Energy Patterns for Business Model Innovation

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Abstract English

Several transformations are occurring in the energy sector, from new emerging technologies, governmental pressure for decarbonisation and clean energy targets, to new market regulations. This changes impact on how the energy is produced and distributed to consumers, increasing the urge for energy utilities to innovate their traditional established business models, to remain competitive in the energy landscape. Business model innovation is essential to organizational performance, and it has the power to change the logic of entire industries.

Business model patterns are a promising tool to support business model innovation, which can be described as solutions to recurrent problems in a business model context. Although there are several published collections of business model patterns, a structured overview on energy patterns in order to support business model innovation in the energy field is missing. In the interest of filling the gap between business models and the energy sector, an energy pattern taxonomy for business model innovation was created. Applying the modified-Delphi card sorting methodology by Paul (2008), in an iterative way, 1 expert in business models and in the energy field was asked to perform a card sorting activity in a model revised and validated by 2 other experts in a previous phase, resulting in a taxonomy with 51 energy patterns organized in 10 meaningful groups. This pattern taxonomy is useful to help energy utilities to innovate and reform their business models, and it can be used from academics and scholars to managers to innovate the business models of their firms.

Keywords: Business model innovation; business model patterns; energy

Abstract Portuguese

O sector da energia está a sofrer diversas transformações, desde novas tecnologias emergentes, pressões governamentais face a metas de descarbonização e energia limpa, a novas regulações do mercado. Estas mudanças impactam na forma como a energia é produzida e distribuída aos consumidores, aumentado a urgência de inovação das modelos de negócio estabelecidos das *utilities* energéticas, de forma a manter a sua competitividade no sector. A inovação de modelos de negócio é essencial ao desempenho das organizações, tendo o poder de afectar a lógica de negócio de todo o sector.

Padrões de modelos de negócio são uma ferramenta promissora para apoiar a inovação, sendo descritos como soluções já comprovadas para problemas recorrentes. Apesar de existiram diversas colecções de padrões de modelos de negócio na literatura, está em falta uma visão global e estruturada sobre padrões de energia. No interesse de preencher a lacuna entre modelos de negócio e o sector energético, foi criada uma taxonomia de padrões de energia para apoiar inovação no sector. Aplicando a metodologia Delphi modificada (Paul, 2008), de uma forma iterativa, 1 especialista em modelos de negócio e em energia realizou uma actividade de *card sortig* num modelo revisto e validado por 2 outros especialistas, numa fase anterior, resultando numa taxonomia com 51 padrões organizados em 10 grupos significativos. A taxonomia final resultante será útil para apoiar as *utilities* energéticas a inovar e reformar os seus modelos de negócio, podendo ser usada desde académicos a gestores com o objectivo de inovar os seus modelos de negócio.

Palavras-chave: Inovação de modelos de negócio, padrões de modelos de negócio, energia

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List of abbreviations

CES	Cloud energy storage
DRP	Demand resource provider
DSM	Demand side management
DSO	Distribution network operator
EE	Energy efficiency
ES	Energy storage
ESC	Energy savings certificate
ESCO	Energy service company
EV	Electric vehicles
FiT	Feed-in tariff
IoT	Internet of things
IT	Information technology
NASDAQ	National Association of Securities Dealers Automated Quotations
PPA	Power purchase agreement
TPO	Third-party ownership
TSO	Transmission system operator
VPP	Virtual power plant

1. Introduction

The electricity business model is facing disruptive changes, the liberalization of several modern energy markets, aligned with the governmental pressure for decarbonisation and clean energy targets, along with the new emerging technologies, are bringing a period of uncertainty for power utilities (Facchinetti and Sulzer, 2016; Hamwi and Lizarralde, 2017; Klose et al., 2010). The game is changing, consumers are now becoming prosumers, and energy storage systems are becoming more and more efficient. Energy utilities, as the major stakeholders in this transformation, in order to remain competitive in this new energy landscape, will need to adapt and reform their business models (Richter, 2011).

When an enterprise is settled, it employs a business model, defining the way it delivers value to customers, how it attracts customers to pay for that value and how to convert the payments into profits (Teece, 2010). Accordingly, business models are the fundamental organizational logic in order to create, deliver and capture that value (Osterwalder and Pigneur 2010). Business models are not static entities, they evolve over time. That system of activities leading to value creation needs to be innovated and adapted to changes in the environment (Bohnsack et al., 2014). Taking as example the telecommunication sector, business models for telecoms have evolved due to several factors such technological advances and market liberalization. Exploring new business models to generate new revenue became just important for telecom operators as attaining operational efficiency and customer retention. As a result, the telecom business model evolved, from the concept of charging for time (the duration of a call) to a more dynamic, integrated and complex model shaping our lifestyle presently (Oseni and Pollitt, 2017).

The changes and developments occurring in the energy sector will have an impact on the way energy is produced and distributed to consumers. Due to their dominating position in the energy sector, utilities are being confronted with disruptions in their way of doing business (Richter, 2012), as the current business model for many companies is reaching its practical limit. Utilities will need to innovate their business models to remain competitive in the energy landscape, shifting from simple commodity providers to service providers (Hamwi and Lizarralde, 2017; Richter, 2012). According to Helms, (2016), *servitization* represents a specific form of business model innovation.

Academics developed several tools to help with business model innovation, such the business model canvas by Osterwalder and Pigneur (2010) - a tool that that fosters understanding, discussion, creativity, and analysis of new or existing business models (Osterwalder and Pigneur 2010), and business model patterns (Braun, 2018). A pattern is a solution to a recurrent problem (Alexander et al., 1977), and business model patterns are problem-solution combinations in a business model context, in order to help managers and decision makers to adapt and innovate their business models, or even to create new ones (Abdelkafi et al., 2013). Business model patterns help to deal with business model innovation, managing the complexity inherent to disruptive technologies and anticipating the business logics in new markets (Amshoff et al., 2015).

Although it exists a vast literature around business model patterns, there are still challenges to overcome. Many reviews fail to identify many patterns available, resulting in limited collections of patterns, and making it necessary for innovators to apply patterns from different sources (Remane et al. 2017), also, patterns identified by different authors are sometimes redundant or overlapping (Abdelkafi et al., 2013). It is still difficult to compare between different patterns as they underlie different business model understandings and there is no consistent logic on how to characterize them (Abdelkafi et al., 2013). Further, a structured overview on energy patterns in order to support business model innovation in the energy field is missing in the literature.

This dissertation aims to support the business model innovation emerging in the energy sector. By investigating business model patterns in the energy field, in order to help energy utilities dealing with the disruptive changes occurring in the environment and to innovate and reform their business models. The goal is to create a taxonomy for energy patterns, which can be used not only by academics and scholars, but also by managers to innovate the business models of their firms.

The method chosen to create a taxonomy for energy patterns is a 5-step methodology. First a literature review was performed to identify and create business model energy patterns in peer-reviewed and practice-oriented papers. Second, the patterns were described in a standardized way in an excel database, removing the duplicates, redundant or irrelevant ones. Third, using the modified-Delphi card sort by Paul (2008), two experts in business models and the energy sector were asked to review and adapt the database, creating the initial model of the taxonomy. In the fourth step, another expert in the energy sector was questioned to examine and adapt the initial model. In the fifth and last step, using the obtained results, a taxonomy for business model innovation in the context of the energy sector was created.

This developed taxonomy helps to consolidate the current knowledge available on energy patterns, and tries to overcome the challenges inherent to the application of patterns in business model innovation, by using a systematic approach in order to create a useful taxonomy of energy patterns.

In this document structure, Section 2 contains the current state of the literature on the energy sector, business models, business model innovation, and business model patterns. Section 3 includes the description of the theoretical concepts applied in the methodology, the adopted methodology and data collection procedure. Section 4 discusses and analyses the results. Conclusions, limitations and future research are provided in Section 5. The final energy pattern database is present in the Appendix.

2. Literature Review

2.1. The energy sector

2.1.1. From a decentralized to a centralized industry

In the birth stage of the electric power development, electricity production and usage was limited to the outputs derived from small generators, with very low technology levels (Zhou et al., 2016). So, about a century ago, the energy industry was highly fragmented and localized, whereas the systems for generation and delivery of power were aggregated near the production sources (Valocchi et al., 2010).

The first great business model innovation was induced by the transition from several small and fragmented generation points, operating within limited areas, to few large power plants, delivering energy covering considerable distances, through high-voltage. This transition shifted the industry from a decentralized to a centralized energy system (Valocchi et al., 2010; Zhou et al., 2016). The argument that electricity is a natural monopoly, due to the high investments inherent and large benefits to populations, was the foundation for this turnaround, resulting in a "vertically integrated, nationalized or government regulated" business model shaping the energy sector through many years (Valocchi et al., 2010).

Demand for electricity expanded, stimulated by wars, the economy, new technologies and devices, among other factors, and the central assumption was that it will continue to grow indefinitely (Sioshansi, 2012). The demand expansion led energy utilities to seek for a "grow-and-build" approach, which was enabled by economies of scale (Valocchi et al., 2010), and business models for energy utilities were founded on the assumption that they provide an elementary commodity, focusing on supply reliability in a one way flow from supplier to consumer, and a pricing structure encouraging high usages of electricity. Under this model, energy utilities have been able to thrive, accomplishing great profits for the generated and sold electricity (Klose et al., 2010).

However, economies of scale eventually plateaued, reaching its practical limit as production units reached its efficient size by the early 1970s, leading to stagnation of the business model as well (Valocchi et al., 2010). Also, demand for electricity in mature economies is experiencing a steady decline, since mature economies are becoming less energy-intensive (Sioshansi, 2012).

2.1.2. Traditional Energy Value chain

According to Richter (2012), the traditional generic electricity value chain is assembled as a sequential coordinated process, from generation to consumption.

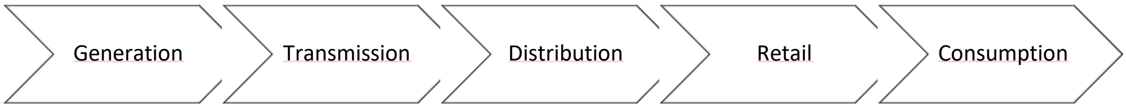

Figure 1 – The electricity value chain

He describes the steps in the traditional electricity value chain, and also remarks challenges inherent to each step:

Generation is the conversion of primary resources into electric power. Usually, the biggest contribution for the electricity produced in modern countries comes from large scale power plants, mainly operated by a small group of utilities. Still, renewable sources are being considered as promising substitutes for conventional plants in the future.

Transmission concerns the transportation of electricity through high voltage over great distances, by transmission grid. The transmission system operator (TSO) is the entity entrusted to transport the energy from the generation plants to regional or local electricity distribution, using a fixed infrastructure. Though, it's necessary to re-design and innovate the transmission grid, as large scale renewable energy generation systems are usually not near consumption. Also, the fluctuating nature of renewable sources demands for a more resilient transmission grid.

Distribution refers to the delivery of electricity to end consumers at low voltage level. The distribution network operators (DSO) are companies that are responsible the regional electricity distribution networks that connect the high voltage transmission grid to users. Nonetheless, as energy consumers have now the opportunity to become producers, an increasing number of distributed sources of small-scale renewable production will be connected to the grid, making necessary to increase the flexibility in the distribution network, and to provide the possibility for information an energy to flow in two directions.

