Energy entrepreneurship business model innovation: insights from European emerging firms

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Abstract

The power sector stands at the edge of a transition phase in which the liberalization of energy markets permits new actors to be involved and develop new business models. The emerging businesses seem to have a different logic than the centralized, large-scale and fossil fuel based energy utilities. Energy entrepreneurs are promoting clean energy technologies and creating innovative business models that associate commercial benefits and sustainability aspects. However, the process of finding out the appropriate business models poses challenges to new market actors, researchers and policy makers. This paper explores how new entrepreneurs in the energy sector create and capture value from innovative business models. The study combines the distributed renewable energy resources and demand-side management including energy efficiency and demand response. The paper draws on activity system business model as an analytical framework in order to outline the key characteristics of the energy entrepreneurship business model innovation. The result can assist new market actors and professional during their early development stage to construct new business models in the energy market. As a result, the paper proposes a business model framework for energy entrepreneurship that is characterized by decentralized small-scale assets, service-oriented, end-user relationship and process focus, consumer co-provider, intermediary model and pay-per-use revenue. Furthermore, the regime barriers and the environmental impacts have been analysed.

Key words: Business model innovation, energy entrepreneur, energy service, aggregator, demand-side management, energy transition.

1. Introduction

The power sector presents almost 40 percent of the total Greenhouse Gas (GHG) emissions. Therefore, electric power transition towards a more sustainable form of energy is a key measure to combat climate change. In the OCDE countries, the traditional energy utility business model has been disturbed. For decades, the total investments have been dispersed over the increasing number of the consumers, which reduces the price per unit. But, this economies of scale based utility golden age is now diminishing (Sioshansi, 2015). Moreover, in the U.S, the energy utilities electricity demand growth is slowing or even declining, in 2015 it reached its lowest rate level since 1950 (QER, 2015). Today, energy utilities in OCDE countries are regarded by the financial communities as high risk and unprofitable companies (IEA, 2016). Besides, the renewable energy market share is expanding, 2015 was an extraordinary year for renewable energy with the largest global capacity additions seen to date (REN21, 2016).

Recently, a stream of energy entrepreneurial activities have received increasing attention. This activities are based on novel business models that deliver new products and services by employing renewable energy technologies (Okkonen and Suhonen, 2010; Tolkamp et al., 2018). However, empirical studies are limited. There remain major gaps regarding how business model innovations by energy entrepreneurs evolve. In this paper, we seek a deeper understanding of business model innovation through cases from the energy sector. Our main research question is the following: how do entrepreneurs innovate in the energy sector and how are these innovations reflected in their business models?

The paper is organized as follows: section two describes the theoretical background. Section three introduces the employed methodology and section four illustrates the main results of the case studies analysis and the business model framework for energy entrepreneurs. Section five discusses the main characteristics of the energy business model framework and the paper finishes with conclusions in section six.

2. Theoretical background

2.1 Business model theory

Despite the theoretical heterogeneity and diversity over the term business model (BM), the literature review shows some shared notions on the topic. First, the BM draws a holistic picture of the firm and describes how the firms capture and create value (Zott et al., 2011). In this regards, BMs represent a structure that explains and illustrates the firm transacts with customer, supplier, partner and vendors (Zott and Amit, 2008). They are narratives that tell the story of businesses by considering the three major components (McGrath, 2010; Osterwalder, 2004), namely the value proposition, value creation and value capture. Secondly, scholars agree that BMs are source of competitive advantage (Baden-Fuller and Morgan, 2010; Chesbrough, 2007; Mitchell and Coles, 2003).. BM can also be regarded as a way to unlock the latent value of technologies. It can be used to commercialize an early-stage technology and introduces new commercial spin-offs (Chesbrough and Rosenbloom, 2002). Another notion for the BM concept is a scientific investigation tool that tells stories about innovations and abstract ideal types in order to introduce principles that are replicating the organizational knowledge (Baden-Fuller and Morgan, 2010). Lastly, BMs can be conceived as blueprints or templates to generate archetypes or morphologies, building on existing knowledge to drive new BMs (Bocken et al., 2014; Frankenberger et al., 2013; Osterwalder, 2004).

2.2 Business model innovation

The research on BM evolved from being a static description to a more dynamic concept focusing on BM development and innovation (Chesbrough, 2010; Demil and Lecocq, 2010; Teece, 2010). However, there is no consensus concerning the business model innovation (BMI) definition (Spieth et al., 2014). BM innovation is seen as an experiment of mapping the business processes and considering their alternatives (Chesbrough, 2010). Choosing a new BM can bring competitive advantages and better performance (Amit and Zott, 2012; Cavalcante et al., 2011; Lambert and Davidson, 2013). BMI entails disruptive as well as continuous changes and its emergence is associated with market environment changes such as novel technology that has better performance and follows a different logic. Continuous innovation occurs often within big corporations who strive to adapt their products to customer needs while disruptive innovations are often brought by new entrants. (Engel, 2011) stresses on that the most disruptive innovations are not technical or product innovations alone; rather, they combine technological innovation and BMI. In this regard, we can distinguish between technology-driven and market-driven BMIs (Habtay, 2012). The main difference is that the technology-driven is associated with high sophisticated technology development such as the outcomes of R&D. In contrast, the market-driven is a result of radical changes in the value proposition to the existing customer, or/and altering the firm's roles in the existing value chain.

