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UNDERSTANDING THE CUSTOMER ENGAGEMENT AND THE VALUE CO-CREATION WITH SMART ENERGY SERVICES

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Understanding the customer engagement and the value co-creation with Smart Energy Services

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To my family

ABSTRACT

The expansion of smart services in the current energy sector brought to attention the key role the adoption of smart energy services has in the energy scenario, either as a facilitator of the energy transition, as a driver of the carbon emission decreasing (environmental agenda) or as a driver of innovation in business models and policies. As such, boosting smart energy services has become a strategic challenge for the energy sector. Although smart services have been employed from multiple perspectives and embedded in different energy settings, an in-depth and holistic comprehension that encompasses the examination of the customer experience with the service, understanding how the customer engages and co-creates value with the service, and how engagement strategies can be designed to foster the information, participation, and cocreation of new smart energy services are lacking.

In this sense, this investigation addresses as research objectives the understanding of how customers experience the smart energy service, understanding and identifying the value cocreation practice styles and customer engagement behaviors and developing a framework to enable the design of strategies to foster customer engagement with smart energy services.

The objectives led to three contributions following a qualitative methodological and design science research approach. Study 1 comprises an in-depth understanding of customer experience in smart energy service settings and traditional energy settings. This study shows that customer experience with smart services involves a multidimensional set of perceptual responses (specific smart service dimensions, relationship dimensions, and traditional technology-enabled service dimensions). Analyzing contextual factors (goals, activities, actors, and artifacts) also shows that smart services enable a more autonomous experience.

Study 2 advances the understanding of value cocreation and customer engagement in the smart energy service context, showing how value cocreation practice styles and customer engagement behaviors are shaped by the different roles customers play, as well by their activities and interactions with a myriad of other actors in the smart energy service setting. Study 3 offers a framework (CESF – Customer Engagement Strategy Framework) through which stakeholders (service providers, and managers, among others) can design citizen engagement strategies and actions according to each energy service context and the engagement level with smart energy services.

Overall, this thesis offers two substantial contributions to the service and the energy sectors: (a) a more in-depth and nuanced understanding of customer experience, customer engagement and value cocreation with smart services, and (b) a new framework for a more nuanced development of citizen engagement strategies.

Keywords: smart service, energy, customer experience, value cocreation, customer engagement, framework, engagement strategies.

RESUMO

A expansão dos serviços inteligentes no setor de energia atual trouxe à tona o papel fundamental que a adoção do serviço de energia inteligente desempenha no cenário energético, seja como facilitador da transição energética e como impulsionador da diminuição das emissões de carbono (agenda ambiental) ou como um motor de inovação para os modelos de negócios e novas políticas regulatórias. Como tal, impulsionar os serviços inteligentes de energia tornou-se um desafio estratégico para o setor. Embora os serviços inteligentes tenham sido abordados sob várias perspectivas e incorporados em diferentes contextos de serviços de energia, uma compreensão profunda e holística que engloba a análise da experiência do cliente com o serviço, com o objetivo de perceber como o cliente se envolve e cocria valor com o serviço, e como as estratégias de "engagement" podem ser desenhadas para promover a informação, a participação e a cocriação de novos serviços de energia inteligente estão faltando.

Neste sentido, esta investigação aborda como objetivos de pesquisa (1) a compreensão de como os clientes experienciam o serviço de energia inteligente, (2) compreender e identificar os estilos de práticas de cocriação de valor e os comportamentos de "*engagemen*t" do consumidor, (3) e desenvolver um modelo que permita o desenho de estratégias para aumentar o "*engagement*" do consumidor com os os serviços inteligentes de energia.

Neste sentido, os objetivos conduziram a elaboração de três estudos seguindo uma abordagem qualitativa e de "*design science research*". O Estudo 1 compreende uma compreensão aprofundada da experiência do consumidor no contexto dos serviços inteligentes de energia e dos serviços tradicionais de energia. Este estudo mostra que a experiência do consumidor com tais serviços envolve um conjunto multidimensional de respostas perceptivas (dimensões específicas dos serviços inteligentes, dimensões de relacionamento e dimensões tradicionais dos serviços de base tecnológica). A análise dos fatores contextuais (objetivos, atividades, atores e artefatos) também mostra que os serviços inteligentes possibilitam uma experiência mais autônoma.

O Estudo 2 avança com a compreensão da cocriação de valor e do "engagement" do consumidor no contexto de serviços de energia inteligente, mostrando como os estilos de prática de cocriação de valor e os comportamentos de "*engagement*" são caracterizados pelos diferentes papéis que os consumidores desempenham, bem como por suas atividades e interações com uma infinidade de outros atores. O Estudo 3 oferece um modelo (CESF – Customer Engagement Strategy Framework) por meio do qual as partes

interessadas (prestadores de serviços, gestores, entre outros) podem desenhar estratégias e ações de "*engageme*nt" de acordo com cada contexto de serviço de energia e com cada nível de "*engageme*nt" do consumidor com smart serviços de energia.

Em geral, esta tese oferece duas contribuições substanciais para os setores de serviços e energia: (a), uma compreensão mais profunda e diferenciada da experiência do consumidor, engagement do consumidor e da cocriação de valor com serviços inteligentes, e (b) um novo modelo para desenhar estratégias de "engagement" diferenciadas.

Palavras-Chave: Serviços inteligentes de energia, experiência do consumidor, cocriação de valor, *"engagement"* do consumidor, modelo, estratégias de *"engagement"*.

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1 Introduction

In recent years, the service sector has witnessed a paradigm shift grounded on technological advances, where traditional boundaries and provider roles are being redefined as services become highly interconnected. Consequently, new experiences and interactions emerge, enabling new ways of cocreating value and new ways to engage not only with the firm but with other customers, brands and technologies to address individual needs, promote environmental sustainability and foster behavioral changes (Alexander et al., 2018).

The most remarkable technological disruption in the last few years is grounded on the widespread penetration of smart technologies, enabling the development of new smart services built on intelligence and connectivity anytime and anywhere (Allmendinger & Lombreglia, 2005). These technologies radically change the relationship between customers and firms due to the bidirectional data flow in real-time, going beyond a traditional dyadic relationship to a networked interaction with multiple actors in the service network.

Different sectors are being transformed and adapted due to the penetration of smart technologies such as communications, e-commerce, logistics, transportation, and manufacturing, among others. The energy sector, in particular, has dramatically changed to address the governmental agenda of decreasing carbon emissions to minimal levels until 2050 (IEA, 2015). Approximately 40% of global carbon emissions are emitted from electricity (generation, transmission, distribution, and consumption) due to the extensive use of fossil fuels (Abdallah & El-Shennawy, 2013). Households are at the center of this discussion, as residential consumption is associated with 19,6% of the carbon emissions in Europe (Eurostat, 2016).

The feasible solution to address this challenge is the integration of smart technologies into the overall electricity grid that ranges from generation to final consumption. To this end, smart grid technology has been massively implemented worldwide in the last few years. Smart Grid is a modernized electrical network of complementary components, subsystems, and services under the control of highly intelligent management and control systems throughout the electricity power system (Haidar et al., 2015). Smart Grid technologies can contribute to emission reductions by increasing efficiency and facilitating renewable energy and electric vehicle integration from the final customer side (Moreno-Munoz et al., 2016). In practical terms, this new perspective enables, for example, the extensive use of renewable sources located at different grid points, including households. Final customers can also manage and monitor the consumption of their own houses, therefore contributing to the use of renewable energy sources.

In this context, energy customers gain protagonism as they are able to get closer to the grid operation by assuming active roles in the production, consumption and management of residential energy consumption. Customer participation, therefore, becomes an essential part of grid digitalization and key to the successful energy transition, as it requires proactive use of smart energy services for efficient consumption of renewable energy resources in the long term. However, the assumption of an active role of customers in this new scenario has been challenging for energy providers and regulators as customers do not seem motivated in the long term. Previous studies indicate that smart service adoption and customer behavioral change (Stern, 2011) are keys to successfully integrating the power grid operation (Geelen et al., 2013). On the other hand, other studies also highlight the lack of customer interest due to lower perception of monetary benefits and lower engagement since initial interest in a new technology diminishes over time (Hargreaves et al., 2013). It indicates the customer's perceived value is insufficient to guarantee its use continuously, and the customer engagement with smart energy services is lower (Niesten & Alkemade, 2016; Boork et al., 2014). Moreover, understanding the customer experience in complex technology contexts has been approached as a way to unveil how the connectivity among people, devices, data, and other processes emerge leverage smart technology for service provision and consumption (Ostrom et al., 2021). However, few studies in smart services address a deep understanding of the overall customer experience, value cocreation and customer engagement that can be quite different from traditional technology services due to active customer roles, interactions and connectivity (Wünderlich et al., 2013).

Addressing these challenges starts with an exploratory qualitative study to analyze the customer experience with smart energy services, as little is known about this concept in smart service settings. The understanding of the customer experience is further developed through examining value cocreation and customer engagement with smart energy services. The aim is to provide inputs for developing new smart energy services, policies and engagement strategies to support energy transition through customer behavioral change to address the energy efficiency both as energy consumers or producers and long term use.

Moreover, grounded on the knowledge gained with the customer experience, customer engagement and value cocreation examination in a smart energy services setting, this thesis provides a deep analysis of a different approach to customer engagement, namely citizen engagement, to address the need for strategies grounded on heterogenous engagement levels and respective models to facilitate the strategy development. (Crescenzo et al., 2020). To this end, the Citizen Engagement Strategy Framework (CESF) was developed through a design science research approach. CESF enables energy providers to design citizen engagement strategies to increase customer engagement with smart energy services to foster smart service adoption and behavioral change towards energy efficiency and sustainability.

As such, this thesis first concentrated on understanding the service concepts (customer experience, value cocreation and customer engagement) from the customer perspective to address the challenges faced by the energy industry of integrating proactive customers in the smart grid operation and smart energy service network. Second, the study developed CESF to support the development of strategies to foster citizen engagement in a smart energy service context targeting a successful energy transition.

In this sense, the objectives of this investigation are three folded (1) understanding how customers experience smart energy services; (2) understanding value cocreation and customer engagement in smart energy service settings, to leverage the behaviorial change and the adoption of sustainable and smart energy services; (3) developing a framework to support the development of strategies to foster customer engagement with smart energy services in different ways.

Following these objectives, this thesis has developed three interconnected studies. Aiming to understand how customers experience smart energy services, the first study involved qualitative research with 31 energy customers to gain an in-depth understanding of customer experience in smart energy service settings and traditional energy settings. This study shows that customer experience with smart services involves a multidimensional set of perceptual responses, comprising specific smart service dimensions (e.g., controllability, visibility, autonomy); relationship dimensions (relationships with the service provider and with the community); and traditional technology-enabled service dimensions (e.g., ease of use, accessibility). The analysis of contextual factors such as goals, activities, actors, and artifacts also show that smart services enable a more autonomous experience, wherein customers can integrate a myriad of actors and artifacts and expect the service provider to support them in taking the lead. This study was published in the Journal of Service Management (Gonçalves et al., 2020).

These first outcomes enabled an in-depth understanding of the smart energy customer journey. They motivated the second study, which adopted a different perspective, focusing on how the value is cocreated and the customer engagement behaviors in this new setting. As such, aiming to understand value cocreation and customer engagement in smart energy service settings, to leverage the behavioral change and the adoption of sustainable and smart energy services, the second study analyzes both concepts, showing how value cocreation practice styles and customer engagement behaviors are shaped by the different roles customers play, as well by their activities and interactions with a myriad of other actors in the smart energy service setting. This study was published in Energy Policy Journal (Gonçalves et al., 2022).

Aiming the development of a framework to generate strategies to foster citizen engagement with smart energy services from the customer engagement perspective, the third study extends the customer engagement analysis started in in the second study to offer a framework (CESF) through which stakeholders can develop citizen engagement strategies and actions according to each the engagement level with smart energy services and specific goals. The study offers an approach to support the development of engagement strategies, as engaged customers with new energy services and efficient energy consumption will easily participate and influence, to generate innovative smart energy services and mitigate adverse risks to the energy transition (Ahlers et al., 2019).

Finally, this thesis is organized in the following chapters. Chapter 2 presents the Theoretical Foundations that comprise the review and analysis of literature, definitions of customer experience, customer and citizen engagement, value cocreation adopted in this study, as well as the research gaps and questions related to customer engagement and sustainable energy transitions. Chapter 3 presents the Methodology that describes the research design and explains how the three studies were developed and complement each other to address the research challenges, objectives, and questions. In Chapters 4, 5, and 6, the studies developed in this thesis are presented and discussed. Chapter 7 presents the integrated contributions and implications of this investigation. Finally, Chapter 8 presents the conclusions and future research direction.

2 Theoretical Foundations

This chapter brings an overview of the smart energy service context in which the studies were developed and introduces the background concepts for each study. This thesis is grounded on the analysis of different service concepts in the smart energy service context. The chapter introduces the theoretical foundations involved in Study 1 (customer experience), Study 2 (value cocreation practice styles and customer engagement behaviors), and Study 3 (customer and citizen engagement).

2.1 Smart Energy Services

Within this environment, the energy sector faces the emergence of smart energy services for final customers to promote carbon emission decrease and minimize global warming impacts. To address this issue, governments have set an action plan to keep global warming below 2°C (IEA-ISGAN, 2017). As a practical solution, the energy sector has been shifting the grid structure to become smarter, aiming to facilitate the large-scale integration of renewable energy sources (e.g., wind and solar power). This technology delivers electricity from suppliers to consumers using digital technology through control automation, continuous monitoring, and distribution system optimization through smart services. An energy service delivered to or via a smart device is defined as a smart energy service (Wunderlich et al., 2015; Gonçalves et al., 2020). This results in energy savings, consumer cost reduction, and improved reliability (Phuangpornpitak & Tia, 2013).

This study focuses on the smart energy context analysis from the customer perspective. Literature reveals that customer adoption is the primary key enabler for the energy transition (Gellings & Samotyj, 2013). In this context, smart energy services are responsible for shaping the offerings and value propositions to provide new service dynamics (Moreno-Munoz et al., 2016). The successful implementation of smart services in the energy sector requires rearranging positions and levels of interaction of traditional actors (consumers and service providers). It means to include new actors and artifacts in this ecosystem, as customers, energy community, providers, and manufacturers can interact to deal and trade energy, improve the grid balance and integrate different services as such home energy management systems to the electric vehicle, provide energy to a house or the grid using the car battery).

Consequently, this changes how value is created, and new forms of value cocreation in energy markets become crucial (Böhm & Neumann, 2017). However, achieving long-term household engagement with these new services has proven to be hard (Hargreaves et al., 2013). Moreover, European energy projects in demonstration sites have shown that fostering customer engagement represents a challenge (Boork et al., 2014). The value creation is still far due to most customers' lack of interest, strategies and policies (Tokoro, 2016b). Studies advocate that customers can experience the smart service differently due to actors' active roles, new connections, intense data flow and multiple interactions. However, few studies approach the understanding of the customer experience with smart services in general, including the energy context (Lemon & Verhoef, 2016).

2.2 Customer Experience

Customer experience has been defined as a holistic and context-specific construct influenced by a rich set of contextual elements that include customer, situational and socio-cultural contingencies (Becker & Jaakkola, 2020), or individual, social, market and environmental aspects (De Keyser et al., 2020). This definition sheds light on customer responses such as cognitive, affective, emotional, sensorial, social, physical and behavioral (Verhoef et al., 2009) to interactions with a service and the surrounding context.

Early research on customer experience in technology-based settings identified customer response dimensions like efficiency, fulfilment, control, and convenience, among others (Parasuraman et al., 2005; Collier & Sherrell, 2010). As smart technologies emerged, recent literature has identified customer perceptual responses that are specific to the smart service, such as invisibility and autonomous decision-making (Wünderlich et al., 2015) in contexts characterized by pervasiveness, information intensity, interactivity grounded on intense data flow, interactions in a network of actors, and visibility of data (Carsten et al., 2018).

In energy context, literature indicates that the new smart energy service stimulates utility companies and customers to act together to establish consistent relationships, encouraging technologies and behaviors that optimize the entire energy system rather than only the individual parts (Geelen et al., 2013). Since this is a new energy consumption setting, the customer experience can be different, and new opportunities to create value can come up.

As such, a deep understanding of customer experience is crucial to identify the main changes in energy consumption and support the energy transition. The analysis of the customer experience with smart energy services proposes the analysis of contextual factors since it has been explored mainly in technology-enabled service contexts (Breidbach et al., 2013). It involves a deep understanding of key human goals and actions for the success of the interactions with smart systems (Breidbach et al., 2013) and the different roles actors can take when cocreating value with technology (facilitator, enabler, performer,...). Therefore, methods grounded on Activity Theory (Kaptelinin & Nardi, 2006) like the Customer Experience Modelling (Teixeira et al., 2012) support the identification and systematization of the goals, activities, people, devices, and organizations that shape the service environment and the understanding of how new actors and artifacts integrate the smart ecosystem.

However, there is still a vast knowledge gap in how customers experience smart energy services. Given the impact of smart technologies on the service environment observed in recent years, further understanding is needed of how new paradigms of use, connectivity, interactions and roles (Wuenderlich et al., 2015; Ostrom et al., 2021) impact the customer experience as smart technologies grounded on connected devices, interactions and active roles can deeply change not only the way service is delivered but also consumed.

2.3 Value Cocreation and Customer Engagement

Motivated by the knowledge gained with the customer experience analysis, other service concepts like value cocreation and customer engagement could also be analyzed to compose a robust understanding aiming to support the behavioral change and customer adoption in the energy transition through the development of new services. In this sense, new activities, interactions, and perceptual responses of smart services will leverage the way value is created. Previous studies recognize that the new forms of value cocreation and customer engagement in energy markets become crucial (Böhm & Neumann, 2017; Burshell et al., 2016) as it addresses not only customer adoption and long-term use but competitive advantages in an emerging market through the development of tailored solutions to satisfy customer needs and goals (Niesten et al., 2016; Geelen et al., 2013).

Value cocreation has been defined in the literature in different ways. This study defines it as the "benefit realized from integration of resources through activities and interactions with the customer's service network" (McColl-Kennedy et al., 2012, pg 375). It may extend beyond the firm's boundaries (Prahalad & Ramaswamy, 2003) through multiple points of exchange where the consumer and the company cocreate value, as customers are increasingly recognized as active cocreators (Payne et al., 2008). This concept is useful in the smart energy service analysis, as value cocreation sheds light on the different active roles customers play, such as collaborating in service provision and realizing the service benefit, as value is cocreated in use (Vargo & Lusch, 2016a). In this sense, value cocreation can occur either through dyadic relationships between customer and service provider or through multiple interactions with a myriad of actors at a network level (Jaakkola & Hakanen, 2013). Understanding the various ways customers can cocreate value in smart service contexts, therefore, requires the analysis of customer roles, interactions and activities (McColl-Kennedy et al., 2012; Ng et al., 2011). Such analysis results in the identification of the value cocreation practice styles, which represent what customers do when they cocreate value, comprising the perceived roles they play, as well as their cocreation activities and interactions (McColl-Kennedy et al., 2012; Ng et al., 2016; Ng et al., 2019).

In this context, a cohesive comprehension of value cocreation in the smart energy context is lacking (Niesten et al., 2016). Moreover, despite the need for further understanding of how smart technology can be turned into value cocreating services (Breidbach & Maglio, 2016), research on customer value cocreation practice styles has not been applied to smart services.

Aiming to gain knowledge of the service constructs that will leverage the envisioned behavioral change to support the energy transition, the customer engagement concept emerged as the value cocreation analysis sheds light on the customer engagement as well as customer engagement research has focused on the customer active presence in value cocreation processes (Zyminkowska et al., 2017). Customer Engagement is defined as customers' disposition to invest resources in their interactions with a focal object such as smart energy technologies and/or services (Brodie et al., 2019). In the current market scenario, customers no longer perform passive end-user roles but proactively contribute to their interactions. Customers are increasingly engaged in shaping firms' offerings and cocreating value through these interactions (Hollebeek & Andreassen, 2018). It implies that new ways of value cocreation and customer engagement can be identified to address the knowledge gap in Energy research (Niesten et al., 2016; Boork et al., 2014).

This study analyzes the customer engagement from the behavioral perspective. Although customer engagement has been approached from a multidimensional perspective that includes the behavioral, cognitive and emotional dimensions (Brodie et al., 2013), the study approaches the concept from a more actionable perspective as the analysis is carried out in the context of energy consumption. Customer engagement behaviors are defined as voluntary customer contributions toward a service that goes beyond the fundamental transactions and occur in interactions with multiple actors (Jaakkola & Alexander, 2014).

Previous studies in Energy literature recognize that fostering customer engagement represents a challenge (Boork et al., 2014; Ellabban & Abu-Rub, 2016). Firstly, customers are not inclined to adopt the smart services for different reasons like lack of interest and interest, and they do not perceive the value and benefits of adopting not only new smart energy solutions/services but also changing the way they consume energy (Boork et al., 2014). Secondly, energy service providers and policymakers do not have a thorough understanding of energy customers to design and tailor smart energy service offerings that result in services that do not meet the current scenario of energy transition and weak strategies to leverage the customer participation in this new energy service setting characterized by the active roles played by the energy consumers (Ahlers et al., 2019). Moreover, different studies concentrate on offering customer engagement incentives in smart energy settings (Niesten et al., 2016) but also claim that they have shown insufficient to engage the customer in the long-term. Other studies (Massey et al., 2019; Francisco & Taylor, 2019) report that engagement will make a difference in implementing climate change mitigation through smart energy solutions (Stern, 2011).

Although these studies highlight lower customer engagement and the need to increase their engagement to smart energy services succeed, an in-depth understanding of customer engagement in the smart energy context is still missing (Ellabban & Abu-Rub, 2016).

2.4 Citizen Engagemet Strategies

Although customer engagement has gained attention in Energy research, the citizen engagement topic has also been considered in different energy studies as a mechanism to bring an individual closer to the design of smart energy services and systems (Massey et al., 2019) due to the challenges that service providers have been facing to implement new energy technologies, services, regulations and infrastructures customers do not naturally shift with the usual initiatives (Falco & Kleinhans, 2018). Citizen engagement is defined as ordinary people's ability to come together, deliberate, and take actions on services and decision-making that they have described as important in the context of a country, a state, a city, or a neighborhood (Gibson, 2006). In this context, citizens are also considered key actors in the energy sector's transformation. However, they need to be further empowered to enable the synergy between power suppliers and consumers/prosumers in an ecosystem based on the collaboration to promote the grid balance when the energy demand has been increasing significantly (Maier, 2016). This thesis approaches citizen engagement with smart energy services, considering that citizens in this context are also customers of such services. Therefore, the study sheds light on the customer component of citizen engagement to understand how citizens use the smart energy services that include the performance of activities, goals and interactions in their respective contexts, addressing the calls for understanding how different customer engagement approaches, namely the citizen engagement that leverages the service design processes and outcomes (Ostrom, 2015).

As such, pushed by the emergency of the massive smart service adoption and increasing energy efficiency in the smart energy scenario, this study approaches citizen engagement as part of the customer engagement analysis as the citizen engages with energy technologies as a customer and prosumer, and can participate in the implementation of new smart energy use paradigms in the energy transition through the co-development of initiatives to promote and change energy systems.

Another important point to highlight is the different models that facilitate the development of engagement strategies. The models approach mostly the participation of citizens in public and urban contexts (Bassler et al., 2008; Elelman & Feldman, 2018), and few studies approach the cocreation in smart energy settings (Preston et al., 2020; Seltzer & Mahmoudi, 2013; Ahlers et al., 2019). Although studies recognize that an energy setting is composed of different people with varied engagement levels with smart energy services (Massey et al., 2019), most models do not cover the heterogeneity of such levels. It makes models limited to one targeted segment of citizens, neglecting the generation of engagement strategies, especially when there is a greater demand for increased participation (Ostrom, 2015). Moreover, the further investigation of different levels of engagement to enlarge the service offerings grounded on specific customer needs and contexts is considered a key priority in engagement research (Ng et al., 2020). Although previous studies (Massey et al., 2019; Tokoro, 2016a) point out the development of tailored strategies to engage the customers with sustainable smart energy services, research on how to engage the customer in the scale-up from traditional energy services to efficient and sustainable smart energy services through tailored strategies and mechanisms/tools that facilitate the development of such strategies are lacking (Ahlers et al., 2019).

