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A review of business models towards service-oriented electricity systems

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Abstract

One of the main interest of product-service system (PSS) is its potentiality to minimize the environmental impact of both consumption and production. In the energy sector, Product-Service System has been discussed in the literature as a concept associated with energy efficiency. However, the liberalization of the energy markets and the increasing market share of distributed renewable energy allow ventures and new actors to employ Product-Service System in both decentralized renewable energy generation and demand-side management. This paper is a review paper exploring different business models (BMs) for energy transition. It outlines three major business models: Customer-owned product centered BMs, where the customer owns the product related to the electricity generation or management; Third-party service centered BMs, where a third party offers energy services to the customer; and finally Energy community BMs, where resources are pooled and shared between community members.

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Keywords: Product-service system, energy transition, business model

1. Introduction

The extensive amount of CO^2 emissions is considerably affecting the climate change. Large emission facilities such as fossil fuel based power generation, are at the top of the list of these emission sources [1–4]. With sales of 590 billion euros, the German electricity market became the greatest energy market in Europe in 2013. However, the "big 4" energy utilities market share, which are considered the main energy actors, shrunk from 84% in 2010 to 74% in 2013 [5]. The total contribution of these utilities to the renewable market share has been 20% during the last 20 years. This means that 80% has been generated by other market actors [6].Additionally, 68% of the U.S energy utilities estimate a stagnant or minimal electricity demand growth during the next five years, as a result of energy efficiency and rooftop solar generation growth [7].

Recently scholars have discussed the need for energy utilities to reform their BM, replacing electricity as a commodity with a provision of services. However, this transition to a service model holds many obstacles and challenges for utilities. [1,3,8]. Energy utilities within their conventional energy system paid little attention to the BM concept. Consequently, their BM has not evolved significantly the last years. This is due to the fact of: first, the utility BM is centered around tangible commodity where the intangible value is an afterthought. Second, the production and distribution of this commodity are protected by public regulation where competition has been very limited. Moreover, in this system, utilities capture value by simply selling electricity in the established markets. There is no need for innovation as the revenue covers the fixed and variable cost of the generated electricity.

Lately, new technologies are penetrating the energy sector and energy market has begun to be liberalized. In addition, in the emerging energy market, consumers have several choices: related to the different transaction costs, heterogeneity among producers, etc. Moreover, there are upward trends among consumers to reduce environmental impact by, for example, consuming renewable energy. The share of renewable energy in the market is augmenting at the expense of fossil energy

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while the prices of the former technologies are decreasing.

Responding to these emergent changes, new companies have been positioned in the energy sector; offering new products, services, and energy supply conditions. These new entrants are constructing their position in the electricity market by developing new BMs based on innovative services, creating a new ecosystem and involving new partnerships [9].

This paper presents a review of these new business models. This review has been realized from the customer point of view and includes all the stages of the electricity value chain: generation, transmission, distribution, and consumption.

The paper is organized as follows: section 2 introduces the business model theory. Section 3 explains the research methodology. Section 4 is a review of emerging business models for energy transition and includes three subsections: first, customer-oriented product centered BMs. Second, Third-party service centered BMs, and finally energy community BMs. Then the main conclusion is drawn in section 5.

2. Innovating through the Business Model

The concept of business model has received increasing attention from scholars and practitioners during the period of the emerging e-business in the middle of 1990s. Despite the large use of this concept since that time, there is no agreed definition among scholars [10]. Recently it has been used interchangeably by academic as well as by practitioners as an analytical and a classification tool [11].

The business model concept may execute several functions including the articulation of the value proposition, identify a market segment, define the value chain and value network, estimate the cost and profit structure and formulate the competitive strategy [12]. Business models pave the way for new technologies to take a place in the markets and create value for them. Therefore, it is considered as a construct that mediates the value creation process. It translates the technical inputs to the economic domains of outputs [12]. Two major components form up the BM concept. First, the “Unit of business” which refers to what firms are offering and what customer are paying for. Unit of business is critical for strategy choice [13]. The second is “Key metrics” which refer to the process and the activities that firms perform to sell a product or service [14].

The external environment, including partners, suppliers, and customer, is crucial in the BM concept. BMs clarify how the value is created and captured [10]. Johnson and Suskewicz showed that in large infrastructure changes, like the transition from fossil fuel to renewable energy, the focus should be shifted from developing individual technologies to creating the whole new system.[15]. BMs have been recognized as a locus of innovation [16] and know how to capture this value is an essential part of the BM function [17]. Developing a suitable BM is often necessary for technological innovation, it facilitates bringing inventions to the market and it satisfies unrequired customer needs. Correspondingly, technological innovation by itself does not guarantee business success.

