Developing a viable business model for community owned solar farms in the Netherlands

A. D'Souza[1], H. Velthuijsen[1], J. C. Wortmann[2] and G. B. Huitema[2]

[1]School of Communication, Media & IT, Hanze University of Applied Sciences, Zernikeplein 11, Groningen, The Netherlands.
[2]Faculty of Economics, and Business, University of Groningen, Nettelbosje 2, Groningen, The Netherlands

Abstract.
Purpose
The energy industry is experiencing a tremendous growth in the number of energy cooperatives in Europe. These energy cooperatives are spear heading the transition to a sustainable energy system. The energy cooperatives aim to satisfy the consumers demand for sustainable energy and related services. Grunneger power is such a cooperative in the north of the Netherlands. They aim to setup and exploit community owned solar farms in the north of the Netherlands. In order to successfully setup and exploit community owned solar farms, Grunneger power needs a viable business model. However, existing literature treats the business models of energy cooperatives superficially. In particular, there is not much information on the business model of community owned solar farms. Designing a viable business model for community owned solar farms is a complex task because it spans several organisations. This implies that the business model has to be able to deal with the competing interests of the organisations. In addition, they have to be able to facilitate value capture by each of the participating organisations such that they are committed to the business model. Additionally, the literature on business model design is missing a comprehensive artefact that can facilitate the design of viable business models in a business ecosystem setting. Therefore, the goal of this paper is twofold: i) to design a viable business model for community owned solar farms that will be setup in the north of the Netherlands. ii) To present the findings from this case study, and to propose generalisations that are relevant for the development of artefacts that can be used to facilitate the design of viable business models in a business ecosystem setting.
Design/methodology/approach
The design science research approach is best suited for designing artefacts, and drawing generalisations from the design process. Since our goal is to design an artefact and draw generalisations from the lessons learnt, we frame this research as a design science research problem. Additionally, we have used business model ontologies to design the business model. Business model ontologies are languages use to conceptualise and communicate business models.
Findings
It was hard to design a viable business model for community owned solar farms, due to the competing interests of different organisations. It was necessary to have a clear business service concept before starting the business model design. Furthermore, in order to design a viable business model it was necessary to conceptualise the business model from Grunneger power's perspective as well as from a business ecosystem perspective. In addition, to arrive at a viable business model, we had to eliminate the traditional energy retailers from the business ecosystem because they were not adding sufficient value. Further, the role of traditional energy retailers and the associated value creation activities, value streams, and captured value had to be reallocated to a different stakeholder within the business ecosystem. Moreover, the viability of the designed business model is sensitive to several factors, such as availability of subsidy, the assumed operational costs of the solar farm, wholesale price of electricity, cost of capital, etc.

Originality/Value
Without much guidance from literature, firms such as Grunneger power rely on trial and error methods for finding viable business models. These trial and error methods of finding a viable business model are risky, expensive, and time consuming. Therefore, this research addresses the above-mentioned gap by designing a viable business model to exploit the community owned solar farms that is directly implementable by cooperatives such as Grunneger power. In addition, several generalisations, relevant to the development of business model design artefacts are drawn from this research, for example it is crucial for firms operating in business ecosystem setting to approach business model design from the perspective of the focal firm as well as from the perspective of a business ecosystem.

1. Introduction

The traditional energy industry is highly centralised. This industry largely generates electricity using large-scale power generation units that mainly use fossil fuels. The electricity is then retailed to passive consumers through a network of wholesalers, and retailers. However, in recent times affordable decentralised renewable energy generation technologies are penetrating the market. These technologies coupled with changing customer needs, liberalisation of the energy market, growing environmental concerns, and government action is putting increasing pressure to transition to a sustainable energy system. Several initiatives are taken to transition to a sustainable energy system. One of these initiatives has been gaining momentum at the grassroots level namely the energy cooperatives. The consumers are organising themselves into energy cooperatives. These energy cooperatives are socio-economic organisations that are positioning themselves in the sustainable energy and related products/services market (Schreuer & Weismeier-Sammer, 2010). As of February 2014, approximately 500 energy cooperatives were active in the Netherlands (Avelino et al., 2014). These cooperatives are seen as crucial agents of change and innovation that are spearheading the transition to a sustainable energy system (Asmus, 2008; Schreuer & Weismeier-Sammer, 2010).

Grunneger Power (GP) is one such organisation in the city of Groningen, The Netherlands. Their long-term goal is to transition to a sustainable energy system that produces and consumes sustainable energy on a local scale. In addition, they want to stimulate the local economy by creating local jobs in the energy sector, and to serve their customers with sustainable products and service at a fair price. Furthermore, they invest their profits in local sustainable energy projects.

GP intends to setup and operate community owned solar farms in the city of Groningen. Residents living in close proximity own a typical community owned solar farm in the Netherlands. A community owned solar farm allows its members to purchase individual shares in a solar farm. This is done to create economies of scale, ease of use, and cater to customer segments ignored by current market offering (Asmus, 2008). In order to successfully setup and operate community owned solar farms, GP needs a viable business model. However, existing literature treats the business models of energy cooperatives superficially. In particular there is not much information on community owned solar farm business model, despite the fact that scholars have categorised it as a high-potential business model (Asmus, 2008; Huijben & Verbong, 2013). In addition, there are several stakeholders involved in a community owned solar farm business model, such as the *prosumers*, service providers, distribution system operators (*DSOs*), and local municipalities. Therefore, if the business model is to be viable the stakeholders should be able to capture sufficient value such that they are committed to the business model. However, ensuring the viability of each stakeholder is particularly hard because of his or her competing interests (Chesbrough, Vanhaverbeke, & West, 2006; Huijben & Verbong, 2013).Furthermore, the business model design literature is missing a comprehensive artefact that can be used to design viable business models in a business ecosystem setting (D'Souza, Beest, Huitema, Wortmann, & Velthuijsen, 2014a). Hence, there is a need for a viable business model design for community owned solar farms that can be directly implemented by cooperatives such as GP. A viable business model that is directly implementable will help cooperatives such as GP to avoid risk and losses, and save time. In addition, important generalisations can be drawn from the design activity that are relevant to the business model design domain. These generalisations can be used to develop comprehensive artefacts that can be used to design viable business models in a business ecosystem setting. Therefore, the goal of this paper is twofold: i) one is to design a viable business model for community owned solar farms that will be setup and operated in the north of the Netherlands. ii) To present the findings from this case study, and to propose generalisations that are relevant for the development of artefacts that can be used to facilitate the design of viable business models in a business ecosystem setting.