2.5 Research Questions

This investigation addresses primarily the research gaps of the lack of a comprehensive understanding of the overall customer experience, value cocreation, customer engagement behaviors, and customer engagement strategies in the smart energy settings, which promote the expected behavioral change and the adoption of the smart service to hamper smart service innovation (Ostrom et al., 2015; Wünderlich et al., 2015) and the sustainable use of efficient energy solutions and services that grounds the energy transition and addresses the climate agenda set by governments. This research formulated research gaps and research questions linked to the constructs approached in this thesis to tackle these challenges.

First, since customer experience studies in smart services are scarce (Wünderlich et al., 2015), it is necessary to understand how residential customers experience the energy service in a smart energy context to identify what emerges from this new setting. As such, the first study research question was formulated as the following: *what are the drivers and context of customer experience with smart services?*

Grounded on the need to understand the value creation and customer engagement in the smart energy service context and the lack of studies that provide a coherent vision of both in the complex context of smart energy services, the second research question of the study was formulated as the following: *how do customers cocreate value with smart services, and how does that lead to customer engagement?*

To address the lack of strategies and mechanisms to develop engagement strategies, further citizen and customer engagement analyses are needed to create strategies that ground on engagement levels to increase participation, smart service adoption, energy efficient consumption and boost smart service innovation. As such, the third question of this study was formulated: *what kind of strategies can be pursued to foster customer engagement with smart services towards energy transition?*

3 Methodology

In order to answer the research questions previously defined, this thesis followed a qualitative methodological approach and design science research. It is organized into three studies. From the qualitative perspective, focus groups and semi-structured interviews were conducted in Study 1 and Study 2. Using the design science approach, Study 3 covered the development of a framework to support the development of engagement strategies. Figure 1 presents the research design comprising these studies. The following subsections describe how the studies are connected and how they were developed in details.

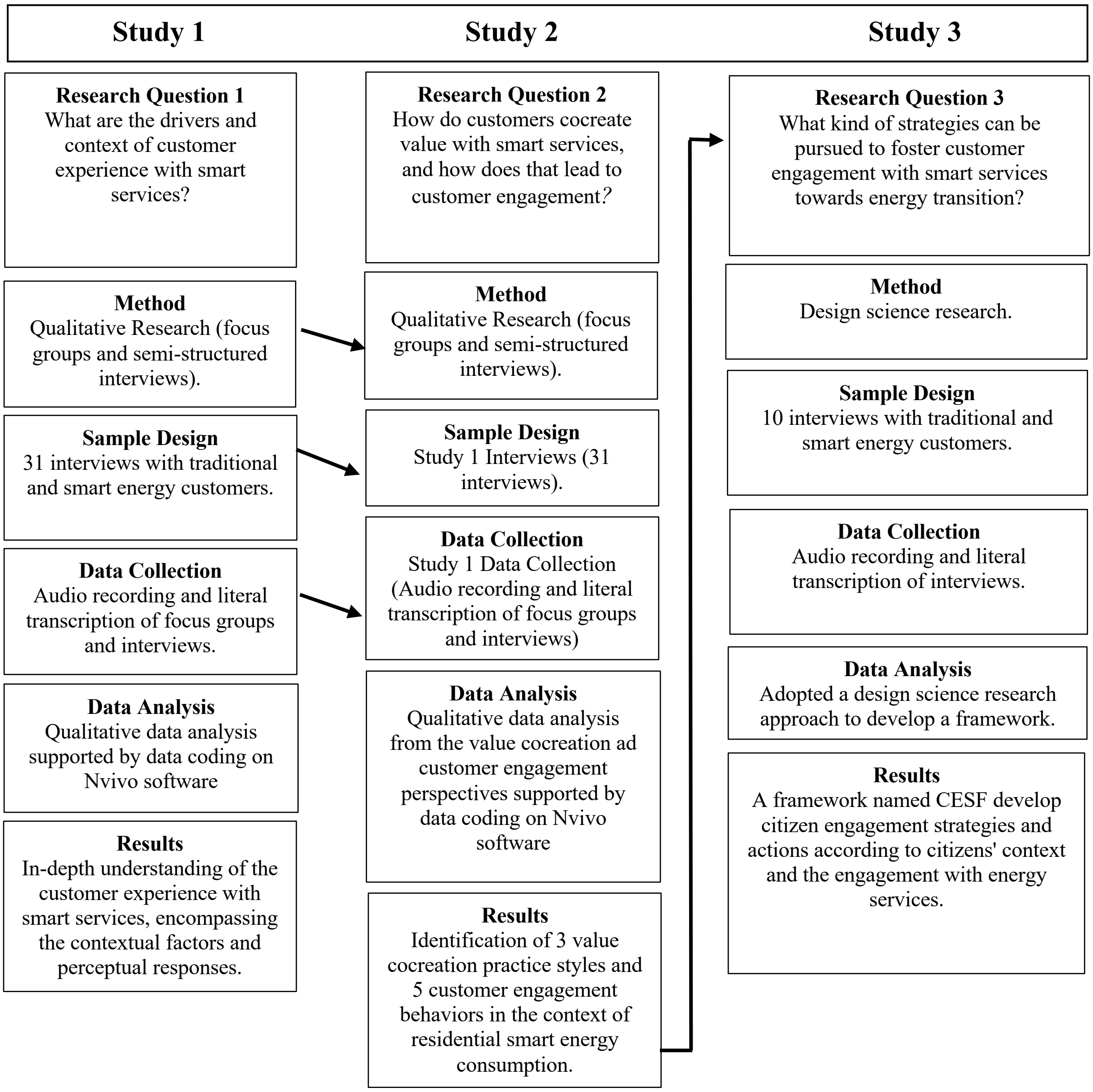

Figure 1: Research Design

3.1 Study 1

The first study was developed from a qualitative perspective to address the first research question previously defined that aimed to gain an in-depth understanding of the drivers and context of customer experience with smart services.

Study 1 results are grounded on the analysis of data collected through focus groups (Krueger & Casey, 2001) and semi-structured interviews. The study started with an initial sample covering different ways of experiencing smart services. An initial set of 10 interviews with energy customers was conducted and analyzed, from which three groups emerged (residential smart energy services customers, electric mobility customers and residential customers with higher consumption of electricity). Additional interviews and focus groups were then undertaken to further densify the emerging categories of data analysis in terms of customer perceptual responses and contextual factors until no new categories emerged.

The overall sample had a total of 31 interviewees. The semi-structured approach provided consistency for the data collection (Corley et al., 2004) while encouraging a broad discussion of customer experience (Ng et al., 2016). Building upon Customer Experience Modeling (Teixeira et al., 2012), the interview protocol (See Appendix 1) covered customer experience contextual factors and customer responses to the multiple interactions with their smart energy service solution. As such, interviews covered the smart energy services customers used, how and why they started using the smart services to identify their goals and activities, as well as the actors and artifacts with whom customers interacted. The interview then covered customer perceptions that emerged from the energy use.

The study involved a combination of 17 in-depth individual interviews lasting 40–60 min with smart and traditional energy service customers. In addition, two focus groups were undertaken with early adopters of smart energy services lasting approximately two hours each. The individual interviews were voice recorded, the focus groups were video recorded, and all were literally transcribed for descriptive validity (Maxwell, 2012).

Data were processed using open coding to identify first-order concepts (Gioia et al., 2013). In this stage, data indicated the different activities and interactions along the overall journey of energy consumption, which produced a considerable number of categories. Emergent themes were analyzed in relation to and were substantiated by the literature (Corbin & Strauss, 2008).

A detailed explanation of the methodological approach used in the first study is presented in subsection 4.3 in the Study 1 chapter of this thesis.

3.2 Study 2

During the data analysis of Study 1, the researcher identified the opportunity to understand how value is cocreated, which also involves the analysis of roles, activities, and interactions and how this result in specific customer engagement behaviors. The way the customer experience with smart services can leverage the value cocreation and the customer engagement as customers immersed in a smart service environment can apply knowledge and skills to interact with multiple actors that range from the service provider to other customers (Solakis et al., 2017). As such, building upon the data collected in Study 1, Study 2 focused on identifying how customers cocreate value and the customer engagement behaviors in the smart energy consumption context.

Study 2 addressed the second research question previously defined to gain an in-depth understanding of value cocreation practice styles and customer engagement behaviors with smart energy services. Similar to the first study, this second study developed qualitative research (Gioia et al., 2013) by examining the 31 interviews to understand how value is cocreated and the resulting customer engagement behaviors in smart energy service contexts. It means that the qualitative data collection approach of Study 1 was considered adequate as the data collected through focus groups and interviews could be used to unveil details like daily activities, multiple customers' interactions, and learning processes with their smart energy service solutions from the early stages of adoption to the current usage. Then, an iterative process of data analysis and further sampling led to the densification of data analysis categories. This allowed for identifying customer roles, actors, and smart devices with whom they interacted, which enabled identifying value cocreation practice styles and, consequently, identifying customer engagement behaviors in the context of energy use.

Building upon literature on customer engagement behaviors (Jaakkola & Alexander, 2014) as well as value cocreation practice styles (McColl-Kennedy et al., 2012), the categories were refined and could be aggregated (Gioia et al., 2013). The software NVivo supported the data analysis process, from the first-order concepts to the aggregation of dimensions. A detailed explanation of the methodological approach used during the second study is presented in subsection 5.3 in the Study 2 chapter of this thesis.

3.3 Study 3

Study 3 adopted the design science approach to address the third research question aiming to develop a framework to support the design of strategies to foster customer engagement with smart energy services towards sustainability.

Building upon the literature review, the study first identified the main focus of research related to smart energy consumption and customer and citizen engagement (Ahlers et al., 2019; Ellabban & Abu-Rub, 2016). Such studies claim the need to engage customers through strategies to support the increasing active participation of final customers to achieve environmental sustainability, energy efficiency consumption and long-term use. Moreover, tools and mechanisms to design the strategies are also needed (Ahlers et al., 2019). In this sense, different models of participation (Arnstein, 1969; Corsini et al., 2019), citizen engagement strategies, and best-practices recommendations (Bassler et al., 2008) were reviewed and grounded the structure of the aimed framework.

As such, the study adopted design science research (Peffers et al., 2007) to address the development of a framework that enables the generation of engagement strategies, considering the customer engagement analysis, since customers interact with different energy solutions and other actors to consume and/or produce energy in daily life. Building upon (Peffers et al., 2007; Grenha Teixeira et al., 2017), Study 3 proposes 3 main steps that were followed iteratively: (1) Identify the class of problems and the solution objective, (2) Designing and developing a solution to a class of problems, (3) Applying the artifact and evaluating.

A qualitative research was approached as part of the overall design science research method to understand the context (Peffers et al., 2007) to thoroughly understand the customer and citizen engagement with smart energy services in a specific context of energy.

Finally, the framework developed was applied and validated in a real context through a workshop with energy stakeholders. A detailed explanation of the methodological approach used during the third study is presented in subsection 6.3 in the Study 3 chapter of this thesis.

4 Study 1 - Understanding the customer experience with smart services[1]

This chapter presents the development and the outcomes of Study 1, which provides an in-depth understanding of customer experience with smart services, examines customer perceptual responses to smart and connected service environments and enriches this understanding by outlining how contextual factors (in terms of goals, activities, actors and artifacts) influence the customer experience. This chapter is organized by the following subsections. In subsection 4.1 Introduction, the research challenges and research questions for this study are identified. Subsection 4.2 presents a literature review on customer experience and smart services, which supported data analysis in this study. These subsections are followed by the 4.3 Methodology, 4.4 Results, 4.5 Discussion, and 4.6 Conclusions, specific for this study.

4.1 Introduction

Technology has been considered a game changer in the service contexto (Ostrom et al., 2015). Smart devices can sense their own condition and surroundings, facilitating real-time data collection, continuous communication, and interactive feedback (Allmendinger & Lombreglia, 2005). They provide connectivity for customers anywhere and offer unprecedented opportunities for companies to provide services, such as pre-emptive monitoring or diagnostics, which enable customers to control objects like their home appliances (Georgakopoulos & Jayaraman, 2016). A service delivered to or via such a smart device is commonly referred to as a smart service (Wünderlich et al., 2015). Although smart services offer multiple benefits for service providers and customers alike (Wünderlich et al., 2015), many customers still struggle to adopt complex smart service systems like smart homes (Ahuja & Patel, 2018). To understand the barriers that arise in smart service adoption and to design smart service systems that appeal to customers, managers need to gain insight into how customers experience smart and connected service environments.

This study explores customer experience in smart service contexts. The study contributes to the literature by identifying how smart technology impacts customer experience, which is becoming increasingly

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relevant with the emergence of smart devices and services (Foroudi et al., 2018). Smart services typically involve a vast array of interactions between multiple actors, such as customers, providers, and technology artifacts, which, in turn, enable different kinds of activities and interactions, from transactions to social information sharing (Verhoef et al., 2017).

This paper offers an in-depth understanding of customer experience with smart services through a qualitative study with smart energy service customers. The energy sector offers a rich empirical setting, as it is going through a large transformation toward the digitization of energy services (IEA, 2019). New smart home technologies enable home owners to experience home energy consumption in novel ways (Raimi & Carrico, 2016). Operators and utility providers expect that the implementation of smart services will result in cost reductions for customers, as well as reductions in environmental impacts through the decrease of carbon emissions (Dincer & Acar, 2017). However, how the smart service context impacts customer experience has remained largely unexplored.

This article advances the understanding of customer experience with smart services by shedding new light on customer perceptual responses to smart services, revealing a) smart service-specific dimensions such as information visibility, controllability, or autonomy; b) different relationship dimensions with both service providers and communities; and c) traditional technology-enabled service dimensions such as ease of use and accessibility. Building on Activity Theory (Kaptelinin & Nardi, 2006) and Customer Experience Modeling (Teixeira et al., 2012), this study further enriches this understanding by outlining how contextual factors (De Keyser et al., 2020; Becker & Jaakkola, 2020), such as customer goals, activities, actors, and artifacts, influence the customer experience in the smart service environment.

The paper is structured as follows: The conceptual background section covers extant literature related to customer experience with smart services. The methodology section describes the qualitative approach based on 31 interviews with energy customers. The study findings provide an in-depth characterization of customer experience with smart services, examining its perceptual dimensions and contextual factors. Finally, the discussion section examines the contributions of the study's findings to service research as well as implications for managing customer experience in the smart service context.

4.2 Conceptual Background

4.2.1 Smart Service

The ongoing trend of virtualization and digitization is accelerating the shift from a product-oriented business paradigm to a service-dominant logic (Vargo & Lusch, 2016b). This trend, which profoundly transforms businesses and societies around the globe, is fueled by synergies between new technological developments, the widespread adoption of mobile devices, data science, and the Internet of Things (IoT). Smart solutions comprise both the core parts, which enable their basic function, and smart components, such as sensors, microprocessors, data storage, and connecting technology, which enable remote communication and establish the link between devices, users, manufacturers, and service providers (Porter & Heppelmann, 2014). Smart objects considerably alter the design and delivery of services, as they can gather and analyze data, make decisions and act accordingly, enabling the development of an ecosystem of interconnected smart services (Allmendinger & Lombreglia, 2005). The spectrum of smart services ranges from monitoring, optimization, control, and autonomous pre-emptive services, (e.g. smart metering), to interactive remote repair services of complex industrial machines (Wünderlich et al., 2015; Vargo & Lusch, 2016b).

Smart services extend to many service settings across industries such as energy, healthcare, transportation, and information and communication technology (ICT). The implementation of smart services is expected to result in substantial efficiency gains due to cost reductions, more flexibility, and time saving, while at the same time providing increased value to their customers (Porter & Heppelmann, 2014). Moreover, the “always on” connection and maintenance of smart products allows service providers to establish and cultivate close ties with their customers (Beverungen et al., 2019), enabling the use of customer behavior data that will translate to better information about customer needs and business models (Wangenheim et al., 2017). However, the analysis of customer behavior data is interwoven with questions regarding the protection of data and data privacy (Ukil et al., 2014). To address the data protection and privacy challenge, different smart solutions have been deployed using policies, rules, and profiles to provide security and privacy for customers (Ukil, 2010).

Research on smart services has greatly increased in recent years, due to new developments that embed intelligence into objects, immerse customers in complex networks of people, organizations, and objects (Verhoef et al., 2017), and enable new ways of using and interacting with smart services.

Research in the areas of service marketing, management, information systems, and engineering has explored the phenomenon of smart services mostly from two perspectives. One area of research has focused on the identification of technology resources (e.g., devices, infrastructure, communication protocols, platforms); the various stakeholders and people involved; and organizations that operate together for mutual benefit (Maglio et al., 2009). For example, technology for smart homes or smart cities not only needs a common infrastructure but must also satisfy multiple stakeholders (Beverungen et al., 2017; Perera et al., 2014). Against this backdrop (Breidbach et al., 2013 p. 428) emphasize that "successful technology-enabled value cocreation is contingent upon the quantity and quality of interpersonal relationships, or social connectivity, between humans that interact and exchange resources by means of ICT (Information and Communication Technology)."

Particular attention has been given to user adoption of smart services, which has been predominantly explored in business contexts so far. Studies have identified substantial adoption barriers, such as concerns regarding self-efficacy, control, privacy, and data security (Keh & Pang, 2010; Wünderlich et al., 2013). Customers, for example, tend to reject service innovations that are highly invisible and enable the service provider to access sensitive information (Wünderlich et al., 2015). Studies in the context of mechanical engineering show that both employees directly affected by smart services (machine users) as well as administrative personnel express anxiety regarding loss of control and fear of reduced self-efficacy (Wünderlich et al., 2013; Paluch & Blut, 2013). This underlines the need to design smart services with a high level of transparency and visibility, as well as to implement overriding controls that increase the actual and perceived control of adopters (Wünderlich et al., 2015). Previous research has already explored some barriers to user adoption, but a deeper understanding of customer experience with smart services is needed.

4.2.2 Customer Experience with Smart Services

The concept of customer experience was introduced by Holbrook & Hirschman (1982) and gained increased attention with Pine & Gilmore (1999) seminal article. Since then, customer experience has become a central concept in both marketing and service research (Kranzbühler et al., 2018), as well as a top business priority (De Keyser et al., 2020). Customer experience can be broadly defined as "non-deliberate, spontaneous responses and reactions to offering-related stimuli along the customer journey"(Becker & Jaakkola, 2020). However, this definition has been considered too broad and all-encompassing, and a set of customer experience components was proposed to make this definition more actionable (De Keyser et al., 2020). These components include customer responses to interactions with a service and their surrounding context.

Customer responses are the building block of several definitions of customer experience (Schwager & Meyer, 2007; Verhoef et al., 2009; Lemon & Verhoef, 2016; Becker & Jaakkola, 2020). Customer responses can be characterized through several dimensions such as cognitive, affective, emotional, sensorial, social, physical and behavioral ones (Verhoef et al., 2009; Becker & Jaakkola, 2020; De Keyser et al., 2020). Customer experience has also been viewed as a holistic and context-specific construct influenced by a rich set of contextual elements that include customer, situational and sociocultural contingencies (Becker & Jaakkola, 2020), or individual, social, market and environmental aspects (De Keyser et al., 2020).

However, although smart technologies are predicted to lead to profound changes in service (Ostrom et al., 2015), there is little research on customer experience in this new environment, namely regarding customer responses and the context of interaction with smart services.

Early research on customer experience in technology contexts identified specific customer response dimensions such as efficiency, fulfillment, system availability, and privacy (Parasuraman et al., 2005). Related research on technology-based services has focused on factors such as control and convenience, exploring how they influence different customer experience responses (Collier & Sherrell, 2010). Recent literature has also started to identify customer perceptual responses that are specific to the smart service context, like invisibility, autonomous decision-making, and risk (Wünderlich et al., 2015), or the main barriers for adopting smart home services, namely perceived risk, privacy, and safety concerns (Yang et al., 2017; Chou et al., 2014). Research on technology dimensions has identified characteristics such as pervasiveness, information intensity, autonomy, and interactivity, which are enabled by the implicit characteristics of smart technology that are grounded on intense data flow, interactions in a network of actors, and visibility of data (Carsten et al., 2018). While some literature has already examined customer perceptual responses in technology-enabled contexts, customer perceptions of smart services still require further research (Wünderlich et al., 2015).

The importance of contextual factors in technology-related settings has also been studied, namely the pivotal role of human goals and actions for the success of the interactions with technology-enabled systems (Breidbach et al., 2013), and the different roles (facilitator, enabler, performer, task allocator, quality controller, governor, conductor and expert) that actors can take when co-creating value with technology (Breidbach & Maglio, 2016). Building on Activity Theory (Kaptelinin & Nardi, 2006), Customer Experience Modeling (Teixeira et al., 2012) advocates that the customer context can be captured by focusing on the goals, activities, people, devices, and organizations that shape the service environment.–However, research on contextual factors related to smart services is still lacking.

Overall, given the profound impact of smart technologies on the service environment, further understanding is needed on customer experience with smart services, particularly in terms of what customer perceptual responses and contextual factors are relevant, and how they impact the customer experience. Namely, it is important to understand what the customer perceptual responses to smart services are, what goals customers want to achieve with these services, what activities they perform to achieve these goals, and in what context (actors, systems, and physical artifacts) shapes these responses.

4.3 Methodology

To gain an in-depth understanding of customer experience with smart services, a qualitative study was undertaken in the energy sector, involving in-depth interviews and focus groups. The energy sector was selected because it has been going through major transformations due to the emergence of new smart technologies (Raimi & Carrico, 2016), which are profoundly changing the customer experience. This study considered that a smart energy system consists of management systems that enable customers to control and visualize home energy consumption, among other functionalities and devices (i.e., electric vehicles, home appliances, etc.), and has sensors embedded that allow the connection with management systems through Wi-Fi and autonomous operation.

The study followed theoretical sampling procedures (Charmaz, 2006), starting with an initial sample that tried to cover different kinds of usage and different ways of experiencing smart services. An initial set of 10 interviews with energy customers was conducted and analyzed, from which three groups emerged. Additional interviews and focus groups were then undertaken to further densify the emerging categories of data analysis in terms of customer perceptual responses and contextual factors, until no new categories emerged. Moreover, the additional interviews explored the different groups and enabled a richer understanding of customer experience perceptual responses and contextual factors. Based on this process, three final customer groups were defined: Advanced Smart Energy (ASE) service customers; Electric Mobility (EM) customers; and High-Consumption (HC) residential customers

Advanced smart energy service (ASE) customers (*n* = 11) actively used a set of smart energy services to manage and control their home energy consumption. This group used some kind of smart home energy management system, which consists of a centralized system that provides information about home consumption and energy production in real time, allowing to remotely monitor, control, and manage home appliances so that they work according to schedules defined by the customer (Liu et al., 2016). Customers in this group also used at least one energy production tool at home, such as photovoltaic panels.

The second group consisted of electric mobility (EM) customers (*n* = 10) who owned a car that required electricity instead of gas. EM customers adopted smart energy services to use the car more efficiently, namely, to remotely control the electric vehicle's functionalities (e.g., automatic charging or automatic adjustments of temperature).

Finally, the third group consisted of high-consumption (HC) residential customers (*n* = 10) characterized by a high consumption level of electricity and no utilization of smart energy services. Since the Portuguese energy regulator considers a 100 EUR average monthly bill as a higher level of consumption (www.erse.pt/atividade/regulacao/tarifas-e-precos-eletricidade/), this was the criterion used. These HC customers had not yet adopted smart energy services and used traditional energy services to perform regular daily activities like cooking and washing.

The overall sample had a total of 31 interviewees, comprised of 26 males and five females. This uneven gender distribution can be considered a limitation, but may also reflect the population of smart service users, as reports have shown that males tend to be more technology-oriented (Standal et al., 2020). A semi-structured approach to the interviews provided a broader scope and consistency for the data collection (Corley et al., 2004), while encouraging a broad discussion of customer experience (Ng et al., 2016).