Developing a new BM requires a deep understanding of the fundamental customer needs, how the competitors failed to satisfy those needs, and the technological and organizational trajectories. While designing the desired BM seems the most important, the process of learning and adjusting the BM holds the same importance. Furthermore, estimating the customers and competitors behaviour’s changes from initial conjectures makes adopting a new BM go faster [17]. Boons and Ludeke-Freund proposed a social, technological and organizational classification for delivering sustainability through innovative BMs [18]. Previous studies indicate that PSS, as a functional-oriented approach, is a promising concept in environmental terms [19]. Employing PSS has the potential to increase efficiency by delivering functionality (e.g. pay-per-use) rather than selling ownership [20]. Delivering renewables, energy efficiency and demand response through a service-oriented BM holds the potential to support a shift towards more sustainable energy production and consumption [3,21,22]. The PSS concept is used in this paper to explore various configurations of product/service in the evolving electricity sector.

3. Methodology

The authors conducted a systematic review of the existing academic publications. The systematic review is a way to address a specific problem by summarizing the existing research and presenting it in one single document. [23]. The research method comprises four steps [24,25]. First, the definition of the research question: “how the BM concept has been used in the literature concerning energy transition and what the different types of BMs are in this electricity domain”. Thus by applying business model concept, as a structural framework, different BMs for energy transition have been outlined. The aim is to close a gap related to identifying what could be the upcoming business model that can contribute to reduce and optimize the use of energy and to present the status quo of research on BMs for energy transition.

Secondly, the inclusion and exclusion criteria have been defined: Thus, our criteria determine the articles that tackle the description of the different components of emerging energy BMs in the energy sector. Technical articles dealing only with technological aspects have been excluded. The main focus has been done on specific publications in the framework of socio-technical system theory that define the relationship between the core business values and the sustainable energy systems mainly in the electricity sector. In addition, we considered only the articles that rely on a previous business model definition. Our research is limited to the residential sector rather than commercial or industry. Articles dealing with specific BMs for developing countries have been excluded.

Thirdly, a search strategy has been defined. The following bibliographic databases have been used to identify all the articles related to our topic between 2000 and 2016: EBSCO Business Source Complete and EcoLit, IEEE Xplore, and Direct Science. Our research comprises few key keywords “Energy, power, electricity, renewable and distributed generation” and “Business model” in the title.The research process resulted in 80 articles. After reading the abstract and assessing the articles according to evaluation criteria, 22 articles that are relevant to our research question were considered. Then, 8 articles were added from the citation. As a result, 30 articles were considered. The majority are published in the following three Journals: “Energy Policy, Journal of

Cleaner Production and Renewable and Sustainable Energy Review".
Fourthly, in order to synthesize our collected data, a process of coding has been performed which has enabled us to homogenize the concepts found in different papers. It has contributed to categorize over 30 business models in the proposed categories. These clusters of the BMs are mainly based on the literature review. The analyzed papers have explicitly or implicitly referred to one, two or three of the presented categories. Furthermore, for each BM, the following criteria has been analyzed: the ownership, the place (assets installation) and the source of the financial resources.

4. Business models for energy transition

This subsection describes the three BM categories: Customer-owned product centered BMs, third-party service centered BMs and energy community BMs.

4.1. Customer-owned product centered business models

In this subsection, product-oriented BMs are analyzed. In these BMs the end-user purchases the system and finances or performs directly the installation and maintenance of the system. On one hand, the consumer can purchase renewable energy technologies (e.g. Photovoltaic panels, PV) to generate electricity. On the other hand, the consumer can invest on Demand Side Management (DSM) devices which includes energy efficiency products (e.g. isolation materials) and energy management tools (e.g. smart meters).