The related work section reviews work related to business models, services, business model ontologies, and community owned solar farms. The methodology section elaborates on the methods and techniques used to design a viable business model for community owned solar farms. The following section presents the process of designing the business model, the viable business model deign, the sensitivity analysis, and the derived generalisations. Finally, the paper ends with a conclusion section.

2. Related Work

Scholars still do not agree on a common definition of a business model (Zott, Amit, & Massa, 2011). However, based on the common ground among found among stakeholders D'Souza et al. (2014a) define business models as a description of the underlying logic of how value is created, exchanged, and captured from a focal organisations perspective as well as from a business ecosystem perspective. It includes a description of the stakeholders involved, their value proposition for other stakeholders, and their roles. In addition, it also defines the business architecture that enables value creation, exchange, and capture logic. A business model is said to be viable when all the participating members are able to capture value such that they remain committed to the business model (Chesbrough et al., 2006).

Since GP intends to provide a service to its customers, we will briefly explore service science in context of business model design. Business models and services are intricately linked. A business model is perceived as a mediation device between services and value creation (Bouwman, De Vos, & Haaker, 2008; Chesbrough & Rosenbloom, 2002). Even before an organisation/s venture into new service development the business model has to be attractive. However, before the business model for the intended service can be designed, the business service concept has to be clear. Business model design and service design are often carried out in close collaboration.

We distinguish between two type of services namely business services and information systems services (Bardhan, Demirkan, Kannan, Kauffman, & Sougstad, 2010). A business service is a service that is usually offered to a customer for example transportation, or health care service (Lankhorst, 2012). Business service refers to the concept of service in the service-marketing domain. A well-established definition of a business service in the service marketing domain defines it as "*the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself*" (Stephen L Vargo & Lusch, 2004, p. 2). Furthermore, scholars also stress the following characteristics of a business service: value is co-created with the end user; services are usually performed in a business ecosystem setting; goods are seen as distribution mechanism for services; and a service creates customer experiences (Bitner, Ostrom, & Morgan, 2008; Stephen L. Vargo & Lusch, 2008). The service-marketing domain adopts a customer centric, and a business ecosystem approach towards business service, which is very valuable in context of business model design. A customer centric approach helps to develop value propositions and customer experiences that the end user wants this increases the chances of designing a viable business model. Furthermore, the ecosystem approach to services is valuable because it helps the business model designer to identify stakeholder who have the capability to add the desired values, and configure them in a viable manner. An information service is a service that exposes automated behaviour (Lankhorst, 2012). Information services leverage data, software, and hardware to support business services in an automated manner, for example a web service. Information services are an important part of business models because they have to support the business service, otherwise the business service cannot function. Therefore, for the sake of this research we develop the business service concept, which is the blue print of the service offered to the customer. Next, we develop information services architecture, which is the organising logic of the information services necessary to support the business service.

Business model ontologies (BMOs) are languages used to design and evaluate business models. D'Souza, Beest, Huitema, Wortmann, and Velthuijsen (2014b) have reviewed several well-established BMOs and found that none of them fully support the design of a viable business model in a business ecosystem setting. In addition, they also found that existing BMO's either adopt a focal firm perspective on business models, or a business ecosystem perspective. However, in business ecosystem setting it is necessary to combine the focal firm perspective as well as the business ecosystem perspective for a viable business model design. Since no single BMO allows the combination of these perspectives, D'Souza et al. (2014b) recommend using two different BMOs namely the business model canvas and the e3-value to design viable business models.

Solar photovoltaic is the fastest growing renewable technology globally in terms of install capacity; from 2008-2013, the average install capacity grew at the rate of 55% annually (Sawin & Sverrisson, 2014). However, the growth of solar photovoltaics is being hampered by lack of viable business models (Frantzis, Graham, Katofsky, & Sawyer, 2008; Huijben & Verbong, 2013). Table 1 presents the different types of business models for PV systems found in the literature.

Table 1 Business model types for PV systems

Business model type	Description	Source
Turnkey projects provider	In this business model the service provider targets commercial and residential customer segments who want to own PV systems, but don't want the hassle of doing the research, installing it, and maintaining it. Their value proposition is ease of use. Ease of use refers to one stop shop solution for all PV system related needs including customer support, pre and post sales.	(Frantzis et al., 2008; Huijben & Verbong, 2013; Schoettl & Lehmann-Ortega, 2011)
Third party	Here the energy retailer installs the PV system on the customers premise, or rents space from real-estate owners. However, the retailer owns and operates the PV system, and retails the energy to the customers on whose premise the PV system is installed. The energy retail contracts usually span several years with a fixed energy price. This business model has several variants in terms of Key partners, value proposition, and cost	(Frantzis et al., 2008; Huijben & Verbong, 2013; Schoettl & Lehmann-Ortega, 2011)

	structures, for example the energy retailer who owns the PV system may have to pay a rent to the real-estate owner for using their space for setting up and operating the PV system.	
Value added service provider	The service provider assists the customer with specific tasks in acquiring and operating the PV system, for example, administration for subsidies. These service providers are usually the consulting firms and they target commercial as well as residential customers.	(Schoettl & Lehmann-Ortega, 2011)
Construction and installation service provider	The service provider provides construction and installation services necessary for the PV system. They target both commercial as well as residential customers.	(Schoettl & Lehmann-Ortega, 2011)
Large scale power producers	Here the power producer owns large-scale PV systems primarily for producing and selling energy. They mainly target energy retailers or large-scale consumers of energy.	(Schoettl & Lehmann-Ortega, 2011)
Virtual power plant	The firm acting as a virtual power plant tries to balance the grid by controlling supply and demand. Such a player is usually a market maker since they have insights in total demand and supply. Such players can have varied revenue streams such as, transaction fees, and membership fees.	(Schoettl & Lehmann-Ortega, 2011)
Community owned solar farms	Here the community usually forms a cooperative and they collectively invest in an offsite solar farm. The member of the cooperative purchase shares in the solar farms, and or purchase power produced at the solar farm. Such cooperatives usually target residential and small businesses that are unable to or do not want to purchase and install PV systems on their own location.	(Asmus, 2008; Huijben & Verbong, 2013)