Retail is the administrative function concerning the communication channel with customers. Usually, retailers buy the energy from wholesale markets, or directly to producers or traders, and sell it according to the needs of the consumers. Yet, as consumers can now produce their own electricity, the retail functions will need to be innovated, as retailers will need to find and develop new offers and services.

Consumption is carried when the consumer uses the provided electricity. The changes occurring in the consumption side, shifting consumers into producers, will likely change and reinvent several customer segments and channels.

2.1.3. From a centralized to a distributed and smart and connected industry

Several transformations are occurring in the energy landscape, bringing a period of uncertainty and change for power utilities. The liberalization of several modern energy and gas markets is intensely increasing competition in the utilities sector (Facchinetti and Sulzer, 2016; Hamwi and Lizarralde, 2017). Intense competition encourages technological advances and leads to falling prices, bringing significant changes to the traditional energy business model (Oseni and Pollitt, 2017). This allowed a horizontal reorganization of the sector, a vertical segregation of the value chain and the creation of wholesale energy markets. The liberalization also facilitated an increase of distributed energy producers (Corsatea et al., 2016).

Encouraged by the EU 20-20-20 targets (reduce greenhouse gas emissions by 20% from 1990 levels, apply energy-efficiency measures to reduce usage by 20% compared with estimated levels and have 20% from EU energy consumption from renewable sources), government policies are promoting several subsidies regarding renewables, and centralized energy systems are being displaced by localized generation systems. The landscape for electric power in the future will build more on small distributed sources, and energy production by consumers themselves (Klose et al., 2010). Distributed energy systems can be seen also as a supplement for traditional centralized power systems, in terms of ensuring the balance between supply and demand, improving energy efficiency and to promote sustainable development (Zhou et al., 2016).

New emerging technologies, such as smart grids, allow for a two way communication flow between energy utilities and consumers, either for electricity or general information. This two way interaction enables more efficient pricing schemes, and creates the possibility for consumers to contribute to the energy supply as "prosumers" (Klose et al., 2010). The traditional utility business model is based on consumption per kWh, so the higher the consumption, the higher the return for the company. This drove some consumers in mistrusting energy utilities as they have been making profits by incentivizing their previous high consumptions (Hamwi and Lizarralde, 2017), in a landscape of a shifting mentality towards the awareness of the pollution problems caused by traditional power generation. Aligned with rapid technological advances - such as energy management systems for households, energy storage systems, solar PVs and smart devices, among others - developments are taking place on the demand side, shifting the consumption from the undifferentiated kWh delivered by utilities to a more conscious consumption scheme, carried out by self-generators using less energy from the grid (Sioshansi, 2015).

The exponential technological developments are reshaping the landscape for both centralized and distributed energy systems. A new smart and connected energy system is emerging, facilitated by smart metering and big data, reshaping the business model with two flow interactions, personalized energy consumption and service quality (Zhou et al., 2016).

2.1.4. Implications

These changes and developments will have effects on the way energy is produced and distributed to consumers. Utilities business model is being challenged, due to their prevailing position in the energy sector (Richter, 2012), as the current business model for many companies is reaching its practical limit. It implies heavy investments in aging infrastructures, and the political drive through clean energy is creating barriers to those investments (Klose et al., 2010).

Utilities will need to adapt and reform their business models to stay competitive in the energy landscape, shifting from simple commodity providers to service providers (Hamwi and Lizarralde, 2017; Richter, 2012). According to Helms, (2016), *servitization* represents a specific form of business model innovation. The transition to a service model implies many obstacles and challenges for energy utilities. In the traditional utility business model, the value is captured by directly selling the energy in established markets, and as long revenues covered the costs, utilities didn't gave many though about innovating their business models, and therefore they didn't evolved significantly in the last years. Presently, in response to the emergent challenges, energy companies will need to re-construct their position in the electricity market by developing new business models based on innovative products, services, channels and partnerships (Hamwi and Lizarralde, 2017).

2.2.Business Models

According to Magretta (2002), business models "are, at heart, stories – stories that explain how enterprises work". The concept is not new, although it gained popularity in the 90's, its first appearance remounts to 1957 – in an academic literature by Bellman et al. (1957) (Osterwalder and Pigneur, 2005). Since 1995 at least 1,177 peer review papers in academic journals have been published addressing the term business models (Zott et al., 2011).

There are two main points of view concerning the reason why business models gained such notice, and both are, directly or indirectly, related to the phenomenon of the Internet. Osterwalder and Pigneur (2005) argue that business model concept was one of the great buzzwords of the "Internet boom" (Magretta 2002), as its appearance overlaps the rise of the NASDAQ stock market for technological companies. It gained significance with the creation of new electronic business, and from since it evolved from an operative plan to create an informational system, to an integrated and holistic concept of the company organization (Wirtz et al. 2016). Other authors claim that, aligned with the arrival of the Internet, emerging markets experienced a rapid growth, lifting the interest in the "bottom-of-the-pyramid" and in growing industries reliant on post-industrial technologies (Zott et al., 2011). In this context, the business model concept is framed by business opportunities emerging in underdeveloped countries. Arguing that resources and capabilities can be exploited in order to create business models in new emerging markets, that satisfy both the needs of people with less resources and the needs of the company, regarding economic returns (Seelos and Mair, 2007; Thompson and MacMillan, 2010).

The Internet was the main driver in the advent of business models and, therefore, the consequent literature around the topic suggests an early technological orientation, business models were seen only as fraction of the company (Wirtz et al., 2015). Porter (2001) criticizes this appearance of the concept, regarding its definition as "murky", and referring it as a loose interpretation on how a company does business, instead of focusing on strategy and competitive advantage. He adds that business models should not be appraised independently to the structure of the industry.

The concept evolved, and from a small part of the company it started to be seen a representation of the company itself, and an abstract toll to provide a picture of the company's competitive situation. An increasing consensus among authors shifted business models from an operating management tool to a future-oriented strategy tool. Therefore, it is necessary to differentiate between business models and strategy (Wirtz et al., 2015).

While business models describe the overall structure of a firm business system, strategy is the connection between the business model and the market context (Grant, 2016). Strategy indicates the choice of business model through which firms compete in the market (Casadesus-Masanell and Ricart, 2010). Business models describe how the pieces of a business fit together as a system, but they do not incorporate competition, a critical dimension of performance, strategy's function is to deal with competition (Magretta, 2002). According to Osterwalder and Pigneur (2010), "business models are blueprints for a strategy to be implemented through organizational structures, processes, and systems."

Despite the overall accepted distinction between business model and strategy, and the vast literature around the concept, business models still allow for considerable interpretative flexibility, as definitions vary greatly (Massa and Tucci, 2013). The academic interest and attention increased considerably, but there is still no generally accepted definition and understanding of business models (Schneider and Spieth, 2013), and a very heterogeneous understanding of the term (Wirtz et al. 2016). As different conceptualizations have been proposed, the literature developed in silos, according to the interest of different researchers (Zott et al., 2011).

Though, authors generally conceive business modes in a broad sense (Bohnsack et al., 2014), and there are some common denominators among its various perceptions (Massa and Tucci, 2013), leading definitions to get more homogeneous. According to Schneider and Spieth (2013), common to several definitions of business models, there is the characteristic that they comprise a holistic perspective integrating internal elements of the firm and external environmental factors. Zott et al. (2011) identified 4 common characteristics in several business model definitions:

1) Business models emerge as a completely new entity, distinct from the product, firm, industry, or network;
2) Business models intent do explain how firms "do business";
3) The firm's activities and its partners perform a critical position in several perceptions of business models;
4) Business models explore both the value creation and value capture process of a firm.

Briefly, business models are described as the fundamental operational logic of an organization in order to create value, to deliver it and capture it, for its stakeholders (Casadesus-Masanell and Ricart 2010; Osterwalder and Pigneur 2010). Being value creation the root of business models, they encompass the fundamental and holistic understanding of the system of activities that lead to value creation, and those synergetic and complementary activities decide on how the company "does business" (Amit and Zott, 2012; Massa and Tucci 2013). Business models characterize the way firms deliver value to customers, how they appeal customers to pay for that value and how they convert the payments into profits (Teece, 2010), including the unique combination of products, services, image and operational infrastructure used by the company (Chesbrough and Rosenbloom, 2002). Profits are important also because they provide valuable feedback on whether the business model is working, and give the opportunity to evaluate it (Magretta, 2002). In short, business models concatenate the rationale and information to back a value proposition, and a feasible arrangement of revenues and costs for the enterprise to deliver that value (Teece, 2010). It describes architecture for value creation, taken into account the customer and market components, in order to achieve competitive advantage (Wirtz et al., 2015).

According to Magretta (2002), "business modelling is the managerial equivalent of the scientific method – you start with a hypothesis, which you then test in action and revise when necessary". Thus, a business model evolves over time in order to adapt itself to the environment, shifting the attention for business model innovation (Bohnsack et al., 2014).

The literature presents various ways of characterizing a business model (Bocken et al., 2014), and in order to accomplish a generally accepted comprehension and definition of business models, several authors recognized elements belonging to the concept. The most popular example is probably the business model canvas by Osterwalder and Pigneur (2010) (Remane et al., 2017). For Osterwalder and Pigneur (2010) a business model can be described as a set of nine interrelated pieces: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure. Gassman et al. (2014) describes a business model according to four dimensions answering each dimension to a question: Who? The customer; What? The value proposition; How? The value chain; Why? The profit mechanism. For the author, a business model defines who the customers are, what is being sold by the firm, how it is being produced, and why the business is profitable. Richardson (2008) proposes also a consolidated view of the elements composing a business model: the value proposition, the value creation and delivery system, and the value capture system.

2.3.Business Model Innovation

There is an rising general agreement regarding that innovation of business models is key to the firm's performance (Zott et al., 2011), but still it is recognized as crucial for organizations, there is no precise definition of business model innovation (Schneider and Spieth, 2013). Most of existing literature focuses on static perspective of business models, neglecting they are vulnerable to change, and they must be addressed as dynamic entities. Business models need to be analysed through a dynamic perspective, regarding they may need to evolve and innovate, due to internal or external alterations (Wirtz et al., 2015).

Massa and Tucci (2013) argue that business models have two complementary roles regarding innovation. The first is that business models allow companies to commercialize innovative ideas and technologies. According to Abdelkafi et al. (2013), business models and technology innovations are strongly linked. By allowing the commercialization of novel ideas and technologies, as they do not have economic value per se, the adjacent business model becomes a vehicle for innovation and value creation. The second, is that business models represent a new dimension of innovation itself, with companies favouring new business models over product innovation to achieve competitive advantage (Amit and Zott, 2012; Frankenberger et al., 2013; Teece, 2010). The challenge goes beyond creating new products or ideas, into the rearrangement of resources and capabilities in order to develop new forms of value creation (Schneider and Spieth, 2013).

According to Remane et al. (2017), business model innovation is place when a firm modifies or improves one or several of the elements belonging to the business model. To pursue novel ways of value creating and capturing, through changes in the firm's activity systems (Amit and Zott, 2010). It builds on adding new tasks, connecting activities in new ways or changing the way they are performed (Amit and Zott, 2012). According to Gassmann et al. (2014), business model innovation occurs when at least two of the dimensions defining a the business model are changed – the who, what, how and why – re-defining the way a company creates and captures value.

The process goes from developing new architectures for the value chain, developing new products, new value delivery systems, new marketing arrangements, as well as obtaining and utilizing innovative resources (Günzel and Holm, 2013). It aims renewing the firm's core business logic, concerning the firm's current business model, its external environment and its alliances with partners and customers (Schneider and Spieth, 2013). According to Bohnsack et al. (2014) business model innovation main objective is to leverage existing complementary assets, to create cost efficiencies and reinforce the competitive position.