BMI has been conceived as a tool to foster innovation. A cognitive tool that supports managers who try to change their BMs. For example, by using analogical reasoning and looking at similarities between BMs or by employing conceptual combination and focusing on differences, managers may get inspired and have new ideas (Martins et al., 2015).

In order to set our analysis, the business model framework of (Zott and Amit, 2010) has been adopted thanks to its rich underpinning theoretical foundation. This concept has been widely used and accepted in the energy research field (Bolton and Hannon, 2016; Hellström et al., 2015). Its design serves the entrepreneurs who look for different alternatives. It defines BMs as "the content, structure, and governance of transactions designed so as to create value through exploitation of business opportunities" and outlines four sources of value namely novelty, lock-in, complementarities and efficiency. This activity system consists of three design elements: content which refers to the activities selection, structure which refers to how the activities are linked and governance which refers to who and where the activities are performed (Zott and Amit, 2010). The value capture element has been integrated into this framework following the (Hellström et al., 2015) framework who have studied the collaborative BMs and ecosystem changes in the energy sector.

2.3 Business model in the energy sector

The concept BM has been employed to explore new initiatives that have been emerging since the liberalization of the energy markets. A significant part of the literature focuses on distributed renewable generation, specifically the solar PV systems. One of the dominant BM in the solar markets in the U.S is the third-party own BM, which does not require upfront cost from customers and offers customer Power Purchase Agreement or lease contract (Wainstein and Bumpus, 2016). It has been found that in other countries such as Japan and Germany, the solar PV systems that are hosted by customers, are employed with different BMs. For example in Germany, the customer often is the owner while in Japan the PV system is embedded in the contract of the new home purchasing process (Strupeit and Palm, 2016).

Demand response BMs are another important types of energy BMs, they do not focus on renewable energy but on balancing the gird operations in more sustainable and cost efficient way. Though the variety of values that the demand response BMs can create, they have received a little attention as a new BM (Behrangrad, 2015). Demand response refers to a mechanism to change end-user normal consumption patterns in response to changes in the electricity prices over time or incentives. (Albadi and El-Saadany, 2008). The demand response provider aggregates the consumers' flexibilities and offers them as a commodity to the System Operator (SO), either through the energy markets and ancillary service markets or through a direct contract. The aggregated flexibilities serve various purposes and guarantee security for the whole energy system (e.g. grid balance, peak demand mitigation, etc.), for the distribution network (e.g. voltage regulation), for the transmission lines (e.g. frequency regulation), for retailing (e.g. optimizing procurement) and for load (optimize consumption cost) (Behrangrad, 2015).

3. Methodology

3.1 Research design

Research on business models has been subject of interest during the past decade. Their role in changing the industry mainstream BMs remains an unexplored phenomenon, therefore the case study approach fits well into the paper purpose (Eisenhardt and Graebner, 2007). Given that there is limited theoretical background about BM concept and energy entrepreneurship, the inductive research through multiple case studies offers useful and reasonable methodological approach. One crucial aspect of BMs is that they can be used as a unit of analysis (Zott et al., 2011). As our focus is on the disruptive and radical changes that occur in the energy system, led by energy entrepreneurs' BM innovations, a multiple case design methodology has been chosen to drive this research study (Yin, 1989).

Three case studies from energy sector have been analysed, exploring the particular phenomenon of BMI and energy BM change. Taking three case studies, clearly is not sufficient as a true inductive study (Eisenhardt, 1989). However due to the novelty, originality and innovativeness embedded in the cases and their convenience as illustrative cases supporting energy transition, the authors have decided to present these cases that will be part of a sample of 12 cases that will be analysed during 2018.

3.2 Sampling and data collection

The cases were selected based on theoretical sampling principals embedding polar characteristics that illustrate contrast within the context. First, in our search, the focus was on particular cases that can explain the engagement of the entrepreneurs in changing the energy system through exemplar BMs, where new logic of business is needed but only some academic attention has been given. Secondly, all the cases entail novel BMs that are unique and different from the main dominant BMs of energy utilities. The cases are of different type and have different outcomes, thereby they address three major areas in energy transition. The general characteristics of the cases are presented in Table 1.

	Energy Pool	**Stimergy**	**Enie.nl**
Energy area	Demand response	Energy efficiency	Renewable energy
Country	France	France	The Netherlands
Started	2009	2013	2013

Table 1 Firms general characteristics

Two of the cases come from demand-side management. While the first one focuses on demand response, the second deals with energy efficiency. Finally, the third is chosen from the renewable energy generation area.

Our research approach is explorative. Overall, the data of interviews was the main source, including questions related to BM components, motivation, challenges and barriers, opportunities and future developments. In addition, a secondary data of internal resources (e.g. firm websites) and external resources (e.g. published articles) are examined.

4. Result

This section focuses on the insights from a cross-case analysis that emerge from the interplay of empirical case analysis and a predefined business model framework.

4.1 Case description

4.1.1 The demand response case "Energy Pool"

The first case focuses on the first electricity aggregator in France that was found in 2009 and one year later entered into a strategic partnership with Schneider Electric. Energy Pool, among others, is an energy aggregator that bundles industries' negawatts[1] based on real-time metering in exchange of payment. These negawatts are sold to Transmission System Operator (TSO) of France: Réseau de Transport d'Électricité (RTE). On one hand, the firm aims at optimizing the industries' consumptions and reduces electricity bill up to 40%. On the other hand, it offers a demand response (DR) mechanism to reduce RTE's load peak. Currently, the firm is developing offers to work in "white label" for utilities. Most of its commercial development today is based on offers for utilities provision of services and consulting services to operate demand response and flexibilities.

