Providing energy services to prosumer communities

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Keywords (3):

Bottom-up local energy initiatives, prosumer communities, energy services

Abstract:

Recent years have shown the emergence of numerous local energy initiatives (*prosumer communities*) in the Netherlands. Many of them have set the goal to establish a local and sustainable energy provision on a not-for-profit basis. In this study we carried out exploratory case studies on a number of Dutch prosumer communities. The objective is to analyse their development process, to examine the barriers they encounter while organising their initiative, and to find how ICT could be applied to counteract these barriers and support communities in reaching their goals. The study shows that prosumer communities develop along a stepwise, evolutionary growth path, while they are struggling with organising their initiative, because the right expertise is lacking on various issues (such as energy technology, finance and legislation). Participants stated that, depending on the development phase of their initiative, there is a strong need for information and specific expertise. With a foreseeable growing technical complexity they indicated that they wanted to be relieved with the right tools and services at the right moment.

Based on these findings we developed a generic solution through the concept of *a prosumer community shopping mall*. The concept provides an integrated and scalable ICT environment, offering a wide spectrum of energy services that supports prosumer communities in every phase of their evolutionary growth path. As such the mall operates as a broker and clearing house between

prosumer communities and service providers, where the service offerings grow and fit with the needs and demands of the communities along their growth path. The shopping mall operates for many prosumer communities, thus providing economies of scale. Each prosumer community is presented its own virtual mall, with specific content and a personalised look-and-feel.

Introduction

Since the year 2007 there is a remarkable increase of the number of local energy initiatives, mostly bottom-up movements started by civilians, which was preceded by the emergence of wind cooperatives some twenty years ago. At the beginning of 2014 one counted in the Netherlands about 95 energy cooperatives and 15 wind cooperatives. When all kinds of other neighbourhood-like initiatives are included, such as collective PV panel purchase projects and collective energy savings programs, the number of energy initiatives even grows to 300 or 400 [1].

In this article we focus on local energy initiatives that want to organise sustainable energy supply in their own neighbourhood. We call these initiatives *prosumer communities*, which we characterise as: *"A prosumer community is a local, collective initiative, organized by a group of civilians, with the aim to establish not-for-profit local, self-supportive energy provision for their members/customers, with the use of both individual and collective local renewable generation facilities."* Many of these initiatives are still in a start-up phase, while their formulated goals are very ambitious and the road ahead is full of barriers and uncertainties. New technologies are being developed (e.g. smart grids, smart meters, smart appliances) to accelerate the energy transition process, but the lack of standardisation and interoperability between equipment and software is still a pressing issue [2]. In our research we investigated how the stepwise, evolutionary growth path of prosumer communities, from an idea in the start-up phase towards a full-fledged prosumer community, can be supported and accelerated by offering ICT enabled energy services. Therefore we analysed a number of

prosumer communities to identify and characterise the various phases of their growth path, and to list the requirements they have with respect to supportive energy services. Based on our findings we designed an ICT based environment, which provides a rich variety of energy services that meet the requirements of the prosumer community in each phase of their growth path.

Methods

Research approach and strategy

The research question we wanted to answer is: "How can we provide an energy services environment that supports prosumer communities in their evolutionary growth path?" In order to answer this question we followed design science as our research approach [3], where the focus is on understanding real-life phenomena, identifying practical problems, and on designing explicitly applicable solutions in the form of artefacts [4, 5]. In the context of our research the emergence of prosumer communities and their quest for the right sign posts to avoid the pitfalls along their development route, illustrate the topical phenomenon and the related practical problems. The designed energy services environment for prosumer communities, which meets the requirements of the target group, is the artefact that provides the practical solution. The inductive-hypothetical research strategy [6] was chosen, while the research problem at hand exhibits the typical characteristics of an ill-structured problem. This research strategy provides a roadmap for the generation of alternative solutions by following various modelling steps, from initiation, abstraction, theory formulation, implementation to evaluation [7].

Requirement elicitation

We identified two target groups as the main stakeholders of our research. First of all the prosumer communities, as the organisational entities that want to establish a local, sustainable energy provision. And secondly the individual members of a prosumer community (e.g. households, companies), who actively want to participate in and contribute to a local sustainable energy system, both within their own premises as well as within the community. We have chosen an exploratory approach both for the elicitation of the requirements of prosumer communities and also to identify and characterise the life cycle phases of their evolutionary growth path. Therefore we examined four real-life prosumer community cases by performing interviews and analysing further information (e.g. websites, newsletters). The requirements of individual households were identified by performing two group panel sessions with prosumer community members using a Group Support System [8] (collaborative electronic brainstorming).