Innovation of business models has the power to change the logic of entire industries (Massa and Tucci, 2013), and business model innovation can be an artery for competitive advantage if the model is amply differentiated and difficult to imitate (Teece, 2010).

How business model innovation is effectively achieved is a widely neglected question, so several authors proposed phases, in order to support managers to innovate firms business models (Remane et al. 2017). Frankenberger et al. (2013) proposed a framework with four generic phases: initiation, ideation, integration and implementation. Schneider and Spieth (2013) also presented a framework describing the phases for business model innovation, namely exploration, exploitation and effects. Osterwalder and Pigneur (2010) propose a 5 phase process: mobilize, understand, design, implement, and manage. The mobilization phase regards framing objectives, testing ideas as assembling teams. The second phase consists in understanding the context in which the business model will evolve. The design stage regards adapting and modifying the business model according to market response. The implementation stage caries out the business model prototype in the field. Finally, the manage phase includes adjustments and modifications in the business model, according to market reaction.

There are several tools to support business model innovation, such the business model canvas or business model patterns (Braun, 2018). The nine interrelated building blocks describing a business model, by Osterwalder and Pigneur (2010), compose the business model canvas – a tool that that promotes understanding, discussion, creativity, and analysis of new or existing business models (Osterwalder and Pigneur, 2010). By improving and rearranging these dimensions, existing business models can be innovated. Gassman et al. (2014) found that about 90% of business model innovation results on the re-combination of already existing business models. Furthermore, these combinations are repetitive, showing the existence of a pattern (Lüttgens and Diener, 2016). Business models patterns can, therefore, be used as another tool for business model innovation.

2.4. Business Model Patterns

History

Christopher Alexander, an architect, and the pioneer in the understanding and creation of patterns, formulated 253 architectural related patterns in the late 1970s (Abdelkafi et al., 2013; Amshoff et al., 2015; Remane et al. , 2017). According to Alexander et al. (1977), “each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice”

Briefly, patterns define the core of the solutions to recurring problems, and they seek to diminish the complexity and increase performance in problem solving contexts. Meanwhile, patterns started to be used across several domains, from the theory of architecture in the 70’s, engineering and software design in the 80’s, human-computer-interaction, security and e-e-learning in the first decade of the twenty-first century, and finally business models (Amshoff et al., 2015).

According to Osterwalder and Pigneur (2010), business model patterns are business models with same characteristics, related dispositions of the business model canvas, or similar behaviours. By knowing patterns of business models, managers and decision makers can easily generate new business models or adapt existing ones; like chess players, by knowing patterns of previous games, can easier make decisions for the next move (Abdelkafi et al., 2013).

Amshoff et al. (2015) proposed a classification of business model patterns according to their granularity, and identify three different categories:

1) Frameworks: like the business model canvas by Osterwalder and Pigneur (2010), describing patterns of whole business models;
2) Prototypical business models: as industry-specific problem-solution combinations (Lüdeke-Freund et al., 2018). They are

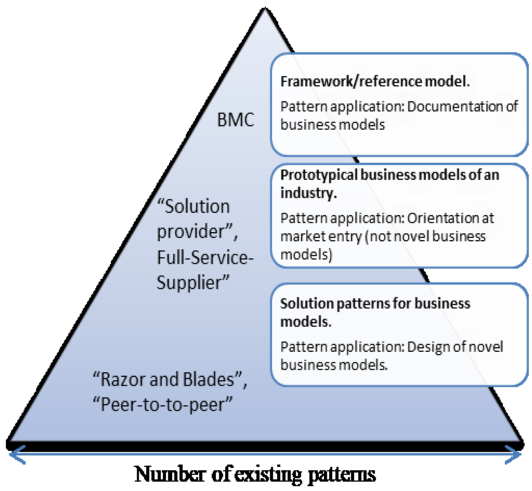

Figure 2 - Types of business model patterns

holistic business models that enable a rapid orientation when entering new markets, but they are not suitable for new business model development.

3) Solution patterns: are proven building blocks for business model design, addressing single or several components of a business model. They are the patterns with lowest granularity, addressing very specific aspects of business models (Remane et al. 2017).

Several authors consider business model patterns as a very useful tool. Osterwalder and Pigneur (2010) agree that business model patterns benefit the comprehension of the business model dynamics, and can be used as a source of inspiration to work with business models. In their view, the patterns should be described in their business model canvas language, one important tool for business model innovation, to make them comparable, understandable, and applicable. According to Amshoff et al. (2015) business model patterns help to deal with the biggest challenges in business model innovation, handling the distress inherent to upcoming disruptive technologies and anticipating the business logics in new markets. Gassmann et al., (2014) mention that business model patterns can serve as blueprints for business model innovation, a strong and effective tool to help thinking "out-of-the-box" in order to generate innovative ideas for new business models. Conforming to Remane et al. (2017), business model patterns can be used for systematic business model innovation. Lambert (2015) argues that classifying business model patterns allows collecting and retrieving information regarding the value creation, delivery, and capture logics employed by different organisations. In general, academics agree about the usefulness of business model patterns for business model innovation.

Patterns can be used in different situations, contexts and areas of expertise, and the degree needed for the conception in cause can be attained by describing the patterns using a standard template adapted from Alexander et al., (1977), the pioneer of the creation and understanding of patterns. This template defines the least information essential to describe a problem-solution combination, and for patterns described in this template it can be said that they are in the "Alexandrian" form (Lüdeke-Freund et al., 2018). Osterwalder and Pigneur (2010) identified five business model patterns, translating them into the language of the business model canvas, as well an "Alexandrian" adaptation overview for the identified patterns. This "Alexandrian" adaptation describes a business model pattern by name, context, problem, solution, and examples. Gassmann et al. (2014) investigation has also revealed 55 business model patterns, defining them as specific arrangements of the four business model dimensions: who, what, how and why. Remane et al. (2017) through an exhaustive literature review, created database with 182 business model patterns, also adopting the Alexander's patterns theory to describe the patterns (Lüdeke-Freund et al., 2018). According to Lüdeke-Freund et al. (2018) the "Alexandrian" pattern description has been proven its suitability for business model classifications.

Although it exists a vast literature around business model patterns, there are still many challenges to overcome. Even the most comprehensive reviews fail to identify many patterns available, resulting in limited collections of patterns, and making it necessary for innovators to apply patterns from different sources (Remane et al., 2017). Also, some collections of patterns developed by different authors are sometimes redundant or overlapping (Abdelkafi et al., 2013). Further, it is difficult to compare between different patterns as they underlie different comprehensions for business models, and there is no consistent logic on how to characterize them. The identification of patterns is lacking a systematic approach, as it is frequently based on examples (Abdelkafi et al., 2013). Therefore, it is challenging to navigate through the different compilations of patterns when attempting to apply tem to business model innovation (Remane et al.2017).

2.5. Energy Patterns for Business Model Innovation

As it was stated previously, utilities will need to adapt, reform and innovate their business models, to remain competitive in the energy landscape, as they need to react to the several transformations occurring in the energy sector (Hamwi and Lizarralde, 2017; Richter, 2012). Business model patterns are a proven useful tool to support business model innovation (Amshoff et al. 2015; Lambert 2015; Osterwalder and Pigneur 2010; Remane et al. 2017), and structured overview of energy related patterns is missing in the literature. It is necessary to investigate business model patterns in the energy field, to fill the gap between business models and the energy sector, and to help energy utilities to innovate their business models. For this study, it was used the following definition for business model patterns for the energy sector:

A business model pattern for the energy sector *describes a solution to a reoccurring challenge caused by the changes that the energy sector is facing. It represents a core of a solution which is generic and adaptable during the business model innovation process.*

3. Methodology and data collection

3.1.5-step methodology

To develop a taxonomy for business model patterns for the energy sector, the applied methodology is based on the modified-Delphi card sort by Paul (2008), being is a combination between the Delphi method and card sorting. Accordingly, 5 steps were undertaken. First, a selection of relevant practice-oriented and academic studies was made. The relevant literature was searched in several databases, such Science Direct and EBSCO, using keywords like “business models”, “patterns”, “business models AND patterns”. Nevertheless, other terms for “patterns” are used in the literature, such “archetypes”, “typologies”, “solutions”, and “prototypes” (Lüdeke-Freund et al. 2018; Remane et al. 2017). So they were incorporated as keywords either. Second, it was conducted a search for energy patterns in the aforementioned list of papers, all the patterns were extracted and organized in a standardized way. The duplicates, redundant and irrelevant patterns were removed. Third, all the determined patterns were organized into self-defined groups by a seed participant. Furthermore, two experts in the field of BMI and the energy sector were asked to confirm all patterns and groups, and make adjustments in order to make them perfectly understandable and plausible. In the fourth step, one more expert was asked to conduct a card sorting activity with the aim to confirm all the patterns, their classification and grouping. Finally, a taxonomy of patterns for the energy sector was created, to facilitate its usage by academic and practitioners.

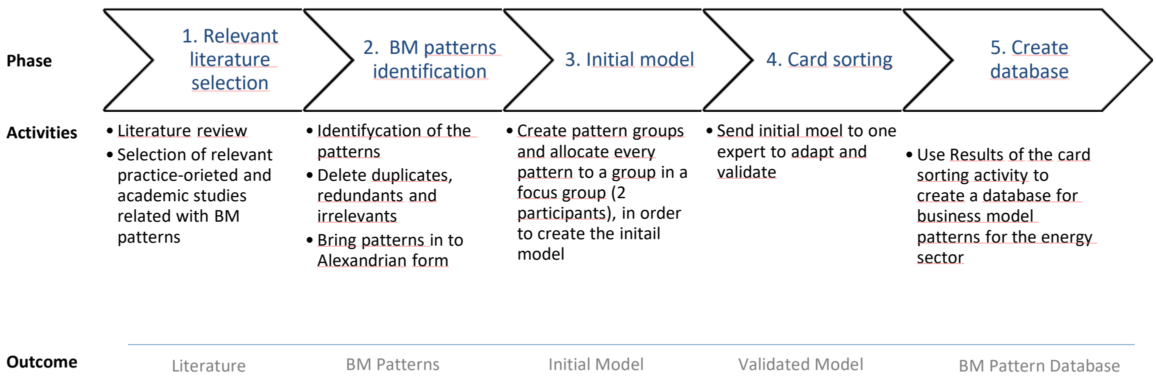

Figure 3 – Overall methodology (Braun, 2018).

3.2. Literature review for the applied methodology

3.2.1. Classification and taxonomy

According to Bailey (1994) a classification can be defined as the ordering of entities into groups or classes, based on their similarity. This exercise is crucial for the understanding of the objective reality, since ordering objects into classes provides meaning to reality itself (Lambert, 2015). A classification is equivalent to the dimensions or variables on which it is based. It can be unidimensional, if it is based on a single dimension, or multidimensional, being based on several dimensions; and that can be done either conceptually, where only concepts are classified , or empirically, where only empirical entities are classified (Bailey, 1994). The majority of the research regarding business models is based on classification, and often, the classifications are proposed with little or no justification, as they are designed to meet the needs of each researcher (Lambert, 2015). According to Nickerson et al. (2013), there is still no common understanding concerning the specific characteristics of classifications, in the academic literature.