The activity system framework is used to illustrate the BM logic Table 2. Regarding the BM content, the firm conducts audit analyses in order to check the potential of load shift and to identify the flexibility. It installs smart meters and automation equipment, monitors and gives measurements. Furthermore, the firm submits offers, manages the commitments and the administrative tasks, and provides training for the team. With regard to the structure of Energy Pool activity system, the focus has been done on the organization and architecture of activities value chain. In this value chain, Energy pool is an intermediate that lies between industrial consumers and the RTE. It links the need of RTE for load shift at specific period times to the latent capacity of industrials consumers to shift their consumption. The Energy Pool receives a "Call" from the transmission system operator RTE. Then it asks the industrial consumers to shift their consumption each according to its capacity, aggregating the consumer's negawatts to be equal to the RTE capacity need. They are implementing dispatchable and controllable methods to avoid the behavioural risk and using their own smart meter to measure the real-time consumer's consumption. The activity system's governance defines who performs the defined activities. Energy Pool collects the real-time consumption of the customers by installing DR boxes, and then Energy Pool conducts data analysis and optimization. On the operational level, shifting consumer's consumption may be automatically

[1] Negawatt refers to electrical power and energy saving, it has been used for the first time by Amory B. Lovins in 1985, Negawatts market refers to the markets that treat electricity saving as a commodity (Lovins, 1990).

performed by Energy Pool or might be performed by the consumer. Calculating consumer's remuneration is also the responsibility of Energy Pool. Customers have two complementary offers: "Availability" and "Call". In the former, the consumers put their availabilities at Energy Pool's disposal and stand-by for consumption shift. Often, they have a pre-determined capacity and price. However, the fee may be reduced by a penalty if the consumer proves not available. In the latter, Energy pool calls the consumers and asks for load shift by making an offer. In this case, the consumer is paid according to its performance. If the consumer is engaged into a program entailing « availability payments » and « calls », it cannot refuse (or has to face penalties). The firm captures the economic value from providing ancillary services to the TSO. Then part of this income is distributed among the industrial participants each according to its provided capacity. Additionally, the firm BM contributes to mitigating the environmental impact of the energy sector through two outcomes. First, it reduces the need for additional energy supply plant, which are usually source ofCO_2 emissions. Second, it delays or avoids the need of distribution and transmission network reinforcement, thus reduce material usage on the system level.

Business model elements	**Energy Pool**
Content	Identify flexibilities on the customer side, create fast and reliable communication infrastructure and sell flexibilities.
Structure	Translating TSO signal into curtailments and actions, choose, match and aggregate industrials and maintain the communication equipment ownership.
Governance	Customer's offers: availability (fixed price based) and call (performance based) and the expertise to change market regulations.
Value capture	Economic: payment from the TSO for the balancing service and positive externalities: avoid network cost and CO_2 emission reductions.

Table 2 Energy Pool business model description

Regarding activity themes, novelty, complementarities and efficiency are what distinguish the firm's BM. Novelty, because it provides DR as a service, which is rather new to the energy market. This BM compensates partially the generation assets businesses, providing reserves or balancing energy (e.g. Combined Cycle Gas Plant), which are based on supply response to balance the electric grid, as described in Figure 1.

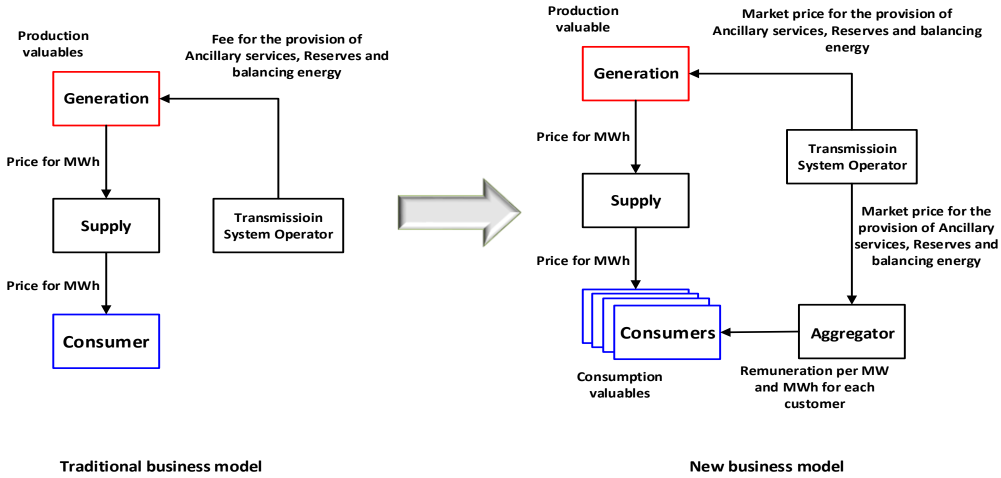

Figure 1 The emergence of demand response business model

Complementarities, because it bundles industrial consumption with demand response service and provides comprehensive services, including measurement, calculation, installation, expert advice, remuneration etc. This BM has two benefits. First, it mitigates for additional generation units and second, it deferrals reinforcement of the distribution and transmission network. Therefore, efficiency is a main value source.