Asmus (2008) makes the case for community owned solar farms in the United States of America. The author provides a high-level description of how community owned solar farms work in the United States. This information provides valuable input for designing the community owned solar farm business model, but it misses important elements of a business model such as cost structure. Furthermore, the community owned solar farms developed in the Netherlands would be subjected to different rules and regulations. Huijben and Verbong (2013) analyse business model experiments for PV technology in the Netherlands. They found community solar farm business model as one of the emerging business models. Furthermore, they also found that the financial viability of this business model depends on the net metering regulation. The net metering regulation refers to the ability to deduct the amount of energy supplied to the grid from the total amount of energy taken off from the grid. Similar to Asmus (2008) a high level description of the business model is provided. According to Huijben and Verbong (2013) the community owned solar farm business model is unviable because the net metering regulation does not apply to them in current regulation in NL. However, according to the website *hier opgewekt* since 2014 new regulations and subsidies have been announced for community owned solar farms, such as post code subsidy (“*Postcoderoos regeling*”), and SDE+ ("*De regeling in het kort*," 2015). These subsidies could lead to a viable business model for community owned solar farms. Since the community owned solar farm business model is described at a very high level and in a generic manner, GP or any other organisation will be unable to implement the business model because the description is missing many important business model design details such as cost structures. Furthermore, the business model has been described in an informal manner, which leaves a lot of room for misrepresentation and misinterpretation of the business models. The role of BMOs in designing and evaluating the above mentioned business models has largely been ignored. BMOs are languages that are used to design, communicate, and evaluate business models for example the business model canvas by (Osterwalder & Pigneur, 2010). It is important to use BMOs because they leave little room for misrepresentation and misinterpretation (D'Souza et al., 2014a)..

3. Methodology

In this paper, we seek to design a business model, which will define how GP and its partners are going to create, capture, and exchange value in a business ecosystem setting. Therefore, we adopt the design science research approach, which is a well-established method to design artefacts that are of relevance to organisations (Hevner, March, Park, & Ram, 2004). Design science research focuses on designing objects with an embedded solution to an understood research problem (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007, p. 49).

Hevner et al. (2004) prescribes seven guidelines for applying the design science research method. First, a problem or a gap and the relevance of solving that problem should be clearly articulated. The problem and the relevance of solving the problem are presented in sections one and two. Second, the contribution towards solving the articulated problem should be clearly articulated in terms of an artefact design, design foundations, and/ or design methodologies. The contributions towards solving the problem are clearly articulated in the introduction. Third, to ensure rigour appropriate methods should be employed to design/develop and evaluate the artefact. This section presents the methods used to design and evaluate the designed artefact. Fourth, the product of a design science research process should be a construct, a model, a method, or an instantiation. The solution and the derived generalisations are presented in sections 4.6, 4.7, & 4.8. Fifth, the designed artefact should be evaluated on its utility, quality, and its efficacy. The evaluation of the artefact is carried out in section 4.8. Sixth, the design of an artefact using design science research process should be viewed as an iterative process. The design process was carried out in iterative steps. The designers actively sought feedback from industry experts and academics. Seventh, the produced artefact should be communicated to the relevant audience. The artefact was communicated to relevant stakeholders within GP. Additionally, the viable business model is communicated via this paper to academics and practitioners.

In order to design a viable business model for GP the following steps were taken: first, a literature review was performed in order to set the foundation and understand the state of the art in the domain of community owned solar farms. Second, a high-level description of the business idea was developed based on the data collected (interview, and literature). The first and the second step have already been presented in the introduction, and the related work section. Third, a stakeholder analysis was performed. Fourth, based on the stakeholder analysis value propositions were formulated for each stakeholder. Fifth, a detailed business service concept was created using the service blue printing technique. The service blue printing technique is a well-established technique use to explore all the issues inherent in creating and managing a service (Stickdorn & Schneider, 2012). Sixth, the technical architecture necessary to support the envisioned service and business model was conceptualised. Seventh, the business model is conceptualised using business model canvas from the focal actors perspective. The business model canvas is a well-established tool used to design business models of individual firms. Eighth, the e3-value business model ontology is used to design the business model from the perspective of the business ecosystem. Finally, the resulting business model is evaluated for its viability and the results of the evaluation are used as feedback until a viable business model design emerges, or until it is decided that a viable business model cannot be designed.

The data necessary for designing the intended business model was collected through primary and secondary sources. Ten interviews were carried out with experts, and potential stakeholders in the business model. Semi-structured questionnaires were used to conduct the interviews. The interviews lasted for about 45 mins - 1.30 hrs. The interviews were transcribed and then used as inputs for designing the business model. In addition, a workshop was organised to develop the business service concept. Seven participants attended the workshop. Three participants were academics and four of them were experts in the domains of energy, and ICT. Furthermore, the researchers also attended meetings organised by GP for potential *prosumers* who wanted to buy shares in the proposed community owned solar farm. Moreover, the researchers were also given access to four internal documents that described the business idea, cost and revenue structures. Secondary sources of data were used to triangulate the information such as, reports on PV technologies, community owned solar farms, and GP's website.

4. The community owned solar farm business model

In accordance with the guidelines of Hevner et al. (2004) this section presents the designed business model.

GP is an energy cooperative and they intend to setup and operate community owned solar farms on behalf of communities. They are doing this in order to achieve their goals of transitioning to a sustainable local energy system and profit for a purpose. The service that GP wants to provide involves identifying appropriate sites for setting up the solar farm. The people who are interested in a sustainable energy system or renewable energy will be approached for sales of shares in the solar farm. The interested *prosumers* will then be organised into a cooperative who will then collectively invest in the solar farm. GP will manage all the administration and logistics around setting up and operating the solar farm in return for a fee. The *prosumers* will earn revenues that include subsidies and sale price of the electricity.

4.1. Government policy

The Dutch subsidising agency has introduced the post code subsidy ("*postcoderoos regeling*") policy. This policy allows the members of the small-scale cooperatives, and housing associations to get approximately 9 euro cent subsidy per Kwh of electricity supplied to the energy retailers. In addition, this discount can be availed by residents living in the same post code area as well as neighbouring post code areas. Fig 1 shows that under the post code policy post code area 9733 and the post code areas surrounding it, marked in red, qualify for the subsidy (RVO, 2014).