Classification, typology, taxonomy and framework, are different terms used for grouping objects into domains based on common characteristics, and these terms are often confused and used interchangeably (Nickerson et al., 2013). Framework is a general term used for organizing objects (Nickerson et al., 2013). According to Schwarz et al. (2007) frameworks are defined as "the exposition of a set of assumptions, concepts, values, and practices that constitutes a way of understanding the research within a body of knowledge", and they are "commonly used to synthesize the research literature on a topic area". Classification concerns the ordering of items in terms of their similarity, and it can be broken down in two approaches – typologies and taxonomies. A typology is a form of classification used conceptually, and the results are types or type concepts. A taxonomy is an empirical form of classification, with the goal of classifying entities according to their measured similarity on observed variables (Bailey, 1994).

Developing a taxonomy is a complex process (Nickerson et al., 2013), and taxonomic approaches are important methodologies for uncovering relationships in complex phenomena. Many researches propose that taxonomy development is a fundamental part of the research process (Gartner et al. 1989). The present dissertation employs an empirical and multidimensional taxonomic approach to identify and organize business model patterns in the energy sector.

Considering the research conducted by Nickerson et al. (2013) a useful taxonomy could be defined based on five qualitative attributes.

1) Concise: Bailey (1994) notes that one of the weaknesses of taxonomies is that they are not sufficiently parsimonious. Meaning that they should contain a restricted number of dimensions and characteristics in order to be easily understandable;
2) Robust: although it must be concise, a useful taxonomy should accommodate at least enough dimensions and characteristics to differentiate plainly the objects in study;
3) Comprehensive: taxonomies developed empirically should classify all known objects and entities within the domain that is been taken in consideration;
4) Extendable: a useful taxonomy should allow to incorporate new dimensions and characteristics when new types of objects appear. Taxonomy is a dynamic concept, and taxonomies that are not extendible may soon become obsolete. According to Bailey (1994) the lack of changeability can be perceived as a weakness.
5) Explanatory: a useful taxonomy should contain dimensions and characteristics that provide useful explanations for the nature of the objects under study, and not describe every detail of such object. Taxonomies should be explanatory and not descriptive.

3.2.2. Card Sorting Methodologies

Sorting techniques are tools to help the exercise of categorization, they are useful for identifying relevant categorizations and for investigating commonality and differences on the use of that categorization by experts (Rugg and McGeorge, 2005). One subgroup of sorting techniques is the card sorting methodology. According to Wood and Wood (2008), card sorting was originally created by psychologists as a method to the study of how people arrange and categorize their knowledge. The method consists in giving the participant a set of cards containing information, and the purpose is to sort the cards into groups and describe them (Spencer, 2009).

There are several card sorting methods, and there are two types used at different informational stages. The first is the pre-design method, used to gather input at early stages of the design process, for creating an informational architecture. The second is the post-design method, used after and informational architecture is crated, for validation or edition purposes (Paul, 2008). One pre-design method is called “open card sort”, where participants sort cards in categories created by themselves. Participants have few restrictions on how to manage the cards, and this degree of freedom enables the method as one of the most effective for drawing out a fundamental mental model of the participants, nevertheless, it takes long to analyse the results. One post-design method is the “closed card sorting”, where participants sort the cards into pre-existing categories, a method used to add new content to an already existing information architecture, or to test one information architecture by scoring participant results (Paul, 2008).

Regarding the number of participants to include in a card sorting study, it is still a theme under debate, with some card sorting guides suggesting as few as 4 participants, to other suggesting a minimum of 20 to 30 participants. It is true that more participants provide more consistent results, but also increase the costs and analysis time (Paul, 2008).

3.2.3. Delphi Method

“Project DELPHI” was the name of a study conducted in the 1950s by the Air Force-sponsored RAND Corporation. The technique employed is called the Delphi method, and the purpose is to achieve the most possibly reliable consensus of opinion within a group of experts, through a sequence of exhaustive questionnaires with controlled opinion feedback (Dalkey and Helmer, 1963).

According to Linstone and Turoff (2002), this method is indicated to structure the communication process of a group of people, allowing the group to handle a complex problem more efficiently. By avoiding direct confrontation of the experts, this techniques employs its repeated individual questioning, by interview or questionnaire (Dalkey and Helmer, 1963). Delphi intention is to use the positive aspects of group interaction, such as variety of knowledge, while removing the negative ones, as social difficulties. For this intent, four features are necessary to characterize a Delphi procedure (Geist, 2010; Linstone and Turoff, 2002; Rowe and Wright, 1991):

1) Anonymity for the individual responses, by using questionnaires;
2) Interaction, allowing the participants to change their opinions and the opportunity for to revise views, meaning the study is conducted in an interactive way over a number of rounds;

3) Controlled feedback, as only between rounds, when each member is informed of the opinions of the other group members;
4) Statistical group response where, at the end of the procedure, the group judgment and views are assessed and expressed by means of quantitative feedback.

Nowadays, the Delphi method exists in two distinct ways, the first is the traditional paper-and-pencil, where a monitor team outlines a questionnaire, which is sent to the respondents to answer and return, to be evaluated, and then re-sent in a form of a new questionnaire developed according to the answers. The computerised form is the second way, where the monitor team is replaced largely by a computer to analyse the group results, having the advantage of reducing the delay and turning the process into a real time communication system. However, it does require that the communicational features are well delineated previously to the Delphi, whereas that in a paper-and-pencil Delphi form, the monitor team can individually adjust these features as a function of the group responses (Linstone and Turoff, 2002).

The controlled interaction and avoidance of direct confrontation by the experts is a key advantage of the method (Okoli and Pawlowski, 2004), representing an attempt to tackle the predisposition to a respondent be influenced by a dominant personality or the tendency to defend a stand once taken (Dalkey and Helmer, 1963; Geist, 2010). A common reason for Delphi failure is the imposing of the monitor’s view and preconceptions, by over specification of the Delphi and not allowing the contribution of other perspectives (Linstone and Turoff, 2002). Because the moderator, or the monitor team, has the charge of the assemblage of information collected, it’s very important that he maintains his objectivity and a neutral position, without introducing unnecessary bias (Dalkey and Helmer, 1963; Paul, 2008).

Taxonomy development is one of the applications of the Delphi method, as it has already been used several times for that purpose. Mokkink et al. (2010) developed a taxonomy for the relationships of measurement properties that are relevant for evaluating HR-PRO instruments based on a Delphi study, reaching consensus on terminology’s and definitions. Nambisan, et al., (1999) conducted a Delphi study to situate organizational mechanism in the knowledge creation taxonomy. The goal of the Delphi study was to use "expert" opinion to classify mechanisms. According to Okoli and Pawlowski (2004) this type of application for the Delphi method is a two-step process, first with the identification and elaboration of a set of concepts and second with the classification an taxonomy development.

3.3.Modified-Delphi card sort' by Paul (2008)

According Paul (2008), there are numerous methods with knowledge gathering purposes, with collaboration and iterative informational flow. He adds, that the Delphi method is one of the most efficient to gather knowledge between a group of experts. The modified-Delphi method combines the traditional Delphi method with card sorting, in order to take advantage of the methodical and structured flow of information, and to minimize the bias. In this modified method, each expert is given the work of the previous expert to work on, and it is allowed to modify the work after reviewing it. The goal is to reach an informational consensus, keeping in mind that there is rarely a single correct answer, but usually a few suitable answers that can accommodate most of the audience (Paul, 2008),

The modified-Delphi card sort can be summarized in four steps (Paul, 2008):

1) The initial model is created by a seed participant who proposes an informational structure;
2) The following participant work and comment on top of the previous model, mas make arrangements or even propose a new model;
3) The informational structure evolves during the iterations, changing to a model incorporating input from all the participants;
4) The consensus is finally reached when the iterations stabilize and there is no more significant alterations to be performed.

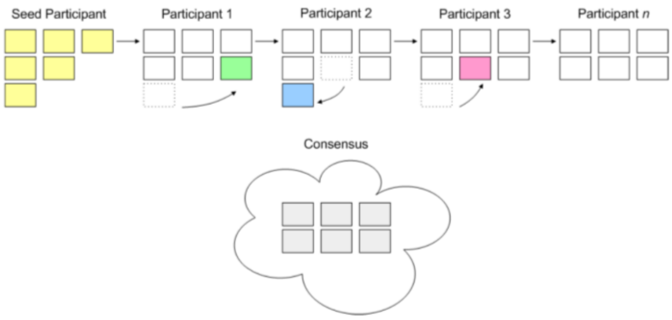

Figure 4 – Workflow for the Modified-Delphi card sorting (Paul, 2008).

According to the author (Paul, 2008), the modified-Delphi card sort is an approach still in an early stage of development, meaning that the methodology can be redefined to fit the specific needs of each study, therefore, some adaptations were made.

A single seed participant was considered in order to develop the initial structure of the model. Paul (2008), states that a single participant working alone in the modified-Delphi card sorting is similar to a participant in an open card sorting study. Furthermore, two experts in the field of business model innovation and the energy sector were asked to confirm the first iteration of the model, and made adjustments in order to make all patterns and groups perfectly understandable and plausible.

According to Nickerson et al. (2013), in order to develop a useful taxonomy, that is concise, robust, comprehensive, extendible and explanatory, the methodology needs to be straightforward to apply, with a specific set of steps guiding the process, be concluded in a reasonable time period, it needs to reduce the risk of including *ad hoc* characteristics or dimensions, by using a systematic process, and it should be adaptable to the area of expertise. The modified-Delphi card sort methodology was chosen for this study in order to meet this four characteristics proposed by Nickerson et al. (2013). Nevertheless, the modified-Delphi card sorting gives the possibility to add *ad hoc* dimensions and characteristics, but such negative aspect is minimized by the fact that only experts were selected in order to do so.

3.4. Data collection

3.4.1. Identification of the patterns

The first step consisted in a systematic literature analysis in order to identify and elaborate all the energy patterns. The starting point was the generation of a list with the relevant practice-oriented and academic studies for the pattern identification. The relevant literature was searched in several databases, as Science Direct and EBSCO, using keywords such as “business models”, “patterns”, “business models AND patterns”. Nevertheless, other terms for “patters” are used in the literature, and keeping that in mind, in order to avoid neglecting relevant papers, other terms were also considered in the search such “archetypes”, “typologies”, “solutions”, and “prototypes” (Lüdeke-Freund et al. 2018; Remane et al. 2017).

The purpose is not only for existing patterns to be extracted from the literature, but also to create new patterns, since business model patterns are a relatively new research field (Remane et al. 2017). The papers were carefully chosen according to 2 criteria: they had to focus on business models, and they need to deal with energy. According to these guidelines, 98 academic papers were selected in total.

All the identified and elaborated patterns were based on the principles that they need to have a clear relation to the energy sector or to the new emerging energy related technologies, and its effect on the way energy is produced and distributed to consumers. Based on these criteria, 247 energy patterns were extracted from the list of relevant literature. These patterns did not have a common underlying structure: they were listed in a table with a brief description, with no conducting wire adjacent to the criteria describing each pattern. To overcome this, and to create a common and consistent structure, all the patterns were further revised and listed in the Alexandrian form (Lüdeke-Freund et al., 2018). From the total initial 247 patterns, 180 patterns were removed: 20 duplicated patterns, 102 patterns considered irrelevant, since they did not fit entirely the purpose of this study, and 58 patterns were removed since they were redundant with existing ones. This led to a final sample of 67 energy patterns for business model innovation, further organized in 13 groups.