Building upon Customer Experience Modeling (Teixeira et al., 2012), the interview protocol covered customer experience contextual factors and customer responses to the multiple interactions with their smart energy service solution. As such, interviews covered the smart energy services customers used, how and why they started using the smart services to identify their goals and activities, as well as the actors and artifacts with whom customers interacted. The interview then covered customer perceptions that emerged from the service use.

The study involved a combination of 17 in-depth individual interviews lasting 40-60 minutes. In addition, two focus groups were undertaken, one with nine ASE customers and another with five EM customers, lasting approximately two hours each. The themes that emerged from the initial interviews and focus groups were examined in the subsequent interviews to facilitate closure (Lincoln et al., 1985). The individual interviews were voice recorded, the focus groups were video recorded, and all were literally transcribed for descriptive validity (Maxwell, 2012).

To develop a comprehensive understanding of customer experience with smart energy services, the data analysis involved an iterative process of joint data collection and analysis (Shah & Corley, 2006). The software NVivo supported the data analysis process, from the first-order concepts to the aggregation of dimensions and additional revision of authors. Data was processed using open coding to identify first-order concepts (Corley et al., 2004; Gioia et al., 2013) that captured the customer experience along the overall journey of energy consumption, leading to the emergence of a considerable number of categories. The analysis was performed by one main coder, complemented with regular sessions to analyze the coding with two additional researchers, wherein the categories and the raw data were analyzed. This analysis considered the terms customers used and the themes that were raised (e.g., daily consumption, self-sufficiency, mobility, sustainability, energy costs, regulation issues, support services, and community, among others).

In the second-order analysis, the emergent themes were analyzed in relation to, and were substantiated by the literature (Corbin & Strauss, 2008). The next step consisted of identifying similarities and differences among the many categories and reducing them to a manageable number (Corbin & Strauss, 2008; Gioia et al., 2010). Building upon literature on customer experience, as well as Activity Theory and Customer Experience Modeling (Teixeira et al., 2012), these categories were refined and consensus was reached in five categories where dimensions could be aggregated (Gioia et al., 2013). A summary of these levels of categorization can be seen in Figure 3.

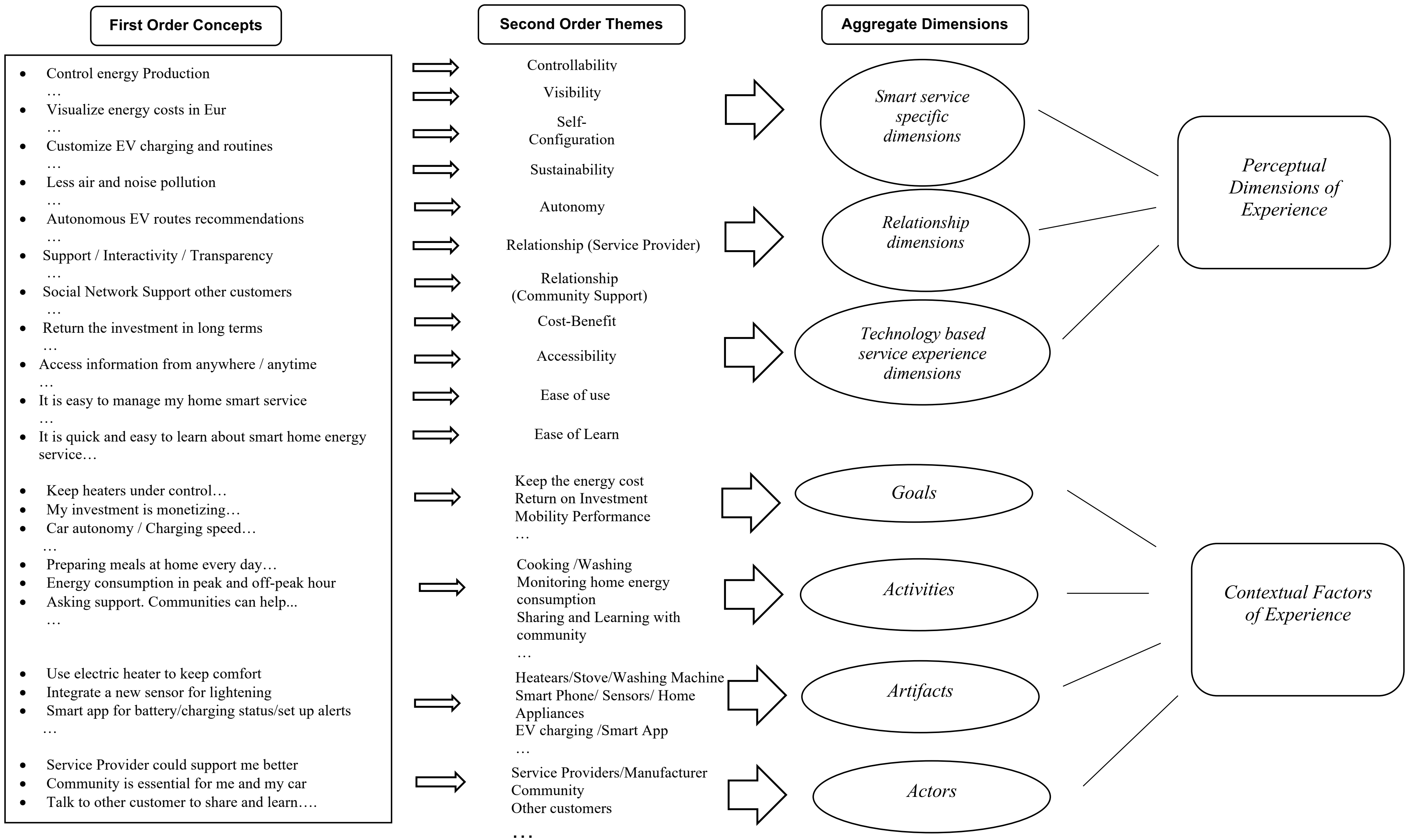

Figure 2: Example of categorization process, leading to the identification of perceptual dimensions and contextual factors of experience

4.4 Findings: Understanding the Customer Experience with Smart Services

To achieve a rich understanding of customer experience with smart services, this qualitative study focused on two elements: First, it examined a multidimensional set of customer experience perceptual responses to smart services, considering the multiple interactions with a myriad actors and artifacts that comprise the smart energy service context. Second, it enabled the understanding of the contextual factors that influence customer experience with smart services in terms customer goals and activities, as well as the actors and artifacts with which the customer interacts.

4.4.1 Customer Experience Perceptual Responses to Smart Services

The findings show that the customer experience with smart services involves a multidimensional set of perceptual responses, as shown in Table 1. These dimensions correspond to customer perceptual responses to stimuli and interactions with multiple actors and artifacts along the customer journey (Becker & Jaakkola, 2020), which in this case is the home energy management journey with smart services. These dimensions were structured in three groups: smart service specific dimensions, relationship dimensions, and technology-enabled service dimensions.

Category	Sub-Category	Frequency (N=31)	Description	Quote	Related Literature
Smart Service Specific Dimensions	*Controllability*	*25*	*The extent to which the smart system enabled customers to change the service status and behavior, as well as to define the way the service should behave according to a set of rules they defined.*	*"I remotely control my home energy, such as switch on/off lights and heaters." (ASE_1).* *"I control everything in my car remotely, since opening the windows until starting the charging process according to the needs at that moment…(EM_4)."*	(Wünderlich *et.al.*, 2013) (Cronin, 2010)
	Visibility	*20*	*Visualization of personal energy consumption as well as the different smart service status and behavior, namely energy consumed per devices, home appliance status, energy production, and electric vehicle charging status, among others.*	*"…I usually visualize the charging status and the charging points every day through the smart service…(EM_5)."* *"…I visualize on my home management system when my home appliances start and finish working according to a daily schedule… (ASE_9)."*	(Nilsen and Mack, 1994) (Peffer *et al.*, 2013)
	Self-Configuration	*17*	*The extent to which customers can assemble and configure the entire, or part, of the smart service overall solution to fit their specific needs.*	*"I installed sensors on my PV (photovoltaic) panels to remotely control and visualize the energy production rate per day through my smartphone. (ASE_11)."* *"I developed a smart application to analyze the service quality in different public charging points around Portugal" (EM_10).*	(Montgomery and Smith, 2009)
	Sustainability	*16*	*The smart service ability to decrease energy consumption-related environmental impact, namely in terms of noise (electric vehicles) and air pollution (CO_2 emissions).*	*"My electric car can help to decrease noise pollution in my city" (EM_4).* *"My energy consumption is more efficient through the smart energy management. It means that I emit less carbon into the atmosphere. I feel more responsible (ASE_10)."*	(Nowotny et al., 2018)
	Autonomy	*14*	*The ability of the smart service to offer useful suggestions or taking adequate actions without customer intervention, such as turning on and off home appliances according to photovoltaic energy production or suggesting the best routes for EVs according to available charging stations*	*"I appreciate how automatized the home appliances operations and lightening can be with the smart service. I do not even need to be close to them all the time."(ASE_10)."* *"My charging system at home start automatically whenever I plug the car to the charger. The smart service alerts me about failures and the current charging status…(EM_2)."*	(Sifakis, 2019)
	Relationship with the service provider	*29*	*The degree to which there is an adequate level of interactions, the service provider is knowledgeable, provides adequate support to customer needs, and is transparent in terms of procedures and rules.*	*"My relationship with the service provider is scarce. I do not interact with them (ASE_3)."* *"I usually send emails to report problems with the smart service app. The service provider rarely answers(ASE_8). "*	(Parasuraman, Zeithaml *et al.*, 1988)

Relationship Dimensions	*Community Support*	*12*	*The extent to which customers interact with online communities to learn and share experiences.*	*"I learned how to explore the smart service of my electric car with the online community" (EM_9).* *"We share our good and bad experiences with the community. It is relevant to improve the autonomy of my car (EM_8)."*	(Martins & Patrício, 2018)
Technology-Enabled Dimensions	*Cost-Benefit*	*29*	*The benefits gained through the smart service with the cost and effort of using them.*	*"…with the smart service my consumption is more efficient, consequently my energy bill decreased significantly (ASE_4)."* *"Currently, an electric vehicle is expensive. However, the electricity used to supply the car is much cheaper than gas. It's worth (EM_9)."*	(Ellabban & Abu-Rub, 2016)
	Accessibility	*12*	*Potential to access and act upon the smart service from any location at any time*	*"I also manage the solar production of my house remotely through the smart service app when I am travelling... (ASE_4)."* *"The smart energy service is useful, as I can manage and control my home energy consumption from everywhere. In this case, only a WI FI connection is required... (ASE_5)."*	(Parasuraman *et al.*, 2005) (Wolfinbarger & Gilly, 2003)
	Ease of Use	*10*	*The degree of easiness to which customers use the smart service to accomplish a specific task.*	*"I only plug and play the smart service. It is very easy (ASE_6)."* *"Currently, the smart service is easy to assemble (components and sensors) and integrate to other devices" (ASE_3).*	
	Ease of Learning	*9*	*The degree to which customers learn about the smart service basis and capabilities before and during the use.*	*"I have learned with my community how to use the smart service to manage my electric car…It is easy (EM_3)."* *"I could learn how to use the smart service to improve my overall energy consumption very quickly… (ASE_11)."*	

Table 1: Customer experience perceptual responses to smart services

Smart service specific dimensions

Data analysis identified five perceptual dimensions that are specific to the smart service context (see Table 1): controllability, visibility, self-configuration, sustainability and, autonomy. These perceptions are associated with smart service-specific characteristics, namely the ability to sense and collect data on their own condition and surroundings (Allmendinger & Lombreglia, 2005), and to enable customers to monitor and control artifacts like their home appliances (Georgakopoulos & Jayaraman, 2016).

Controllability was mentioned by most interviewees as the extent to which the smart service enables them to change the system's status and behavior, as well as to define the way the service should behave according to a set of rules. For example, interviewees valued the possibility to change the smart service status (e.g., turn home appliances and heaters on and off) according to their own needs. As mentioned by an ASE user, *"I program the washing machines to work from 10:30 am until 3:30 pm to reap the benefits of the energy produced by the photovoltaic panels"* (ASE_11). While controllability has been shown to be a relevant factor in the B2B smart service context (Wünderlich et al., 2013), this study extends current knowledge by showing its importance in the end consumer context as well: *"I use the smart service to control my home consumption and my electric vehicle… I feel safer if I can control everything"* (EM_4).

Related to controllability, visibility was often mentioned by the interviewees, as customers perceived that they can control the smart service by visualizing relevant information on system status and behavior. Most of the interviewees positively remarked on how the smart service interfaces enabled them to visualize their personal energy consumption as well as the different smart service behaviors, such as the energy consumed, home appliance status or energy production. As stated by one EM customer: *"...My management system allows me to view the total consumption of the house, the energy, the EV charging status, among other things. I have a detailed view"* (EM_10). In addition, interviewees valued the support that visibility gave them in making decisions regarding energy consumption. As mentioned by one customer *"I look at my energy consumption daily. Based on this information, I program the home appliance operations and the heating system to work in specific periods" (ASE_9).*

Self-configuration was also identified as the extent to which customers can assemble and configure the entirety, or part of, the smart service overall solution to fit customer specific needs. As mentioned by an ASE customer: *"I choose, buy, assemble and configure the sensors and other smart artifacts needed to manage the system solution"* (ASE_3). The multiple artifacts, information systems, and interfaces that comprise the smart service environment enable customers to personalize the combination of devices they use, the home appliances they sense and control, the information they visualize, and the automatic instructions the smart service follows. For example, if customers decide to manage a non-smart appliance, they can add a sensor to it in order to have remote control and visualize the appliance status*: "I have added smart plugs to the home appliances and developed an app to analyze the grid quality before charging my car in my house"* (EM_9). While previous studies have addressed personalization as undertaken by the service provider (Montgomery & Smith, 2009), study results show that smart energy customers configure and personalize the solutions by themselves to support their specific goals and daily activities, while considering the costs of implementation and the devices available in the market.

Another perceptual dimension that emerged from the data is the smart service autonomy, viewed as the ability of the smart service to offer useful suggestions or take adequate actions without customer intervention. For example, turning home appliances on and off according to photovoltaic energy production or suggesting the best routes for electric vehicles depending on available charging stations. Interviewees highlighted that after they assembled and configured the smart service solution, it could operate autonomously: *"I configure my home management to operate autonomously. It usually alerts me if a programmed operation goes wrong"* (ASE_1). Autonomy has been previously analyzed from a technical perspective as the capacity of a system to achieve a set of coordinated actions on its own (Sifakis, 2019). This study shows that, in a smart service context, these autonomous actions should also be adequate for the customer as they bring automation for daily activities that would otherwise require customer intervention. As mentioned by an EM customer, *"My electric vehicle system calculated where and when to stop to charge the car when I traveled to France before I requested [it]"* (EM_9).

In addition to the previous dimensions, which are more related to the technological characteristics of the smart service, sustainability also emerged as a relevant perceptual dimension specifically associated with smart services. The results showed that sustainability is related to smart service ability to decrease energy consumption-related environmental impacts, namely in terms of noise (electric vehicles) and air pollution (CO_2 emissions). Customers highlighted that sustainability is something they consider in the early stages when deciding which smart solutions to implement: *"When I bought my electric vehicle, I installed an application to visualize the noise pollution impacts"* (EM_4). Interviewees also mentioned that sustainability may become more appreciated as they use the service and realize how it positively impacts the environment, as highlighted in the following comment: *"Through my electric car, I decreased my carbon footprint significantly… 300 kg in one year. It is amazing!" (EM_1).*

Relationship dimensions

The results reveal the importance of relationship perceptual dimensions with the service provider and the community of other smart service customers. The relationship with the service provider was viewed by interviewees as the degree to which there is an adequate level of interactions, and the service provider is knowledgeable and provides adequate support for customer needs. This relationship dimension is also related to the extent to which the provider is transparent in terms of procedures and rules, including support and maintenance procedures, data protection, and compliance with regulations. However, the majority of interviewees, particularly ASE and EM customers, evaluated their relationship with the main energy service provider in a negative way, voicing a lack of interactivity and support, and criticizing the complexity of integrating multiple service providers and offerings*: "The service provider installed my home management system in my house and never contacted me again… providers should better support their customers"* (ASE_2).The relationship with the service provider has been shown to be a key perceptual dimension in traditional services (Parasuraman *et al*., 1988). Study results reveal that, in the smart service context, customers are not dependent on one main service provider. Instead, they combine multiple offerings and are more prone to taking the lead, expecting the service providers to support them in this role. As one customer noted: *"…I usually solve the problems of the smart service by myself, but I think the service provider should support me more with the maintenance"* (ASE_4).

The results also show that the relationship with online communities is an important dimension in the smart service context. Interviewees expressed the value of interacting, learning, and sharing experiences in online communities, social networks, and forums, mainly to get advice regarding alternative solutions, to learn about the usage of smart services, or to share best practices*: "An electric vehicle customer from the online community recommended the best solution for an issue with the battery health information on my the smart app… the solution was crucial to saving time and money"* (EM_4). Company social networks can be used by customers as a supplementary information source offered by the service provider (Martins & Patrício, 2018), but study results show that smart service customers view social networks and consumption communities as primary information sources. One customer highlighted the importance of the relationship with a community as follows: *"A customer learns more from the community than from the information made available by (electric vehicle) manufacturers…"* (EM_7).

Technology-enabled service dimensions

Some perceptual dimensions that have been found in other technology-enabled contexts (Parasuraman *et al.,* 2005) also emerged in the smart service context. Study results highlight the importance of cost-benefit perceptions. As shown in Table 1, a large majority of interviewees often compared the benefits gained through the smart services with the cost and effort of using them. The interviews highlighted that this trade-off emerges more intensively in the early stages, as customers analyze the costs and benefits of a smart service before choosing and implementing the service, which is related to the goal of value for money: *"I implemented the smart energy service to save money… it is an investment that will return in the long term"* (ASE_11). Customer cost-benefit considerations have been discussed in previous literature predominantly in a financial context, e.g., building a balance between savings and the use of devices (e.g., thermostats) (Ellabban & Abu-Rub, 2016).

Ease of use, ease of learning, and accessibility were identified as relevant perceptual dimensions of customer experience with smart services. Interviewees remarked that smart energy services do not require too much effort to use and learn. As some customers stated*, "It is very easy to use the smart service"* (ASE_5) and *"It is simple and quick to learn"* (ASE_8).

Accessibility was also mentioned as the opportunity to access and act upon the smart service from any location at any time, enabling customers to act in real time to change anything they need: *"I like to see my home energy consumption even when I am on vacation…"* (ASE_5). Such responses have also been identified in previous studies of technology-enabled services (Wolfinbarger & Gilly, 2003).

Overall, the results reveal a multidimensional set of customer experience responses to smart services. These responses comprise smart service-specific perceptual dimensions that emerge from the technological characteristics of smart services (controllability, visibility, self-configuration, and autonomy), as well as sustainability that is indirectly associated with smart technology positive environmental impacts through efficient use of home energy. Relationship dimensions were also deemed important in the smart service context, as results highlighted the growing role of consumption communities and the secondary role of traditional utility service providers. Finally, a set of perceptual dimensions that relate to previously identified technology-enabled literature (cost-benefit, ease of use, ease of learning, and accessibility) were found to be relevant in the smart service context as well.

4.4.2 Contextual Factors of Customer Experience with Smart Services

To further enrich the understanding of customer experience, this study also identified a set of contextual factors associated with the smart service environment in terms of customer goals and activities, as well as the actors and artifacts the customer interacts with.

Customer goals and activities in the smart service context

Using the lens of Activity Theory, the data analysis enabled the identification of a set of interdependent customer goals and activities. Goals are conscious, reflecting what customers intend to achieve (e.g., thermal comfort, value for effort), and activities are defined as a set of actions undertaken to achieve customer goals (Kaptelinin & Nardi, 2012). For example, a customer with solar panels who wants to be energy self-sufficient (goal) monitors daily solar energy production and programs home appliances to function on peak periods of production (activities). As shown in Table 2, the different goals and activities offer a rich illustration of how customers shape their daily routines of energy consumption in the context of smart services.

Categories	**Sub-Categories**	**Frequency (N=31)**
Goals	Value for Money (Save Money, return on Investment, keeping energy costs under control).	28
	Comfort	9
	Sustainability	9
	Value for Effort (Hassle-free energy consumption and management)	8
	Mobility Performance	7
	Energy Self-Sufficiency	7
Activities	Managing Energy Consumption	21
	Researching and planning the implementation	10
	Sharing and Learning with Community	10
	Charging EV	10
	Cooking and Washing	10
	Planning daily routines and longer trips.	8
	Managing Home Energy Production	8
	Install efficient appliances.	8
	Heating the house	6

Table 2: Customer goals and activities in the smart service environment

The large majority of interviewees mentioned value for money as one of the goals they want to achieve with smart services, as shown in Table 1. Value for money may range from the goal of keeping energy costs under control, to saving money, or to having a positive return on investment. For example, HC customers were more focused on keeping costs under control: *"I check the electricity bill monthly… don't want to pay more for electricity"* (HC_3). On the other hand, ASE customers highlighted the need for return on investment, as they made significant investments in renewable energy production and new energy management systems*: "My analysis indicates that return on investment will occur in five years…"* (ASE_10). Additionally, although EM customers assume that an electric car is expensive, they mentioned that they can save money with fuel as the overall cost with electricity is lower than gas: *"…300 km of autonomy costs 3 EUR… now compare it with the gas costs for the same 300 km…"* (EM_9). Study results therefore indicate that, as using smart service solutions requires a significant initial investment in terms of money and effort, the goal of value for money, and the related perceptual dimension of positive cost-benefit, are crucial for adoption decisions and significantly affect the customer experience.

Customers also vary in terms of other goals, according to their different profiles. Whereas comfort and hassle-free consumption is key for HC customers —"*My daily life is busy… I do not have time to manage my energy consumption"* (HC_3) —ASE customers value energy self-sufficiency. EM customers, meanwhile, value mobility performance and the sustainability of electric mobility and smart service solutions. As mentioned by two EM customers: *"I want to increase the autonomy of my car as much as possible"* (EM_3)*;* or "*I chose an electric vehicle as I aim to be cleaner and greener…"* (EM_2);

Data analysis also shows that goals are achieved through a sequence of activities that range from activities related to daily energy consumption (e.g., heating the house, cooking, and washing, planning daily routes for the electric vehicle), to activities related to controlling and monitoring of energy consumption. ASE and EM customers make a significant effort in activities related to rethinking and improving the existing smart service, such as researching and planning the implementation of the smart service based on information gathered through social networks and communities. For example, one customer stated: "*…I started to research on the Internet to learn more about the smart service…"*

(ASE_11). Sharing and learning activities involve knowledge acquisition based, not only on the technical content published, but also on the experiences of other customers who are members of online communities dedicated to sharing. These recommendations help customers use energy efficiently and develop their plans for daily activities (e.g., charge the car based on car autonomy, locate charging stations, or configure sensors). The customers value community-based information because it relates to their own problems and experiences: *"In the community we all share the same difficulties and different experiences"* (EM_4).

Actors and Artifacts in the Customer Experience

Building upon Customer Experience Modeling (Teixeira et al., 2012), the understanding of the customer experience was enriched by other contextual elements, e.g., artifacts and actors. Artifacts can be physical or digital devices with which the customer interacts to perform energy management activities, such as smartphone applications to visualize energy consumption and production levels. Actors are participants with whom the customer interacts (Teixeira et al., 2012). As shown in Table 3, the data analysis identified a myriad of actors and artifacts that support the customer experience with smart services. Actors and artifacts facilitate the performance of the daily activities, enabling customers to visualize system status and behavior, control the inputs and outputs, and manage consumption according to their needs.

Categories	Sub-Categories	Frequency (N=31)
Actors	Family, Friends and Neighbors	24
	Energy Service Provider	23
	Community (online forums, associations, online community)	11
Artifacts	Smart Applications	18
	Heating systems	15
	Home Appliances (smart and traditional)	12
	HEMS	11
	EV	11
	Photovoltaic Panel	10
	Smartphone/tablet/PC	10
	Charging Stations	7
	Sensors (temperature, lights and motion)	3

Table 3: Customer actors and artifacts in the smart service environment.