4.1.1. Customer-owned renewable energy technologies

In this BM, the consumer turns into a prosumer (producer and consumer). In the academic literature, several designations have described this BM. "Plug and play" referring to the traditional way of direct product purchase [26], [27]. "Host-owned model" [28,29], and "Customer-owned PV BM" [30]. The value proposition is the electricity micro-generation and its complementary services. The market segments are the home owners and SMEs who have an appropriate property that fits with renewables (e.g. sufficient rooftop for PV, no shadow, etc.) [30] and who can take the risk of the investments. However, the responsibility of implementation and maintenance may be taken by the consumer or the supplier. It is a transaction-based process, therefore the relationship between the product supplier and the consumer is not crucial. The generated electricity of the micro-generation may be fed into the electricity grid or be consumed by the owner. Prosumer can transmit the electricity surplus into the grid, which depends on the legislations and electricity infrastructure. In both cases, the revenue model is based on long-term return on investments. In the former, the electricity is purchased at a competitive price by utilities, while in the latter; consumers will have a trade-off on electricity monthly bill. Concerning the cost, consumers have to face a high up-front payment, maintenance, associated risk of poor performance and transaction cost of grid interconnection [28]. A good example of a successful implementation of consumer-owned BM can be taken from Germany. Many contextual factors have encouraged and facilitated BM development. Germany, on one hand, has created an attractive feed-in tariff and on the other hand, has proposed a low-interest loan rate for renewable energy technologies. The low migration rate in the building sector has eliminated the landlord and tenant problems. The transaction cost has been reduced through local experience and low legal administrative requirements [29].

4.1.2. Customer-owned demand side management means

Demand Side Management is a method to adjust consumers' demand for electricity. The main purpose is either to reduce consumer's consumption by increasing efficiency or shift consumer's consumption from electricity peak hours to other time windows, what is called Demand Response (DR)[31]. A generic business model has been proposed named "energy efficiency service and devices sales" which is one of the conventional energy efficiency BMs. Herein the demand response provider (DRP) sells a system/device that can help the customer reduce its energy cost. Another variation of this BM is that DRP conducts audit activities and cost/benefit studies to justify selling a more efficient system/device to the consumer [31]. "Value-Added Enabler Model" employs DSM wildly in the mass markets targeting residential and small commercial companies. Providing control elements like smart thermostats, power monitors, and "set and forget" technologies that provide real-time and predictive energy consumption data. This kind of BMs requires building "big data" platforms, design innovative method to capture, present and share data with customer, conserving data security and tools to facilitate and simplify consumer's decision making [4].

4.2. Third-party service centered business models

The base of this BM is providing a service rather than a product. In the energy field, energy service is a concept that often refers to energy efficiency and is associated with Energy Service Companies (ESCOs). Besides ESCOs, this BM is evolving to deliver renewable energy, as a package of services, demand response and energy efficiency. Recent research works have identified that investors prefer this BM rather than BMs focusing on best technology or lowest price [32].

4.2.1. Third-party for renewable energy technologies

In this BM, a third-party offers financing, installing and maintaining a renewable energy system on the site of the consumer. Moreover, it keeps the ownership and sells the generated electricity through a long-term contract (15-20 years). Two terms are used in the literature: "Third-party ownership BM" [28,29] and "Company-driven BM" [26,27]. SolarCity, in the USA, is a good example of this BM. This company has employed BM innovation and specifically financial innovation to scale-up its business. It has created strong partnerships with both the financial institutions to obtain a large amount of capital and with downstream partners to accelerate the sales and minimize cost through a vertical integration along the value chain [33]. The value proposition of this BM is to remove the up-front cost and pay a competitive

electricity price. By fixing the electricity price for (15-20) years, the electricity prices fluctuation risk is eliminated. The system owner has two different revenue streams, offering either a solar lease or a power purchase agreement [30].

"Local white label BM" is a local label supplier who can satisfy the local needs for renewable energy. Whereas the cost of renewable energy is higher than the grid electricity, the local label can use smart meters and mobile application in order to optimize energy use of the consumers, giving signals regarding energy cost and consumption on daily basis. This BM links energy use with daily activities through advanced information and communication technologies (ICT) [34]. The value proposition can be extended to go "beyond-the-meter" (e.g. solar, storage, etc.) developing alternative products from the generation portfolio [4].

"Cross-selling BM", refers to non-PV related companies, who work in different sectors like construction companies engaged in the cross-selling of PV systems benefiting from the pre-existing good relationships with customers [29].The value proposition compromises a competitive price, low transaction cost, and lower electricity bill. The financial benefits for the consumer are electricity savings, while the upfront cost of PV is embedded in the house mortgage [29]. Similarly, "Partner of Partner Model" is prevalent when there are increments of energy technology and choice, and customers are seeking ways to simplify their lifestyle. Companies who are looking for success pursuing this "Partner of Partner" BM, have to create a set of partnerships with solution and service partners, expand their market channels, develop a bunch of offers and keep a high customer satisfaction [4].