The next step consisted in organizing all the patterns in the Alexandrian form and the groups in an excel template, organized alphabetically and containing a concise description of each pattern. The excel file was programmed to allow users to allocate the patterns to the groups interactively.

3.4.2. Round 1 – seed participant(s)

According to Paul (2008), when applying the modified-Delphi card sort, the first iteration, as of the initial model of the taxonomy, should be developed in an open card sort. A seed participant was considered to do so, in order to develop the first iteration of the initial model, identifying the relevant 67 patterns and defining and naming the groups. Two experts in the field of business model innovation and the energy sector were further asked to confirm and develop the initial model in an iterative way. The first expert analysed the elaborated patterns and proposed the allocation of the patterns to the groups created by the seed participant, or considered the creation of new groups, whereas the second expert reviewed and examined the groups, bringing into form a first estimative of the taxonomy, and made adjustments in order to make all patterns and groups perfectly understandable and plausible. This operation resulted in 18 patterns removed, as they were considered irrelevant, 6 groups renamed, 5 groups were deleted, and 2 new groups were created. The initial model was created containing 49 patterns and 10 groups, each group including leastwise 3 patterns and no more than 7. The initial model is to be used for the expert card sorting in round 2.

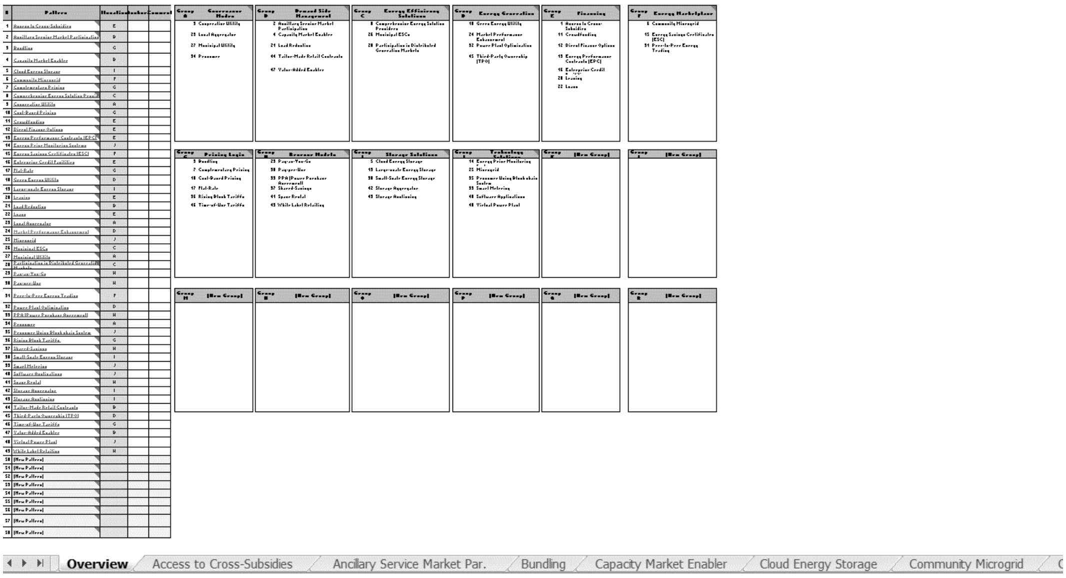

Figure 5 – Excel panel of the initial model

3.4.3. Round 2 – expert cart sorting

The goal of the second round is to reach an informational consensus, keeping in mind that there is rarely a single correct answer, but usually a few suitable answers that can accommodate most of the audience (Paul, 2008). In this round, one expert was asked to review and adjust the initial model with the purpose of reaching the informational consensus regarding the information present in the model. The expert was given two documents, one named "Instructions", containing the background and purpose of this study, the procedure, and information about business model and the pattern theory. The second document, named "Initial Model_BMPatterns for the Energy Sector", is an excel file, containing a first sheet named "Instructions", with a brief description of the procedure, a second sheet named "overview", with all the 49 patterns and 10 groups. In this sheet the expert could interactively adapt the initial model, reallocate patterns within the groups, and create new patterns, new groups and add comments to the patterns. All the patterns were hyperlinked, in order to allow the expert to click on a pattern and open a new sheet containing its description in the Alexandrian form, and to go back to the "overview" sheet.

The expert was asked to carefully read the "Instructions" document and to conduct the card sorting activity within the excel file. The participant had to sort the cards into pre-existing categories, so the method changed from a Closed card sort to an Open card sort, with the purpose to add new content to the existing information architecture, and to test it (Paul, 2008).

To overcome this limitation, it was give him the opportunity to purpose 8 new groups and to add up to 9 new patterns that could me missing according to his opinion.

While performing the card sorting, the expert was requested to clearly understand each pattern and to analyse its allocation to a determined group in the initial model, as it’s important that the pattern is assigned to the group which best suits its context, problem and solution.

4. Results and Analysis

4.1.Results

4.1.1. Round 1 – Seed Participants

In round 1, two experts in business model innovation and the energy sector confirmed and developed the initial model iteratively. The list of the 49 patterns and 10 groups composing the initial model is in Appendix A.

It is possible to analyse this first approximation of the patterns and groups, and identify some types of groups and the logic inherent to their creation. The first type is related to specific parts of the business model, grouping patterns that define value creation mechanisms, as Group A (Governance Models), Group E (Financing), Group G (Pricing Logic) and Group H (Revenue Models). Group F (Energy Marketplace) refers to patterns connecting the business model, or specific parts of it, and the market context. Another type, are groups related and strongly present in the energy value chain, such Group D (Energy Generation), containing patterns related to energy production activities and Group B (Demand Side Management), in order to match supply and demand. Group I (Storage Solutions) is also indirectly present in the energy value chain, containing patterns that ensure the storage of energy to match generation and consumption. Group C (Energy Efficiency Solutions) and Group J (Technology Solutions) are a type of groups containing patterns directly connected to solutions turning the energy processes more efficient and productive, taking advantage of technology.

4.1.2. Round 2 – Expert Card Sorting

In round two, one energy expert, research associate in business models related to smart grid projects, was requested to perform a closed card sorting in the initial model already described. The expert had the opportunity to add in the model 8 new groups and 9 new patterns, and to give feedback in form of a comment on the existing patterns names and descriptions. This feature was disposed to give a greater degree of freedom relative to the previous model, and to reduce its influence.

The expert did not propose any changes related to the groups of patterns, meaning that he did not reallocate any pattern from its predefined group, neither did create any new groups. This means that a consensus was reached regarding the patterns and the groups. Nevertheless, he proposed breaking P22 in two patterns, proposed a new example to describe P38 in the Alexandrian form and proposed two new patterns.

P22, “Loans”, according to his expert opinion, should be broken in two patterns: “Small scale financing” and “Institutional financing”. In P38 “Small-scale energy storage”, was added the example of electric vehicles as forms of energy storage. The new added patterns are P50 “Charging system operator”, allocated to Group J – Technology Solutions, and P51 “Local Market Operator”, allocated to Group F – Energy Marketplace.

The fact that the expert did not proposed significant adaptations suggests that an overall consensus was reached, and the card sorting activity can reach to a closure, according to Paul (2008).

Nickerson et al. (2013) defines a useful taxonomy as one being concise, robust, comprehensive, extendible and explanatory. The methodology chosen, materialized in 5 steps, based on the modified-Delphi card sort by Paul (2008) made it possible to create a useful taxonomy on energy patterns for business model innovation. The final taxonomy for business model patterns in the energy sector, containing the 51 patterns and 10 groups, is present in the Appendix B.

4.2.Patterns and the business model canvas

As it was stated along this dissertation, the business model canvas provided by Osterwalder and Pigneur (2010) is one of the most useful tools to foster understanding, discussion, creativity, and analysis of new or existing business models. These authors identified five business model patterns, translating them into the language of the Business Model Canvas. The canvas is structured as a set of nine interrelated sections: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure (Osterwalder and Pigneur, 2010).

To complete this work, a suggestive allocation of the 51 patterns presented in the identified taxonomy was made to meet Osterwalder and Pigneur (2010) business model canvas, since a database of energy patterns to support business model innovation, is only useful if it can be applied in practice (Braun, 2018). The logic inherent to the applied approach tries to highlight which elements of the business model canvas are affected or influenced by the pattern in question. It is important to notice that the patterns do not describe complete business models, but involve only single or several parts of a business model (Amshoff et al., 2015), since there is no pattern directly affecting all the nine elements of the canvas.

ID	Pattern Name	Key Partners	Key Activities	Key Resources	Value Proposition	Customer Relationships	Channels	Customer Segments	Cost Strucutre	Revenue Stream
					GA - Governance Models					
P9	Cooperative Utility	x			x	x	x	x		
P23	Local Aggregator	x	x		x		x	x		
P27	Municipal Utility	x			x		x	x		x
P34	Prosumer	x				x				
					GB - Demand Side Management					
P2	Ancillary Service Market Participation	x			x					x
P4	Capacity Market Enabler	x			x					x
P21	Load Reduction		x		x					
P44	Tailor-Made Retail Contracts				x	x	x			
P47	Value-Added Enabler		x		x	x	x			
					GC - Energy Efficiency Solutions					
P8	Comprehensive Energy Solution Providers		x	x	x	x	x			
P26	Municipal ESCo	x	x	x	x	x				
P28	Participation in Distributed Generation Markets	x	x	x	x		x			
					GD - Energy Generation					
P18	Green Energy Utility		x	x	x		x	x		x
P24	Market Performance Enhancement				x					x
P32	Power Plant Optimization				x					x
P45	Third-Party Ownership (TPO)		x	x	x	x				x

GE - Financing

P1	Access to Cross-Subsidies				x		x	x		x
P11	Crowdfunding				x		x	x		x
P12	Direct Finance Options			x		x				x
P13	Energy Performance Contracts (EPC)		x	x	x		x			x
P16	Enterprise Credit Facilities			x	x					x
P20	Leasing	x		x	x					x
P22	Loans	x			x					x

GF - Energy Marketplace

P6	Community Microgrid	x	x	x	x	x	x	x		
P15	Energy Savings Certificates (ESC)	x	x	x	x					x
P31	Peer-to-Peer Energy Trading	x			x	x			x	
P51	Local Market Operator		x	x	x				x	x

GF - Pricing Logic

P3	Bundling		x	x		x		x		x
P7	Complementary Pricing		x	x	x					x
P10	Cost-Based Pricing								x	x
P17	Flat-Rate		x	x	x					x
P36	Rising Block Tariffs		x	x	x				x	x
P46	Time-of-Use Tariffs		x	x	x			x		x

GH - Revenue Models

P29	Pay-as-You-Go					x	x	x		x
P30	Pay-per-Use				x	x				x
P33	PPA (Power Purchase Agreement)		x	x	x	x			x	x
P37	Shared-Savings				x			x		x
P41	Space Rental		x	x		x		x	x	x
P49	White Label Retailing	x					x		x	x

	GI - Storage Solutions									
P5	Cloud Energy Storage		x	x	x		x			
P19	Large-scale Energy Storage		x	x	x		x			
P38	Small-Scale Energy Storage		x	x	x		x			
P42	Storage Aggregator		x	x	x		x			x
P43	Storage Auctioning		x	x	x		x			x
	GJ - Technology Solutions									
P14	Energy Price Monitoring Systems				x	x		x	x	
P25	Microgrid			x	x		x		x	
P35	Prosumer Using Block chain System		x	x			x	x	x	x
P39	Smart Metering			x	x		x		x	
P40	Software Applications			x	x			x	x	
P48	Virtual Power Plant		x	x	x		x		x	x
P50	Charging system operator		x	x	x			x	x	

Table 1 – Patterns and the business model canvas

It is important to notice that this allocation of the patterns to the business model canvas by Osterwalder and Pigneur (2010) it is only suggestive, backed by non-validated assumptions, since it’s useful to visualize business model patterns in the canvas, to facilitate the fostering and discussion of ideas in team environments, as the elements are straightforward to visualize in the canvas (Braun, 2018).