4.1.2 Energy Efficiency case “Stimergy”

Stimergy is a distributed datacentre service provider created in 2013. First, the start-up has developed a system for recovering the fatal heat from computers datacentres. Then the firm employed the recovered heat in an innovative BM in order to increase the heat efficiency of collective buildings such as social housing or other types of heat consumers such as swimming pools by being also a datacentres service provider. The company technology “Digital boiler”, which is a combination of computing servers and heat recovery systems, enables the firms to label its services, both the efficiency solution and datacentre, as eco-friendly solutions. The digital boilers are installed at the heat consumer premises (collective residential buildings, communities and businesses, etc.), and used to decrease the main boiler operation hours by transferring the heat of the servers to the building heating system. As a result, the customer profits from a more efficient, certain and steady heating system.

With reference to BM content activities, the firm has two major activities. First, the information technology IT infrastructure service and second is the heat efficiency service. To provide the first service, a large number of servers and information communication infrastructure are required. This service includes workflow analysis and the calculation of servers' numbers, computing power, the required storage and the connection speed. The digital boiler is a constant heat source that is employed to deliver the second service. Herein, the generated heat by these datacentres is recycled and used to lower the building heat consumption. Concerning the structure, the firm has a double-side service that create values for two different kinds of customers as illustrated in Figure 2. First, the cloud computing

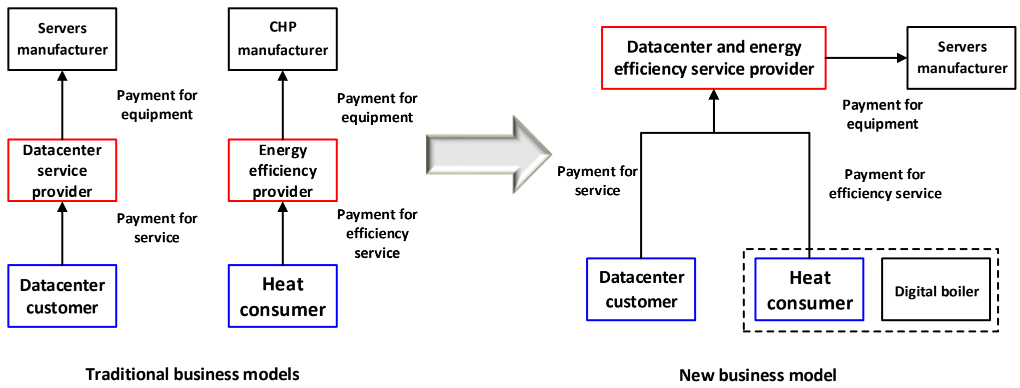

Figure 2 Datacentres and energy efficiency business model combination

service provided to customers such as 3D rendering, animation studios, specialized schools or freelance projects. Second, the heat efficiency service for social landlords, property developers, collectivises and universities. On the organizational level, the firm maintains the ownership of the servers and rents them. This enables the firms to place the servers where heat efficiency is required regardless of the distance and the IT client location. Consequently, the servers are transformed into "digital boilers". The firm tapped on the opportunity of decentralized IT datacentres service in order to produce and sell the fatal heat. With respect to governance of the system activities, the firm collaborates with a manufacturing company that fabricates the digital boiler. It controls and maintains the digital boiler on the consumer's premises to ensure high quality service. It also monitors the servers' performance to ensure secured, high quality storage and stable connection speed.

The firm captures the economic value of selling datacentres' services. By eliminating servers' cooling, thus its related cost by which the firm is able to have a competitive pricing strategy. Another revenue is generated from energy efficiency service. Due to the low variable cost in operating the digital boiler (electricity based) compared with other heat resources such as

Combined Heat and Power (gas-based engine), the firm is able to have free heat resource and sets a competitive energy efficiency pricing strategy as described in Table 3

Business model elements	Stimergy
Content	Providing two different services: datacentres infrastructure and energy efficiency. fabricating heat recovery system, coordinating the two services in one device (digital boiler).
Structure	Connecting the virtual datacentre service for the IT customers to on-site heat efficiency service for heat customers.
Governance	Solution provider, maintain product-service responsibility and long-term contracts
Value capture	Selling: services related to datacentre and energy efficiency.

Table 3 Stimergy business model description

The firm's BM is designed in a way that embeds several design themes. The novelty, because the firm has managed to transform the fatal heat into useful energy, the complementarities because it designed the activities in a way that combines IT datacentre service with energy efficiency service. Consequently, The BM eliminates servers' cooling need, creating free heat source and improve the building's energy performance. Lock-in due to the connection that has been made between the participants and links the customer in the IT industry to the customer in the energy industry.

4.1.3 The renewable energy case "Enie.nl"

The company started as a renewable energy supplier in Netherlands in 2013 selling PV solar panels. The founders were motivated by fighting against climate change by promoting renewable energy. However, the firms realized that around 5000 euros is a big investment for most of the households. To overcome this barrier, Enie.nl decided to be an energy supplier, providing green electricity and gas. Enie.nl Mainly offers free solar panel systems, in which it installs the solar panels on the home rooftop and consumers pay just for the electricity that they produce as described in Figure 3. The solar electricity is offered at a competitive price that is always less than the energy utilities prices. On average and as a result, consumers can save up to 15% of their electricity bill per year. Additionally, the firm supplies green electricity from solar and wind Dutch farms for the customers that do not have a proper home rooftop for PV panel.