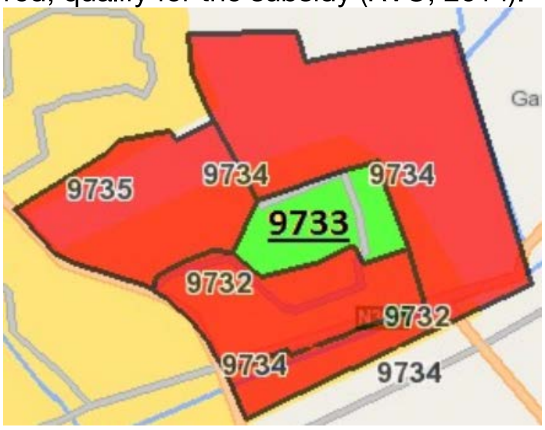

Fig 1 post code subsidy example – areas marked in green and red qualify for subsidy

Therefore, this policy is one of the main factors that leads to a viable business model for community owned solar farms. The Policy also states that the only small-scale user will qualify for the subsidy. In addition, they have to be organised in the form of a housing association or an energy cooperative. The cooperative or the housing association as a whole will not qualify for the subsidy, but the individual members of the cooperation will qualify for a subsidy up to a maximum limit of 10.000kWh's ("De regeling in het kort," 2015).

4.2. Stakeholders

A stakeholder analysis revealed seven stakeholders and the roles they play in this business model. Some of the identified stakeholders are defined as only roles because multiple actors can take them on. The roles are indicated in italics.

4.2.1. Prosumer

A *prosumer* produces or co-creates goods and services that they consume. In this business model the *prosumers* will be co-creating the energy by owning the solar farm collectively. GP will mainly be targeting customers who are early adopters and who are interested in a sustainable life style and therefore want to reduce their impact on the planet.

4.2.2. **Grunneger power (GP)** *- solar farm service provider*

GP is an energy cooperative active in the province of Groningen. Their goal is to provide energy and energy related services that are sustainable, fair, and locally sourced. Moreover, they also want to stimulate the local economy. Their goal is to earn profits with a purpose. The purpose is to reinvested in sustainable energy projects and related services. In context of this business model they will play the role of the solar farm service provider. The responsibilities of this role includes all the activities related to setting up and operating the solar farm such as, administration, acquiring resources (e.g., real estate), and retail of energy.

4.2.3. Energy retailer

The energy retailer retails energy to the end user. Their main activities in this business model are to purchase energy from the solar farm and from the market, and to retail energy to the *prosumers*. In addition, the *subsidising agency* provides subsides to the *prosumers* in terms of reduced taxes on their energy bills. Therefore, the energy retailer functions as a channel through which the subsidies are provided to the *prosumer*. This role can be taken by one or many energy retailers. Their main goal for participating in this business model is to earn a profit.

4.2.4. **Enexis –** *DSO*

Enexis plays the role of the regional *distribution system operator (DSO)*. The DSO is charges with setting up and maintaining the gas and the electricity grid. Additionally, the grid should be reliable, affordable, and safe. Enexis provides transportation service to the solar farm as well as to the *prosumers.* In addition, Enexis currently functions as a sink which absorbs all the energy produced by the solar farm. It is able to do so because the amount of energy produced by the solar farm when compared with the total demand and transport capacity is negligible. However, this could change in the future when the amount of renewable energy increases and the reliability and safety of the grid is at stake. The main goal of the DSO is to earn a profit.

4.2.5. **Municipality of Groningen –** *local governing body*

The municipality of Groningen play the role of the local governing body. They play an important role in facilitating this business model by providing all the necessary licenses and permits. In addition, they also provide cheap access to real estate; in this particular case, they are providing free access to real estate. The municipality is interested in reducing the CO_2 emissions of Groningen, and stimulate the local economy by creating local jobs.

4.2.6. The Netherlands enterprise agency – *subsidising agency*

The Netherlands enterprise agency plays the role of the subsidising agency. This role involves disbursing subsidies in accordance with the government's policy. In this context, they will disburse subsidies in accordance with the post code subsidy policy. Their goal is to reduce CO_2 emissions, and stimulate local economy by creating jobs.

4.2.7. Hardware supplier

The hardware suppliers provide turnkey solutions for the setup and operation of the solar farm such as supplying solar panels, installing the solar panels, and maintenance. GPs will collaborate with local hardware suppliers in order to stimulate local economy. The main goal of the hardware supplier is to make profits.

4.2.8. Information systems supplier

One or many information systems providers can take on this role. They provide all the necessary products and services to market, setup, and operate the solar farm such as, web site, accounting information service, billing information service etc. GP will source these products and services from local firms in order to stimulate local economy. The goal of the information systems supplier is to earn profits.

4.2.9. Accounting firm

The accounting firm provides bookkeeping and accounting services. A local accounting firm takes on this role. The goal of the accounting firm is to make profit.

4.3. Value proposition

A value proposition are a bundle of benefits that an organisation offers its customers (Osterwalder & Pigneur, 2010). Table 2 presents value propositions for all the stakeholders involved.

Table 2 Value proposition

Stakeholder	Value proposition
Prosumers	Sustainable living experience , social benefits, convenience, reliable, reasonable ROI, relevant reports
Grunneger power - *solar farm service provider*	Profit, green energy, stimulate local economy, and reduce dependence on fossil fuels
Energy retailer	Supply of green energy, reduction of CO2, sourcing local energy, reliable suppliers for green energy, profit
Enexis – *distribution system operator*	Profit, sustainability
Municipality of Groningen – *local governing body*	Reduction of CO2, stimulation of local economy by creating jobs
The Netherlands	Reduction of CO2, stimulation of local economy by creating jobs

enterprise agency - *subsidising agency*	
Hardware suppliers	Profit
Information systems provider	Profit
Accounting firm	Profit

4.4. Business service concept

It is important to have a clear conceptualisation of the desired business service before designing the business model because the business model has to be designed to exploit the business service. In addition, a clear conceptualisation of the business service also helps to derive a list of channels, and value creation activities necessary for providing the desired business service.

Fig 2 shows the business service concept. The depicted service evidences are the evidences that the *prosumer* expects to experience in a consistent manner, for example consistent and relevant information. The *prosumers* action shows the actions that the *prosumer* has to take to co-create, or to consume the service, such as login to the online portal. The front stage shows the touch points through which the *prosumer* will interact with the service for example website. The back stage depicts the value creation activities necessary to realise and deliver the service.

4.5. Technical architecture

A technology architecture is a collection of fundamental concepts or properties of the technical system in its environment that are embodied in its components, relationships, and in the principles of its design and evolution (Lankhorst, 2012). The technical architecture is an indispensable part of a business model. Especially for business models that rely on technologies for creating, capturing, and exchanging value (Bouwman et al., 2008). In context of this case there are two layers of technology architectures namely the physical technology architecture layer and the information services architecture layer.