5. Main conclusions and future research

The academic interest and attention around business models increased considerably (Schneider and Spieth 2013), and the concept has been gaining momentum since the turn of the century (Braun, 2018). As in recent years, business models have been in the spotlight for academics and practitioners (Zott, Amit, and Massa 2011).

Magretta (2002) states that “business modelling is the managerial equivalent of the scientific method – you start with a hypothesis, which you then test in action and revise when necessary”. This statement illustrates clearly that business models are dynamic entities that need do evolve and adapt in order to survive. Business model innovation emerges within the scope of satisfying ignored market needs, bringing new services and products to the market, to help to improve or even revolutionize an existing market with more suitable business models, or even to create absolutely new markets (A. Osterwalder and Pigneur 2010). Business model innovation is one of the greatest challenges for today’s managers (Chesbrough, 2006), and, according to Amit and Zott (2012), managers, entrepreneurs and academics should be interested in business model innovation for several reasons. First it often results in unused sources of value generation. Second, competitors find it harder to duplicate an integrated activity system than a single product or process. Third, because it can be a powerful competitive toll – managers should be watchful to competitor’s efforts in this area, and lean to identify competitive threats beyond the traditional industry boundaries.

Several tools have been established to support innovation of business models, being one of most notable the business model canvas by Osterwalder and Pigneur (2010), which characterizes a business model as a set of nine interrelated building blocks: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure. By improving and rearranging these dimensions, existing business models can be innovated. Gassman et al., (2014) found that about 90% of business model innovation results on the re-combination of already existing business models. Furthermore, these combinations are repetitive, showing the existence of a pattern (Lüttgens and Diener, 2016). Business models patterns can, therefore, be used as a tool for business model innovation. There are many collections of patterns present in the literature, but none addresses in an expeditious way the energy sector and the transformations that are reshaping its business model. A structured overview of energy related patterns is missing in the literature to foster business model innovation. This dissertation tries to fill that research gap, with the creation of a taxonomy of 51 business model energy patterns, organized in 10 meaningful groups.

Nickerson et al. (2013) defines a useful taxonomy as being concise, robust, comprehensive, extendible and explanatory. In order to achieve it, the methodology applied was based on the modified-Delphi card sort by Paul (2008), in 5 sequential steps. Academics, practitioners and managers can benefit from the created taxonomy, as the applied methodology allowed the consolidation of the current available literature on business model patterns in the context of the energy sector. Also, the energy patterns present in the taxonomy were described in a standardized form based on the pattern language of Alexander et al. (1977). This language tries to overcome the challenge of the difficult comparison between different patterns underlying different logics on how to characterize them (Abdelkafi et al., 2013). In addition, the developed pattern taxonomy can be used by energy utility managers as a source of inspiration to innovate and reform the established business models of their firms, or even to develop entirely new business models. For example, pattern 35, "Prosumer using block chain system", is a vanguard pattern dealing directly, and almost surgically, with one of the main questions reshaping the energy sector: consumers can now produce and store electricity, more and more efficiently, and this pattern can therefore be used a source of inspiration and creativity for an entirely new business model. Also, many patterns assist established energy utilities to adapt and remain competitive in the energy landscape, by aiding with the *servilization* process (Helms, 2016), such Pattern 8, "Comprehensive Energy Solution Providers", targeting the use of mobile, social and web interfaces to provide customers a two-way communication.

This dissertation seeks to narrow the research gap between business models and the energy sector, however it has some limitations. The major limitation was the lack of time to include more experts in the round two of the card sorting. The expert asked to review and adapt the initial model did not propose any changes related to the groups of patterns, so it was assumed that a consensus was reached about the information (Paul, 2008), but including more experts in the card sorting activity could lead to different results. Another limitation is inherent to the creation of the model itself, because the initial model was created based on the view of the seed participant and the two experts, leaving it expose to they're subjective knowledge and biases. According to Remane et. al (2017), "taxonomies cannot be universally perfect, but in the best scenario are a solution to a specific problem". Another limitation is that not all patterns are suitable for every business, so the database cannot be considered an "algorithm" to support business model innovation, but a “heuristic tool” to support the process. Imposing innovators, academics and managers, to trust they’re creativity and expertise if a certain pattern is suitable to a certain situation in a certain context.

Regarding future research opportunities, it would be interesting to send the initial model to more experts and analyse their responses to confirm if a consensus was reached. Another future research, regards the fact that the transformation occurring in the energy sector is occurring presently, even this dissertation allowed the consolidation of the current available literature on business model patterns in the context of the energy sector, more information is available every day. Hence, the identification of new energy patterns from this day forward would be interesting to complete this study.

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Appendix

Appendix A – List of patterns and groups present in the initial model

Group A - Governance Modes

→ Cooperative Utility (P9)

→ Local Aggregator (P23)

→ Municipal Utility (P27)

→ Prosumer (P34)

Group B - Demand Side Management

→ Ancillary Service Market Participation (P2)

→ Capacity Market Enabler (P4)

→ Load Reduction (P21)

→ Tailor-Made Retail Contracts (P44)

→ Value-Added Enabler (P47)

Group C - Energy Efficiency Solutions

→ Comprehensive Energy Solution Providers (P8)

→ Municipal ESCo (P26)

→ Participation in Distributed Generation Markets (P28)

Group D - Energy Generation

→ Green Energy Utility (P18)

→ Market Performance Enhancement (P24)

→ Power Plant Optimization (P32)

→ Third-Party Ownership (TPO) (P45)

Group E – Financing

→ Access to Cross-Subsidies (P1)

→ Crowdfunding (P11)

→ Direct Finance Options (P12)

→ Energy Performance Contracts (EPC) (P13)

→ Enterprise Credit Facilities (P16)

→ Leasing (P20)

→ Loans (P22)

Group F - Energy Marketplace

→ Community Microgrid (P6)

→ Energy Savings Certificates (ESC) (P15)

→ Peer-to-Peer Energy Trading (P31)

Group G - Pricing Logic

→ Bundling (P3)

→ Complementary Pricing (P7)

→ Cost-Based Pricing (P10)

→ Flat-Rate (P17)

→ Rising Block Tariffs (P36)

→ Time-of-Use Tariffs (P46)

Group H - Revenue Models

→ Pay-as-You-Go (P29)

→ Pay-per-Use (P30)

→ PPA (Power Purchase Agreement) (P33)

→ Shared-Savings (P37)

→ Space Rental (P41)

→ White Label Retailing (P49)

Group I - Storage Solutions

→ Cloud Energy Storage (P5)

→ Large-scale Energy Storage (P19)

→ Small-Scale Energy Storage (P38)

→ Storage Aggregator (P42)

→ Storage Auctioning (P43)

Group J - Technology Solutions

→ Energy Price Monitoring Systems (P14)

→ Microgrid (P25)

→ Prosumer Using Block Chain System (P35)

→ Smart Metering (P39)

→ Software Applications (P40)

→ Virtual Power Plant (P48)

Appendix B - Final pattern taxonomy

Group A - Governance Models						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
9	Cooperative Utility	Cooperative utilities purpose is to reinforce the energy resilience of the local communities in which they operate.	There are consumers concerned about the wealth of their communities, and the role energy plays in them.	The profits derived from the energy generation supply, typically from distributed sources, can be used for the development and to benefit the local community.	Energy4All is now exploring the possibility of the UK renewable cooperative sector collaborating with the wider European movement.	Bryant et al. (2018)
23	Local Aggregator	Utilities and energy cooperatives can act as aggregators for their customers. An aggregator can also be a business association, a municipality, tenets association or even an industrial cooperative.	High electricity prices and high level of greenhouse emissions encourage the formation of aggregation groups.	The aggregator ensures demand meets supply generation. Smart metering and other systems are required to support the aggregation of the locally generated power. The distribution network operators and transmission system operators can be included, as the aggregator has the potential to contract services that can be of use to these infrastructure providers.	Community Choice Aggregation (CCA) is a game-changing local energy model by LEAN Energy US, which is accelerating the transition to a clean energy future without federal legislation or taxpayer subsidies.	Hamwi and Lizarralde, (2017); Hall and Roelich, (2016)
27	Municipal Utility	A local authority can create a licensed energy supply company, focusing on local markets, with the purpose of linking generation and consumption by proximity.	The main motivation for municipal utilities is the need for improved market circuits to drain local generation, and tariff fairness.	By linking generation and consumption geographically, local distributed energy generation and usage is efficiently facilitated. Also, demand side services have greater potential with geographically aggregated customer bases.	In the United States, the Sacramento Municipal Utility District manages the energy consumption and generation of the Sacramento Country, California. SMUD is the sixth largest municipal utility, serving over 595,000 customers. In 2010, it spent 2.7% of its $1.29 Billion revenues on energy efficiency programs.	Hall and Roelich, (2016)

34	Prosumer	Energy consumers can be producers at the same time, having a dual identity, facilitated by energy internet systems.	The lack of stability and deterioration of reliability for energy systems, due to the fluctuation nature of renewable power supply, can be solved by prosumers. Also, they can increase price competitiveness of distributed generation and reduce electricity costs.	Distributed power generation is being promoted by several governments by a subsidy named Feed-in-Tariff (FiT).	Consumers are becoming producers in the UK, generating electricity through solar PV panels and other technologies (small wind, hydro and anaerobic digestion, etc.).	Zhou et al., (2016); Hwang et al., (2017); Oseni and Pollitt, (2017)
Group B - Demand side Management						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
2	Ancillary Service Market Participation	Services to support the transmission of electric power between generation and consumers, maintaining a satisfactory level of operational security and quality of supply.	There is a lack in the reliability and security of the energy supply, and in the integrity and stability of transmission and distribution systems. There are also problems related also to congestion management.	The load balance can be bided in the ancillary market, competing with other resources.	All 6 major Service Operators in the USA (CALISO, ERCOT, MISO, PJM, NYISO, and ISO-NE) allow for load adjustment in their ancillary service markets.	Behrangrad, (2015); Gaspari et al., (2017)
4	Capacity Market Enabler	Demand-side management are adjustments in the consumer demand patterns, to meet a more efficient energy usage. The demand resource provider is the entity entitled to perform the DSM activities for its stakeholder.	The goal is to reduce the energy in need to perform an activity through energy efficiency (EE), promoting reduction of consumption. The situation is that EE is not a dispatchable resource, and it does not respond to situations such as renewable energy intermittency or price fluctuations.	The DRP of the stakeholder notifies when the excess EE is to be achieved, and if it's approved by the regulator, it can bid it in the capacity market, competing with generators for capacity provision. If a bid is accepted, the DRP EE is paid according to the market price.	ISO New England is responsible for keeping electricity flowing across the six states, and to ensure a reliable and competitive price in the wholesale electricity.	Behrangrad, (2015)