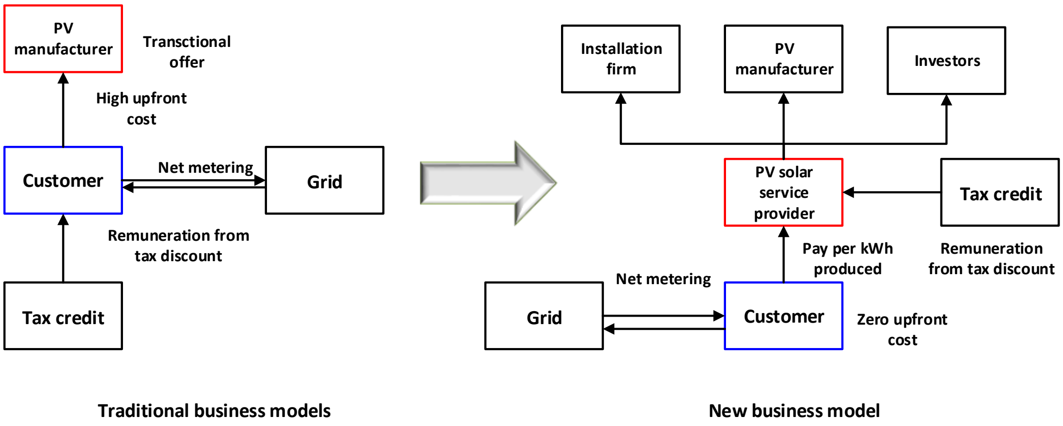

Figure 3 Solar PV panel energy business model transformation

In the activities system related to the content, the firm invests and purchases the solar panel from a PV manufacturer. They have two offers, either selling the PV system or installing it for free. In the latter, the firm installs and maintains the PV system on the consumer's home rooftop, sells the consumer the electricity that the PVs produce over a 15 years contract. After that, the consumer has the right to own the solar panels, enjoying about ten years of free solar electricity. Regarding system activities structure, Enie.nl managed to collect investment for their company by initiating a firm called "solar shift" to fund their investment. They realized that electricity consumers have the willingness to be sustainable but they are not able to purchase the PV system due to the upfront cost. The law permits only the PV owners, whose PVs are on their premises to take advantage of the feed-in tariff. Thus, the firm managed to obtain a legal permission, from the legislators after one year of a court dispute, which allows them to profit from the feed-in tariff of the PVs that are on customers premises. Consumers pay per kWh they produce including what they really consumer from the solar PV. For the solar electricity that they produce but not consumer (surplus), consumers supply it to the grid and are remunerated based on Feed-in Tariff policy. Regarding governance activities, the maintenance and installation service are provided by third-party. Enie.nl has 50 per cent shares of the funding firm. Additionally, consumers are motivated by having zero upfront payment and by the sustainable impact that they would generate during their future consumptions. The firm captures the value from the consumers' monthly payment. Thanks to "Net metering" instrument, the customers can netting off the amount of electricity that they produce, directly on their monthly energy bill. Though the firm had to put a huge sum of investment, the governmental renewable energy scheme of tax credit compensates part of its investment cost that is made on PV solar panels as described in Table 4.

Business model elements	Enie.nl
Content	Ordering PVs from the manufacturer, installation, maintenance and billing.
Structure	Partnership with funding firm and athletes advertising and sponsorship.
Governance	Selling solution, PVs systems are under provider responsibility, take advantage of net metering and incentives from tax credit.
Value capture	Economic: monthly income from the selling solar electricity, positive externalities: promoting sustainable energy, give people access to renewables and its related subsidies and CO2 emission reductions

Table 4 Enie.nl business model description

The design themes and the sources of value of this BM are related to lock-in, complementarities and novelty. The lock-in is due to the service-oriented BM that creates a long-term contract with the customer (15 years). Lock-in value generates stable, long-term income and avoids customer acquisition cost. Complementarities is related to the comprehensive offering that includes financing, installation, maintenance and billing. Finally, novelty refers to the offer that has been made by employing already existing technologies (PV solar panel) in innovative service-oriented BM.

4.2 Energy business model characteristics

This section aims at illustrating the main characteristics of the studied cases in an attempt to answer the paper research question of how entrepreneurs innovate in the energy sector and how this innovation is reflected in their business models. A set of BM characteristics are identified namely: decentralized small-scale assets, service-oriented, end-user relationship and process focus, consumer co-provider, intermediary model and pay-per-use revenue. Table 5 summarize the business model characteristics of the three firms.

Decentralized/distributed assets is part of the BM content as it refers to the main elements that have been employed and their transactions. Enie.nl, as renewable energy supplier, creates value from the distributed PV systems on contrary to the traditional centralized and large-scale power plants. This reduces the total cost by diminishing the need of transmission and distribution services. Energy Pool creates demand-supply balance value from the small and distributed flexibility capacities of industries in reverse to the conventional balancing model that is based on supply response by activating large power plants. Stimergy creates value from the decentralized nature of the IT server's services and translate these values into practical distributed heat resource. Although the studied firms generate local, small and distributed values, the accumulation of these values would have a significant impact on the system level.