The findings show that the main energy service provider is only one actor in the customer constellation—and one with whom customers have few interactions. The results also reveal that the customer experience with smart services is social (Lemon & Verhoef, 2016), as it involves a network of actors interacting with each other during the performance of activities (Mickelsson, 2013). Families, friends, and neighbors play a key role, and online communities are especially important for ASE and EM customers. Interactions with online communities are intense and customers consider them as essential for the learning process and for improving the smart service, as mentioned by an EM customer: *"I ask the electric vehicle community for recommendations when I have to charge my car in a public charging station…"* (EM_1). On the other hand, interactions with the traditional utility service provider are few, as customers revealed that service providers and manufacturers do not actively develop relationships with them. As an EM customer highlighted: "*When I have a problem or a question, I usually ask [for] help [in] my community… I rarely contact the provider"* (EM_7).

The results also show that customers use a large variety of smart artifacts that support their daily activities by enabling the visualization of energy consumption status or the control over home appliances or energy production. Artifacts like smart applications, smartphones, and home energy management systems and sensors enable overall management of energy consumption by acting upon photovoltaic panels, heating systems, home appliances, electric vehicles, and charging stations, among others. This use of a wide set of smart artifacts is beyond the control of the main service provider, as customers select and configure them by themselves to satisfy their needs.

Overall, the results indicate that in a smart service environment, both customer goals and activities go well beyond the typical effort tied to the use of traditional energy services. Customer goals range from getting the best value for money and value for effort to goals that are more related to the smart service, like energy self-sufficiency, mobility performance, and sustainability. While HC customers aimed for a hassle-free consumption, the activities of ASE and EM customers seemed to require significant effort to manage the smart service in a more independent way, supported by the online communities that enable customers to learn and share experiences.

Results also indicate that goals and activities are supported by the use of smart artifacts and the interaction with different actors goes well beyond the main traditional service provider. In this smart service context, a broader network of actors, including other customers and communities, actively influences the customer experience, which is also supported by the smart artifacts that are selected, installed, and used by the customer.

4.5 Discussion

This study offers an in-depth understanding of customer experience with smart services, including the exploration of customer perceptual responses and contextual factors. This study therefore makes four major contributions to both theory and practice on customer experience with smart services. First, the study contributes to smart service literature by providing insights into the customer experience with smart services. While some of the perceptual dimensions found in the study have already been identified in smart technology literature from a technical perspective on a specific system (Beverungen et al., 2019), this study empirically examines these perceptual responses from a customer and service perspective. For example, although visibility and autonomy have already been associated with smart technologies (Carsten et al., 2018), study results show that in the smart service context, visibility focuses on customer ability to visualize the system and consumption status and behavior, especially as it supports them in making energy consumption decisions. Moreover, by identifying and analyzing these perceptual dimensions and contextual factors since the early stages of the experience, this study also contributes to the literature on smart service adoption (Wünderlich *et al.*, 2013). Although the study focuses on the energy sector, this understanding of the customer experience may also be applicable to other domains like smart home services, which involve smart energy management as well as the management of water consumption, security systems, heating systems that also require a smart system composed of sensors and smart applications.

Second, the study contributes to deepening the understanding of customer experience with smart services by capturing the perceptual responses that emerge in this new setting. Going beyond traditional dimensions associated with technology-enabled services (Wolfinbarger & Gilly, 2003), this study expands this understanding by analyzing the perceptual responses that are specifically associated with smart service technology, such as controllability, visibility, autonomy, and self-configuration. These specific dimensions highlight how the experience with smart services changes when compared with traditional services, showing what customers value and how they now take more control over their experience in a more autonomous way. While some of these dimensions have been conceptually discussed in previous literature (Wuenderlich et al., 2015), this study empirically examines them in a rich smart service context.

Third, the study shows that relationship dimensions, which are key in traditional dyadic services such as retail banking (Parasuraman et al., 1988), are also relevant in the smart service context. However, this study shows how this relationship goes beyond one main service provider and how the relationship established with a community of customers that support each other in their daily routines of energy consumption becomes crucial. At the same time, the relationship with the main service provider may become infrequent and weak. While previous research has shown that company social networks can enhance service provision (Martins & Patrício, 2018), this study indicates that in the smart service environment customers develop and contribute to their own online communities, where they share experiences and support each other. These results therefore contribute to a more in-depth understanding of how smart services to lead to more autonomous, networked customer experiences (Ostrom et al., 2015). At the same time, in the smart service context, customers may not see the service provider as the focal actor, highlighting the need for service providers to move from a reactive performer role, to a proactive facilitator role in the customer experience (Gronroos & Voima, 2013) (Breidbach & Maglio, 2016).

Fourth, this study offers a rich understanding of the contextual factors that enable the customer experience with smart services (Becker & Jaakkola, 2020; De Keyser et al., 2020), showing that it involves a myriad of actors and artifacts. Smart service customers interact with a complex set of devices such as smart apps, home appliances and home energy management systems, and interact with multiple providers, family, friends, and communities that go well beyond a unique service provider. These results therefore extend knowledge on service orchestration in complex human-centered service systems (Breidbach et al. 2016), by illustrating the interdependencies between actors and resources in smart energy contexts. Moreover, by examining customer goals and activities associated with smart service usage, the study enables better understanding the context within which the experience unfolds and exploring the interrelationship with perceptual dimensions. For example, as value for money is a key goal for customers, cost-benefit is a highly mentioned perceptual dimension of customer experience with smart services. By acknowledging that customers expect smart services to support their activities of managing energy consumption and planning daily routines, it also becomes clearer why control and visibility are important dimensions of customer experience. This study therefore reveals that customer experience with smart services is embedded in the daily routine and is interpreted by the customer, furthering the understanding the interdependencies and the impact of contextual factors (Becker & Jaakkola, 2020; De Keyser et al., 2020).

Study results also offer relevant managerial implications, as they show which perceptual responses dominate customer experience with smart services. As smart services involve novel technologies and require a significant initial investment in terms of money and effort, cost-benefit is an important factor in the customer experience. Managers should therefore carefully support customers in evaluating alternatives and configuring a good value for money solution, especially in the initial stages of the customer journey.

Results indicate that managers should also cater to customer needs for information visibility and sustainability of smart services. Customers are highly interested in the sustainable outcomes of the smart services and value the display of information regarding their usage patterns (visibility). Some also value the controllability and self-configuration of smart services, so managers are advised to provide the appropriate means and processes to customers to enable visibility, personalization and control. This effort may require the analysis of customer data between partners in the service network, focusing on touchpoints that are most relevant for the customer experience along the journey. On the other hand, as customers can autonomously integrate different solutions from different providers, each service provider needs to be aware that a negative experience in one touchpoint in the network can cascade and damage the overall experience. As such, managers need to balance how much control and personalization they allow their customers to have to enhance the customer experience with their smart service.

The findings further indicate that, in the smart service environment, there are multiple activities and interactions that go well beyond one provider's control. For example, customers use a multitude of smart technologies and interact with many providers and other customers to configure their own smart energy solutions. For smart service providers, it is therefore crucial to look beyond their offerings and to understand the constellation of actors and artifacts that facilitate the customer experience (De Keyser et al., 2020), so they can better position and design their offering within the customer value constellation (Patricio et al., 2011).

Moreover, smart service providers need to understand how customers are re-defining their role within the smart service context and the implications of the increasing customer autonomy (Ostrom et al., 2015). Study results show that customers value the ability to configure their own solutions and expect a supportive relationship from the service provider. In this context, service providers should understand how they can become partners and support customers in creating their own experience, instead of being lead orchestrators. Also, service providers should offer customers access to other fellow customers, for example by integrating them in the smart service network and communities. This may represent a substantial change in the role traditional service providers such as utility companies have played, as well as a significant power shift from providers to customers.

4.6 Conclusion and Future Research

Technology advances enable the emergence of a new, always on, and always connected smart service environment, where customers are taking the lead in their experiences in a more personalized and autonomous way (Ostrom et al., 2015). This study offers an in-depth understanding of the customer experience with smart services, examining customer experience perceptual responses and characterizing smart service contextual factors in terms of customer goals, activities, actors, and artifacts. The study highlights how these customers are empowered and are taking the lead, valuing the controllability, visibility, self-configuration, autonomy, and sustainability offered by smart services. Customers are also seeking the support of fellow customers in online communities, replacing service providers as the main go-to actor in their networks. These findings advance our understanding of customer experience in the smart service environment and offer important implications for smart service managers. However, future research could expand the understanding of how the contextual factors and perceptual dimensions of smart services are interlinked, and how these responses are interconnected.

This study also has some limitations, as it focuses on smart services related to energy. While rich and timely, the energy-related smart service setting is only one possible context for smart services. Future research can study other smart service contexts and draw comparisons between them. It would be particularly relevant to study how the relative importance of customer experience perceptual dimensions changes in other contexts and how this depends on the prevalent smart artifacts, goals, and activities in each context. Continuing smart service research in different settings, such as health care, characterized by different customer goals, activities, actors, and artifacts, can expand the current study's findings. Future research can also explore customer experience in more open contexts of interactions, such as smart cities, which represent a more complex setting, or to understand how customer experience changes with smart services supported by open access technologies. Additionally, as smart service solutions expand, become more integrated and customers gain experience and become more knowledgeable, future research could focus on how customer perceptions evolve. Namely, it would be interesting to explore how customer perceptions related to the relationship with the service provider and autonomy, and how other perceptions, e.g. related to data privacy and security, might evolve and emerge, respectively, as smart service solutions and customers become more mature.

A more in-depth comparative analysis of different groups of customers can bring relevant contributions for managers. For example, comparing the relevant perceptual experience dimensions and contextual factors between advanced smart energy customers and traditional high-consumption customers can help managers design their service offerings to influence customers that have not yet started using smart services, turning them into active and advanced customers in the smart service network. This transformative vision of smart services can also enable managers to understand how to engage actors, including service providers, in different roles and with different levels of control.

With the rapid evolution of smart technologies, customers are taking the lead in their experiences. As the smart service context evolves, it will offer new and interesting challenges for both service providers and researchers as customer wishes for a connected and sustainable lifestyle already spill over to their expectations regarding service offerings. This study advances the understanding of the customer experience in this fast-changing smart service context and paves the way for future research on how the use of smart offerings enables customers to “become smarter” and fulfill their goals.

5 Study 2 - From Smart Technologies to Value Cocreation and Customer Engagement with Smart Energy Services[2]

This chapter presents the developments and results of Study 2, which provides an in-depth understanding of customer value cocreation and engagement with smart energy services through a qualitative approach based on 31 semi-structured interviews conducted in Study 1. The study development encompassed a data analysis from the value cocreation and customer engagement perspective. Supported by literature, the results identify three value cocreation practice styles and respective engagement behaviors.

Moreover, the results offer relevant policy implications toward more service-focused policies grounded on an in-depth understanding of different styles, roles, and engagements behaviors customers assume in energy settings: the importance for ESCOs and policy-makers to go beyond new technology solutions by developing more holistic services that are in tune with different customer value cocreation practice styles; and the need for a nuanced and tailored approach to more effectively promote engagement for different groups of energy customers.

This chapter is organized by the following subsections. In the subsection 5.1 Introduction, the research challenge and research question for this study are indicated. Subsection 5.2 presents the study background focused on the value cocreation and customer engagement concepts. Subsection 5.3 presents the methodology of Study 2. These subsections are followed by the 5.4 Findings, 5.5 Discussion, and 5.6 Conclusions and policy implications, specifics for this study.

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5.1 Introduction

The increasing penetration of decentralized electricity production and renewable sources to the grid is profoundly changing the energy industry (Niesten and Alkemade, 2016). These changes are grounded on the smart grid technology, which implies the application of information and communication technologies to manage and control the power system, in an effort to ease the integration of low-carbon energy sources (e.g. wind and solar power) and improve energy efficiency (Nyborg and Røpke, 2013). Due to the two-way communication capability, the grid information becomes accessible not only for operators but also for the final customers on the demand side (Mengolini and Vasiljevska, 2013). It enables them to play a more active role in managing their consumption and production (Geelen et al., 2013) to increase efficiency and savings. Although the smart grid technology is not a synonym of sustainability, it has potential to catalyze the energy transition aiming the decrease carbon emissions (Moura et al., 2013).

Reaping the benefits of grid operation therefore requires changing the energy service dynamics (Moreno-Munoz et al. 2016). While traditional energy services are based on the linear grid architecture, one-way communication, and passive service relationship (Ponce et al. 2016), smart energy services allow the real-time data collection, continuous communication and interactive feedback, therefore opening new forms of value cocreation with customers (Wünderlich et al., 2015). The demand for energy service companies (ESCOs) may decline in the future as the penetration of energy technologies that support final customers in adopting more energy-efficient houses will increase significantly (Magnusson, 2012), emphasizing the need to find new revenue streams for their businesses.

However, moving from a traditional energy business model (i.e., producing, distributing, and selling electricity and heat) to a more service-based approach has been challenging (Kindström et al., 2017). According to the European Consumer Organization, customers have traditionally found new energy services and markets as not engaging (BEUC, 2019). A perceived lack of customer knowledge, interest, and trust of potential energy service customers are also a significant barriers for ESCOs (Kindström et al., 2017). Although smart energy technologies have evolved significantly, a deeper understanding of how customers cocreate value and engage with these services is needed to inform

ESCOs and policymakers on how to create smart energy services and design adequate policies to overcome the barriers in this market (Magnusson, 2012), and effectively support the energy transition (Parrish et al., 2020).

Recent research highlights that, for smart energy technologies to be adopted and effectively promote efficient energy consumption behaviors, it is crucial that these technologies are leveraged through the development of new services that enable customers to cocreate value (Breidbach et al., 2016). Customer value cocreation can be defined as the "benefit realized from integration of resources through activities and interactions with the customer's service network"(McColl-Kennedy et al., 2012 pg 375). This perspective highlights that the customer is always a cocreator of value, and that value cocreation may involve the integration of resources, not only from the focal service provider, but also from other sources such as other companies, providers, social networks, or customer own activities (personal sources). The comprehension of how services enable customers to cocreate value is closely related to customer engagement, as only engaged customers can adopt new efficient behaviors by assuming more active roles and establishing new interactions with different actors (Boork et al., 2014). Customer engagement can be defined as customers' dispositions to invest resources in their interactions with a focal object such as a smart service solution (Brodie et al., 2019). This disposition manifests through engagement behaviors, namely by customers voluntarily contributing resources that go beyond what is elementary to the exchange (Alexander et al., 2018), as well as by learning and sharing knowledge (L. D. Hollebeek et al., 2019). For example, customers engaged with smart energy services may invest more in learning about these solutions, actively managing their home energy consumption, and sharing their experience with others.

In this context, the in-depth analysis of value cocreation practice styles, grounded on customer roles, activities, and interactions, can deepen the understanding of value cocreation with smart services and how it relates with customer engagement behaviors. This can contribute to the development of successful service offerings and policies that foster adoption of smart energy services and better support customers in assuming new roles and behaviors toward efficient energy consumption (Buchanan et al., 2016; Furszyfer Del Rio et al., 2020). This understanding is crucial to provide insights for ESCOs and policy makers to devise strategies that foster these engagement and consumption behaviors. For example, what are the best engagement strategies for different kinds of customers? How to encourage customers to become prosumers, and what kind of energy solutions do these customers want? And how to bring disengaged customers onboard in the energy transition?

Against this backdrop, this paper presents a qualitative study of value cocreation practice styles and engagement behaviors with Portuguese energy customers, deriving important policy implications for the development of new smart energy services. The paper is structured as follows: The conceptual background section covers extant literature related to smart energy services, value cocreation and customer engagement. The methodology section describes the qualitative approach based on 31 interviews with energy customers. The findings section provides an in-depth understanding of different customer roles, activities, and interactions with smart energy services, resulting in the identification of three value cocreation practice styles and respective engagement behaviors. The discussion section examines the study contributions to a more nuanced view of multiple styles of value cocreation. The last section provides conclusions and policy implications grounded on a service-oriented approach, exploring the development of tailored services and policies that are more in tune with different customer value cocreation practice styles to foster desired engagement behaviors more effectively.

5.2 Conceptual Background

Smart Energy Services

Energy markets are rapidly integrating smarter, connected, reliable infrastructure and cleaner generation on the supply side, also implying greater control, more choices and flexibility for customers (Daziano, 2020). Such elements allow the development of smart energy services that enable customers to autonomously manage their own energy consumption that can potentially increase of energy efficiency. Building upon smart service literature, a smart energy service can be defined as an energy service that is "delivered to or via intelligent objects that feature awareness and connectivity" (Wünderlich et al., 2015 pg 2) that are able to sense the surrounding conditions and allow the connection of real-time data (Allmendinger and Lombreglia, 2005). Such services allow the integration of a vast array of connected devices, like smart applications and smart appliances. These services facilitate real-time data collection, consumption management, continuous communication and interactive feedback to promote energy efficiency of households, electric vehicles, among others (Gonçalves et al., 2020).

Digitalization within the energy sector drives energy efficiency improvements through increased use of household controls, automation, and analytics, which will ultimately lead to greater reliability of energy savings estimates through more streamlined measurements (IEA 2018). For example, the deployment of home energy management systems can potentially increase penetration of active energy management systems in domestic environments. As a consequence, advancements in remote monitoring platforms can aid Energy Service Companies (ESCOs) to find opportunities in residential energy market development in the future (Virtanen, 2015). ESCOs offer final energy services for predefined prices, drawing revenue streams from energy savings (Hall & Foxon, 2014). ESCOs provide energy services that could come in many forms, but in most cases involve delivering conventional energy or load management interventions to facilities owned by a customer (Kangas et al., 2018).

However, creating compelling value propositions for customers has been challenging for these companies, due to the high cost of implementation and the lack of attractive financial incentives. Such incentives can potentially smooth the impacts of these cost in the short term (Brown et al., 2022). At the policy level, ESCOs' market also faces a lack of standardized measurements and verifications that leads to mistrust from the potential clients. In some cases, the ambiguities in the legislative framework mainly related to data privacy and transparency also contribute to clients' mistrust (Boza-Kiss et al., 2019). These barriers result in modest penetration rates in the residential energy sector (Bertoldi & Boza-Kiss, 2017; Brown et al., 2022). For example, in the Portuguese market, the development of smart energy services is limited due to the absence of credible and visible reference cases with a clear household focus to inform about the cost-benefits of such services and solutions (Lopes et al., 2016). In this context, ESCOs may find opportunities to increase its penetration in the residential electricity market through the combination with other business models to offer attractive energy services.

Against this backdrop, studies advocate that more service oriented approaches can bring opportunities to increase ESCOs market participation in this market. Such market has been increasing significantly as it has the potential to provide innovative services for customers willing to become more efficient and to decrease household electricity costs (Shomali & Pinkse, 2016). Although previous research has already acknowledged a more service-oriented approach for different types of customers, ESCOs and customers still face policy barriers in this market that should be overcome to enable such opportunities (Kindström et al., 2017). Moreover, the lack of knowledge about the ESCO service offerings, as well as high transaction costs are considered key barriers on several studies, regardless the study context (Boza-Kiss et al., 2019). In this context, smart energy customers should be positioned at the center of this technology and service network (Steg, 2008). The successful introduction of smart energy services and the desired behavioral change require the increasing support of household customers in their activities (Verbong et al., 2013), acknowledging that traditional boundaries between "customer" and "service providers" such as ESCOs become blurred, pushed by the emergence of decentralized energy production and distributed generation (Carù & Cova, 2015). In the smart grid context, it therefore becomes crucial to understand how customers cocreate value and engage with smart energy services, not only to foster long term adoption but also to enable an effective demand side response and full participation of customers in the market (Zangheri et al., 2019)). However, existing literature in smart energy technology tends to be focused on operation and functionalities (Solaimani et al., 2015). Although recent research has explored customer attitudes and perceptions toward smart energy services (Buchanan et al., 2016), namely customer engagement from a technology acceptance model perspective (Park et al., 2014;Park et al., 2017) a deeper understanding is needed on how customers cocreate value and engage with the smart energy services.

Value Cocreation Practice Styles and Customer Engagement Behaviors

Value cocreation has become a key concept in marketing and service research, as customers are increasingly recognized as active co-creators of value, rather than passive recipients of service (Payne et al., 2008). This concept is useful in the smart energy context, as value cocreation sheds light on the different active roles customers play such as collaborating in service provision, but also realizing the service benefit, as value is cocreated in use (Vargo and Lusch, 2016). Value cocreation can therefore take place in diverse ways, either through dyadic relationships between customer and service provider, or through multiple interactions with a myriad of actors at a network level (Jaakkola and Hakanen, 2013).

Understanding the multiple ways in which customers can cocreate value in smart service contexts therefore requires the analysis of customer roles, interactions and activities (McColl-Kennedy et al., 2012; Ng et al., 2011) that can characterize stylized ways of value cocreation (Chandler and Chen, 2016). Such analysis enables the identification of value cocreation practice styles, which represent what customers do when they cocreate value, comprising the perceived roles they play, as well as their cocreation activities and interactions (McColl-Kennedy et al., 2012; Ng et al., 2016; Ng et al., 2019). This analysis reveals how cocreation can be carried out in different styles depending on actors' resources and preferences. For example, previous research has typified different value cocreation styles in health care that range from "team management", "controlling" to "partnering", followed by the identification of the respective roles like "assemble and manage team", "control from distance" and "partnering with other actors" (McColl-Kennedy et al., 2012). However, in spite of the need for further understanding how smart technology can be turned into value cocreating services (Breidbach & Maglio, 2016), research on customer value cocreation practice styles has not been applied to technology-based services, including smart services.

The analysis of value cocreation practice styles can also bring relevant insights into customer engagement with smart services, as customer engagement research has focused on the customer active presence in value cocreation processes (Zyminkowska et al., 2017). Customer engagement behaviors are defined as customer voluntary contributions toward a service that go beyond the fundamental transactions and occur in interactions with multiple actors (Jaakkola and Alexander, 2014). Previous studies have found that increasing engagement levels may be associated with engagement behaviors such as augmenting, learning, sharing knowledge, influencing, or co-developing (Hollebeek et al., 2019; Jaakkola & Alexander, 2014).

In the energy context, customer engagement has also been explored, as customer active participation is considered key to reap the benefits of smart grids (Verbong et al., 2013; Moreno-Munoz et al., 2016; Ellabban & Abu-Rub, 2016; Stephens et al., 2017). Both energy and service literatures highlight that understanding value cocreation and customer engagement can offer key insights to the successful development and adoption of new technologies (Park et al., 2014; Niesten and Alkemade, 2016; Ellabban and Abu-Rub, 2016; Jaakkola and Alexander, 2014). However, a more nuanced understanding is still lacking on how customers cocreate value and engage with smart energy services in order to foster behavioral change and to successfully leverage smart grid technologies for energy transition. Against this backdrop, this paper offers an in-depth understanding of value cocreation practice styles, through the identification of roles customers play in energy production and consumption in the context of the smart energy services, followed by an in-depth understanding of the interactions and the activities developed that characterize these roles. This paper also identifies customer engagement behaviors associated with the different value cocreation practice styles, therefore providing important insights for developing competitive smart energy services offerings and policies.

5.3 Methodology

This study aimed at an in-depth understanding of value cocreation practice styles and customer engagement behaviors with smart energy services. The study was developed in the context of the Portuguese energy market that is going through a transition in the physical electricity system and retail electricity market (Lopes et al., 2016). In the last few years, the deployment of smart services mainly grounded on home energy management systems, demand response, electric vehicles and renewable energy have increased significantly. As such, Portuguese regulations and policies targeting the use of such services by final customers have been reviewed and discussed in large scale, aiming not only to address the European agenda for decabornization, but also add, improve and change policies for a new emerging market in the energy sector (Anjo et al., 2018). This makes the Portuguese energy market an interesting setting for studying the value cocreation and customer engagement.