21	Load Reduction	Consumers have to pay for the use of the distribution grid, on top of the energy they consume.	Reducing electricity costs for the consumer.	A DRP could commit to reduce consumption at peak times, and consequently the grid utilization costs.	"Paraskevakos" developed a load-management system with an automatic meter-reading technology, at the request of Alabama Power.	Behrangrad, (2015)
44	Tailor-Made Retail Contracts	Personalized contracts between energy retailers and industrial entities.	Retailers fear that market prices increase to values superior to the energy purchased, leading to losses. And consumers are hesitant in signing long term contracts when the foreseeable future for prices is uncertain.	Tailor made contracts aid consumers to deal with the uncertainty associated to long term contracts. Also, retailers can be compensated for providing services to the consumer.	In the UK is possible to go for interruptible contracts for energy intensive users, with direct control tariffs.	Gaspari et al., (2017)
47	Value-Added Enabler	Customers can embrace DSM, with EE measures enabled by products such isolation materials, or energy management tools and smart meters.	The main purpose is to reduce consumption, either by increasing EE or to shift consumption from peak times.	Audition activities and cost/benefit studies can be conducted to justify selling a more efficient system to a consumer. Value-Added Enabler employs DSM wildly in the mass markets targeting residential and small commercial companies.	Several third parties have already become active in the Value-Added Enabler for private households, e.g. the diverse number of demand-response providers (nest, OhmPower, Tesla etc.).	Hwang et al., (2017); Behrangrad, (2015)
Group C- Energy Efficiency Solutions						
ID	Name	Context	Problem	Solution	Example	**Source**
8	Comprehensive Energy Solution Providers	Utilities transitioning to become energy solution providers.	The increasingly challenging energy market conditions and the volatile electricity sales prices.	Provide services beyond energy sales. Using mobile and social interfaces in order to provide the consumer a complete view of their energy use, enabling a two way communication between the utility and the customer.	Some uilities in the United States, as ATandT and Verizon Wireless, have attempted to shift their image from energy sellers to into trusted energy advisors.	Bryant et al., (2018)

26	Municipal ESCo	Energy Service Companies (ESCos) provide services, as efficient appliances or illumination, rather than energy supply by kWh.	The main problem is the lack of environmental sustainability, and high carbon emissions.	Municipal energy involves a local authority buying locally generated energy and selling to customers in its own area through its own fully licensed supply company.	In the UK, the London Borough of Tower Hamlets Council and EDF's partner up through Barkantine Heat and Power Company (BHPC).	Hall and Roelich (2016); Oseni and Pollitt (2017)
28	Participation in Distributed Generation Markets	Participate in markets for distributed generated energy.	More engagement in distributed generation markets is needed, due to the exponential increase in distributed sources.	Energy utilities can invest, acquire or partner with renewable energy developer, such PV establishment, storage and other projects.	Grid scale storage, as AES in the USA, provides affordable sustainable energy over to 15 countries as well as thermal and renewable generation facilities.	Tayal and Rauland, (2017)
Group D - Energy Generation						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
18	Green Energy Utility	Awareness regarding environmental issues, leading customers to turn on "green energy".	Society is shifting away from non-renewable energy sources, like fossil fuels, but renewable options are not usually available in traditional utilities.	Utilities focusing on providing consumers for efficient and reliable green energy, free from greenhouse emissions and from renewable sources.	Ecotricity, in the UK, provides electricity from renewable sources. Just green electricity made from wind, sun and sea.	Bryant et al. (2018)
24	Market Performance Enhancement	Market performance is measured as a combination of the electricity cost and society's willing to pay for it. Whereas market power is an agent's capability to change the market balance.	EE can be used as a tool to lower the market power by new players.	Introducing EE solutions as a commodity in the market will aid the overall energy utilization efficiency, ultimately reducing greenhouse emissions. The EE developments can be tradable as commodities in the market.	Gencos are generation companies, with the main purpose of producing electricity, and they are accountable for energy supply in both energy and reserve markets, which commonly operate at the same time. Profits are the difference between the accepted bidding selling price and its cost.	Behrangrad (2015); Behrangrad et al. (2008)

32	Power Plant Optimization	Supply demand balancing is the main context.	The central problem is the volatile price of fossil fuels, and also the regulatory constraints. Also, the technical restrictions of power plants can be seen as a problem, such as “maximum loads, ramp-up speed limits, and maintenance needs”.	Power plant optimisation encompasses a program determining when is more efficient to operate a power plant, and at what capacity.	Global consulting company Deloitte and German consultancy ProCom are to offer joint services for power plant optimization in the European energy market.	Helms, Loock, and Bohnsack, (2016)
45	Third-Party Ownership (TPO)	The energy production technology is owned by the producer/seller, who charges a fee for delivering the generated energy.	There are consumers, such household owners, who are engaged in reducing their consumption and protecting the environment from greenhouse emissions.	The third party finances, installs and maintains the renewable energy technology on the location of the customer. It controls the ownership of the installation and sells the electricity through a long term contract. Customers can use the energy with no upfront costs regarding the installation; the price of the electricity is also very competitive and predictable, evading fluctuations from utility rates.	TPO arised in the United States, around 2005, and SolarCity is a good example of this pattern. Several TPO models can now benoticed in many countries such the Netherlands, Denmark, China, Germany.	Hamwi and Lizarralde (2017); Horváth and Szabó, (2018); Provance, Donnelly, and Carayannis, (2011)
Group E - Financing						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
1	Access to Cross-Subsidies	There are utilities targeting different segments of customers, ones richer and other poorer in rural areas.	Different tariffs applied for different customers.	Determine different tariffs for different segments, for example applying lower tariffs for rural and low income customers.	In Brazil, some utilities provide cross-subsidies to serve local needs in poorer regions.	Zerriffi, (2011)

11	Crowdfunding	Renewable energy projects could be financed by different investor groups.	Scarcity of banking loans to finance renewable energy projects. There is a need to look for other funding opportunities.	Crowdfunding can furnish legitimacy to distributed and renewable projects, as the selection among several options is perceived as democratic. Also, crowdfunding can introduce novel customers to the projects.	Windcentrale in the Netherlands is a crowdfunding project, which has collected already 14 million euros. It provides wind shares that can be bought by individuals. The energy created by the wind turbines is then deducted from the electricity bill.	Dilger, Jovanović, and Voigt, (2017); Vasileiadou, Huijben, and Raven,(2016)
12	Direct Finance Options	Yield credit for customers for energy services and technology.	Customers interested in acquire energy services and technologies who are in need for financing.	To grant credit to customers, so payments can be spread over time. "This can include splitting purchase payments into multiple payments or deferring payments into the future".	Heat Saver Loan in Vermont provides low rates and fair terms.	Zerriffi (2011)
13	Energy Performance Contracts (EPC)	The DRP/ESCo would allow the customer to accomplish a determined EE performance level.	High levels of energy consumption, which lead to high electricity bills.	Through an EPC a consumer can achieve energy savings. The ESCo/DRP funds EE measures, including the engineering, design, services and installation, with no upfront costs. EPCs are mechanisms for acquiring and implementing financing, through savings and evading building work improvements.	Econoler is a world leader in the use of energy performance contracting (EPC) to facilitate the implementation of energy efficiency projects.	Behrangrad (2015); Bleyl-Androschin and Ungerböck, (2009); Hamwi and Lizarralde (2017); Xu, Chan, and Qian, (2012)
16	Enterprise Credit Facilities	Credit to finance energy projects, in an enterprise perspective.	Firms find it difficult to obtain credit from many traditional creditsfacilitates, for energy projects.	Financing arrangements applied specifically for energy projects.	Central Bank in China provides credit facilities for energy entreprses.	Zerriffi (2011)
20	Leasing	Companies lease energy equipment for customers who own, install and manage.	Some customers are reluctant or cannot afford for the cost of owning the equipment and its installation.	The client can use the generated electricity or sell it to the grid to receive FiT, being the advantages in terms of energy savings or FiT income.	Solar City, in the USA, leases solar equipment for 15 to 20 years.	Tongsopit et al. (2016)

22-A	Small scale financing	Financing for energy efficiency and renewable energy upgrades for households.	Consumers who cannot afford new energy services and technologies need financing options.	A loan offering up to 100% financing. The bank enables this type of loan due to the guarantees given by the EPCs for the EE performance of the system, thereby reducing the risks.	In Thailand there is available the K-Energy Savings Guarantee, for commercial scale solar installations.	Tongsopit et al. (2016); Zerriffi (2011); Sypros Giannelos
22-B	Institutional financing	Financing for energy efficiency and renewable energy upgrades.	Consumers who cannot afford new energy services and technologies need financing options.	A loan offering up to 100% financing. The bank enables this type of loan due to the guarantees given by the EPCs for the EE performance of the system, thereby reducing the risks.	UK employs the FiT, enabling the application for payments from the energy supplier for the generated electricity.	Tongsopit et al. (2016); Zerriffi (2011); Sypros Giannelos; (https://www.gov.uk/feed-in-tariffs)
Group F - Energy Marketplace						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
6	Community Microgrid	To aggregate the inputs and outputs of distributed generation within municipal regions.	Community members that may not be able to host a PV, due to space restriction or upfront costs, but are interested in commit to the use of clean energy.	The community microgrid delivers clean energy through smart metering for the members.	There are community shared projects in the USA, enabling customers to "access energy produced by the systems in solar parks or solar gardens, without installing their own photovoltaic panels".	Hamwi and Lizarralde (2017); Horváth and Szabó (2018); Tongsopit et al. (2016); Provance et al. (2011)
15	Energy Savings Certificates (ESC)	Certificates ensuring that a certain amount of energy was saved from energy saving projects.	To compensate for energy excess or shortage.	The supplier commits to achieve a certain amount of energy savings and if they are in short, it's possible to buy from other suppliers. If they have an energy surplus, they can sell ESC.	The first ESC program was implemented in the New South Wales in 2003.	Behrangrad (2015); Vine and Hamrin (2007)

31	Peer-to-Peer Energy Trading	P2P energy trading enables energy transactions in the decentralized market, ultimately emulating the wholesale market activity of the power system on a local scale.	Distributed generation is usually intermittent and unpredictable. It is difficult for prosumers to deal with a surplus of energy and how to store it.	P2P energy trading represents a platform for direct trading of energy between peers. Enabling the trade of energy from distributed sources from prosumers and consumers.	SunContract, the world's first live blockchain-powered peer-to-peer platform that empowers individuals to freely buy, sell or trade electricity.	Hall and Roelich (2016); Hamwi and Lizarralde (2017); Tang, Zhang, Mclellan, and Li (2018)
51	Local Market Operator	The LMO will be responsible for managing the congestions arising in the distribution network operated by the DSO (distribution system operator).	Resolving congestions in the distribution network may be particularly challenging given the extensive use of distributed energy resources and the resulting complex power flows.	The LMO "sells" the congestion management service to the DSO and "buys" the required flexibility to solve the congestions through the available providers. In this case, the providers would be the active consumers, the distributed energy resources producers and the Charging system operators (participating through their aggregators).	Such an operator has not yet been implemented but details of it have been mentioned in the deliverables of the Upgrid project.	Sypros Giannelos
Group G - Pricing Logic						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
3	Bundling	In the energy context, several products and services are sold together.	Increases in distributed electricity resources and different providers lead some ESCOs to achieve lower revenues.	With bundle, several products or services can be purchase together at a discount.	ScottishPower is a Scottish company offering bundling options, named as dual fuel contracts.	Oseni and Pollitt (2017)
7	Complementary Pricing	Firms deal with consumers with higher transaction costs.	Energy production has high fixed costs associated, these cost need to be recovered without "undermining scope and scale effects", with an appropriate pricing strategy.	To price some products with the purpose to maximize sales, stimulating at the same time demand for other products.	A two part pricing, composed by a "lump-sum" charge (e.g., connection/metering charge)" that is fixed, and a variable parcel dependent of the usage per kWh.	Oseni and Pollitt (2017)