Intermediate model is part of BM structure as it determines the position of the firm among its partners and main actors in the sector. The three companies have positioned themselves in new places along the energy value chain. Enie.nl has moved, in the PV value chain, from being in the position of selling the PVs to the downstream towards customers. It stands between PV manufacturers and customers. Energy Pool tapped on the opportunity of the weak and not efficient communication channels between the French Electricity System Operator RTE and the big industries, the Energy Pool also has a position close to the customer using viable and fast communication channels. Stimergy has found its new position by coming up with a new ring in the value chain. It has linked IT server's service with the energy efficiency and positioned itself into the energy heat supply-side as well as into the IT service. The studied cases transform the convenient BMs into innovative BMs by creating new path value (Merli, 2013).

Service-oriented is related to the BM structure as service-oriented BMs require intensive partnerships, human resources and high-quality customer relationship. The new entrepreneurs in the solar energy sector have a modest growth due to high upfront cost and the relatively low cost of fossil fuel electricity prices. Therefore, they have been looking for improving their profitability by offering services as in the case of Enie.nl, which generates and supplies renewable energy on the consumer's premises. By this service, it eliminates consumer upfront cost and added complementary services such as assurance and maintenance. Energy Pool delivers an access for big industries for participating in the demand response programs through its own communication infrastructure. This service includes some tasks that the TSO would have supposed to corporate with the corresponding industries such as fast and reliable communication. Stimergy fulfils part of the consumers' heat needs at a lower cost, and assumes most financial and technical risk. Its offer is an energy efficiency solution that eliminates the consumer's need to purchase more efficient heat boiler or energy efficiency measures. In addition, Stimergy offers IT servers in a form of service.

End-user relationship and process focus explains the selection of activities that should be performed with the customer, thus included in the BM governance element. The three companies have relationship-base rather than transaction-base. Their offer is based on long-term contract and fixed price rather than transactional prices. The employed technologies are important, however they are part of the offer rather than in the core, thus it can be interpreted as process focus BM (Oliva and Kallenberg, 2003). In case of Enie.nl, the PV, which is the tangible product, is part of the offer rather than the centre of the value proposition, which includes financing, installation and assurance. Similarly, is the case of digital boiler of Stimergy. In case of Energy Pool, the communication infrastructure of Energy Pool has a marginal value against the holistic value proposition, which includes flexibility identification, expertise' advice, stakeholders' coordination, load shift mechanism support and consumption scheduling. The three cases offer long-term contracts following close relationship-base, which generates a fixed revenue over years.

Consumer co-provider is included in the governance activity as it determines the role of customer in performing value creation process. The studied BMs are consumer-focus and consumer's engagement is essential to success. Enie.nl's consumers provide their home rooftop to install the PV systems. Energy Pool totally depends on its industrial consumers' interaction to activate demand response, thus generate sufficient capacity to be traded in the balancing and ancillary service market. Herein the consumers' decisions are critical and have considerable influence on the BM. Stimergy value creation is achieved through two types of consumers, both the IT clients and the heat consumers. The IT customers, by accepting the decentralized datacentre service, contribute indirectly to heat production and allow the firm to harvest the wasted and fatal heat of the used servers. Heat consumers involved by allowing the digital boiler to be installed on their premises. The three cases show that the customers have agreed to be part of the service value creation processes and have been engaged in a long-term contract.

Pay-per-use revenue refers to the value capture and payment and revenue model. Enie.nl has changed totally the revenue model. It has replaced the traditional revenue model of PV solar panel selling with another one that is based on the amount of the sold kWh. Stimergy offers a monthly subscription for the IT datacentre customers and fixed or competitive prices based on the unit of heat production. Finally, Energy Pool has a fixed price based on a commitment to shift consumption (availability offer) once is required and a variable price that is based on performance (call offer). It can be noticed that the three firms developed a pricing mechanism that fits into the service-oriented BM, in which there is no upfront payment and based on the generated unit of energy in the case of Enie.nl and Stimergy or on the shifted negawatts in the case of Energy Pool.

Case	*Content*	*Structure*		*Governance*		*Value capture*
	Decentralized and small scale assets	**Intermediate model**	**Service-oriented solutions**	**Relationship and process focus**	**Consumer Co-provider**	**Pay-per-use**
Enie.nl	Distributed PV system at the customer site, funds	PV manufacturer and residential consumer	Solar energy service	15 year of PV generation	Rooftop provider	Pay per kWh produced
Energy Pool	Industrial plant flexibilities and Reliable and fast Communication system	Energy System operator and industries	Demand response service	One year contract	Load shift provider	Pay per call/ availability
Stimergy	Digital boiler	Datacentre users and heat consumer	Datacentre and efficiency services	10 year heat supply contract	Technology host	Pay per united consumed or pay for guaranteed level of efficiency

Table 5 Energy Business model innovation characteristics

5. Discussion

The main purpose of this study is to investigate the emerging business models in the energy sector. The analysis of the firms' business models shows that the examined business models differ significantly from the extent and traditional utility BM. Although the presented cases come from three different areas: renewable energy, energy efficiency and demand response, their BMs have common characteristics that have been employed to build a conceptual framework for future energy entrepreneurship BM.