Fig 3 shows the technical architecture of the business model. The physical technology architecture shows all the necessary physical technologies needed and their organising logic, for example PV panels, inverter, etc. The solar farm will be using the grid of the DSO because it is cost effective. Furthermore, it can also be observed that important data meter readings and operation related data (e.g., are the PV panels functioning properly) are transmitted to the appropriate information service. The information service will then process the data into necessary information needed to support the business service. The information services architecture part of the figure shows the different information services necessary to support the business service. The boxes with sharp edges represents the stakeholder, the box with rounded edges contained within the stakeholder box represents the information service, and the dotted lines connecting the boxes represent the flow of information and data. The stakeholders containing the information services are responsible for providing the contained information service/s. The figure also shows the distributed nature of the information services.

In order to derive the depicted information services, first high level business processes were designed. Designing high level business processes is an important logical step in arriving at the depicted information services architecture (Lankhorst, 2012). However, discussing the designed business models is beyond the scope of this paper. Following is a brief description of the information services.

GP will provide the following information services.

4.5.1. Product /service information service

The product/service information service provides potential customers, and collaborators with relevant information related to the service GP is providing, such as value proposition.

4.5.2. Sales /reservation information service

Sales /reservation information service facilitates the sales and reservation transactions.

Service evidence (deliverables)	Information through social media, advertisements, and word of mouth	Information through website, and sales personnel	Purchase online, or via sales personnel, documentation, sales confirmation/welcome emails	Welcome package, reduced energy bills, reports, participate in management meetings, customer portal, customer support, energy	Social media, newsletters, mobile apps, investment certificates
Prosumer action	Read messages on electronic channels, interact with family and friends	Browse website, talk to sales personnel, decision to buy	Register, pay, receive document	Receive welcome package, co-create (e.g., participate in the cooperation, and online community), benefits, reports, energy	Receive news letter, check app
Line of interaction Frontstage	Print media, electronic channels (e.g., social media), sales personnel, word of mouth, events	Print media, electronic channels (e.g., social media), sales personnel, word of mouth, events	Electronic channels (e.g., website), sales personnel	Electronic channels (e.g., website, and apps), customer support personnel	Print media, electronic channels (e.g., customer portal, and apps)
Line of Visibility Back stage (Value creation activities)	• Marketing/ advertising • IS infrastructure (e.g., website, and social media apps)	• IS infrastructure • Sales • Marketing/ advertising	• Sales • Accounting • Customer relationship management • Administration • IS infrastructure (e.g., accounting systems)	• Customer relationship management • Solarfarm setup • Solarfarm operation • Partner management • Technology infrastructure (IS and physical technology infrastructure) • Marketing • HRM • Accounting • Administration • Energy retail • Energy transport	• Marketing/ advertisement • IS infrastructure • Custoemr relationship management

Fig 2 Business service blue print – this figure describes the service offered to the prosumer

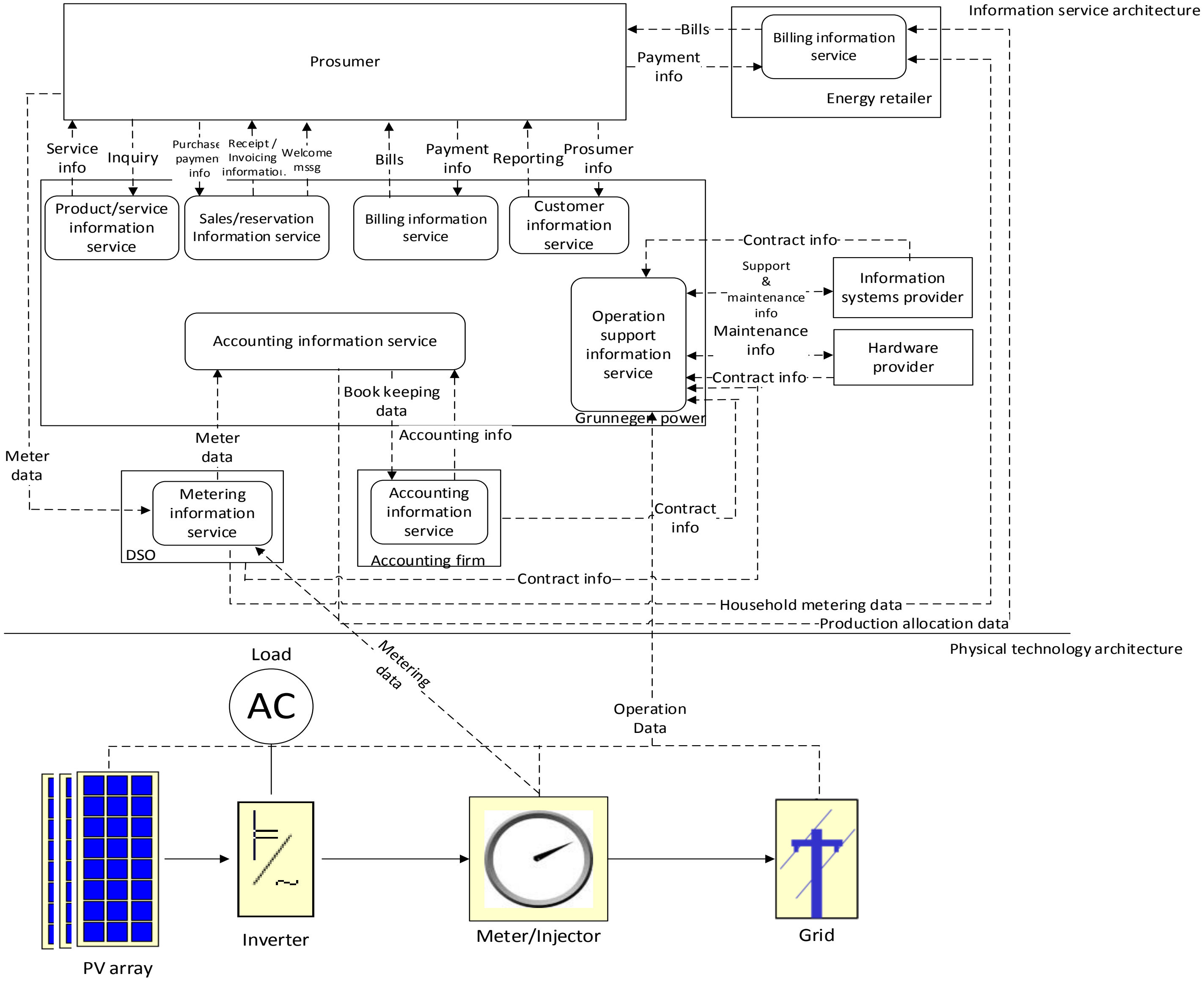
Information service architecture
Prosumer
Bills
Payment info
Billing information service
Energy retailer
Service info
Inquiry
Purchase payment info
Receipt / Invoicing information
Welcome mssg
Bills
Payment info
Reporting
Prosumer info
Product/service information service
Sales/reservation Information service
Billing information service
Customer information service
Contract info
Support & maintenance info
Information systems provider
Maintenance info
Hardware provider
Contract info
Operation support information service
Accounting information service
Book keeping data
Grunneger power
Meter data
Accounting info
Meter data
Metering information service
DSO
Accounting information service
Accounting firm
Contract info
Contract info
Household metering data
Production allocation data
Physical technology architecture
Load
AC
Metering data
Operation Data
PV array
Inverter
Meter/Injector
Grid