Exploratory case studies

For our exploratory case studies we approached four Dutch prosumer communities: TexelEnergie, Grunneger Power, LochemEnergie and Zeenergie. We selected these four while they are seen as frontrunner initiatives in the Netherlands as they are all four involved in a smart grid pilot project. In these pilot projects new technologies are being developed and field tested, including experiments with innovative energy services. The Dutch ministry of Economics Affairs subsidises these pilot projects through the Innovation Program Intelligent Networks (IPIN). The projects can operate under relaxed regulatory conditions, in order to guide the transition towards a future sustainable energy system [9]. In the analysis of our four cases we focused on the history of the development of the community organisations, which activities they have deployed so far, and which goals they have set for the future, in particular regarding their planned sustainable energy projects and projected energy services that are needed. The first results showed that within all four initiatives multiple sustainable generation facilities are being installed, both at individual households as well as at communal

locations. Which energy technologies are being implemented or explored for future implementation, strongly depends on the local and regional circumstances and the availability of resources. The application of biomass or tidal energy is much more suitable for the island of Texel than for an urban area like the city of Groningen. None of the initiatives is self-supportive yet, as they are all still dependent on external energy supply. A number of energy management services for energy monitoring and energy balancing are being deployed, although still in a limited way and on an experimental basis.

Group panel sessions

Individual households play an important role in prosumer communities as active participants and supporters of the initiative. We organised two group panel sessions with members of the prosumer community Grunneger Power by using a Group Support System. The sessions were held at location in the local community centre, and were prepared using the ThinkLets building blocks methodology [10]. The first session was used for discussion and forming of opinion on the collective purchase of PV panels in the neighbourhood. In the second session the participants were challenged to express their requirements with respect to information and control services in a projected future smart grid environment. The main priority that came forward was that they wanted to be in control of the energy flows within their homes. Secondly the ability to have insight in the energy flows was highly rated. Another important requirement is related to the usability of the energy management tools and services. They should be easy to use, self-explanatory, and plug-and-play. Although the participants indicated that they were willing to offer some flexibility, such as automatically lowering the room temperature with half a degree, they explicitly stated that security of supply should be guaranteed at all times. Furthermore they indicated that managing and controlling smart devices in their homes, based on for instance hourly or even minutes-based fluctuating prices, might become

too complicated. So these functionalities should be automated, under the strict conditions that they could trust the operation, and when necessary, they can overrule the system.

Results

Life cycle phases

The exploratory case studies gave us insight in the development process of prosumer communities and which activities they have executed so far, and how their future evolutionary growth path might look like. From our analysis we can distinguish four separate life cycle phases, which are derived from the study of Jawahar and McLaughlin on organisational life cycle models [11]. In the *start-up phase* the main concern of the prosumer community is to build up an organisation from scratch, based on the ideas of a group of like-minded people. Collective goals are being formulated and an initial business plan is worked out. In this phase it is important to find people with the right expertise and drive that want to contribute to building out the organisation. Various working groups need to be started that each can focus on a specific activity, such as recruitment of members, finding financial resources, or setting up a collective PV purchase project as a service offering for the members. Furthermore a legal entity has to be set up that best fits to the goals of the organisation. Many times a cooperative organisational form is chosen. Also orientation on potential partners in the value network is an important activity. In the *emerging growth phase* the focus is on further growth and on actively seeking expansion opportunities. In this phase an active role as energy supplier is being investigated and implemented, in first instance as a reseller. This activity can generate revenues that can be invested in community owned sustainable production installations. Later on, when sufficient revenue streams are being generated from an extended customer base, the prosumer community can take up the role of energy supplier itself or in cooperation with other communities. This activity has to be organised in a separate legal entity, due to the involved legal and financial obligations and

risks. Taking over control of the energy supply is attractive, while higher margins can be generated, leading to higher revenue streams. In this phase investments are being made in communal generation facilities. Apart from the revenue streams from the energy supply, other internal or external financial resources have to be found, possibly from green investments funds or private investments from members or via a crowd funding platform. As it grows the organisation of the prosumer community has to be professionalised, while the span of control is becoming too big and too complex for volunteers to run. The *maturity phase* follows the emerging growth phase and in this phase the growth rates with respect to the number and size of energy projects and the number of customers will decline. The prosumer community organisation needs to be run more business-like. Characteristic for this this phase is the high level of automated processes for monitoring and controlling the energy flows within the community boundaries. Various local communal energy projects will have been implemented, like wind mills and PV projects on communal buildings or PV parks, and possibly storage facilities. The participating households invested in private energy resources and smart appliances that form active components within the energy exchange and balancing process inside the community. The community will aim at becoming self-sufficient as much as possible, thus minimising their dependency on external energy supply. Active supply and demand balancing will be implemented both at the community level as well as at the household level. Finally in the *revival phase* the organisation enters a period of change or decline, where the focus will shift to reorientation and transition.