To gain an in-depth understanding of customer value cocreation and engagement with smart energy services, a qualitative approach was considered adequate as it can be used to unveil details like daily activities, multiple customer interactions and learning processes that are difficult to capture through quantitative methods (Maxwell, 2012). Being a qualitative study, the study followed theoretical sampling procedures, which involves seeking pertinent data to develop emerging theory (Charmaz, 2016). In this line, the theoretical sampling aimed at covering the different sources of variation in value creation with energy services, conducting interviews to identify and densify the categories of value cocreation practice styles and engagement behaviors, until no new categories emerged. In this line, the study started with an initial sample of 10 individual interviews that tried to cover a theoretically relevant and diverse set of energy customers, namely different levels and types of usage of energy services (Fuentes et al., 2019). The majority of interviewees were contacted with the help of a utility provider and were further complemented with invitation through energy and EV forums. Then, an iterative process of data analysis and further sampling led to the densification of data analysis categories and to the emergence of three groups of customers, corresponding to three value cocreation practice styles, until saturation was reached with 31 interviews (Charmaz, 2016).

Data collection involved in-depth semi-structured interviews and focus groups (Maxwell, 2012), which were considered adequate to understand the processes by which value cocreation activities and engagement behaviors unfold.-The interview protocol covered energy consumption activities as well as customer responses to the multiple interactions with their smart energy service solutions from the early stages of adoption to the current usage. This allowed for identifying customer roles, as well as the actors and smart devices with whom they interacted, which enabled identifying value cocreation practice styles and consequently, to identify customer engagement behaviors in the context of energy use.

The study involved 17 in-depth individual interviews lasting 40-60 minutes. In addition, two focus groups were undertaken with 14 participants, lasting approximately two hours each. The individual interviews were voice recorded, the focus groups were video recorded, and all were literally transcribed for descriptive validity (Maxwell, 2012). The themes that emerged from the initial interviews and focus groups were examined in the subsequent interviews to facilitate closure (Lincoln et al., 1985).

Data analysis involved an iterative process of joint data collection and analysis (Shah and Corley, 2006). Data was processed using open coding to identify first-order concepts (Corley et al., 2004, Gioia et al., 2013). In this stage, data indicated the different activities and interactions along the overall journey of energy consumption, which produced a considerable number of categories. This analysis considered the terms customers used and the themes that were raised (e.g., daily consumption, energy production, management, efficiency, energy costs, regulation issues, support services, and multiple interactions, among others). In the second-order analysis, the emergent themes were analyzed in relation to, and were substantiated by the literature (Corbin and Strauss, 2008). The last step consisted of identifying similarities and differences among the many categories and reducing them to a manageable number (Corbin and Strauss, 2008; Gioia et al., 2010). Building upon literature on customer engagement behaviors (Jaakkola and Alexander, 2014) as well as value cocreation practice styles (McColl-Kennedy et al., 2012), the categories were refined and could be aggregated (Gioia et al., 2013).

The software NVivo supported the data analysis process, from the first-order concepts to the aggregation of dimensions and additional revision of authors. The results of data analysis revealed that customers may cocreate value with smart services in very different ways, identifying three value cocreating practice styles, and enabled the identification of five different customer engagement behaviors with smart energy services and how they are associated with value cocreation practice styles, as presented in the findings section.

5.4 Findings

The results of the qualitative study enabled the identification of three value cocreating practice styles with smart services, as shown in Table 1: Advanced Home Energy Management (AHEM); Mobility Energy Management (MEM) and Hassle-Free Home Energy Consumption (HFEC). These styles are reflected in different roles customers play in relation to energy, as well as the activities they undertake and the energy system actors they interact with. This analysis enabled a deeper understanding of each practice style through the characterization of how the role played by customers was reflected in the set activities and interactions with a network of energy actors.

Value Cocreation Practice Styles (N=31)	Role	Activity (N=31)	Interaction (N=31)	Customer Engagement Behaviors (N=31)
(AHEM) Advanced Home Energy Management (#11)	To develop a smart energy solution and proactively manage energy production and consumption with the latest technologies	Monitoring and controlling home energy consumption and production (#10). Proactively Customizing home energy solution (#8) Proactively solving problems with energy solution (#5) Programing home appliances (#4) Searching for and sharing information about new solutions on the Internet and social networks (#5)	High number of interactions with multiple devices to support home energy management. (#11) Medium to high number of interactions with online and offline communities (e.g. forums and online communities) (#9) Low interactions with the energy service provider, which they consider does not offer adequate support. (#10)	Actively Orchestrating (#10) Learning and Improving (#8) Knowledge Sharing (#3) Co-Developing (#3)
(GMEM) Green Mobility Energy Management (#10)	To proactively manage and drive the car based on ecological and energy efficiency, and electric vehicle performance	Monitoring and controlling electric vehicle (EV) energy consumption and functionalities (#11). Sharing usage experience (#12) Integrating solutions with community (#8) Sharing analysis and research (#7) Proactively customizing EV and energy solutions (#5). Co-designing home energy management system and car apps in open source (#5) Proactively Solving problems with energy solution (#3) Sharing schemas to co-develop (#3)	High number of interactions with other EV customers through forums and online communities (#10) High interactions with multiple devices to support the daily use of the car improve and performance (#10) Low interactions with the energy service provider and manufacturer (#3)	Active Orchestrating (#10) Learning and Improving (#9) Knowledge Sharing (#6) Co-Developing (#6)
(HFEC) Hassle-Free Home Energy Consumption (#10)	To comply with existing energy solutions and maintain the desired level of home comfort with the least cost and effort	Monitoring energy costs through incomes (#10) Monitoring home comfort levels (#7)	Low interactions with few individuals including the energy service provider and community (#3) Low interactions with energy devices to monitor consumption (#2)	Complying (#10)

Table 4: Value Cocreation Practice Styles and Customer Engagement Behaviors

5.4.1 Advanced Home Energy Management (AHEM)

Study results showed that the Advanced Home Energy Management (AHEM) value cocreation practice style (N=11) involves proactive use of a set of smart energy services and devices to manage and control home energy consumption and production. These AHEM customers assume the role of developers and assemblers of their own smart energy solution, as well as a proactive role in managing their home energy production and consumption.

To play this developer and assembler role, AHEM customers not only customize but also develop their own energy solutions to achieve their goals toward the energy efficiency and lower electricity costs. To this end, they undertake a myriad of activities and have a high number of interactions with other customers through forums and online communities to gain knowledge of how to develop and improve their solutions. One interviewee mentioned: *"I have learned with the forums how to improve my home energy consumption through the PV panels…"* (AHEM_9). These online communities can be defined as groups of people with a shared interest or purpose who use the internet to share experiences, recommendations, suggestions, co-develop and give support to each other (Roy, 2010). Such online communities differ from the concept of energy communities, defined as collective organizations grounded on the cooperation among consumers to promote citizen-driven energy actions and provide direct benefits to citizens through energy efficiency (Roy, 2010). Nevertheless, study results show that online communities can also contribute to adoption and long-term use of smart energy services, as these customer-to-customer interactions provide crucial support for implementing these services and reaping their benefits in terms of energy efficiency and savings.

AHEM customers highlighted that interactions with the energy provider and ESCOs are infrequent, which they consider do not provide adequate support. Most interviewees indicated the lack of support and interactivity, which push them to solve problems, maintain the energy system and improve it by themselves. Interestingly, while AHEM customers are very proactive in managing and improving smart energy solutions, they seem more focused on their own home solution, and are not so active in co-developing new solutions for and with the online community.

Additionally, to proactively manage their energy production and consumption, AHEM customers use home energy management systems to remotely monitor, control, and manage home appliances so they work according to schedules, and manage energy production through photovoltaic panels for self-consumption. This style includes performance analysis based on the overall energy consumption and production to increase the energy efficiency. Consumption and production information is considered valuable, enabling customers to adapt their schedules and routines (i.e.: washing or cooking) to get benefits of the solar production.

While the proactive role played by final customers and early adopters has been shown to be a relevant factor in studies developed in energy service settings (Geelen et al., 2013; Ellabban and Abu-Rub, 2016), this study extends current knowledge by showing its importance in the home energy management and prosuming context as well. Study results reveal the importance of a myriad of interactions, not only with smart devices to manage home energy efficiently, but also with online communities to support energy consumption management and increase the knowledge on smart energy services and solutions. This relationship significantly replaces the interactions with the main energy service provider, going far beyond provider's control, as mentioned by one customer: *"I have been learning how to improve my smart home energy management solution on the online forums" (AHEM_3).*

5.4.2 Mobility Energy Management (MEM)

The Mobility Energy Management (MEM) value cocreation practice style comprises electric vehicle customers (n = 10) who play the role of proactive car drivers mainly for ecological purposes and energy efficiency, as well as for electric vehicle performance. To this end, MEM customers adopt smart energy services to use the car more efficiently, namely, to remotely control energy consumption and functionalities of the electric vehicle (e.g., monitor the load levels, battery health). These customers mentioned that the daily use of the vehicle increases environmental awareness as the car can help to decrease carbon emission and noise pollution, but this is not a priority for them in the early stages of the car use. Moreover, they mention that driving an electric car requires managing functionalities and load levels to achieve higher efficiency in terms of cost and range, as mentioned by one interviewee: *"Using smart applications to manage my car functionalities is part of my daily routine" (MEM_9)*. To support these activities and role, customers in this style have multiple and intensive interactions with other customers through online communities, partnering with them for the development and improvement of new solutions. In this sense, the cocreation of value is based on the sharing of experiences with others, recommendations, and co-development.

Other studies (McColl-Kennedy et al., 2012) have identified this partnering style, which is characterized by medium level of activities and medium number of interactions with different individuals to solve problems and collaboratively generate solutions. This study reveals that, in the smart energy context, information sharing among customers in online communities related to EVs is more intense, also enabling the development of new solutions in partnership. One interviewee highlighted: *"I developed a system to monitor my electric vehicle charging status with the online community" (MEM_10).* Differently from AHEM customers, MEM customers have intense interactions with other customers through online communities, not only to develop new solutions by and for themselves, but also to co-develop with and for the community.

These customers also interact with a myriad of smart devices, mainly smartphone applications that support their management and decisions toward car. They usually integrate smart applications that provide different information that range from the battery health to charging station locations and status. While previous studies have addressed activities and multiple interactions within online communities of electric vehicle customers from a customer experience perspective (Gonçalves et al., 2020), this study results deepen this understanding by examining the roles and the MEM value cocreation practice style associated with these interactions.

5.4.3 Hassle-Free Home Energy Consumption (HFEC)

The Hassle-Free Home Energy Consumption (HFEC) value cocreation practice style comprises high-consumption residential customers (N=10), characterized by a high level of energy consumption (more than 100 EUR monthly bill). Unlike the other groups, HFEC customers play a more passive role and prefer to comply with existing energy solutions to maintain the desired level of home comfort with the least cost and effort.

These customers have not yet adopted smart energy services. As such, their energy management activities revolve around managing home comfort and controlling costs, without proactively seeking new energy solutions. Nevertheless, data analysis indicated that HFEC customers are open to embrace new smart energy services if they are not required to constantly control and manage them, as highlighted in the following comment: *"I am open to know new solutions to decrease my energy costs, but I don´t want to control anything" (HFEC_5).*

Customers in this style rarely interact with other energy customers or with the service company. Data analysis identified that few interactions were mentioned by customers for two reasons. First, they do not consider energy efficiency and new smart energy services as a priority. Second, technical issues that require interactions with the service provider are infrequent, as mentioned by two interviewees: *"I do not give much attention to my home energy services (HFEC_1)"; "I only contact the energy service provider when I have some issue, but it's rare (HFEC_5)"*. Previous studies (McColl-Kennedy et al., 2012) have identified the style passive compliance, which is characterized by a low level of activities and interactions with different actors. Customers tend to comply with what the service provider determines, which is in line with the role HFEC are willing to play. However, this study shows that these customers are nevertheless open to adopt smart energy services, as long as they can reap the benefits without much effort.

5.4.4 Customer engagement behaviors with smart energy services

Study results also showed how value cocreation practice styles trigger different customer engagement behaviors with smart energy services. The findings showed–that customers are primarily engaged with their houses and/or their electric cars, instead of engaging with a specific service, firm or technology. The engagement behaviors are sourced from different value cocreation practice styles that unveil a series of roles played around activities and interactions to use and improve the smart energy service to achieve customer goals. From this analysis, five customer engagement behaviors were identified: *actively orchestrating*, *learning and improving*, *knowledge sharing*, *co-developing*, and *complying* (see Table 2). While the first four engagement behaviors fit with the concept of customer voluntary contributions toward a service that go beyond the fundamental transactions (Jaakkola and Alexander, 2014), complying can be considered a disengagement behavior, reflecting the lack of willingness to go beyond service transactions in energy consumption.

Customer Engagement Behaviors (N=31)	**Activity (N=31)**
Actively Orchestrating (augmenting) (AHEM #11; GMEM # 10)	Monitoring and controlling the EV energy consumption and functionalities (#11) Monitoring and controlling my home energy consumption and production through app (#11) Programming home appliance (#4)
Learning and Improving (learning) (AHEM #8; GMEM #9)	Proactive Customization (#12) Problem-Solving (#12) Searching for information about new solutions (#5)
Knowledge Sharing (AHEM #8; GMEM #7)	Sharing usage experiences (#12) Sharing analysis and research (#7) Sharing schemas to co-develop (#3)
Co-developing (GMEM #6; AHEM #3)	Co-design solutions with community (#4) Integrate Solutions with community (#2) Developments based on research and forums inputs (#3)
Complying (disengagement behavior) (HFEC #10)	Monitoring energy costs through incomes (#10) Monitoring home comfort levels (#8)

Table 5: Customer Engagement Behaviors

The *actively orchestrating* engagement behavior was mentioned by interviewees as customer efforts to monitor and control the energy service solution in terms of consumption and costs, also considering home energy production through photovoltaic panels. Active orchestration can be related to augmenting engagement behaviors, meaning customers contributing resources such as knowledge, skills, labor and time to expand service usage in a manner that goes beyond what is offered by the service provider (Jaakkola and Alexander, 2014). Customers develop different efforts to achieve energy efficiency and reap the economic benefits, or to increase electric vehicle performance. One relevant characteristic of this type of engagement behavior is the ability to orchestrate different energy service solutions such as electric vhehicles, home energy production, smart applications, smart appliances, sensors, among others. As mentioned by an interviewee: *“I manage my energy consumption and production periodically through a smart application…”(AHEM_10).* Another interviewee mentioned: *“I integrated different apps to manage my car functionalites and charging status…(MEM_4).* The use of different energy system artifacts has been previously analyzed, but this research has focused on the use of a single device (Standal et al., 2020) . This study results bring new light into how customers orchestrate different devices and service providers simultaneously in the smart energy service context (e.g. smart apps or smart appliances), to increase system automation and efficiency.

Study results also identified *learning and improving* engagement behavior as the customer contributions of knowledge, labor, and time to gather and analyze information, as well as to improve or build a new energy solution with the aim of achieving sustainable and efficient energy consumption. One interviewee mentioned: *“I use the battery of my car to supply energy to my house during the night. I designed and developed the solution by my own…”(AHEM_11).* Learning and improving can be related to learning engagement behaviors, involving the development of mental rules and guidelines for processing relevant service-related information, acquiring new service knowledge, and ensuing behavioral modifications based on new service knowledge (L. D. Hollebeek et al., 2019). Study results show that learning and improving behaviors are important from the initial stages when customers seek for information and analyze multiple smart energy solutions, to the customization of their own solutions and continuous problem solving and improvement.

Smart energy service customers (either AHEM or MEM) have a strong online community sense that motivates them to share experiences and learn about how to manage and operate the. This *knowledge sharing* engagement behavior involves customer contributions by communicating specific knowledge or experience to the network for the purpose of creating value for the customer or others (L. D. Hollebeek et al., 2019), and influencing and supporting other customers (Jaakkola and Alexander, 2014). Interviewees mentioned that the sharing behavior is present since the early stages of smart energy service adoption, as service providers offer poor information and support to configure, assemble and adjust solutions, as well as to solve problems.

Moreover, customers interact with a myriad of artifacts such as smart applications or home energy management systems, which makes it harder for one service provider to offer integrated support.

Energy communities, as the cooperation among consumers to promote energy actions that provide direct benefits to citizens (European Comission, 2022) have become increasingly important for sustainable behavioral change, but have been mostly studied from the operational perspective which examines customer engagement with different energy solutions (Hope et al., 2018). This study extends this view, showing that customers can also be primarily engaged with online communities to use and improve the energy system through intensive interactions and knowledge sharing. In this context, online communities appear as the main go to for knowledge on smart energy services, replacing the main service provider in this role (Gonçalves et al., 2020). As mentioned by one interviewee: *"I have learned with the community how to drive an EV efficiently… Currently, I also share my experiences to help other customers" (MEM_4).*

Combined with the online community sense, the need to improve the service also motivates customers to co-design solutions with other customers. Study results show that MEM customers engage in *co-developing* engagement behaviors through which they contribute with their experiences and knowledge to design and develop new smart energy services, not only for themselves, but also for other customers. Differentely, while AHEM customers develop new solutions, they tend to focus on their own solutions, and not so much on co-developing solutions with and for other customers.. This engagement behavior can also be related to co-developing as contributing with resources such as knowledge, skills, and time to facilitate the firms' development of its offering (Jaakkola and Alexander, 2014). However, instead of co-developing with the main energy service company or provider, results show that co-developing new smart energy services takes place in and with the online community, going well beyond the control of one main service provider, as indicated by the interviewee: *"I developed my home energy and electric vehicle management system with the help of the community members…"(MEM_7).* Although previous studies (Jaakkola and Alexander, 2014) have identified similar types of engagement behaviors in other settings, this study highlights customer engagement behaviors centered on the online community involvement in the daily consumption and co-developing of solutions that is far from providers' control.

Finally, study results enabled the identification of a set of behaviors associated with customers who are disengaged with energy services. *Complying* behavior is characterized by the passive consumption of energy and the scarce contribution to manage and control home energy appliances and systems. This (dis)engagement behavior is predominant among customers in the HFEC style, who basically visualize consumption costs provided by the utility company in the monthly bill, and do not show interest in managing or controlling energy consumption. As mentioned by one customer: *"I see my energy consumption in the monthly bill…I analyze whether it is higher or lower than the previous month…";* or *(HFEC_7); "I don´t want to control anything regarding my energy consumption…" (HFEC_1).*

Overall, this study shows that energy customers may manifest different value cocreation practice styles that are tightly connected to specific customer engagement behaviors. For example, AHEM and MEM styles trigger Active Orchestrating, Learning and Improving, Knowledge Sharing and Co-Developing engagement behaviors, due to the intense activities and interactions towards the learning process, and smart service daily operations and improvements. In contrast, customers with HFEC value cocreation practice styles are related to the complying customer engagement behavior due to their low interest in the topic, few interactions, and basic activities towards the energy consumption.

5.5 Discussion

This study contributes to advance the understanding of how value cocreation practice styles and customer engagement behaviors are shaped by different roles customers play, as well by their activities and interactions with a myriad of other actors in the smart energy service setting, offering important insights for ESCOs and policy makers. Previous research has identified differences in consumer engagement at an individual household level (Whittle et al., 2020; Buchanan et al., 2016). This study goes beyond the household in general and provides a deeper understanding of multiple customer value cocreation practice styles, namely their activities and interactions with a myriad of actors in a broader customer network, and their related engagement behaviors. This more nuanced understanding of different value cocreation practice styles can support energy service companies (ESCOs) in developing solutions that are tailored to each of these groups (Daziano, 2020).

In the smart service context, customers are able to choose the proportion of energy that is coming from renewable sources, as well as to make informed decisions regarding shifting energy use to off-peak times (Helms et al., 2016). Since residential customers have various options, service companies need to identify which smart energy services best meet preferences and needs of their customer base (Fuentes et al., 2019). Study findings suggest that more service-oriented approaches can be considered to find solutions for the different barriers (i.e.: lack of knowledge and trust of the final customers, high costs of implementation) and for the improvement of policies to enable service companies to offer more tailored, attractive, and competitive smart energy services for different residential customers.

Study results also suggest how promoting customer engagement with energy consumption can be adapted to each group to be more effective. For example, in contrast with AHEM customers, HFEC customers may not be willing to proactively search for information about smart service solutions, or to actively manage their home consumption. However, they may be receptive to information and even to adopt these solutions as long as they do not require substantial time and effort. As such, instead of offering incentives for HFEC customers to become highly engaged prosumers (which they are not receptive to), it may be more effective to develop full smart energy solutions where energy service companies orchestrate the different service components to offer a smart, yet hassle-free energy solutions to these customers.

This has important implications for ESCOs in terms of the role they play and how they manage their relationship with customers. On the one hand, AHEM customers may expect ESCOs and energy utility providers to play the role of a facilitator, supporting customers to autonomously develop their own solutions, becoming partners in their proactive management of energy production and consumption, and contributing to the ongoing discussions in online communities. On the other hand, HFEC customers may represent an overlooked opportunity for ESCOs to become orchestrators, profiling customer needs and developing tailored full service smart energy solutions that can offer these customers energy efficiency benefits without the technology complexity and proactive management effort. The role of service providers as orchestrators and facilitators have been discussed in the service domain (Breidbach et al., 2016) but this study highlights how it can offer important insights in the smart energy context.

Evolutions in smart energy technology enable advanced energy customers to shift their energy consumption and reduce their customer reliance on the grid, bypassing the traditional energy service providers (Fuentes et al., 2019). This study uncovers how the relationship of advanced energy customers with the energy service provider becomes less influential, and how the relationship with other energy customers becomes key to foster adoption of smart energy services and engagement behaviors. While energy communities have been pointed out to foster energy transition, this study highlights that the role of online communities should not be overlooked, as they have an important role for advanced energy customers (AHEM and MEM) and can also boost the development of innovative solutions as customers share their experiences and actively contribute to co-develop new solutions. As such, this study indicates that ESCOs should foster their communication and relationship with customers considering the relevance of online communities. In contrast with HFEC, for AHEM and MEM, ESCOs may play the role of facilitators (Gronroos and Voima, 2013), creating opportunities for customers to engage with smart energy services, and moving from reactive service performers to becoming partners and proactive facilitators of customer value cocreation (Breidbach and Maglio, 2016). Overall, this study underscores the need to look beyond the technical aspects of the smart technologies to a broader service context, involving different actors that are part of the customer service network beyond the firm's control, so that ESCOs can better position their offerings within customer value constellations (Patricio et al., 2011).

5.6 Conclusion and Policy Implications

Smart energy services have attracted increasing attention as a valuable resource that can support energy system decarbonization (Parrish et al., 2020). There is evidence that some residential customers already engage with different smart energy services, but previous research shows considerable variation in these behaviors (Lopes et al., 2016), as well as in the enablers and barriers for value cocreation and customer engagement (Parrish et al., 2020). To address these challenges, this study offers an in-depth understanding of value cocreation practice styles and respective customer engagement behaviors with smart energy services. The study highlights how customers co-create value and engage with smart energy services in different ways. While some customers are taking the lead by proactively managing, customizing, and sharing energy service experiences with their communities, others remain disengaged and are only open to smart energy solutions if they do not imply significant effort to reap their benefits. Study findings reveal that advancements in smart home service and technologies are rapidly changing the energy systems, creating new opportunities and challenges for customers, energy service companies (ESCOs) and policymakers.

The in-depth understanding of value cocreation practice styles and customer engagement behaviors offer valuable insights for ESCOs to develop more tailored service offerings to better suit customer needs and overcome adoption barriers, therefore supporting customer transition from traditional to smart energy services. The identification of different groups typified according to the value cocreation practice styles and customer engagement behaviors can support ESCOs to offer nuanced service and incentives that are more robust, reliable, and flexible in line with the new paradigms of home energy consumption in the digital age. In this line, new ESCO services can consider different aspects such as autonomy (AHEM), supporting customers by participating in online communities (MEM), or developing holistic service solutions (HFEC). While literature has dedicated significant attention to study more advanced energy customers, some customers are still disengaged with smart energy services (BEUC, 2019), as reflected in the HFEC group. However, the examination of the value cocreation practice styles and respective engagement behaviors indicates that this group of customers may still be open to adopt smart technologies, although they are not willing to adopt the AHEM style. Given that hassle-free, high-consumption customers may represent a significant share of the residential market with interesting savings potential (Brown et al., 2022), this study shows that HFEC may be an interesting opportunity for ESCOs, if service companies are able to develop smart service solutions that have a good fit with their effortless value cocreation practice style.