Fig 3 Technical architecture – the technical architecture depicts the physical technologies architecture and the information services architecture

4.5.3. Billing information service

Billing information service provided by GP allows GP to send its customers relevant and timely bills.

4.5.4. Accounting information service

Accounting information service allows GP to collect relevant data from the DSO and then process it. Processing the data involves allocating the amount of energy produced to the stakeholders based on their shares. This information is then made available to ener who will then use it to calculate and allocate subsidies to the *prosumers*. Furthermore, this service also allows GP to enter, manage, and transmit relevant book keeping data to the accountants who will then process the information into relevant information and transmit it back to GP.

4.5.5. Operation support information service

Operation support information service facilitate the operation of the solar farm and the coordination of setup and maintenance activities of the solar farm with relevant partners, for example contract expiration dates, work order tracking etc.

The DSO will offer the following information service.

4.5.6. Metering information service

The metering information service will collect and store data from the meters from the solar farm, and from *prosumers* homes. The metering data from the solar farm is made available to GP, and the data from *prosumers* home is made available to the energy retailers.

The accounting firm provides **the accounting information service** receives data from GP and then processes it into important accounting information and transmits it back to GP, for example profit and loss statements.

The energy retailer provides the **billing information service** that allows the energy retailer to receive relevant data and process it in order to send out timely and correct bills to the *prosumers*. This also involves calculating the relevant subsidies and applying it to the relevant customers.

4.6. Business model from GP's perspective

Fig 4 presents the business model from GP's perspective. The costs, revenue, and profitability of the business model are based on the information available at the time of the research. However, this could change when the business model is being implemented. Fig 4 shows that if GP implements the business model as depicted it will make a loss of 512 euros per year. Furthermore, since the focal actor, i.e., GP is unable to make a profit, the business model is unviable. Another important condition for a business model to be viable is that GP's partners should be viable. However, business model canvas does not facilitate the analysis of value capture by all the stakeholders participating in this business model. Since the focal actor is unviable, the traditional business model design efforts would stop here. However, adopting a business ecosystem perspective there is still a chance that this business model can be rendered viable. The following section focuses its design efforts from a business ecosystem perspective.

Key Partners
Municipality
Distribution system operator (DSO) – Enexis
Suppliers
- IS suppliers
- Hardware suppliers

Investors/customers (prosumer)
Finance service provider
Energy retailer

Key Activities
Marketing/advertising
Sales
Setup solar farm
Operate solar farm
Customer/investor relationship management (CRM)
Partner management

Key Resource
Finance
Knowledge
Human resource
Information systems
Hardware (e.g. solar panels)
Accounting capability
Billing capability
Energy transport capability
Realestate

Value proposition

VP for Prosumers:
Sustainable living experience
- Green energy
- Self sufficiency
- Reduction of environmental impact

Social benefits
Reasonable ROI
Reports
Convenience
Reliable

VP for Energy retailers:
Access to green energy produced locally

Customer Relationship
Communities
Personal
Automated
Co-creation

Channels
Sales force
Website
Internet communities
Community resprentatives

Customer Segment
Prosumers who are interested in a sustainable lifestyle, and without the possibility of installing solar panels on thier own roof. Furthermore, customers in this segment are also interested in creating social benefits.

Energy retailers who want to buy green energy and retail it.

Cost Structure

Capital expense	
Investment in solar farm	37.773 €
Operating expense (opex)	
Average annual opex	3.178 €
Average annual divident paid to prosumer	452 €
Total opex	3.630 €

Revenue Stream

Transaction revenue	**Amount**
Sale of shares in the solar farm	37.773 €
Recurring revenue	
Average annual revenue through sale of electricity	1.785 €
Average operational expenses charged to prosumer	1.333 €
Total recurring revenue	3.118 €
Average annual revenue before taxes (revenu stream- cost structure)	-512 €

Fig 4 Business model from GP's perspective – if the business model is implemented as shown above GP will suffer a loss

The business model presented in **Fig 4** is based on the following assumptions:

- the solarfarm will qualify for the subsidy under post code subsidy rules, and it will be available for a period of 11 years
- the solar farm will consist of 150 solar panels and it will require capital expense of 37.773 €, operating expense of 3.630 €
- average annual revenue through sale of electricity 1.785 €, average wholesale price of electricity 0.054 €, average electricity produce annually 33.318 kWh
- lifespan of the project 20 years