Life cycle support

Prosumer communities expressed their strong need to have access to a wide variety of information and expertise as they move forward. The road from start-up towards a mature prosumer community organisation is paved with growing complexity, both in the sense of organisational and technical issues. Prosumer communities are struggling with several barriers they encounter along the road and

they try to find their way through complex regulations. Supportive ICT tools and services can help and advance initiatives in this journey. From our study we identified a long list of possible services that can be provided in each of the life cycle phases. In the *start-up phase* we recovered a strong need for information and expertise on how to set-up an organisation from scratch. Access to success stories, lessons learned, handbooks and the expertise of front runner initiatives is considered very valuable. Intermediate organisations, such as e-Decentraal and HIERopgewekt, can play a pivotal role by collecting and providing all this information. In this phase local authorities can play an important role for a starting community as a resource for information on space planning and regulatory issues, but also as a potential partner of the initiative. In the *emerging growth phase* information and expertise of the energy market and sustainable energy technologies are essential elements. What are the legal and financial obligations and risks related to energy supply? How to apply for a supplier license? Which energy technologies are available and what is the viability? How to fit in communal generation installations in the local and regional space planning? To realise this, intensive cooperation with municipal and regional authorities is necessary, as well as with the network operator to realise the connection of communal installations. Furthermore back office processes need to be equipped in order to handle the growing customer base. In the *maturity phase* support is needed for monitoring and controlling the various active energy components within the community. Sophisticated services are needed to optimally balance supply and demand within both the community and the participants' premises, making use of the available flexibility (e.g. demand shift, embedded storage).

The shopping mall concept

Our research question deals with an energy services environment that supports the evolutionary growth path of prosumer communities. This environment should provide a solution to the needs of the prosumer communities. Based on the findings of our research we designed such an environment,

which is illustrated by the metaphor of a *prosumer community shopping mall*. The shopping mall is an online portal, which offers a rich set of energy services that cover the needs and demands of the two main customer groups, i.e. the prosumer communities itself and the individual participating households. The mall is operated by *the mall facilitator*, who provides the infrastructure of the online shopping mall portal for the prosumer communities. The services in the mall are delivered by different service providers. The mall facilitator offers the service providers a development and deployment platform where they can upload their services. Furthermore the service providers can make use of standard building blocks. Guidelines are provided that dictate the conditions to which the services have to comply to before they can be put into the shopping mall. The concept of the prosumer community shopping mall is depicted in Figure 1 below.

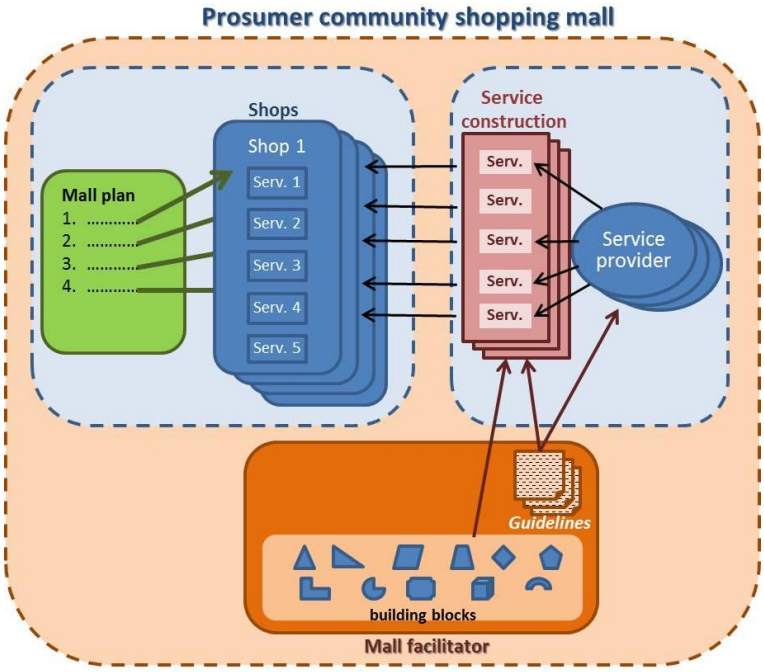

Figure 1: The concept of a prosumer community shopping mall with service shops and mall facilitator