The paper adds value and is consistent with prior research advocating the importance of business model innovation to commercialize novel technologies (Chesbrough and Rosenbloom, 2002), to accelerate sustainability (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013), and to foster energy transition (Huijben and Verbong, 2013; Richter, 2013; Wainstein and Bumpus, 2016). The results show that energy entrepreneurs create new services in order to overcome regime barriers such as market access and upfront cost. Our findings emphasize on the service-oriented BMs development in the energy sector and coincide with previous relevant research studies (Hannon et al., 2013; Helms, 2016; Överholm, 2017). The study emphasizes the essential role of the firm-customer relationship (Apajalahti et al., 2015) which is relational-based and focuses on providing long-term service such as solar panel energy service of Enie.nl or energy efficiency of Stimergy.

The results point up the engagement and the active role of the consumers, the shift from the being passive to be a co-provider (Wainstein and Bumpus, 2016; Walker and Cass, 2007). The product-service system design supports and empowers the consumers to change their behaviour towards new model of interactions and practices within the energy system. The study shows that the consumer can host the technology and may go further to perform critical tasks. The product-service system design supports and empowers the consumers to change their behaviour towards new model of interactions and practices within the energy system. The study shows that the consumer can host the technology and may go further to perform critical tasks. A clear result of this research is that consumers play a key role by employing their latent capacities, which create value not just for them but also for the energy system actors (e.g. utilities, system operator, etc.). That is, the decentralized values can be also accumulated and create value back to energy system actors (Facchinetti and Sulzer, 2016; Hall and Roelich, 2016). Entrepreneurs can use this framework either to create or modify their current BMs, which is envisioned to give some insights into and explore new ways of sustainable values creation. This study provides empirical evidence, based on practical case studies, to support the development of new business models for energy transition.

However, the findings are subject of some limitation. First, while the study covers three main areas in the energy sector, the study is limited to three cases that have been selected for the research purpose. Thus, it does not represent all the emerging BM innovation trends and is being completed by the authors with the analysis of 12 more cases.

6. Conclusion

The present study employs the business model concept to investigate how new entrepreneurs have found new market opportunities in the context of energy transition. Three different business models are selected from three practical cases and are analysed on the basis of semi-structured interviews. Thereby, the paper makes a theoretical contribution to the emerging field of energy business model as well as to business model innovation. It highlights the role of entrepreneurs who come up with competitive BMs that employ existing technologies. That is, novel firms employ original business models that differ in an important way from the traditional business model.

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References

Albadi, M.H., El-Saadany, E.F., 2008. A summary of demand response in electricity markets. Electr. Power Syst. Res. 78, 1989–1996.

Amit, R., Zott, C., 2012. Creating value through business model innovation. MIT Sloan Manag. Rev. 53, 41.

Apajalahti, E.-L., Lovio, R., Heiskanen, E., 2015. From demand side management (DSM) to energy efficiency services: A Finnish case study. Energy Policy 81, 76–85. https://doi.org/10.1016/j.enpol.2015.02.013

Baden-Fuller, C., Morgan, M.S., 2010. Business models as models. Long Range Plann. 43, 156–171.

Behrangrad, M., 2015. A review of demand side management business models in the electricity market. Renew. Sustain. Energy Rev. 47, 270–283. https://doi.org/10.1016/j.rser.2015.03.033

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bolton, R., Hannon, M., 2016. Governing sustainability transitions through business model innovation: Towards a systems understanding. Res. Policy 45, 1731–1742.

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007

Cavalcante, S., Kesting, P., Ulhøi, J., 2011. Business model dynamics and innovation: (re)establishing the missing linkages. Manag. Decis. 49, 1327–1342. https://doi.org/10.1108/00251741111163142

Chesbrough, H., 2010. Business Model Innovation: Opportunities and Barriers. Long Range Plann. 43, 354–363. https://doi.org/10.1016/j.lrp.2009.07.010

Chesbrough, H., 2007. Business model innovation: it's not just about technology anymore. Strategy Leadersh. 35, 12–17.

Chesbrough, H., Rosenbloom, R.S., 2002. The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. Ind. Corp. Change 11, 529–555.

Demil, B., Lecocq, X., 2010. Business Model Evolution: In Search of Dynamic Consistency. Long Range Plann. 43, 227–246. https://doi.org/10.1016/j.lrp.2010.02.004

Dilger, M.G., Konter, M., Voigt, K.-I., 2017. Introducing a co-operative-specific business model: The poles of profit and community and their impact on organizational models of energy co-operatives. J. Co-op. Organ. Manag. 5, 28–38. https://doi.org/10.1016/j.jcom.2017.03.002

Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manage. Rev. 14, 532–550.

Eisenhardt, K.M., Graebner, M.E., 2007. Theory building from cases: Opportunities and challenges. Acad. Manage. J. 50, 25–32.

Engel, J.S., 2011. Accelerating Corporate Innovation: Lessons from the Venture Capital Model. Res.-Technol. Manag. 54, 36–43. https://doi.org/10.5437/08953608X5403007

Facchinetti, E., Sulzer, S., 2016. General business model patterns for local energy management concepts. Front. Energy Res. 4, 7.

Frankenberger, K., Weiblen, T., Csik, M., Gassmann, O., 2013. The 4I-framework of business model innovation: A structured view on process phases and challenges. Int. J. Prod. Dev. 18, 249–273.