A part of energy transition towards renewable energy has been discussed from energy utility point of view. In attempted to determine the utility potential role in the future energy markets, the BM framework has been employed. For that reason, two BMs have been suggested: "customer-side renewable energy BM" and "utility-side renewable energy BM" [2]. In the former, the utility produces its electricity on the site of the consumers, with capacity ranges from few kilowatts to (one MW). The value proposition can vary from simple consulting service to finance, ownership and operation of the asset. Whereas the Utility-side renewable energy BM is a large-scale of renewable energy technology that ranges from one to some hundreds megawatt [2].

The current utility revenue model is a barrier that blocks its engagement in the emerging renewable energy system. The utility model is based on consumption per kWh, thus its return is associated with consumer's consumption [2]. Regarding consumer relationship, consumers have no trust towards energy utilities who have been making a profit from their previous consumption for decades [1,3]. The main motivation of utilities to change their BM towards service-oriented BM seems to stem from utility income erosion and not from customer and market changes [1]. The current capital intensity and tangible assets of utilities restrict its ability to develop service-oriented BM which depends more on intangible assets.

4.2.2. Third-party for demand response

"Business model involving load" aims at reducing electricity cost of the load, thus selling load flexibility to the demand response purchaser [31]. By sending electricity price signals, the users may respond to these signals, modify and re-prioritize their actions. These adjustments can be achieved either by raising awareness and exchanging information and prices about consumption through an infrastructure of metering or by providing a system that reacts to the different prices [31]. Third-party "local aggregator" BM links demand and local supply by providing the consumers with smart meters in order to influence consumer behavior and enable them to switch consumption patterns. The virtual net metering enables netting off the local supply from the utility's supply [34,35].

"E-balance business model" aims at integrating consumer in the smart grid through ICT based solutions to increase efficiency and reliability of the energy grid on the local level. The added value is a lower electricity bill for the consumer and a stable power flow for the grid operator. Balancing, controlling and monitoring the electricity and permitting consumers to buy and sell electricity are the main activities. The partners can be smart device vendors, ICT providers, banks and ESCOs. Gamification and price incentives can be used to guide the consumer relationship. The platform can facilitate the communication between actors. The main cost stems from the advanced technologies like smart sensors and apps while the revenue comes from the monthly fee service [36]. Several terms have identified in the academic review around this BM "Timing-based BMs" [35], "E-balance BM" [36], and "Balancing service platform" [37] "Peer to Peer" BM can also be used to allow consumer to choose a mix of distributed generation [34].

Weiller and Pollitt analysed the matching service platform as an intermediate between suppliers who are not able to predict their production and the consumers who have started to take part in the energy market. This platform position is on retail part of the supply chain and provides two functionalities. First, selling and buying electricity for one or different resources and second, reducing peaks and optimizing the electricity usage [37]. The intermediary platform breaks down the traditional electricity system value into a decentralized value constellation where the vertically bundled supply chain transformed into value networks with multiple entry and exit points and it would improve market efficiency and reduce transaction costs. However, a platform service provider can take some decisions on behalf of the consumers in order to limit the behaviour side effects and better control the system [37].

4.2.3. Third-party for energy efficiency

The BM concept has also been used to analyse energy efficiency services. The most prevalent BM is Energy Service Company ESCO which refers to a provision of services that a company provides to the consumer in order to reduce energy consumption rather than providing units of delivered energy (e.g. gas). Two types of BMs can be observed for ESCO. First, the Energy Supply Contracting ESC, which provides "Useful energy" (e.g. hot water, coolant, electricity etc.) this PSS is use-oriented as a primary converter (e.g. a more efficient generator) is used to convert energy to hot water as an example. Secondly, Energy Performance Contracting EPC which provides final

energy service (e.g. space light, space heating etc.) is a result-oriented PSS [8,38]. From a financing point of view, ESCO business models can be divided to "Shared Savings" and "Guaranteed Savings". In the former, ESCO provides the finance and the consumer has to pay a monthly portion of the energy savings while in the latter, the consumer has to finance and ESCO guarantees a sufficient saving to cover consumer's annual debts [39]. However, ESCO has failed to become a major component of the emerging energy market and has had slow market diffusion which can be attributed to the weak knowledge and uncertainty surrounding ESCOs [39], to "locking in" of the traditional energy system model and to the dominance of the incumbent energy utilities [8].