Mall facilitator as broker

The mall facilitator operates as a broker and clearing house between prosumer communities and service providers. The facilitator takes care of the selection and categorisation of the services in the various shops, where each shop covers a set of services with similar functionality. The shops are listed as a service directory in the form of a mall plan, which can be used by the customers to orientate themselves in the shopping mall. The shopping history of the customers is registered in a personal profile, which can be used for further advice and guidance in the shopping process. Furthermore customers can receive recommendations based on the shopping history of others. In a shopping session customers can select various services, which may come from different service providers. As a value added service the facilitator offers a single cash desk where the customer can pay directly for all of his collected services, thus offering his customer an ultimate one-stop-shopping experience. Subsequently the facilitator will take care of the financial settlement with the various service providers.

Departments in the shopping mall

As mentioned before we distinguish two different customer groups of the shopping mall. Prosumer communities will be looking for services that supports them in their development process and operational activities within the community. Individual households, as members of a community, will be looking for services that will help them to monitor and to control the energy flows within their own premises. As both customer groups have different requirements, they will be looking for different kinds of services. Therefore we designed the shopping mall as consisting of two different departments, one for each customer group. This is depicted in Figure 2 below.

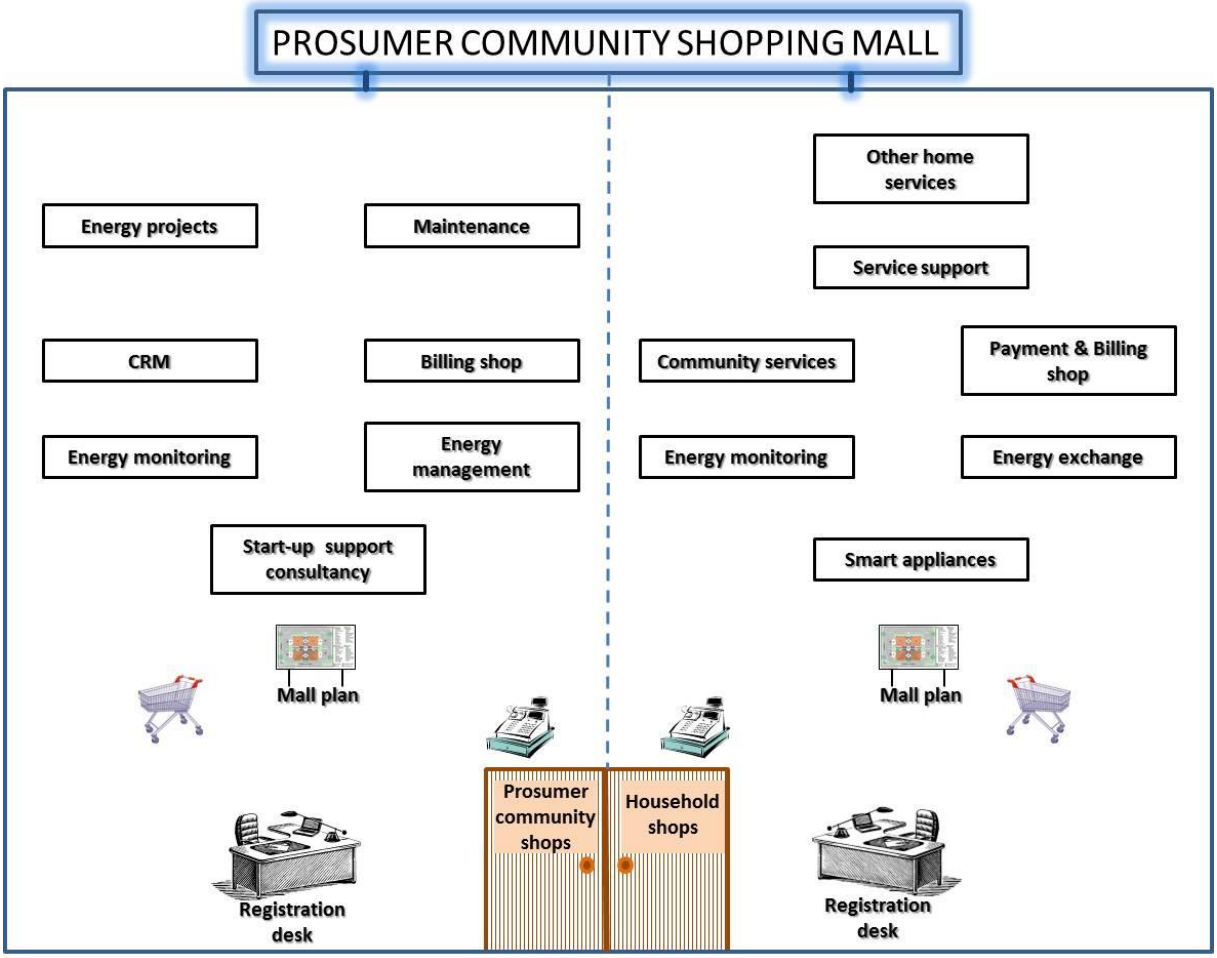

Figure 2: Shopping mall with a department for prosumer communities and for participating households