Studies in mature markets indicate that ESCOs' can become facilitators, supporting customers in their decisions regarding available smart service offerings and carrying out general promotion, training and certification for advanced customers like those in AHEMS and GEMS styles (Bertoldi & Boza-Kiss, 2017). This position encourages ESCOs to assume a facilitator role, partnering with customers by offering a constellation of smart energy services that customers may choose, combine, and manage in an autonomous way.

On the other hand, ESCOs can focus on the orchestration of an integrated service for households that are open to adopt smart energy services as long as they reap the energy efficiency and saving benefits in an effortless HFEC style. In this context, policies can define the basis of more complete, full smart energy solutions, which do not require effort, active control, or autonomy from the customer side. This also implies the development of a set of rules to handle and protect customer data, namely data control and access rights, data use, data storage and data sharing (Mengolini & Vasiljevska, 2013) to ensure smart services that are well suited to HFEC's style and needs.

Study findings also show that some customers (AHEM and MEM) are fundamentally engaged with mobility, sustainability, and the community, shedding light on the social component of smart energy services and identifying the key role of online communities. These communities can enable customers, not only to share information and experiences but also to trade energy and co-develop energy community-based solutions in a near future (Geelen et al., 2013). This configures a different energy service network in which customers support and interact with each other, going beyond the energy company control (Burchell et al., 2016). In this context, ESCOs can assume the partner role in such communities to support, facilitate and engage customers in a different way. By positioning customers at the center of the energy network and playing a partnering role in online communities, ESCOs may better support their customers in overcoming adoption barriers. Overall, this study opens new forms for ESCO's to go beyond mere segmentation based on socio-demographics, to further segment customers according to value cocreation practice styles. Based on an in-depth understanding of the different styles, ESCOs can further identify to which style different customers belong, and then adapt their offering accordingly.

This study also provides relevant implications for policy makers. The understanding of the value cocreation practice styles and customer engagement behaviors can inform policies targeting households. For example, financial incentives have been positively correlated with the adoption of efficient energy solutions (Kwan, 2012). However, while this kind of incentives may be efficient to foster technology adoption, they are less efficient to foster energy service use in the long run, since the value for money is low and customer engagement with solutions decreases significantly along time (BEUC, 2019). In this context, the design of policies considering customer value cocreation and engagement behaviors can inform the development of incentives that are financially more attractive for final customers in the long run. Currently incentive policies aim to attract customers to adopt different energy solutions such as PV panels, smart appliances, home energy management systems, among others. However, policies could expand the attractiveness to ESCOs who can offer a set of solutions and services with incentives that will benefit the customer not only in the acquisition of energy solutions, systems or artifacts, but also through the efficient energy consumption and sustainable behavior (Soroye & Nilsson, 2010). In this context, policies can focus on incentives that increase the attractiveness of the market uptake of energy technologies in the short term and guarantee the long-term use of smart energy services.

This implies that the development of a set of incentives should appeal to different styles, instead of grounding the definition of policies on the peak and off-peak hours of the general household energy consumption (Bradley et al., 2016). For example, tariffs could be applied for AHEMS since they program appliances to work during the periods that the solar production is higher. In this context, tariffs can benefit not only PV panels' adopters in early stages, but also those who increase the use of the solar energy to achieve efficiency goals and self-sufficiency. This nuanced, service perspective can also increase the competitiveness among energy players as they try to offer innovative solutions, services and business models, and approach active and non-active customers in different ways, generating new opportunities in the market.

Another approach could be the generation of policies that support the ESCOs penetration in the residential markets by integrating different business models that could help to reduce customer' expenditure to implement a smart energy service and their responsibility for managing energy devices, thus leading in many cases to better outcomes for customer in HFEC style or similar groups. These differentiated services could also help activate the home energy management and assist with the integration of renewables (Ghasemian et al., 2020). One example would be an ESCO that owns and operates smart heaters in a residential building. This company could schedule the heater to heat the tank during times of high renewable production and low energy cost (Brown et al., 2022). This type of service for households provides efficient consumption through time shifting of electricity demand and savings without the customer intervention in the operation of the system.

Overall, building upon a service-oriented approach, this study highlights how going beyond engagement with smart technologies to value cocreation and engagement with smart energy services can broaden the perspective and open new possibilities to foster changing behaviors. Besides these policy implications, this research also brings together and encourages further research at the intersection of energy and service research. Despite the barriers faced by the energy companies to increase their participation in the residential energy market, the study highlights that a service-oriented approach can help them better understand customer contexts, value cocreation practice styles and customer engagement behaviors, aiming to develop tailored and nuanced smart energy services grounded on new paradigms of energy consumption to foster energy transition.

6 Study 3 - From Customer Engagement to Citizen Engagement - CESF (Citizen engagement strategies framework) applied to the energy context of a smart city

This chapter presents the development and the results of Study 3, which integrates and builds a shared ground to support the design of citizen engagement strategies through the development of CESF - Citizen Engagement Strategy Framework. This research leverages the understanding of customer engagement with smart service solutions in the previous studies to develop a framework and an approach to design strategies for citizen engagement.

6.1 Introduction

During the last decade, the discussion around energy consumption has attracted considerable attention to address the challenge of decreasing carbon emissions (Karnouskos et al., 2012), requiring the redefinition of energy use and supply systems (Tokoro, 2016a). This led to the emergence of smart energy services, which play a significant role in the sustainable households and communities of the future, enabling increased energy efficiency through the consumption and production of renewable energy sources. Smart energy services are defined as connected energy services that enable consumption and production management in real-time, efficient consumption through accurate information about energy efficiency, demand response services, and platforms that enable P2P (peer-to-peer) transactions, among others (Maier, 2016).

To address this challenge, governments and entities positioned energy supply to the final customers at the center of climate change discussion, as these customers are able to locally produce renewable energy through photovoltaic panels (renewable source) and support the electrical grid balance to decrease carbon emissions. This new scenario brings final customers closer to the operation of the grid and requires their active participation. As such, energy service providers are not only challenged to re-design the electrical infrastructure to integrate more renewable sources but also to engage citizens to adopt smart energy services (Ahlers et al., 2019). In this sense, citizen engagement with energy transition and new and smart energy services has become key to support providers. Citizen engagement is defined as ordinary people's ability to come together, deliberate, and take actions on services and decision-making that they have described as important in the context of a country, a state, a city, or a neighborhood (Gibson, 2006).

In the energy context, a successful energy transition requires engaged citizens to adopt smart energy services and participate in the cocreation and improvement of smart energy services with other stakeholders (Massey et al., 2019). This implies that citizens involved in such initiatives also become smart energy service customers and adopt engagement behaviors like knowledge sharing and co-developing (Gonçalves et al., n.d), enabling them to share experiences and provide inputs to the design of new services grounded on their smart energy experience. Despite the growing importance of citizen and customer engagement, an integrated vision of how to develop more nuanced engagement strategies for different citizens is lacking.

This highlights the importance of developing strategies to increase the levels of engagement that consequently foster the shift of citizens' role as customers from the passive consumption of traditional energy services to more proactive roles where citizens engage with energy prosumption (consumption and production) and with the cocreation of innovative smart energy services (Hamwi et al., 2016). As such, to address the call for such strategies, this paper develops a framework - Citizen Engagement Strategy Framework (CESF) to support the design of citizen engagement strategies in a smart energy service context, with an application to the development of engagement strategies with smart energy services in positive energy districts (Peffers et al., 2007;),; Grenha Teixeira et al., 2019) CESF was developed to support energy service providers and other stakeholders to create nuanced engagement strategies to promote more proactive customer roles concerning smart energy services, namely proactive usage, and the service cocreation to build smart energy services that enable clean energy production and efficient consumption. CESF contributes to existing research by offering a framework grounded on the analysis of citizen engagement and customer engagement that simultaneously covers different groups of customers and segments according to their respective engagement levels and different goals.

Building upon a Design Science Research (DSR) approach achieved through strategies, this paper is structured as follows: the conceptual background section covers extant literature on citizen and customer engagement in the energy context, particularly strategies to foster citizen engagement. The methodology section describes the DSR approach adopted in the study. The study findings detail CESF - a tool to support the development of citizen engagement strategies, encompassing its structure. Finally, the discussion section examines the study's contributions and implications for developing engagement strategies in smart energy service contexts using CESF.

6.2 Conceptual Background

From customer engagement to citizen engagement with smart energy services

Smart technology-enabled services associated to renewable and distributed generation are key to minimizing the impacts of climate change and addressing the governmental agenda related to the topic (Hoffman & High-Pippert, 2010). However, as the concept becomes mainstream, energy service providers have been challenged to implement new energy technologies, namely smart energy solutions that require more active participation on the customer side. This involves the development of new regulations and infrastructures that bring customers closer to the operation of smart energy services and the cocreation of new ones with energy service providers (Falco & Kleinhans, 2018). However, customers do not readily adopt smart energy services due to the higher costs to implement and unawareness regarding the benefits (Falco & Kleinhans, 2018).

Therefore, customer engagement has been gaining attention in the last few years in the energy context. This concept is often associated with the new energy technology paradigms requiring citizens not only to adopt smart energy services but also to proactively manage them to efficiently produce and use energy to decrease carbon emissions in the medium and long term (Ellaban et al., 2016). Customer engagement can be defined as customers' disposition to invest resources in their interactions with a focal object such as smart energy services (Brodie et al., 2019).

Moreover, engaged customers who are skilled users of smart energy services can join initiatives focused on developing and long-term use of a wide range of innovations and citizen-centric activities related to energy consumption and production (Massey et al., 2019). As such, understanding customer engagement with smart energy services contributes to the development of strategies to increase citizen engagement in the energy context, stressing the hybrid relationships between people and smart energy services that involve different goals, activities, and use of different smart artifacts (smart applications, appliances,…) and the different roles people can take on as users, consumers, protesters, supporters and prosumers (Ryghaug et al., 2018). As such, customer and citizen engagement approaches push the development of engagement strategies that strongly include citizens, also viewed as energy services customers in the energy transition context.

Recent energy literature indicates that analysis of citizen engagement has been increasing in the energy context (Crescenzo et al., 2020; Francisco & Taylor, 2019; Massey et al., 2019). However, the term has evolved without much agreement on how citizens should be engaged, which approaches are most effective, and what outcomes should be expected (Tokoro, 2016b).

In fields like social science and politics (Arnstein, 1969; Nelson & Stenberg, 2018), citizen engagement ranges from merely being informed of decisions and providing information and feedback (such as in public hearings) to advising on planned programs or controlling implementation. In such fields, citizen engagement efforts involve examining models that consider different levels of participation (Berger, 2009), recalling that other strategies to involve citizens in decision-making should be considered. As such, different models (Arnstein, 1969; Cardullo et al., 2019; Siminofski et al., 2020) offer a typology depicting the interplay between the powerless and the power holders.

In general, at the lowest steps, participants are provided with training sessions to learn about a topic and events are designed to educate them. The mid-steps involve officials providing information and seeking advice. Citizen surveys and public hearings are common approaches in this category. However, there is no assurance that citizen voices will be heard. At the highest steps are three degrees of power redistribution — partnership, delegated power, and citizen control. The partnership involves negotiations and trade-offs between citizens and officials. At the top are actions that give citizens a voting majority on decision-making bodies or control of policy and management, such as through decentralizing public services such as police, schools, and health to neighborhood governing bodies. (Arnstein, 1969;Preston et al., 2020).

In summary, the models such as the Arnstein Ladder (Arnstein, 1969) focus on strategies to increase citizen participation. Such models consider that citizens are heterogeneous, and as such, different participation strategies can be designed to target citizens according to their current level of participation in political decisions. Such models were highly considered to be applied in the energy sector in the early stages (Tokoro, 2016a). However, recent studies (Nelson & Stenberg, 2018) advocate that engaging energy citizens is not an isolated event that invites citizens to make decisions but a process that comprehends multiple components such as information, participation and cocreation.

Information encompasses providing basic information regarding a specific topic. The information content should be simple and concise in order to give an overall overview of the main concepts and benefits surrounding the topic. For example, explaining the main concept of smart energy services and the benefits in the medium and long terms. This concept involves one-way interaction, and there is no assurance that citizens will be heard (Arnstein, 1969; Nelson & Stenberg, 2018). Participation consists in allowing the citizen to increase the knowledge he/her has about a specific topic to boost the potential of adopting and improving. This concept enables two-way interactions between actors (Preston et al., 2020). For example, citizens are invited to join a platform or application to gain knowledge, discuss novelties in smart energy services and technologies, and improve their energy consumption patterns aiming at energy efficiency and sustainability.

Cocreation is related to the role citizens play within the design of a system, a service or decision-making that can range from using or giving feedback within integrated systems and services to playing a meaningful role in the design and implementation of innovative services. This allows increasing two-way interactions between actors due to their joint activities (Ahlers et al., 2019; Preston et al., 2020). For example, citizens share their experiences with a smart energy service, so they effectively become a living data point.

Citizen engagement strategies in the smart energy services context

In the energy transition context, several authors advocate for the design of strategies to foster citizen engagement (Crescenzo et al., 2020; Hope et al., 2018). These strategies may involve raising awareness through the interaction with other energy consumers (smart energy literacy, efficient energy consumption and benefits) aiming to provide more information, allowing the citizen to improve their home energy system to be more efficient by inviting him/her to be part of an online energy community, or cocreating innovative smart energy services to offer tailored services. Some studies have developed models and tools for designing strategies to address information, participation and cocreation separately. For example, promoting campaigns to attract the attention and inform a specific community (i.e.: schools) about the concepts and benefits of smart energy services (Nowotny et al., 2018), developing guide books targeting energy service providers and managers to help them to communicate with an overall community to promote the smart energy service offerings (Ahlers et al., 2019). Other methods focus only on strategies for cocreation, targeting local communication and participation hubs to design and implement innovative energy services and initiatives (Ahlers et al., 2019). However, a framework that enables the design of engagement strategies grounded on the information, participation and cocreation simultaneously and assuming that citizens can present different levels of engagement ranging from low to higher levels of engagement with smart energy services is still lacking. Such strategies are relevant for providers to engage a more significant number of citizens. Although engaging one group of citizens targeting to provide information or push participation or cocreation separately are appropriate for energy transition, strategies covering multiple segments targeting the three concepts simultaneously can attract more citizens to adopt the required active roles with an ultimate goal of smoothing the energy transition(Emmerich et al., 2020).

Another critical point to highlight is the definition of goals to achieve through strategies observed in previous engagement studies (Nowotny et al., 2018; Ahlers et al., 2019). Literature indicates that existing models address the goals to achieve through very generic strategies (Crescenzo et al., 2020). For example: providing information or promoting cocreation. As such, a detailed definition of the goals to achieve through strategies would support the generation of diverse, innovative ideas targeting the engagement of a specific group of customers. This detailing would be important to sharpen the engagement and develop more tailored strategies. However, the models that detail these goals are missing (Ahlers et al., 2019).

In summary, engagement strategies have been approached from the information or participation or cocreation perspectives, and such strategies are considered important steps toward a more holistic approach of citizen engagement. However, these strategies do not consider that different citizens and customers compose an energy setting (Massey et al. 2019) with varying levels of engagement, interests, perceptions, and knowledge of smart energy services. Consequently, tailored and nuanced strategies targeting heterogenous citizens and customers would engage them in the long run to support the energy transition. As such, considering the challenges surrounding the final energy customers and citizens, engagement strategies grounded on the customer engagement with smart energy services and the detailing of specific goals to achieve can enable stakeholders to create meaningful and prosperous smart energy services to change and establish new energy production and consumption paradigms (Perri et al., 2020). However, a framework based on these components to develop more nuanced and tailored engagement strategies is lacking.

6.3 Methodology

To develop a framework that enables the design of nuanced and tailored engagement strategies targeting different groups of citizens and customers to provide information, invite them to participate and cocreate, a design science research (DSR) approach was adopted, as this research method focuses on understanding the context, developing and evaluating artifacts that solve a class of problems (Hevner et al., 2004). These artifacts can be constructs, models, methods, and implementations that are innovative and valuable to advance the field (Peffers et al., 2007). This article develops CESF (Citizen Engagement Strategy Framework), which is a framework for developing citizen engagement strategies that consider the heterogeneity of engagement levels with smart energy services and the different goals to achieve through strategies that will be applied to energy citizens. As such, DSR was considered an adequate methodological approach to this study because of its technology background and focus on developing models and methods that address complex problems (Hevner et al., 2004) and innovative technology-enabled services (Beloglazov et al., 2015).

In this study context, DSR supports the development of an artifact (Peffers et al., 2007), namely a framework to address the lack of frameworks that enable the development of different citizen engagement strategies that encompass information, participation and cocreation simultaneously. In this sense, CESF development was grounded on a search process built upon existing literature on customer and citizen engagement, engagement strategies and respective models and tools to develop them. This knowledge enabled to come up with a solution to a defined problem (Peffers et al., 2007).

Moreover, the DSR method comprises the activities of building and evaluating (Hevner et al., 2004). In this study, "building" is the process of developing the artifact for a specific purpose and evaluating comprises the process of determining how well the artifact performs. As such, building upon Peffers et al. (2007) and Grenha Teixeira et al. (2019), CESF was developed following the process:

1. Identify the class of problems and the solution objective: The literature review supported the problem formulation and the solution objective for developing CESF, namely customer and citizen engagement with smart energy services (Brodie et al., 2011; Nelson & Stenberg, 2018; Hope et al., 2018), citizen engagement strategies (Crescenzo et al., 2020; Massey et al., 2019), the mechanisms to design such strategies like participation models and tools (Arnstein, 1969; Corsini et al., 2019) and service design grounded on DSR (Grenha Teixeira et al., 2019). Moreover, the study also covered relevant literature on citizen engagement initiatives and engagement goals in different energy projects, mainly focusing on citizen engagement strategy goals addressed by governmental entities, namely the European Commission (EIP SCC's Citizen Focus Action Cluster, 2016) to identify the challenge of creating an artifact to design engagement strategies in real and dynamic energy settings. As such, an objective was defined as a new artifact – a framework - that supports solutions to problems.

2. Designing and developing a solution to a class of problems: this phase comprises the development of CESF – Citizen Engagement Strategy Framework, its integrated tools and the implementation process. In this context, qualitative research (Gioia et al., 2013) can be used as part of the overall DSR method to examine and understand the context (Hevner et al., 2004; Peffers et al., 2007). As such, CESF used this approach to understand how citizens as customers use the smart energy services, encompassing daily activities toward energy consumption, the energy systems and devices involved in this context and the interactions with other actors. The qualitative study supported this phase through the analysis of ten semi-structured interviews (Appendix 3) with local customers to deeply understand the use of smart energy services, identify the citizen engagement levels and the customers' interactions with multiple actors to use and improve the smart energy services. Sampling proceeded on theoretical grounds, a common approach in qualitative research that guides data collection toward adequately developing the relevant concepts and categories (Gioia et al., 2013). Afterwards, interviews were literally transcribed and coded in NVIVO.

3. Applying the artifact and evaluating: The application phase regards the implementation of CESF in the design of citizen engagement strategies in the context of smart energy services. The evaluation phase assessed how well the artifact supports the development of new citizen engagement strategies in the energy context and its usefulness. This stage followed the DSR criteria (Peffers et al., 2007) and interaction design (Forlizzi et al., 2008), which involves the evaluation of usefulness and relevance. CESF was applied and evaluated along a European project (https://pocityf.eu/) to support the development of citizen engagement strategies with smart energy services related to positive energy districts. Positive energy districts are characterized by the annual net zero rates between the energy produced and consumed in an urban area (Shnapp et al., 2020). The city of Évora, Portugal, was chosen to implement the project positive energy districts. The city is considered a lighthouse, where the developed concepts and models will be replicated in other European cities. The project has mapped different smart energy solutions that would be implemented, such as home energy management systems, smart energy production and

increasing the penetration of electric vehicles to achieve the net zero objectives. In this sense, the project aimed to push active customer management and increase self-consumption of electricity and thermal energy to reduce energy use and carbon emissions. Positive energy districts' success requires that engaged citizens assume active roles to increase energy efficiency. However, the project struggled to engage citizens with such solutions and services. Therefore, CESF was applied in a real context to develop strategies according to the project needs and could be evaluated through a workshop with stakeholders with different backgrounds, including engineers, and project managers, among others. The session involved an initial brainstorming to generate as many strategies as possible for each engagement level and goal. After that, the strategies converged into a number of strategies according to the project's priorities and the resources available to implement such strategies.

Having described how design science research was applied to develop CESF, the following section introduces its conceptual structure. Later, the artifacts' application, evaluation and research contributions are detailed.

6.4 CESF - Citizen Engagement Strategy Framework

The Citizen Engagement Strategy Framework (CESF) integrates different perspectives sourced in literature, enriched through the qualitative study data analysis to enable the design of effective strategies targeting the engagement of citizens at different levels of engagement. As such, CESF is structured as a matrix that supports the development of multiple strategies, considering the levels of citizen engagement and the goals to be achieved (Figure 4). As such, one axis of the matrix (framework) is defined by the citizen engagement levels. The other axis is defined by the goals that will support the stakeholder in developing strategies for citizens at each level. The following sections detail each axis by explaining how the qualitative study supports this development stage.

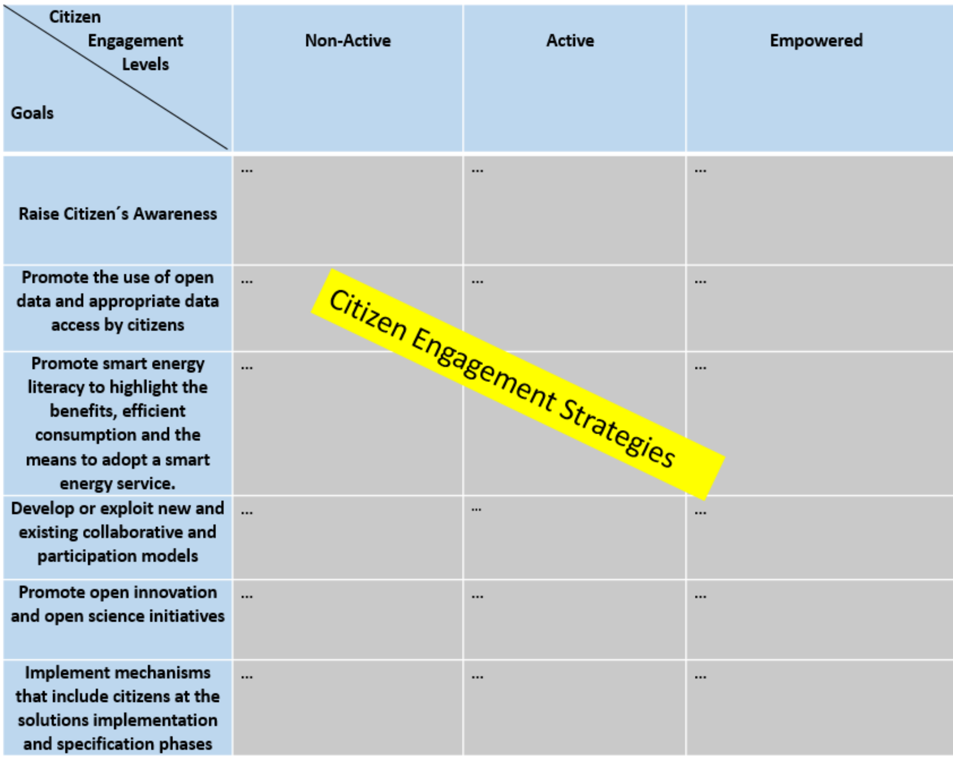

Figure 3: CESF - Citizen Engagement Strategy Framework

Citizen Engagement Levels

The citizen engagement levels are related to the extent to which citizens are committed and involved with the smart energy service, ranging from lower, medium, and higher levels. Citizens engage at different levels based on their understanding, involvement and perception of the services (Massey et al., 2019). In this study, the citizen engagement levels were derived from qualitative research. Firstly, the identification of the customer engagement behaviors in Study 2 supported the understanding that different groups of customers ranging from customers who are not smart energy service users and have little knowledge on the topic to those who are early adopters and skilled users that have different behaviors according to it such as complying, active orchestrating, co-developing, among others engage in different ways with the service. Secondly, the qualitative study performed in the positive energy district setting revealed that different groups could be part of the same setting (Arnstein, 1969), ranging from those who are not active in the positive energy districts to those with medium knowledge and interest in such services, and those who are advanced customers in terms of knowledge and skills to become autonomous users and support the cocreation, leading to the identification of three groups.