10	Cost-Based Pricing	Price based on providing energy.	Energy production has high fixed costs associated, these cost need to be recovered without “undermining scope and scale effects”, with an appropriate pricing strategy.	Price the electricity such it covers the provision cost plus a profit margin.	Energy tariff is set at the cost of provision plus a certain profit margin, not (necessarily) signifying price differentiation.	Oseni and Pollitt (2017)
17	Flat-Rate	Charging a fixed priced for electricity.	There are fluctuations in the electricity prices that the consumer may want to avoid.	Charging a fixed price and providing the consumer unlimited energy access.	The Synergy Home Plan is an Australian company targeting “busy people and families”. The bill is straightforward to understand as there is only one flat rate applied to all kWh consumed.	Remane et al. (2017); www.synergy.net.au
36	Rising Block Tariffs	Different prices charged dependent on the quantity purchased, such quantity discounts for big quantities.	Intensive energy consumers usually face higher charges.	The energy tariff changes according to consumption intervals, with a low priced bock covering a basic energy use, and consequent blocks for a higher energy use.	This pricing scheme is usual South East Europe.	Oseni and Pollitt (2017)
46	Time-of-Use Tariffs	In this tariff the energy prices change throughout the day..	Consumers with high demand during cheaper periods could benefit from a discount at those times.	Time-of-use tariffs are dynamic tariffs that change according to the loading and congestion of the network. During demanding periods the tariff is higher.	Green Age company in the UK offers this pricing scheme type.	Oseni and Pollitt (2017); https://www.thegreenage.co.uk/an-introduction-to-energy-tariffs/
Group H - Revenue Models						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
29	Pay-as-You-Go	A financing option for energy services.	Different financing options to benefit different household situations. Some people can’t afford for energy services.	Pre-payment cards to insert in the meter, in which the customer has to charge with money to activate the meter and enjoy the energy services.	OVO energy in the UK offers pay-as-you-go options with their prepayment meters.	Zerriffi (2011); https://www.ovoenergy.com/guides/energy-guides/prepayment-meters.html

30	Pay-per-Use	With pay-per-use users pay for a service or resource with no ownership or subscription for it.	Need of change of consumers behaviour in concerning the environmental impact. Also, companies need to take responsibility for product lifecycle issues.	With pay-per-use consumers can be more aware of their consumption patterns, enabling sustainable consumption.	HOMIE is a start-up focusing on reducing the environmental impacts for households, offering pay-per-use services.	Bocken et al. (2018); Herbes et al. (2017)
33	PPA (Power Purchase Agreement)	A power purchase agreement is a contract between two parties, the party that generates the electricity (seller) and the party who buys it (buyer).	This type of contracts is suitable to avoid high up-front cost, to reduce peak demand events, reduce system performance risk and to guarantee a steady price for the electricity generated.	The buyer/owner signs a contract to purchase the electricity generated by the seller, at a pre-determined price. He guarantees the installation of the system and maintains its ownership for the schedule of the contract (usually 15-20 years).	EDP, a Portuguese utility, signed a PPA for 200 MWh to sell the produced energy by its wind farm to Great Plains Energy, a holding company based in Kansas.	Wainstein and Bumpus, (2016); https://www.edpr.com/
37	Shared-Savings	Shared-savings is a loan used to finance the savings resulting from energy efficiency improvements. Shared-savings is proposed for energy-intensive buildings and factories.	Some facilities face high electricity costs, and they could benefit from this type of solution.	The developer improves the customer's facility to be less energy intensive and more efficient. The loan provided is repaid by the savings achieved, no upfront costs are required.	Associated Renewable in the USA offers this type of solutions for its customers.	Tongsopit et al. (2016); http://www.associatedrenewable.com/
41	Space Rental	Developer who rent available spaces and to install and own an energy generating system. The electricity subsequently sold to the grid.	Some developers could have know-how and available energy solutions, but can't afford to buy a space to operate them.	The developer installs and manages the system in the rented site (e.g. a roof). The energy produces is sold to the grid. Revenues flow to the developer who pays a rent to the owner of the space.	The UK government in 2010 launched the FiT for PVs, the affordable tariffs enabled installers the solution of renting rooftops.	Tongsopit et al. (2016); https://www.theecoexperts.co.uk/

49	White Label Retailing	A white label company works in partnership with a licensed energy supplier, to sell energy to consumers at more affordable tariffs under their own brand.	High costs of entering the energy market supply.	White label retailing allows companies to offer energy supply to their existing customers/residents, without the burden of additional regulation or installation of new systems, commonly using those of their fully licensed partner. It also provides a revenue stream through payment of commissions to the recruiting entity.	In the UK, Sainsbury's Energy partnered with British Gas to operate under a white label named Sainsbury's and MandS.	Hamwi and Lizarralde (2017); Hall and Roelich (2016)
Group I - Storage Solutions						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
5	Cloud Energy Storage (CES)	Provide storage solutions for small scale consumers. .	Storing the energy produced by small scale distributed sources is costly and sometimes inefficient.	This system enables energy storage in the grid centralized batteries at affordable cost, providing users the opportunity to store or withdraw the energy when suitable.	Sonnenbatterie is a German company that provides energy storage for households.	Liu, Zhang, Kang, Kirschen, and Xia, (2017)
19	Large-scale Energy Storage	Energy storage is essential to balance supply and demand, because allows for production to be uncoupled from supply.	Energy resources are ineffectively used when the produced energy cannot be stored and there is no demand available.	The energy storage market offers solution for large scale storage at grid level, delivering directly the energy to the grid. This enables balancing the grid at peaks.	AES energy storage provides storage for industrial customers.	Hamelink and Opdenakker, (2018); Lombardi and Schwabe, (2017)
38	Small-Scale Energy Storage	Small-scale energy storage enables storing solutions for households or isolated users.	Uncoupling electricity production from the supply.	Deliver small scale storage solutions in order to enable customers to be independent from the grid.	SMA Benelux is a Belgium company offering storage solutions in form of batteries. Electric vehicles may also be included as forms of energy storage.	Hamelink and Opdenakker (2018); Lombardi and Schwabe (2017); Sypros Giannelos

42	Storage Aggregator	Energy storage is essential to balance supply and demand, being a source of flexibility with applications covering the whole value chain.	As of today, electricity storage solutions are not considered as economically viable.	Each user feeds the storage unit independently and has the right to withdraw the same amount, leading to no conflicts of interest.	Limejump is a technology driven utility, with the largest battery aggregation storage system in the UK, also known as "The Big Battery".	He, Zhang, and Pang, (2017)
43	Storage Auctioning	Energy storage has many advantages, manly in the distributed generation markets.	Storing the energy produced by small scale distributed sources is costly and requires space.	Sharing an energy storage system among households. The participating households submit bids to an auctioneer to get storage capacity in the shared system.	Teréga's, in France, provides storage auctioning. For each proposed storage, the participant bids the desired volume.	Zaidi, Bhatti, and Ullah, (2018)
Group J - Technology Solutions						
ID	**Name**	**Context**	**Problem**	**Solution**	**Example**	**Source**
14	Energy Price Monitoring Systems	Customers want to be aware of their consumption patterns and prices.	High electricity costs for consumers, high levels of consumption, and lack of environmental behaviour.	Systems that monitor and control prices and provide the information to users, allowing them to adapt their consumption patterns. It also enables to reduce energy costs.	The Eletrext system in Dublin, is a monitoring system used to enable customers to improve EE.	Behrangrad (2015), Hamwi and Lizarralde (2017)
25	Microgrid	In smart grid context, microgrids provide energy supply in parallel with the main grid through a group of energy sources.	The problem of distributed generation is how to coordinate and storage the energy from the different sources.	Micrograds aid with the integration of the distributed energy sources in the main grid, along with storage solutions and electric vehicles. Micogrids can supply in parallel with the main grid or be an alternative power source when there's an outage of the min grid.	Les Anglais in Haiti is a community powered by a microgrid, with cloud energy monitoring and smart metering.	Zhou, Yang, and Shao (2016)
35	Prosumer Using Block chain System	Technological advances are bringing significant changes to the energy landscape. The IoT enables people to exchange information intelligently,	This pattern tries to solve problems such the reliability deficiency and high costs in the energy system, and its deterioration caused by the entrance of distributed	Prosumers can resolve the difficulties in the system stability and make prices more competitive for distributed generation and ultimately reduce costs. Blockchain is another way to increment	Electron in London, offers energy services and solutions based on the blockchain system.	Hwang et al. (2017)

		and is evolving together with communication technologies.	sources in the power supply.	reliability and reduce costs, “through a cryptographic hashing system”. Jointly, prosumers and blockchain can make up an innovative energy system.		
39	Smart Metering	A smart and connected energy panorama is emerging, and its foundation relies on smart metering and big data.	The energy sector is constantly being overwhelmed by technological advances, and many informational technologies had already entered in the energy system, such smart metering.	Smart metering enables customers to follow their energy consumptions, and to gain awareness of their consumption patterns. Smart metering facilitates energy and money saving, as customers can react to price signals. It is also a lane for customers to engage in DSM.	The Italian utility Enel has launched a program named Telegestore, which is the first big scale smart metering project for households, costing 2.1 billion euros and projected to perform annual savings of 500 million euros.	Zhou, Yang, and Shao (2016); Torstensson and Wallin 2015); Rawlings et al. (2014); Shomali and Pinkse (2016)
40	Software Applications	Moving from a system where a commodity is differentiated by price, to a system where it is differentiated by quality. Technology layers represent an intelligent energy system based on advanced information and communication technologies.	High competitive market, with new entrants from different sectors, like consumer technology, telecommunication. The ultimate goal is to revolutionize energy production and consumption, in order for the power system to become more smart, secure, stable and reliable. In the end, energy structure optimization, energy conservation, emission reduction, and energy efficiency improvement can be achieved.	Improve software appliances for customers, bundle packages for energy efficiency, offer services to customers, based on a two way informational communication, billing and consumption patters	Powershop in New Zeland is an online energy platform retailer, which slogan is “manage rather than own”.	Tayal and Rauland (2017)

48	Virtual Power Plant	A “virtual power plant” (VPP) is the distributed equivalent of centralized traditional power plant.	The instability and unpredictability of different distributed energy resources, and lack of coordination among multiple distributed resources.	The VPP represents several distributed energy sources in an aggregated group, reducing the instability of the sources in separate. It links the energy to the wholesale markets and presents services to the SO. VPPs can be considered and treated as traditional power plants.	Lichtblick, Next, Kraftwerke and Vattenfall are German VPPs operators. The plants are linked through a platform, and power generation is marketed in ancillary and wholesale markets via that platform.	Zhou, Yang, and Shao (2016); Helms, Loock, and Bohnsack (2016)
50	Charging system operator	Provision of the access both to the charging point and to the distribution grid for electric vehicles (EV).	EV's may lead to greater peaks. For example, if all vehicles charge when their owners return home in the evening, the peak demand will increase further than it was originally.	A charging system operator will be responsible for the provision of the access both to the charging point and to the distribution grid to EV users who require the service. The operator will manage one or several charging points.	A charging system operator is an envisaged, not yet implemented entity (but planned e.g. in the Winter Package regulation of the European union)	Sypros Giannelos