Habtay, S.R., 2012. A Firm-Level Analysis on the Relative Difference between Technology-Driven and Market-Driven Disruptive Business Model Innovations: DISRUPTIVE BUSINESS MODEL INNOVATIONS. Creat. Innov. Manag. 21, 290–303. https://doi.org/10.1111/j.1467-8691.2012.00628.x

Hall, S., Roelich, K., 2016. Business model innovation in electricity supply markets: The role of complex value in the United Kingdom. Energy Policy 92, 286–298. https://doi.org/10.1016/j.enpol.2016.02.019

Hannon, M.J., Foxon, T.J., Gale, W.F., 2013. The co-evolutionary relationship between Energy Service Companies and the UK energy system: Implications for a low-carbon transition. Energy Policy 61, 1031–1045. https://doi.org/10.1016/j.enpol.2013.06.009

Hellström, M., Tsvetkova, A., Gustafsson, M., Wikström, K., 2015. Collaboration mechanisms for business models in distributed energy ecosystems. J. Clean. Prod. 102, 226–236. https://doi.org/10.1016/j.jclepro.2015.04.128

Helms, T., 2016. Asset transformation and the challenges to servitize a utility business model. Energy Policy 91, 98–112. https://doi.org/10.1016/j.enpol.2015.12.046

Huijben, J., Verbong, G.P.J., 2013. Breakthrough without subsidies? PV business model experiments in the Netherlands. Energy Policy 56, 362–370.

IEA, 2016. Re-powering markets. International Energy Agency.

Lambert, S.C., Davidson, R.A., 2013. Applications of the business model in studies of enterprise success, innovation and classification: An analysis of empirical research from 1996 to 2010. Eur. Manag. J. 31, 668–681. https://doi.org/10.1016/j.emj.2012.07.007

Lovins, A.B., 1990. The negawatt revolution. Across Board (N. Y.) 27, 18–23.

Martins, L.L., Rindova, V.P., Greenbaum, B.E., 2015. Unlocking the Hidden Value of Concepts: A Cognitive Approach to Business Model Innovation: A Cognitive Approach to Business Model Innovation. Strateg. Entrep. J. 9, 99–117. https://doi.org/10.1002/sej.1191
McGrath, R.G., 2010. Business models: a discovery driven approach. Long Range Plann. 43, 247–261.
Merli, G., 2013. The transformation of the business model: business modelling, in: New Business Models and Value Creation: A Service Science Perspective. Springer, pp. 67–86.
Mitchell, D., Coles, C., 2003. The ultimate competitive advantage of continuing business model innovation. J. Bus. Strategy 24, 15–21. https://doi.org/10.1108/02756660310504924
Okkonen, L., Suhonen, N., 2010. Business models of heat entrepreneurship in Finland. Energy Policy 38, 3443–3452. https://doi.org/10.1016/j.enpol.2010.02.018
Oliva, R., Kallenberg, R., 2003. Managing the transition from products to services. Int. J. Serv. Ind. Manag. 14, 160–172.
Osterwalder, A., 2004. The business model ontology: A proposition in a design science approach.
Överholm, H., 2017. Alliance formation by intermediary ventures in the solar service industry: implications for product–service systems research. J. Clean. Prod. 140, 288–298. https://doi.org/10.1016/j.jclepro.2015.07.061
QER, 2015. QER Report: Energy Transmission, Storage, and Distribution Infrastructure.
REN21, 2016. Renewables 2016 Global Status Report. Renewable energy policy network for 21th century.
Richter, M., 2013. Business model innovation for sustainable energy: German utilities and renewable energy. Energy Policy 62, 1226–1237. https://doi.org/10.1016/j.enpol.2013.05.038
Sioshansi, F.P., 2015. Electricity utility business not as usual. Econ. Anal. Policy 48, 1–11. https://doi.org/10.1016/j.eap.2015.11.015
Spieth, P., Schneckenberg, D., Ricart, J.E., 2014. Business model innovation–state of the art and future challenges for the field. RD Manag. 44, 237–247.
Strupeit, L., Palm, A., 2016. Overcoming barriers to renewable energy diffusion: business models for customer-sited solar photovoltaics in Japan, Germany and the United States. J. Clean. Prod., Advancing Sustainable Solutions: An Interdisciplinary and Collaborative Research Agenda 123, 124–136. https://doi.org/10.1016/j.jclepro.2015.06.120
Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plann. 43, 172–194.
Tolkamp, J., Huijben, J.C.C.M., Mourik, R.M., Verbong, G.P.J., Bouwknegt, R., 2018. User-centred sustainable business model design: The case of energy efficiency services in the Netherlands. J. Clean. Prod. 182, 755–764. https://doi.org/10.1016/j.jclepro.2018.02.032
Wainstein, M.E., Bumpus, A.G., 2016. Business models as drivers of the low carbon power system transition: a multi-level perspective. J. Clean. Prod. 126, 572–585. https://doi.org/10.1016/j.jclepro.2016.02.095
Walker, G., Cass, N., 2007. Carbon reduction, 'the public' and renewable energy: engaging with socio-technical configurations. Area 39, 458–469. https://doi.org/10.1111/j.1475-4762.2007.00772.x
Yin, R.K., 1989. Case study research: Design and methods, Newbury Park. Cal Sage.

Zott, C., Amit, R., 2010. Business Model Design: An Activity System Perspective. Long Range Plann. 43, 216–226. https://doi.org/10.1016/j.lrp.2009.07.004

Zott, C., Amit, R., 2008. The fit between product market strategy and business model: implications for firm performance. Strateg. Manag. J. 29, 1–26.

Zott, C., Amit, R., Massa, L., 2011. The business model: recent developments and future research. J. Manag. 37, 1019–1042.