On the one hand, some customers are still looking for basic information about smart energy services and tend to have a lower engagement with such services and are yet to use them. The second group of customers has more knowledge about smart energy services and is willing to participate in some initiatives to adopt the energy service and increase knowledge has a medium level of engagement with smart energy services and an active in such initiatives. The customers who are capable of controlling and using the smart energy service to achieve energy efficiency and visualize the benefit of the smart energy services have higher engagement with the services and are empowered enough to cocreate smart energy services and sustainable solutions with different actors aiming the development of new smart energy services.

The study, therefore, identified citizen engagement levels as one axis of the matrix, divided into three levels of engagement: Non-Active, Active and Empowered. The *Non-Active* level is characterized by a low level of engagement with the smart energy services. In most cases, these citizens have little knowledge and interest in the services. Therefore, they are not interested in participating in engagement actions and cocreation initiatives. However, they are open to one-way communication that promotes literacy and awareness about energy efficiency, smart energy services and sustainable solutions.

The *Active* level represents an intermediate level of engagement, in which citizens may have some knowledge about the energy topic but have not adopted a smart energy service yet. At this level, citizens are open to using smart energy services and sharing their experiences with others. The topic is not new for them as they have already heard about energy solutions and services. As such, these citizens are interested in learning about the basic concepts to improve their energy consumption towards efficiency and how smart energy services can help them to achieve this goal. Therefore, they have the potential to increase their knowledge and participate in initiatives that will promote energy efficiency and the adoption of a smart energy service.

The *Empowered* level emphasizes the collaborative process to develop new smart energy services. This is the highest level of engagement in the framework, in which citizens are active customers and share their knowledge and experience to support the cocreation of new services. Citizens at this level are willing to influence, discuss, make decisions, and bring inputs and insights to be considered in solutions design and implementation. This is the highest level of engagement, in which citizens can co-design, co-produce, and more actively cocreate new smart energy services. These citizens have adopted smart energy services to save money and positively impact the environment by using smart energy services and solutions such as photovoltaic panels, electric cars, smart energy applications, and home energy management systems, among others that reduce carbon emissions.

Goals

The other axis of the framework is composed of a set of goals to support the strategy development. The goals defined in CESF are grounded on the three key concepts – information, participation and cocreation (Nelson & Stenberg, 2018). As such, CESF ensures that the strategies will cover different engagement levels according to goals achieved through strategies. The framework narrows down generic goals to specific ones (Table 6) to sharpen the strategies that will be generated. As such, a detailed definition of the goals to achieve through strategies would support the generation of diverse, innovative ideas targeting the engagement of a specific group of customers.

Key Concepts	Goals
Information	• Raise citizens' awareness
Participation	• Promote the use of open data and/or an appropriate access to data by citizens. • Develop or exploit new and existing collaborative and participation models
Cocreation	• Promote open innovation and open science initiatives • Implement mechanisms that include citizens at the service implementation and specification phases

Table 6: Goals approached in CESF

As such, five goals compose CESF (Table 6). Building upon governmental recommendations to engage customers in smart service settings (EIP, 2016). These goals are suggested to create and foster accessible and smart energy services for citizens to improve their quality of life and contribute to sustainable cities and a livable environment (EIP, 2016). As such, the goals suggested in the framework are as the following.

Raise citizens' awareness aims to inform the citizen about the potential advantages and benefits of smart energy services to enhance digital literacy at all levels and to create incentives and rewards for citizens, customers, and overall communities for their continuous engagement with such services. This goal is driven by the premise that smart energy services will converge with informed and connected citizens in an initial stage as people need to be aware of the main concepts and benefits to get an initial mindset around the efficient energy consumption and the services that will support such consumption (Harwood & Garry, 2015).

The second goal of *promoting the use of open data and/or appropriate access to data by citizens* focuses on engaging them with a smart energy service community by applying feedback loops to renew energy systems that culminate in the adoption of smart energy service and improve energy consumption to achieve energy efficiency. Urban areas can increase their potential to engage citizens through open data initiatives. Providing open data to citizens is envisioned to enable data management in real-time and citizen participation through interactions on dedicated forums and opinions space (Francisco & Taylor, 2019). This goal supports the development of engagement strategies to increase citizens' participation.

The goal of *developing or exploiting new and existing collaborative and participative models* also foster citizens' participation. This goal aims to use appropriate collaborative technologies and leverage existing digital social interactions to bring citizens positioned in the intermediate level of engagement (Active) to try the smart energy service, aiming for an upcoming adoption and efficient energy use. As the citizens at this level know smart energy, they can participate in some initiatives grounded on collaboration. Despite this initial motivation to engage in collaborative activities, it is necessary to facilitate citizens' participation and provide clear benefits for keeping up their interests (Kotilainen et al., 2018).

The goal of *promoting open innovation and open science initiatives* focuses on cocreation as an outcome. This goal aims to engage citizens in innovative projects developed by start-ups, research centers, and service providers, among others. It targets empowered citizens who are advanced and knowledgeable on smart energy services to co-generate new energy services ideas and concepts. Open innovation covers a range of innovation activities with external stakeholders to find solutions to problems and hand ideas off to partners (Seltzer & Mahmoudi, 2013). Cocreation can be seen as a sub-category of open innovation, as it is a strategy to get together different actors in order to jointly work towards the desired outcome (Kotilainen et al., 2018).

Finally, *implementing mechanisms that include citizens at the service implementation and specification phases* is considered an extension of the previous goal. The difference is that this goal focuses on other design phases like implementation and specification. It ensures that cocreation will take part in different stages of the smart energy service design encompassing ideation, development, and implementation. This goal aims to push more sustainable and inclusive smart energy services. It will benefit the quality and buy-in of smart energy services and solutions. Strategies supported by this goal consider that empowered citizens are naturally motivated to participate when the outcome directly affects them or their communities. Being part of a process to develop new things offers a sense of autonomy and makes the participants feel they are in control rather than being objects of it (Kotilainen et al., 2018).

As such, the goals are an integrative part of CESF as it will support and sharpen the generation of engagement strategies that covers the heterogenous engagement levels, ranging from the lowest (Non-Active), medium (Active) and higher (Empowered) levels. Building upon the characteristics of each level, the goals address the provision of information to raise citizens' awareness, foster participation and cocreation to invite citizens to get closer to the smart energy services and get involved in the design stages, respectively. Successful development and deployment of smart energy services require informed and connected citizens, open innovation, and combining knowledge and experience of various actors (Ahlers et al., 2019).

6.5 Application of CESF to designing Engagement Strategies with smart energy services in positive energy districts

Following the design science approach, CESF was applied and evaluated along a European project (https://pocityf.eu/) to support the development of citizen engagement strategies with smart energy services related to positive energy districts. Positive energy districts support Europe in the race to become the first carbon-neutral continent by 2050 as they produce at least as much or even more energy as they consume on a period basis (Ahlers et al. 2019). The project builds upon intelligent, customer-driven, and demand-oriented smart energy infrastructures to foster energy efficiency and increase sustainable and smart energy services, aiming to build positive energy districts. In this context, citizen management is essential to balance and optimize the energy grid and promote smart energy services to address the demand response. As such, the project and the positive energy block would succeed only if engaged citizens participates in different initiatives that encompass the integration do smart energy management with home energy production and consumption and electric vehicles and cocreation with multiple actors to develop innovative and tailored smart energy services to address the carbon neutral goal in the energy transition.

In this context, CESF was applied and evolved by supporting the definition of citizen engagement strategies. Building upon the qualitative study undertaken in the development phase, the three levels of citizen engagement were categorized and described (Non-Active, Active and

Empowered). The goals were refined according to the specific context of the project that addresses the need to engage citizens to actively use the smart energy services offered in the positive energy district to achieve higher levels of energy efficiency and participate in initiatives to cocreate different services and sustainable solutions to innovate and improve the systems and service offerings. For example, the generic goal "promoting cocreation among stakeholders" was refined to address the project context and needs to "Promote open innovation and open science initiatives", aiming to engage citizens in innovation projects developed by diverse stakeholders (start-ups, research centers, and service providers, among others).

Different solutions were mapped by the research team in the matrix, examining which strategies and solutions would target each level of customer engagement and would pursue each goal. This is an initial stage and evolved with the application of the framework in a real context.

After the mapping of the different solutions on the CESF framework by the research team, CESF was applied to generate strategies that engage citizens in the project's context and were further evaluated and evolved through a workshop with eight project stakeholders from different organizations and backgrounds who developed different types of activities such as engineering, communication, and project management. CESF was first explained in this workshop, and then a preliminary mapping of the engagement strategies was presented. A discussion followed this to analyze the existing engagement initiatives and generate new ones, considering the respective goals and engagement levels. The workshop session was supported by Miro software so that participants and researchers could visualize and observe the overall process and the strategies generated. Participants then agreed to a selected number of engagement strategies for each goal and engagement level.

Firstly, different strategies (Table 7) were designed grounded on the goals and the engagement levels to educate and inform citizens about energy-efficient and sustainable behaviors and foster awareness about the topic to push the adoption of the services. Secondly, invite the empowered citizens to support the project team in developing tailored, smart energy services. Table 7 is the result of integrating the strategies defined in the workshop. Grounded on the project needs and contexts, engaging the non-active citizens encompasses initiatives to educate and inform, such as building a gamification platform and smartphone apps with efficient energy consumption tips that will engage the citizen through relevant and new information about energy through digital platforms and apps that can be accessed by citizen anywhere and anytime. Providing energy knowledge is the first step to citizens engaging with the smart energy topic through usual digital mechanisms (applications and platforms) that inform and entertain them simultaneously (i.e. gamification platform). Such tools are powerful ways to educate people and influence energy consumption (Hamwi et al., 2016).

Strategies targeting the Active level firstly proposed the development of an application grounded on a home energy system that enables customers to visualize citizen energy consumption on his/her own or, eventually, the community/city energy consumption aiming to promote the use of open data and appropriate data access. Data visualization enables citizens to understand how they consume energy and the impacts on their monthly energy income (Park et al., 2017), which will culminate in changing the consumption behavior as citizens will perceive that they can control the smart service to increase energy efficiency (Gonçalves et al. 2020). Secondly, developing a collaborative model based on an online community using simple methods and language to approach citizens to the cocreative mindset. This would be an initial action to bring citizens to active levels to share their medium knowledge regarding smart energy services and technologies to push them to cocreate soon. Through these models, they can share their knowledge, interact with other actors to learn, improve their energy consumption, and increase their knowledge to potentially adopt a smart service and become a cocreator in the empowered level of engagement.

Citizen Engagement Levels / Goals	Non-Active	Active	Empowered
Raise Awareness	Design initiatives to educate and inform. Such as gamification platform, events, newsletter, and smartphone apps with efficient energy consumption tips. ….		
Promote the use of open data and appropriate data access by citizens		Develop an application grounded on a home energy management system that enables customers to visualize citizen energy consumption by his/her own or eventually, the community/city energy consumption. …	
Develop or exploit new and existing collaborative and participation models		Develop a basic collaborative model based on an online community using simple methods and language to approach citizens to the cocreative mindset. …	
Promote open innovation and open science initiatives			Implement crowdsourcing initiatives in online communities of advanced energy service customers (ex: EV communities, smart home communities).. …
Implement mechanisms that include citizens at the services implementation and specification phases			Promote panels and open calls that invite citizens, local start-ups and scholars to specify and implement an idea or a concept focused on the smart and sustainable energy services …

Table 7: Generation of Engagement strategies using CESF

CESF was evaluated by taking Peffers et al.'s (2007) design-science generic guidelines into consideration, and its contribution to new design methods was assessed according to Forlizzi et al.'s (2008) relevance criterion. As such, the framework was evaluated on its usefulness and relevance to support the design of engagement strategies (Peffers et al., 2007; Forlizzi et al., 2008)

The framework supported efficiently the project to generate engagement strategies to address specific services and solutions implemented in the project context. CESF helped to address nuanced and tailored strategies for different engagement levels and goals addressing a problem solution (Peffers et al., 2007). Concerning relevance (Forlizzi et al., 2008), the literature review indicates the lack of models that covers the design of strategies for different citizen engagement levels and goals grounded on three key pillars that involve information, participation and cocreation. As such, CESF sheds light on the heterogeneity of individuals and respective engagement levels that compose a positive energy district, enabling to cover tailored strategies for each segment group to foster the energy transition aimed by the governmental agenda.

Overall, CESF supported a project team to address the development of engagement strategies to engage heterogeneous citizens in the project's specific context. Such strategies address the need to engage citizens in the positive energy districts not only to support its building through collaboration and cocreation but also to ensure its use in the long term through energy efficient consumption and engagement with smart energy services. The strategies encompass the design of initiatives to educate, inform, participate, collaborate and cocreation through digital platforms and apps, application of collaborative models, promotion of hackathons and crowdsourcing initiatives to joint ideation and implementation of innovative services and solutions. The framework covered strategies ranging from the basic ones grounded on information to the advanced ones grounded on cocreation, reflecting the heterogeneous levels of engagement encountered in a positive energy district (project setting). The workshop enabled to apply and evaluate CESF in a real context, ensuring that the framework can be used under iterative, human-centric and cocreative approaches (Grenha Teixeira et al., 2019). The evaluation examined the usefulness and relevance of the framework. The framework demonstrated how it could facilitate the joint work of multi-disciplinary teams when designing engagement strategies and how it surpasses what existing models can do. Moreover, the European project provided a rich setting for CESF development and validation. It added an engagement strategy design effort to support citizens in heterogeneous engagement levels and specific goals to achieve through such strategies.

6.6 Discussion

This study offers CESF, a new framework to define strategies to foster citizen engagement with smart energy services which was developed following the design science research (Peffers et al., 2007; Grenha Teixeira et al., 2019). Therefore, this study makes three major contributions to theory and practice on citizen engagement with smart services.

First, the framework contribution can be positioned as an improvement, that is, a better solution for a known problem and context. The challenges addressed by CESF were identified along with other models for citizen engagement with different but complementary characteristics. While some models focus on increasing participation in governmental initiatives (Arnstein, 1969; Corsini et al., 2019; Cardullo & Kitchin, 2019; Simonofski et al., 2017), the models applied in the energy context advocate for a more holistic approach grounded not only on participation but also on information and cocreation (Nelson & Stenberg, 2018). Although authors (Massey et al., 2019; Ahlers et al., 2019) recognize that different citizens with different levels of engagement can be found in an energy setting, the respective models do not address strategies that cover all the groups simultaneously.

Second, CESF sheds light on customer and citizen engagement analysis to develop strategies focusing on different citizen engagement levels encompassing lower, medium and higher levels - Non-Active, Active and Empowered. The framework considers that energy contexts are composed of heterogeneous levels of engagement and different goals that can sharpen engagement strategies to invite multiple actors to participate in the smart energy services network in different ways, contributing to a successful and inclusive energy transition. For example, Non-Active citizens will raise awareness of smart energy services as they still do not have knowledge of the topic, Active citizens will increase their knowledge to increase efficiency and adopt a smart energy service in the short term, and Empowered citizens will contribute to the cocreation of energy services as they are considered advanced smart energy customers with knowledge on the topic grounded on their the daily experience with smart energy services and solutions in a real context.

Finally, CESF advances with the engagement research sourced in different fields like Service research with a focus on customer engagement and Energy with a focus on citizen engagement (Brodie et al., 2011; Marinova et al., 2017; Harvey et al., 2020; Crescenzo et al., 2020; Massey et al., 2019). CESF combines both perspectives to develop strategies to engage the citizen, considering that an energy citizen is an energy customer that consumes energy and has adopted or has the potential to adopt innovative smart energy services to achieve energy efficiency and benefit.

6.7 Conclusion and Future Research

This study offers a framework for stakeholders (service providers, managers, and citizens, among others) to design and co-design engagement strategies according to energy context. CESF was developed and evaluated in the real context of a European project focused on building a positive energy district that requires customers to adopt the smart energy services and play an active role in different stages, ranging from the services conceptualization until its implementation to succeed. However, engaging citizens with smart energy services has been challenging. Therefore, CESF was developed first to support the project team to generate different strategies for the engagement and second to advance with research by integrating the customer and citizen engagement to develop tailored strategies to engage citizens who are also energy customers that use the smart energy services and get experience and knowledge on the topic along time. This study also has some limitations, the study focuses on one context of smart energy service implementation (positive energy districts) in a city. This setting is one possible context of energy consumption and production. In future research, the study can extend the analysis to different communities of energy consumption. Therefore, CESF should be applied to other energy service contexts to get more inputs regarding the framework's extensibility, expanding the current study findings. It would be particularly relevant to study how the engagement levels changes in other contexts and how the goals to achieve through strategies can change. Future research can also apply CESF in different open contexts of interactions, such as online energy communities, smart cities, and smart villages, to understand how strategies changes according to each context of energy consumption.

Moreover, as smart energy services expand due to technological advances and implementing strategies, citizens can gain more experience and knowledge. As such, future research could focus on how citizens shift from Non-Active levels to higher levels of engagement (Active and Empowered) along the time. It can bring different relevant contributions to service providers and managers. Namely, it would be interesting to explore the strategies' impacts along the time as smart energy services and citizens become more mature in different energy contexts. This transformative vision of citizens can also enable managers to understand how to develop strategies considering shifting a citizen engagement level in the long run until reaching the Empowered level. As smart energy technologies evolve, the overall service energy provider will face new and interesting challenges as citizens tend to play active roles in the energy transition context. As such, this study offers a tool (CESF) to engage the citizens not only with smart energy services but also with the future of such services.

7 Contributions

The rapid expansion of smart technologies and the constant evolution to address governmental agenda and environmental emergencies enabled people to control and measure the impact of their actions on the future in different contexts that range from a city to a household (Tokoro, 2016a). However, the development of smart energy services has focused on the technical aspects, overlooking other actors' impacts on the service or how they may be affected. This technology focus may hamper sustainability and long-term adoption as it fails to consider broader social implications that may comprise the ability of future generations to meet their needs. In this line, the service community has defined the design of sustainable service ecosystems (Field et al., 2021) and the critical importance of connections involving actor roles and contexts of the customer experience (Ostrom et al., 2021) as research priorities.

Based on the challenges and research objectives of Chapter 1 and Chapter 2, this thesis addresses the lack of a deep understanding of how customers experience and engage with smart service (Wünderlich et al., 2015) and the respective constructs that can leverage and impact the service to foster its potential and foster service innovation (Ostrom et al., 2015). These challenges reflect the need to understand the smart service from the customer side to develop strategies that can effectively facilitate customer engagement with such services.

To pursue these objectives, this research comprised three studies – Study 1 - Understanding the customer experience with smart services; Study 2 - From Smart Technologies to Value Cocreation and Customer Engagement with Smart Energy Services; and Study 3 - From Customer Engagement to Citizen Engagement - CESF (Citizen Engagement Strategies Framework) applied to the energy context. The overall research has enabled a deeper understanding of customer experience, the identification of value cocreation practice styles, and customer engagement behaviors associated with smart services. Building upon this understanding, the thesis developed a framework to generate citizen engagement strategies.

The energy context emerged as motivation during the preliminary stages of the research. The residential smart energy service was adopted as the empirical setting for Study1 and Study 2, which focused on customer experience, value cocreation, and engagement. Building upon this understanding, Study 3 developed a citizen engagement strategy framework in the context of Positive Energy Blocks. The following sub-sections discuss the research contributions in more detail.

7.1 Study 1 - Understanding the customer experience with smart services

Smart services have been gaining attention in the last decade as smart technology penetration has increased in today's service world (Rust and Huang, 2014). More recently, driven by advancements in communication technologies, energy efficiency and more broadly, the Internet of Things, the possibility to remotely connect to objects and products has given rise to the emergence of smart services (Wünderlich et al., 2015). Since this is a new service setting, the customer experience can be different, and new opportunities can arise (Verhoef et al., 2009). However, there is no consensus about how customers experience these services, particularly in terms of customer perceptual responses and contextual factors and how they impact the overall experience.

As such, Study 1 offers an in-depth understanding of the customer experience with smart energy services by examining customer perceptual responses to smart and connected service environments and enriching this understanding by outlining how contextual factors (in terms of goals, activities, actors, and artifacts) influence the customer experience. The analysis of a multidimensional set of perceptual responses (i.e.: controllability, visibility, relationships, accessibility) and the contextual factors such as goals, activities, actors, and artifacts show that smart services enable a more autonomous experience, wherein customers can integrate a myriad of actors and artifacts and expect the main service provider to support them in taking the lead.

Smart technologies have profoundly changed the service environment, but research on customer experience with smart services is scarce (Nancy V. Wünderlich et al., 2015). As a contribution, Study 1 provides an in-depth understanding of customer experience in this new context and discusses relevant implications for management and service research. The study highlights how these customers are empowered and are taking the lead, valuing the controllability, visibility, self-configuration, autonomy, and sustainability offered by smart services contributing to a more in-depth and nuanced understanding of the customer experience with smart services

Moreover, the study extends knowledge on service in complex human-centered service systems (Breidbach et al., 2016) by illustrating the interdependencies between goals, activities, contextual factors and perceptual responses to consume smart energy services. Such analysis enables a better understanding of the context within which the experience unfolds and the perceptual dimensions embedded in this smart context.

This study builds a comprehensive understanding of the customer experience with smart energy services in a residential context, addressing the first research objective of understanding how the customers experience smart services and answering the first research question (*what are the drivers and context of customer experience with smart services?*)

7.2 Study 2 – From Smart Technologies to Value Cocreation and Customer Engagement with Smart Energy Services

Aiming to gain an in-depth understanding of smart services, value cocreation and customer engagement were analyzed. Studies recognize value cocreation and customer engagement in smart energy services as crucial (Böhm & Neumann, 2017; Burchell et al., 2016). Recent studies address value cocreation with smart energy services from organizations' perspective (Tokoro, 2016b), and customer engagement studies concentrate on offering isolated customer incentives, which has been shown insufficient to engage customers in the long term with smart energy services (Stephens et al., 2017). However, a deep and cohesive comprehension of both concepts is lacking (Niesten, 2016). Therefore this study offers an in-depth understanding and identification of value cocreation practice styles and customer engagement behaviors with smart energy services that can push the development of new smart value cocreating services (Breidbach & Maglio, 2016) and ensure long-term consumption and behavioral change.

As such, Study 2 identified three value cocreation practice styles and five customer engagement behaviors. In this context, Study 2 contributes to smart service literature through the analysis of different groups of customers to understand how activities, role play, and interactions leverage how value will be created and cocreated in the customer sphere (Grönroos & Voima, 2013) and consequently generate customer engagement behaviors which are keys to guarantee the adoption and long term use of smart and sustainable services.

The study reveals that each group develops different engagement behaviors, indicating that promoting customer engagement with sustainable energy consumption can also be adapted to each group to be more effective. The study uncovers how the relationship of advanced energy customers with the energy service provider becomes less influential and how the relationship with the community of other energy customers becomes a key to fostering the adoption of smart energy services and sustainable engagement behaviors. Moreover, the nuanced understanding of different value cocreation practice styles can help managers and policymakers develop more nuanced solutions and policies tailored to each of these groups (Daziano, 2020).