4.7. Business model from the business ecosystem perspective

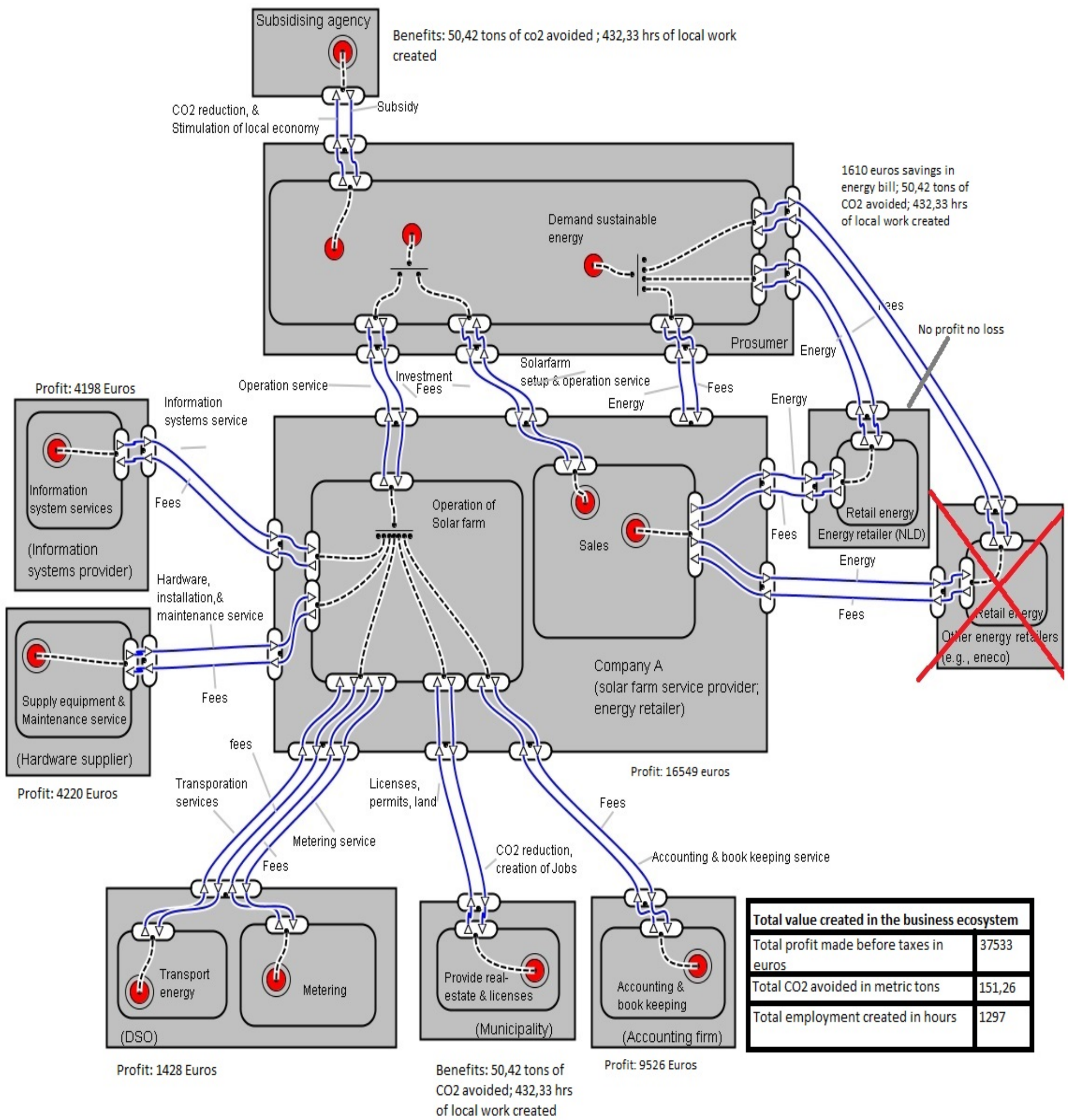

Fig 5 Solar farm business ecosystem – the figure shows the viable configuration of the business ecosystem

The e-3 value modelling technique is used to represent the business model above. Each of the boxes with sharp edges represents a stakeholder in the business ecosystem, and the box with rounded edges with in the boxes with sharp edges represents the value creation activities assigned to each stakeholder. The lines connecting each of these different stakeholders represents the value exchange relationships among the stakeholders, and the red dots represent the start and end of the value exchange relationships. For more details on the semantics see Gordijn (2002). The business ecosystem presented in Fig 5 was found to be viable. As can be observed from Fig 5 the traditional energy retailers were eliminated from the business ecosystem and their role was reassigned to Noordelijk Lokaal Duurzaam (NLD). This was done because the traditional energy retailers were not adding sufficient value in context of this business ecosystem. This means that if the *prosumers* wants to participate in this business ecosystem and avail the full benefits they will have to sign up with NLD for an energy supply contract.

NLD was formed by cooperatives similar to GP. NLD's sole purpose is to retail energy and channel back profits to the member cooperatives based on the number of customers they refer to NLD. This was done in order to lower the operating costs of the energy retail activities and to create economies of scale. On an average, an energy retailer makes a profit of about 78 euros profit per household in the Netherlands (Eneco, 2014; Essent, 2013; OFGEM, 2014). NLD will now be able channel back this profit to GP and they can use this profit to cover their operation expenses of the solar farm. Here it is assumed that the NLD will be able to operate at the same level of profitability as the traditional energy retailers. Based on the above assumption GP will require *prosumers* from at least seven different households to participate in this business ecosystem to break even.

Fig 5 shows that all the stakeholders are viable in the business ecosystem. For stakeholder not interested in profit benefits were quantified in terms of reduction of CO2 and hours of employment created. From Fig 5 the stakeholders are able to capture the following values: GP: 16549 €; *prosumers*: 1610€ in terms of cost savings on energy bills, 50,42 tons of CO_2 avoided, 432,33 hours of local work created; *DSO*: 1428 €; *hardware supplier*: 4220€, *accounting firm:* 9528€p; information system provider 4198 €; *municipality:* 50,42 tons of CO_2 avoided, 432,33 hours of local work created; *subsidising agency:* 50,42 tons of CO_2 avoided, 432,33 hours of local work created. All of the above figures are earnings before taxes, depreciation, and amortisation. Furthermore, the total sum of non-economic values that is CO_2 and creation of local jobs created in the business ecosystem have been divided equally among the interested stakeholders to avoid overestimating the non-economic values. The allocation of value creation activities to different stakeholders was a function of regulations, and price vs value.

The business ecosystem depicted in Fig 5 is based on the following assumptions:

- Assumptions presented in the section business model from GP's perspective
- Analysing the business model of each stakeholder in detail would be very cumbersome and would not add much value to our existing design activity. Therefore, we have assumed profit margins for each stakeholder, and their profitability is calculated based on these assumptions (see **Table 3**). The profit margins were assumed based on literature and interview data.

Table 3 Stakeholders and their assumed profit margins

Stakeholders	Revenue €	Profit margin	Source
GP	1.311.741	4.33%	(GP; Eneco 2014; Essent, 2013; OFGEM, 2014)
DSO	31.728	4,5%	(Enexis 2013)
Accounting firm	11.910	80%	(GP)

Hardware supplier	43.960	9%	(GP)
ICT supplier	26.235	16%	(Guevara, Stegman, & Hall, 2013; Yardeni & Abbott, 2015)

- Annual household energy bill 1087€ (ECN, 2012; PBL, 2013); 1297 hours of local work will be created; 454g CO_2/ kW is emitted in the Netherlands; The required rate of return demanded by the *prosumers* is 1% per annum; 30 households will be participating in this business model.