It is unlikely that every prosumer community will have its own shopping mall. Given the current and projected size of prosumer communities, and the extensive service offerings in the shopping mall, one shopping mall could operate for many prosumer communities. This way economies of scale is realized, both for the mall facilitator as well as for the associated service providers. For each prosumer community a virtual shopping mall can be realised, each with specific content and a adapted 'look-and-feel', which is attuned to the specific requirements of that prosumer community.

Rationale of the shopping mall

The prosumer community shopping mall concept provides a solution for the stated problems of the prosumer communities. But what is the rationale for this online portal concept, and furthermore what is the added value for the various stakeholders? From the perspective of the prosumer communities the shopping mall provides a one-stop-shopping experience. A wide variety of energy services is collected in one place, while the services are validated (i.e. quality of service) by a trustworthy partner, the mall facilitator. As customers of the mall they are supported in their shopping process while the services are organised in a logical way (i.e. shops on mall plan), they receive recommendations based on their shopping history, and the integrated billing service (i.e. shopping cart and central cash desk) prevents the customer from settling payments for each service with the separate service providers. While sharing the shopping mall with many prosumer communities, economies of scale can be realised. The shopping mall provides service providers access to both customer groups (i.e. prosumer communities and their participants). The provided service building blocks and guidelines facilitate the service providers with technical and operational tools for developing and deploying their services. Furthermore, the provided services mall guarantees interoperability and scalability, providing a future-proof environment, which is attractive for both prosumer communities and service providers.

Discussion

Evaluation

In our research we find that the concept of a prosumer community shopping mall provides a solution to the needs and demands of prosumer communities and their participants, while it provides the services that support them in each phase of their evolutionary growth path. Currently such an environment is not (yet) available. Next steps will be to build a demonstrator and present it to a

number of prosumer community organisations, as well as a number of energy business experts, for evaluation and validation purposes.

Business case

The shopping mall concept is set up to be attractive for prosumer communities, service providers and the mall facilitator. Also a next step would be to further work out the underlying business case, showing the economic viability of the concept. Who are potential service providers? Who will be the shopping mall facilitator? There is a wide variety of players that potentially can make use of the shopping mall to offer their services to prosumer communities. We think of developers of smart appliances and services, or energy suppliers and network operators who want to offer value added services on top of their commodity business. Also authorities, both local, regional and national, can offer their services in the mall in the area of space planning, regulatory support or advice services on local/regional opportunities. Advice services from legal offices and financial institutes can also be incorporated. Technical installation and maintenance service companies can use the shopping mall as a platform to offer their services.

Role of the mall facilitator

An interesting question that arises is: who is going to fulfil the role of the shopping mall facilitator? Energy suppliers or even network operators could fill in this new role and extend their business portfolio with a shopping mall service offering. Parties from outside the energy business could pick up this role, while they see interesting business opportunities in the energy market. Major ICT companies could jump in, or parties from the telecom industry. Considering the context of the development of prosumer communities the mall facilitator has to comply to a minimal number of criteria. Trust and reputation are the main prerequisites, while many prosumer community initiatives

started because they were dissatisfied with, and opposed to the interests of the incumbent energy market players. Although there should be a balanced business case for a mall facilitator, it is not obvious that a commercial business will be accepted, regarding the not-for-profit basis where prosumer communities are rooted on.

Implementation

The implementation of the prosumer community shopping mall can be realised in various ways. A number of design criteria are applicable: interoperability, scalability, flexibility, and the use of open source solutions in order to prevent technology lock-in. Criteria from the customer perspective include low cost, adaptability to user's preferences, high standards of usability, and privacy and security protection. The use of Service Oriented Architecture (SOA) and web services can guarantee the criteria of flexibility, scalability and interoperability.

Conclusions

Many prosumer communities are seeking for successful strategies to reach their ambitious goals. The concept of the prosumer community shopping mall can provide the right information, tools and services at the right moment, thus supporting them and accelerate their development process from idea to maturity.

Acknowledgements

The author would like to thank George Huitema, Henk Sol and Rolf Velthuijs for the fruitful discussions on this topic.

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