquiring an Electrical Storage System?"- 10 years Warranty

Figure 20- "What are the services that you consider more important, when acquiring an Electrical Storage System?"- Free Equipment Installation"

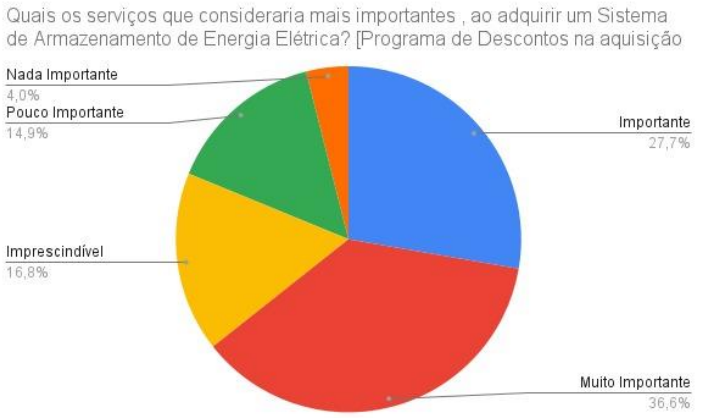

Figure 21- "What are the services that you consider more important, when acquiring an Electrical Storage System?"- Discounts Program to acquire related products

Figure 22- "What are the services that you consider more important, when acquiring an Electrical Storage System?"- Return of Investment Detailed Study

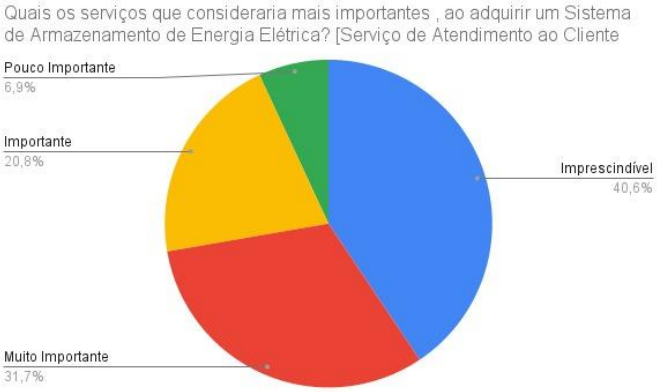

Figure 23- "What are the services that you consider more important, when acquiring an Electrical Storage System?"- Specialized Call- Center Service

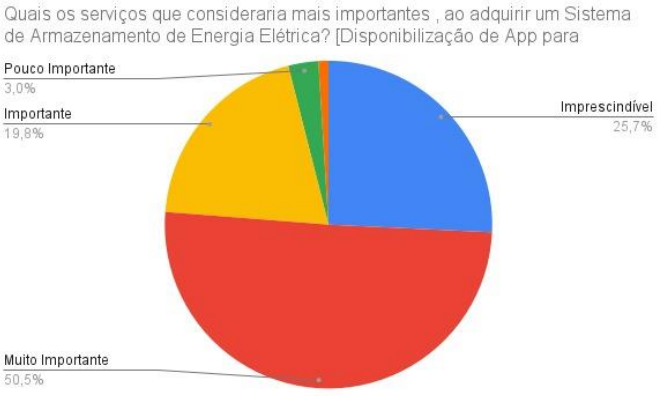

Figure 24- What are the services that you consider more important, when acquiring an Electrical Storage System? - Monitoring App to verify the Equipment's Performance

APPENDIX B: Interview Script- Translated

1- Money saving and Environmental Sustainability were the main reasons pointed out by survey respondents as motivations to having acquired or acquire a Photovoltaic Solar Energy Storage System in the future. Having this into consideration, which way do you believe would be the most viable to design a service from this product?

2- Considering 77,8% of the respondents would only be willing to pay between 1500-4500€ for a System, do you believe selling this product would be profitable for the company?
   a. In case the value customers would be willing to pay is too low compared to the real current price of those, would there be other ways to finance the Customer?
   b. Which instruments should the company use to exponentiate sales?
   c. Would cross-selling be a hypothesis in this context?

3- 65,7% of the respondents expect a return of investment time of 4/6 years. Do you believe it is possible to achieve this deadline?

   a. Would there be a way to monitor this information, making it accessible for the Customer?

4- Should the company position solely as an equipment or service supplier?

5- Some information, regarding the most important service features when acquiring a System, was collected in the survey:
   - Free Equipment Installation: 47% considered it Crucial or Very Important;
   - 10 years Warranty: 47% considered it Crucial;
   - Equipment Performance Monitoring App: 60% defined it as Crucial or Very Important;
   - Specialized Call Center to clarify doubts: 57% defined it as Crucial or Very Important;
   - Discounts Program for acquiring related products: 41% considered it Crucial or Very Important;
   - Return of Investment detailed Study: 56% considered it Crucial or Very Important