4.8. Evaluation of the business model

Expert evaluation of business models is a well-established method to evaluate newly designed business models that are yet to be implemented (Bouwman et al., 2008). The designed business model was presented to four experts active in the field of energy two of them were academics with previous experience in industry, and the other two are still active in management positions in the energy industry. The experts were asked to rate the designed business model on the following scale ++ (very positive), + (positive), +/- (neutral), - (negative), -- (very negative). **Table 4** presents the evaluation results. All of the experts were positive about the viability in terms of value. Furthermore, they were very positive about the technological viability of the solar farm. However, one of the experts expressed some concerns about the assumption that NLD will be able to operate at the same profit margin as the traditional energy retailers. The concerns stem mainly from the fact that NLD still does not have a very large customer base to truly enjoy economies of scale, but on the other hand NLD is a lean start-up without the over heads of large incumbent energy retailers.

Table 4 Evaluation results of the business model

Evaluation criteria	Expert 1	Expert 2	Expert 3	Expert 4
Viability in terms of value	++	+	+	+
Technological viability	++	++	++	++

Furthermore, the experts also reviewed the assumptions and were positive about the validity, completeness, and coherent application of the assumptions.

The business model is critically dependent on the post code subsidy for viability. The profitability of GP is highly sensitive to the number of households participating in the solar farm. GP's profitability will be high if the number of houses participating in the solarfarm is high. GP will need approximately seven households participating in the solar farm to break even. GP's viability is also highly sensitive to their cost structure. The viability of *prosumers* largely depends on the subsidy and the wholesale price of the electricity. If the *prosumers* do not receive subsidy they will not be viable in terms of economic value. If the wholesale price of electricity falls below .043 € and all other factors remain constant the *prosumers* will not be viable in terms of economic value. The viability of the *prosumers* both in terms of economic and CO2 reduction is sensitive to the rate of diminishing production efficiency of the physical technologies. In addition, the viability of the *prosumers* is also highly sensitive to the capex and opex of the solar farm. It is especially sensitive to cost of the solar panels because it constitutes most of the capex. The lower the capex and opex the higher the profitability of the *prosumers* in terms of economic value. However, lowering the opex and capex of the solar farm could have a negative impact on the profitability of other stakeholders in the business ecosystem. Furthermore, the viability of other stakeholders is highly sensitive to the assumed profit margins; the higher the margins the higher the profitability. However, in reality their profitability will also largely depend on competition, the value they provide to their customers, and their cost structures. The non-economic values are sensitive to the number of solar panels installed in the solar farm and the assumed CO_2 emissions. In addition, the viability of the business model also depends on the assumptions made by the designer during the design process.

Before even starting the exercise of designing the business model it was important to have a clear business service concept. Having a clear business concept was useful in identifying key stakeholders, value creation activities, and the necessary channels for creating, capturing, and exchanging value. This finding is in line with Bouwman et al. (2008) recommendation of making business service design an integral part of business model design. Consequently, we generalise that one should have a clear business service concept before starting the process of business model design. Designing the business model from GP's perspective alone was not sufficient; we had to also adopt a business ecosystem approach to arrive at a viable business model. Therefore, we propose that in a business ecosystem setting it is important to design the business model from the focal actor's perspective as well as from the business ecosystems perspective. From Fig 5 it can be observed that it was crucial to eliminate the traditional energy retailers because they were not adding sufficient value to the business ecosystem. Furthermore, the role of the energy retailer and the value streams associated with it were assigned to another stakeholder called NLD within the business ecosystem. Consequently, we were able to arrive at viable configuration of stakeholders, and the value creation activities they would perform in the business ecosystem. Hence, we draw the following generalisations: it is crucial to have clear definition of roles and the value streams associated with the roles; it is crucial that stakeholders not adding sufficient value should be eliminated from the business ecosystem and their roles should be reassigned to other stakeholders in a way that enables viability. The viability of the designed business model largely depends on the post code subsidy (government policy) and the assumptions made about the business model, for example whole sale price of the electricity. Therefore, the business model design artefacts should explicitly consider the environmental factors such as government policy affecting the viability of the business model, and the assumptions made about the business model.

5. Conclusion

The energy cooperatives are spearheading the transition to sustainable energy systems. GP is one such organisation based in Groningen, The Netherlands. They aim to provide their customers with sustainable energy and related products and services. In particular, they want to setup and operate community owned solar farms on behalf of local communities. However existing literature largely ignores how energy cooperatives can design and implement viable business models. Furthermore, the literature treats community owned solar farms superficially. Without much guidance from existing literature, firms such as GP adopt a high-risk strategy of finding viable business models by trial and error method. However, such unnecessary risks can be greatly reduced by adopting a business model design exercise before implementing the business model. Therefore, the goal of this paper is twofold: i) one is to design a viable business model for community owned solar farms that will be setup and operated in the north of the Netherlands. ii) To present the findings from this case study, and to propose generalisations that are relevant for the development of artefacts that can be used to facilitate the design of viable business models in a business ecosystem setting.

In order to achieve the above goals we have designed a viable business model for community owned solar farms. This business model is readily implementable by cooperatives such as GP in the Netherlands. We adopted a design science research approach for designing the business model. In addition, we used two well established

BMO's for designing the business model. Four experts from academia and energy domain successfully validated the designed business model. However, the validation process is limited by the bounded rationality of the experts. We have tried to overcome this limitation by using multiple experts from academia and energy domain to evaluate the business model. Furthermore, we have drawn the following generalisation based on this business model design exercise: i) It is important to have a clear business service concept before starting to design a business model. ii) In a business ecosystem setting, it is important to design the business model from the focal actor's perspective as well as from the business ecosystems perspective. iii) it is crucial to have clear definitions of roles, the value creation activities assigned to these roles and the value streams associated with the roles. iv) All the stakeholders should add sufficient value, if not they should be eliminated from the business ecosystem and their roles should be reassigned to other stakeholders in a way that enables viability. v) The environmental factors and the assumptions directly affecting the viability of the business model should be made explicit. Future research should evaluate how the designed business model will be implemented in practice. Additionally, the derived generalisations should be incorporated in to an artefact that will facilitate the design of viable business models.

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