4.3. Energy Community business models

Energy community BMs can take many shapes: it could be a renewable energy farm in a single place or it could be a renewable system distributed among the members' houses. Citizens have the opportunity to participate by possessing or/and financing each according to its capacity. This BM can be administrated by the members or by a third-party (utility, non-for-profit). The main incentive beyond the development of an energy community is to control the origin of the electricity. Consumers have a high level of involvement at two different levels. Firstly, controlling and managing the community and secondly, guarantying the balance of supply and demand of the micro-grid [27]. This BM depends on the local actors, therefore the local and well-known mediators encourage behavioural changes due to a close and trustworthy relationship.

Building a business model for a community can be organized on the local level through the physical interaction between the members of the renewable energy cooperatives or on the national level through virtual, online portal platform. In a "Grassroot P2P" platform, the members organize and administer the community in order to minimize the cost and improve social or environmental issues [33]. An energy cooperative, as an energy community BM, is a collaboration between members who aim at producing their own renewable electricity [40,41]. Citizen Participation Initiatives (CPI) refers to an innovative social active role of citizens in funding and implementing renewable energy project [42]. It includes marked-based (profit-oriented) CPI and grassroots initiatives (civil-society based community). The energy community BM has many advantages. It minimizes the financial barriers for individuals through the possibility of owning a part of the whole renewable energy system. Moreover, the collective purchasing process reduces the cost and finally eliminating site problems such as suitable rooftop and shading [28,43].

Energy Utilities can take part and establish energy communities. "Utility-sponsored community solar USCS" BM enables utilities to maintain their customers by passing their demand for renewable through the utility, achieve economies of scale and enter new market segments where the home's roof is poorly fit or where the customer is a tenant. [44]. The economic incentives beyond this BM can be either fixed solar rate or shared investment returns. In addition, this BM can generate extra revenue from Renewable Energy Credits.

Energy communities are not isolated entities and they can influence and be affected by other energy communities or actors. The fluctuation of renewable energy creates a need for flexibility, better organize and balance energy on the local level. Integrated Community Energy System (ICES) takes into consideration the internal value like efficiency and sufficiency as well as the external value of flexibility that other actors like suppliers, grid operator, aggregators and other community may benefit from. ICESs main feature is local energy exchange. When local consumers increase their cooperation, a better feasibility is realized on the community level due to the economies of scale (collective purchasing) and local balancing (e.g. optimizing DSM) [45]. It aims at alleviating spatial and temporal variation of renewables and reducing the risk associated with stochastic nature of renewable resources. [45].

5. Conclusion

In this paper, various BMs that new entrants to the energy markets can adopt are reviewed and presented. The three BMs categories permit new ventures to consider a configuration of product-services in the value proposition (e.g. leasing or selling PV system); the different financial models in value capture (e.g. performance or fixed monthly fee base) and diverse value delivery ways (e.g. customer's site or utility's side). The purpose of this categorization is to assist in rethinking the shape of BMs in liberalized energy markets. The paper revealed two outcomes:

The first outcome is that the BM concept has widely been used to address energy transition however, there is no clear framework regarding its deployment and new player's roles. The paper outlines these BMs into three categories based on academic literature review and trying to bridge the gap between the urgent need of sustainable BMs and uncertainty regarding the new players' role in emerging electricity market. The second outcome of this review is that PSS has been widely used to address sustainability potential in many sectors. In the same time, there is an emerging dominant trend towards servitization of the energy sector. However, PSS has received little attention regarding its potential contribution to structuring sustainable energy BMs.

This review paper has proposed three main BM categories: customer-owned product centered BMs, which are product-oriented BMs based on selling renewable technologies or energy management tools. Third-party service centered BMs, including use-oriented PSSs and result-oriented PSSs. Herein, the value proposition is shifted to service due to certain circumstances like legislations, financial system nature, market changes, customer's needs etc. Value captured by providing solutions to complex issues like electricity peaks, or financial issue like up-front cost of renewables or energy efficiency systems. Innovation is more obvious through focusing on consumer's need, minimize consumer risk, and creating new ecosystem through new partnerships. Lastly, the core value of the energy community BMs is pooling and sharing resources. In addition, many social values can be captured like democratic decision making, expand renewable energy access and encourage social acceptance of renewable energy diffusion.

Further research is being conducted to identify practices in

the electricity market along the value chain and integrate these practices with the academic review in order to propose a framework to support innovative BM development in the electricity sector.

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