Study 2 builds a comprehensive understanding of value cocreation and customer engagement, identifying the value cocreation practice styles and the related customer engagement behaviors with smart energy services in a residential context. The study addresses the second research objective of understanding value cocreation and customer engagement in smart energy service settings, leveraging the behavioral change and the adoption of sustainable and smart energy services, and answering the second research question (*how do customers cocreate value with smart services, and how does that lead to different engagement behaviors?*).

7.3 Study 3 - From Customer Engagement to Citizen Engagement - CESF (Citizen engagement strategies framework) applied to the energy context of a smart city

Pushed by the emergency of the massive penetration of smart energy services, citizen engagement has been primarily approached in recent studies to invite citizens and energy customers to support and engage with energy transition (Simonofski et al., 2020; Francisco & Taylor, 2019). However, other studies point out the lack of strategies to cover citizen engagement in the smart energy service context (Crescenzo et al., 2020; Massey et al., 2019) that encompasses not only citizen participation but the provision of information to engage new smart energy citizens and the invitation to cocreate with multiple actors aiming the development of new and tailored smart energy services from ideation to implementation respectively (Nelson & Stenberg, 2018). Moreover, existing models (Ahlers et al., 2019) for the development of citizen engagement strategies do not consider the heterogeneity of citizen engagement levels in a smart energy service setting and the goals to achieve through strategies that enable the development of tailored and nuanced engagement strategies to involve different groups of citizens in the energy transition instead of a single group.

Responding to the call for developing mechanisms to develop strategies that increase citizen engagement, Study 3 offers CESF (Citizen Engagement Strategies Framework). This framework enables the development of nuanced and tailored citizen engagement strategies, considering the engagement levels in the smart energy setting and achieving goals with such strategies.

This study fosters engagement through the CESF – Citizen Engagement Strategies Framework that integrates customer and citizen engagement concepts to develop engagement strategies targeting citizens at different engagement levels. The framework's final aim is to increase citizen knowledge of smart energy services, participation and cocreation in innovative smart energy services (Nelson & Stenberg, 2018) through engagement strategies that cover different groups of customers and different goals will be achieved through such strategies.

Moreover, building upon customer engagement (Brodie et al., 2011), this study enriched the analysis on citizen engagement and considered the customer engagement with smart energy services that encompasses the understanding of the energy consumption context of use that includes devices, actors, service providers, activities, and citizens' perceptions of the services as key aspects to developing efficient engagement strategies. The framework sheds light on the customer component of citizen engagement since citizens are also users of smart energy services.

As such, Study 3 contributes to smart energy service by developing a novel method that will address the development of a number of tailored engagement strategies instead of one single strategy that would not address the heterogeneity of engagement levels in a community.

Finally, Study 3 develop a framework to generate tailored and nuanced citizen engagement strategies. The study addresses the third research objective of developing a framework to support the development of strategies to foster customer engagement with smart energy services in different ways and answers the third research question (*what kind of strategies can be pursued to foster customer engagement with smart services towards energy transition?).*

7.4 Thesis Contributions

Overall, this thesis offers two major contributions to service and energy research: a more in-depth and nuanced understanding of the smart service in the energy context and a new framework for developing citizen engagement strategies.

First, the thesis addresses the need for a deep understanding of smart services that are profoundly changing the service settings (Wuenderlich et al., 2015) and the research priority that calls for an in-depth understanding of the new technology-based services in changing and complex environments, through the in-depth and nuanced understanding of customer experience, value cocreation and customer engagement with such services (Ostrom et al., 2015; Ostrom et al., 2021).

As such, this thesis contributes to research by narrowing down the analysis of the customer context of service use, interactions, and perceptual responses that goes beyond the providers´ control and takes place in the customer context to understand how the customer experience the smart service in smart energy contexts. The extended analysis of the customer context during this experience that encompasses the actors' roles, activities and interactions shed light on the identification of value cocreation practice styles and the customer engagement behaviors with such services. Such analysis addresses the value creation priorities, which focus on value as perceived by customers addressed in new service contexts (Ostrom et al., 2015) and customer engagement priorities, which focus on deepening the investigation of engagement with new forms of technology, and in complex and diverse contexts (Ng et al., 2020). This integrated analysis contributes not only to the development of nuanced and tailored smart energy services but the long-term use of such services, which is crucial for the success of energy transition.

Second, this thesis also contributes to a new framework for developing citizen engagement strategies in smart energy services contexts, aiming to address the calls for understanding how different customer engagement approaches. Namely, citizen engagement affects service design processes and outcomes (Ostrom, 2015), the further investigation of different levels of engagement to enlarge the service offerings grounded on specific customer needs and contexts (Ng et al., 2020), and generating customer engagement, especially when there is a greater demand for increased participation (Ostrom, 2015). In this sense, CESF enables the generation of nuanced and tailored engagement strategies targeting citizens and energy customers positioned in different levels of engagement, ranging from the lowest to the highest level, to increase not only citizen participation but the provision of information and cocreation of smart energy service in a multi-actor network. The framework matrix is complemented by a list of goals that sharpen the generation of engagement strategies for each engagement level.

Finally, this thesis sheds light on the importance of connections, evolving actor roles, activities, artifacts, and goals to identify not only the customer experience with smart service but also the value cocreation practice styles and customer engagement behaviors during this experience. Moreover, the thesis contributes to a framework that enables the generation of tailored and nuanced engagement strategies with a particular focus on different customer engagement approaches (citizen engagement) that has been considered a way to maximize the impacts of a successful energy transition.

8 Conclusions and Future Research

This thesis addresses the need for an integrative understanding of smart service in the context of daily consumption. As such, it aimed at comprehending and integrating service perspectives like customer experience, value cocreation, and customer and citizen engagement to characterize the smart service from the customer side and describing how these concepts can foster smart service innovation.

As such, three studies were developed. The first study offers an in-depth understanding of customer experience with smart services. The study contributes to smart service literature by providing insights into technology-based perceptual responses identified and discussed in previous studies (i.e.: visibility, autonomy…) (Wunderlich et al., 2015; Wolfinbarger and Gilly, 2003) and contributes to deepening the understanding of customer experience with smart services by capturing the perceptual responses that emerge in this new setting. Moreover, the study offers a rich understanding of the contextual factors (goals, activities, actors and artifacts) and multi-actor relationships that enable and support the customer experience with smart services.

The second study offers as a contribution the understanding of value cocreation and customer engagement in the smart energy service context, showing how value cocreation practice styles and customer engagement behaviors are shaped by different roles customers play, as well by their activities and interactions with a myriad of other actors in the smart energy service setting. Moreover, this study contributes to research and practitioners by providing a more holistic understanding of multiple customer value cocreation practice styles, namely their activities and interactions with a myriad of actors in a broader customer network and their related engagement behaviors.

The third study offers as a contribution a new framework to develop citizen engagement strategies in a smart energy context. CESF contributes to research by shedding light on customer and citizen engagement to develop strategies focusing on heterogeneous citizen engagement levels (lower, medium, and higher levels) and different goals to sharp engagement strategies aiming to invite multiple actors to participate in the smart energy services network in different ways. The framework contributes to successfully shifting from traditional energy settings to a smarter energy context required in the energy transition.

These three studies compose two substantial contributions to the service and the energy: an in-depth and nuanced understanding of the smart service in the energy context through the examination of customer experience, value creation and customer engagement with such services and a new framework for developing citizen engagement strategies., and a new framework for designing engagement strategies to foster the citizens' information, participation and cocreation of innovative smart energy services grounded on customer engagement analysis and citizen engagement.

Despite the efforts to advance the understanding of smart service on a daily basis from the demand side, this investigation also has some limitations, which indicate directions for future research. Firstly, all investigate smart services related to the energy context. While rich and timely, the energy-related smart service setting is only one possible context for smart services. Future research can study other smart service contexts and draw comparisons between them. It would be particularly relevant to understand how the customer experience perceptual dimensions changes in different contexts and how this depends on the prevalent smart artifacts, goals, and activities in each context. Moreover, understanding the extent to which value cocreation practice styles, customer engagement behaviors, and citizen engagement levels vary would also be relevant.

It implies a more in-depth comparative analysis of different groups of customers to bring relevant contributions to managers and policymakers. The studies focus on residential smart energy contexts that encompass services offerings grounded on home energy management, electric vehicle use and management, and a positive energy district. These settings are possible contexts for smart energy consumption, but other energy contexts can be examined according to the service offerings. In future research, studies can extend the analysis to different communities of energy consumption that aim to become smarter and more sustainable by focusing on smart energy service solutions (i.e.: commercial and rural contexts of energy consumption) to examine to what extent the customer experience, value cocreation practice styles and customer engagement behaviors vary.

The thesis indicates that examining smart service in a customer context goes beyond the dyadic relationships between service providers and customers to focus on designing new service networks and highly autonomous customers. In this context, this thesis addresses an emerging concern about understanding social structures and reconfiguring new service ecosystems based on novel practices (Edvardsson et al., 2011) typical of smart services. Future research studies can explore customer experience in more contexts of interactions, such as smart cities and smart villages, to understand how the interactions change smart energy services grounded on open access and smart technologies.

Finally, this thesis supports researchers, academics, and practitioners from diverse areas to have a more integrated perspective on smart energy services that go through a profound change with the rapid evolution of smart technologies and with the increasing participation of the customer in the service operation who wishes for a connected and sustainable lifestyle. As such, researchers and practitioners take advantage of this investigation to situate their work better, intensifying the use and development of this approach and, therefore, expanding the frontiers of smart services.

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Appendix 1 – Study 1 - Interview Protocol

Semi-structured Interviews – All the customers (N = 31)

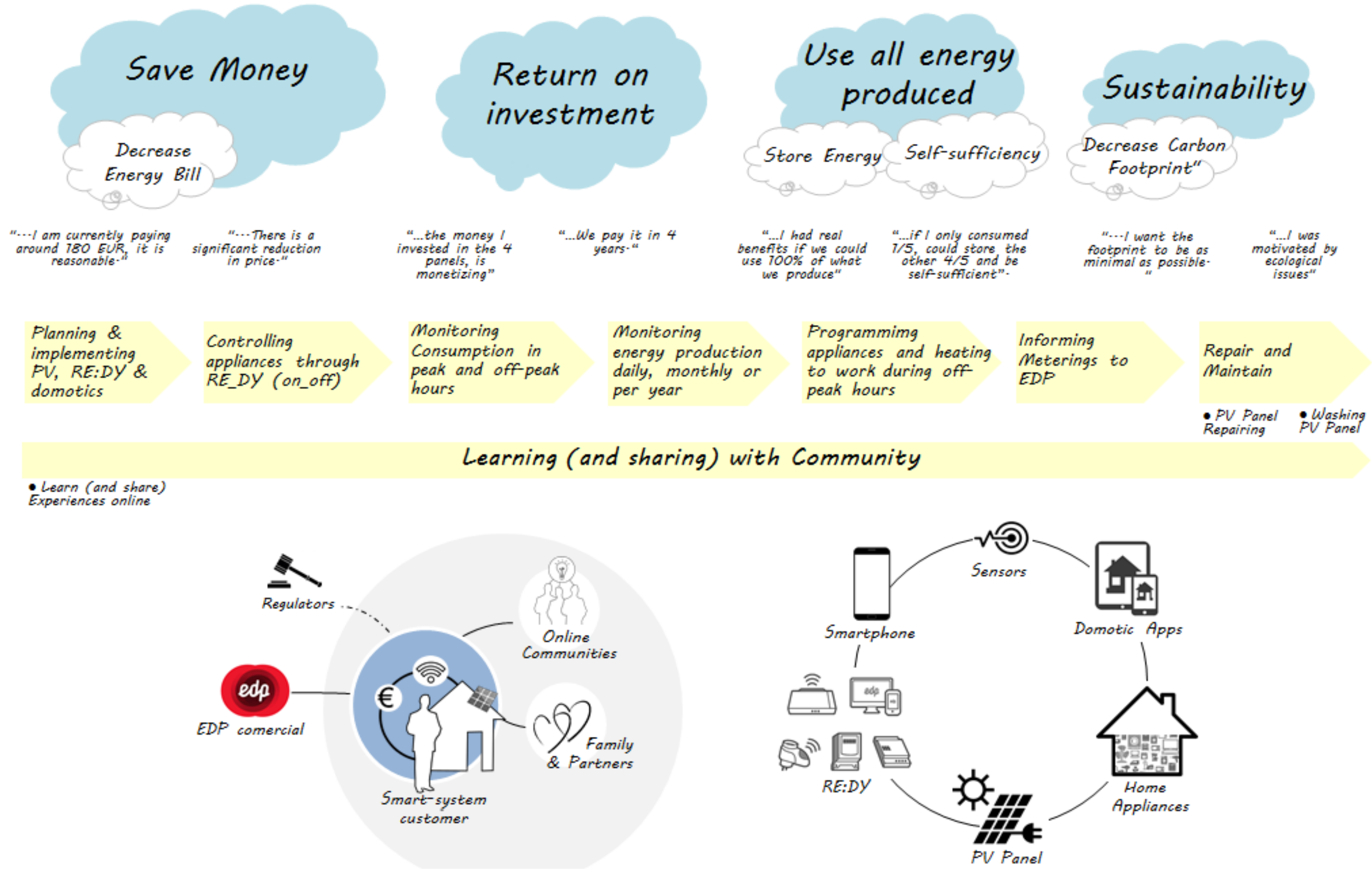
1. Which smart home/energy services do you use?
2. How do you use them?

- How did you come to know about smart energy services? How do you get information?
- Can you describe your daily routine of energy consumption?
- What kind of goals do you have?
- With whom (people, service providers) or with what (technologies, devices) do you interact with?

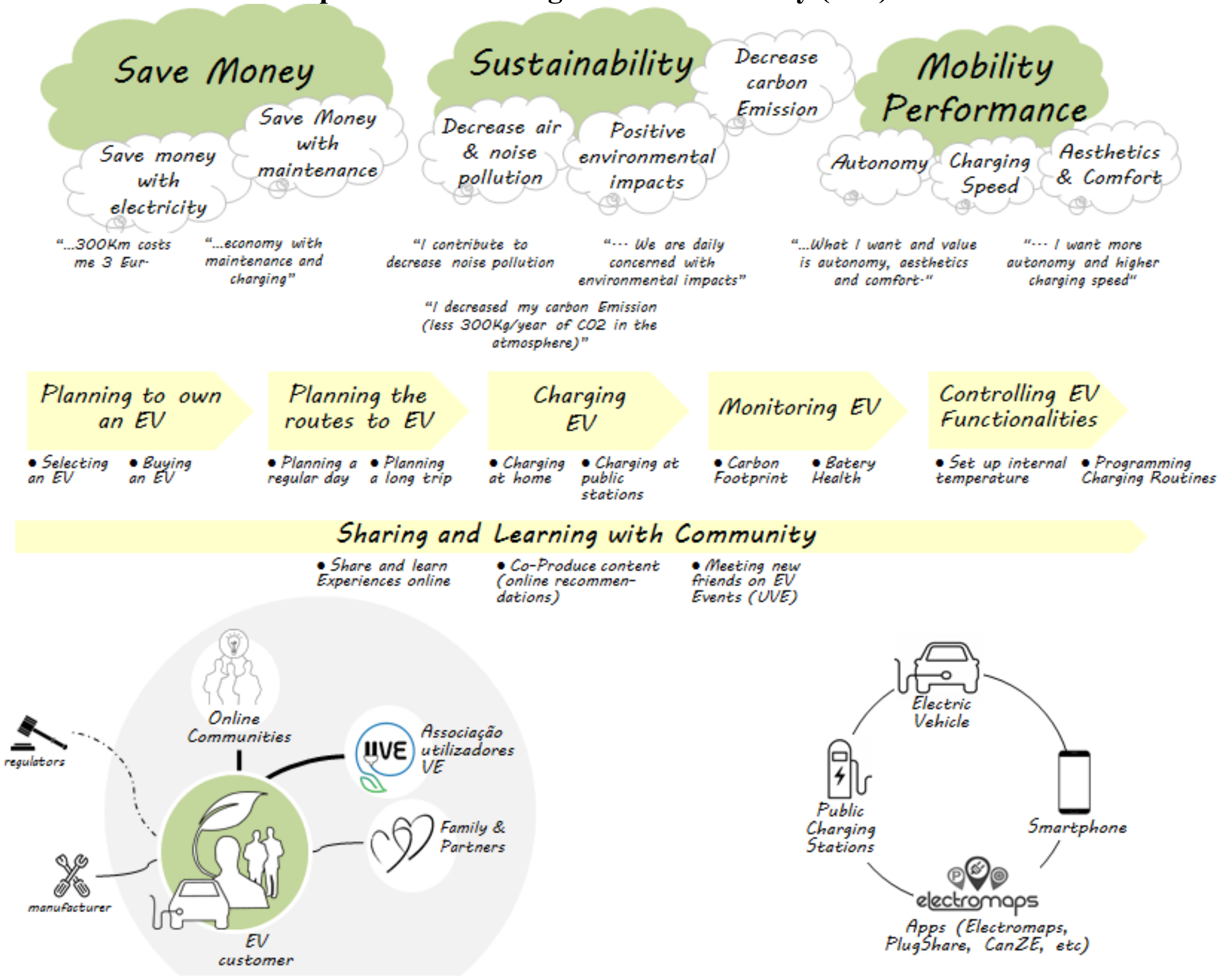
3. What kind of role do you see yourself playing with smart energy services?
4. What do you think about smart energy services?
    - What do you like and dislike?
    - What is your experience with the smart services you use?

Appendix 2 – Study 1 - Customer Experience Modelling Diagrams.

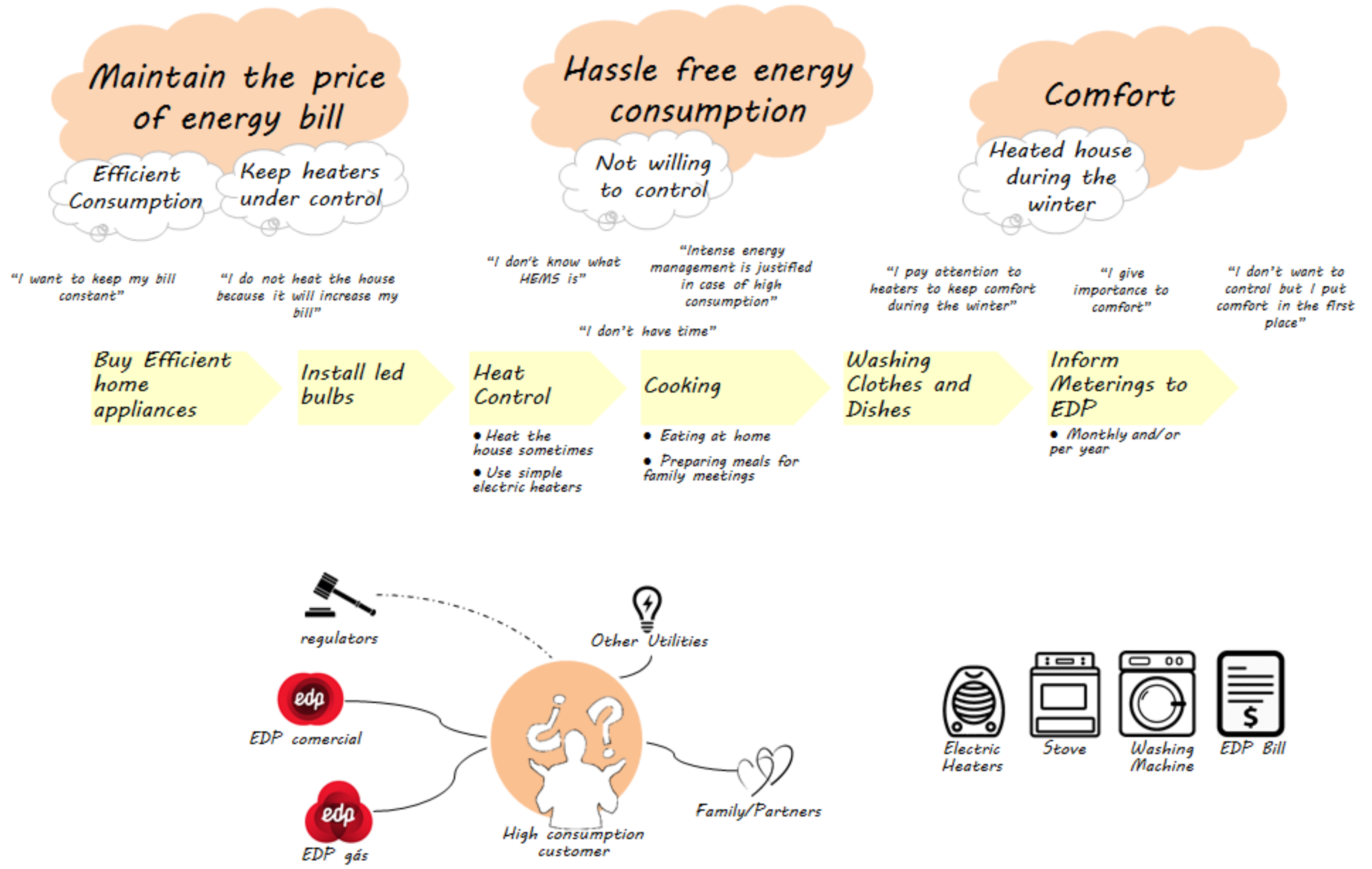
Customer Experience Modeling - Advanced Smart Energy (ASE) customers



Customer Experience Modeling - Electric Mobility (EM) customers



Customer Experience Modeling - High-Consumption (HC) residential customers



Appendix 3 – Study 3 – Interview Protocol

Specifically, the interviewer starts the conversation by covering the following areas:

Welcome participant.

Purpose of the interview, context (the project) and the company affiliation.

Why this person was selected for the interview.

Informed Consent and Confidentiality issues.

Amount of time being requested (30 minutes to 45 minutes).

The moderator will audio-record the interview.

Main interview topics and probing question/topics:

Understanding the citizen context:

Tell me about you and your house:

Age, gender, profession

Type of household (apartment, house)

Type of ownership (own, rent, lodger, other)

Area of household (m^2)

Number of people living in the house

What kind of services/solutions do you have/use?

For what do you use them?

Understanding the daily energy consumption:

Are you interested in, or are you managing your energy consumption?

What is important in managing your energy consumption? Why are you doing it?

Why are you not interested in managing your energy consumption?

How do you manage your energy consumption? Through what activities, for example?

What do you think are the most important daily activities that consume energy?

What do you like or dislike about the products/services you use?

What would make these products/services more useful for you?

With whom do you interact to managing the energy consumption? (family, service providers, communities)?

Understanding citizen participation in local/online communities/city

If you would make a next step in reducing energy consumption or making it cheaper/ produce your own, would you like to do it together with others? Or would you prefer to do it alone?

If you would like to do it together, are you already part of a community with whom you could do this?

Or would you like to be part of a different community? What should this community look like and do? Take up together?

Understanding the citizen view and participation:

Could you give a brief description of your city? Do you live in the new or old part of the city? How do you see the historical and cultural heritage of your city?

How do these heritages influence your daily life?

Do you participate in the city hall initiatives (Ex: sustainability and recycling campaigns, cultural events, etc.). Could you describe them?

How do you interact with the municipality?

Do you envision the implementation of new solutions at the Historic Centre of your town? What solutions would you like to see there?

Understanding citizen engagement with home energy consumption/ smart energy services:

Do you usually try to be informed about how actively manage your home consumption/smart energy services?

Do you carefully consider and plan your energy consumption/usage of smart energy services?

Does home energy consumption mean a lot to you?

What do you do to reduce/improve the energy consumption system of your house?

Understanding the citizen engagement with POCITYF solutions

Would you be interested in an e-car or e-car sharing? Why or why not?

Would you be interested in producing your energy and sell it? Why or why not?

Would you rather store energy in batteries? On which does this depend?

If you would buy new energy systems, what would be the first thing you would add to your home?

Understanding the citizen engagement with e-mobility

What kind of electric vehicle do you have? (car, motorcycle, bike?)

For what purpose do you use it? (work, leisure time)

What kind of services/gadgets do you use to manage your vehicle?

How do you charge your e-vehicle? (at home, in a public charging station)?

What do you like and dislike?

Are you part of any community dedicated to sharing experiences with electric vehicle?