 ISBN: 9789052693958

PASSIVE HOUSE NETWORKS: A SOCIAL INNOVATION TARGETING INNOVATION IN SME'S IN THE CONSTRUCTION SECTOR

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Abstract
This study examines opportunities for the emergence of SME networks regarding highly energy-efficient housing, as well as the barriers they face.
A theoretical innovation diffusion model is developed from the point-of-view of social and environmental entrepreneurship and sustainable consumption.
The qualitative analysis reflects key elements from the theoretical model and is based on a representative case study of a successful passive house network located in the Belgian Flemish Region. Data were gathered during the emergence of the network, by means of participant observation and action-based (thematic innovation) research. Interviews provided further supplementary information.
The study concludes that the successful emergence of an SME network regarding highly energy-efficient housing requires a holistic approach, in which both enterprises and clients are guided in each step of the innovation-decision process. In their role as intermediaries between clients and firms, change agents should be supported by policy that facilitates networks for innovation diffusion.

Keywords: Buildings; Energy efficiency; Passive house; Innovation diffusion; Enterprise networks.

INTRODUCTION

The importance of high energy efficiency in the construction sector is widely acknowledged. A wide range of innovative energy-efficient solutions are already available within enterprises, and thus at issue is why these innovations are not widespread. The outcomes of research into the barriers to and drivers of technological innovation are expected to speed up the necessary transformation of the housing sector towards energy efficiency (EeB 2009).
Of particular interest are enterprise network structures, since these are known to create an environment of formal relationships and contracts between enterprises, providers and clients and cooperation between enterprises, as well as being supportive for regional economic and social development (Brenner and Fornahl 2003; DeBresson and Amesse 1991; Ornetzeder et al. 2005; Porter 1998). In particular, networks are also known to form a 'locus' for the introduction and diffusion of new technological solutions (Ornetzeder et al. 2005).
Although there are some experiences with case studies of successful emergence of enterprise networks in different fields (see for example: Brenner and Fornahl 2003, Ornetzeder et al. 2005, Porter 1998, Scott 1993), how to implement an SME network for the diffusion of highly energy-efficient housing (and related technology) is not well known: the emergence of network structures to implement certain goals of sustainable development or innovation is a relatively new research field.

Nevertheless there are some parallel research fields, most exemplary on innovation diffusion (e.g. Brenner and Fornahl 2003, Rogers 2003), which can contribute to this research field. Indeed, to examine barriers and drivers for the emergence of SME networks, it is important to understand what drives innovation-decision processes in SMEs and how this relates to SME networks. It can be useful to investigate a case study in order to provide a better understanding how individual change in SMEs can result in collective social innovation. This work therefore studies the emergence of an SME network dedicated to innovation diffusion, using theory of innovation-decision processes.

RESEARCH QUESTIONS

The main research question in this paper is:

How can SME networks aiming at highly energy-efficient housing successfully emerge?
In order to investigate this question the work defines several subquestions, taking the emergence of an existing SME network as a representative case study for empirical research. The following subquestions are addressed in the next sections:

How can the emergence of a network dedicated to high energy-efficiency housing be studied in relation to innovation-decision processes?
To answer subquestion 1, a research model is developed in the next section, and a representative successful case study covering the field of highly energy-efficient housing is selected.

How did SMEs decide to adopt such a network?
In the analysis section, the research model is used to describe the case study.

What were the first steps of the network?
The research model is further used to describe and discuss the first actions of the network.

What can be learnt from the case study?
In the conclusion, the most important findings are summarized.

RESEARCH METHODOLOGY

Theoretical background

In general, there are several bodies of literature that can be relevant for answering subquestion 1, like findings in the fields of (emergence of) enterprise networks and networks for innovation development and social or environmental entrepreneurship (see introduction). A full theoretical overview is beyond the scope of this paper, but further reading can also be suggested considering product-service systems (Mont and Tukker 2006) and the concepts of bounded socio-technical experiments, technological innovation systems and in particular strategic niche management (Ornetzeder and Rohracher 2009). Since the focus of the study was on innovation diffusion, for the examination of decision-processes for the emergence of the case study network, as a general framework Rogers' theory of innovation diffusion was selected (Rogers 2003).
Researchers have been working on a scientific framework for diffusion of innovation since the 1950's. An early milestone is the work of Rogers, describing since 1962 methodologies

for diffusion research that even now are still being used, although in modified forms. The newest edition of this work (Rogers 2003) defines diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system. The innovation-decision process was defined by Rogers (2003) as the process through which an individual (or other decision making unit) passes from first knowledge of an innovation, to forming an attitude towards the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. According to Rogers' model, communication channels, and prior knowledge and conditions, can influence adoption. In the persuasion phase, the decision making unit can be influenced by the perceived characteristics of the innovation.
Rogers' scientific framework of innovation diffusion has also been used by Dutch researchers as a guiding model for market introduction of energy efficiency and sustainable development in the construction industry (Silvester 1996, van Hal 2000; Bos-Brouwers 2010). Damian Miller (2009) recently developed an integrated model for emerging markets, including Rogers' theory and based on four broad perspectives in innovation diffusion research defined by Lawrence Brown (1981): communication, economic history, market development, market infrastructure (see further in Figure 2).

Model development

Networks are known to develop, grow and decline similar to enterprises in innovation diffusion theory (see for example: Brenner and Fornahl 2003). Regarding innovation diffusion it thus makes sense to analyze (emerging) clusters or networks as (innovating) enterprises. However, social networks are also identified by a common goal, by a specific way of communication and action, as well as by a minimal internal institutional (organizational) structure (Fürst 2002). Regarding energy-efficient housing, Ornetzeder et al. (2005) suggested a strong focus on creation of trust and social capital, and learning processes and the need for a center of know-how as most important factors in the emergence of networks of enterprises. Also, social networks tend to focus on steering a paradigm shift, which means they try to influence ways of thinking and representing in order to influence action (Fürst 2002, Ornetzeder et al. 2005).
In the development of the present research model, it is noted that key to the social learning process regarding the implementation of highly energy-efficient housing as an innovation is how to break the so-called 'circle-of-blame' (see Figure 1), and transform it into a learning 'circle-of-innovation' (or circle of trust, see Figure 2).

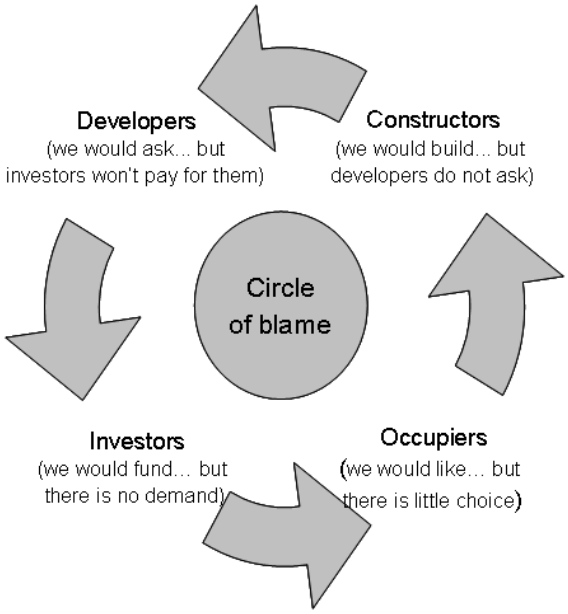

Figure 1: *Circle of blame. Source: SCFG (2000).*

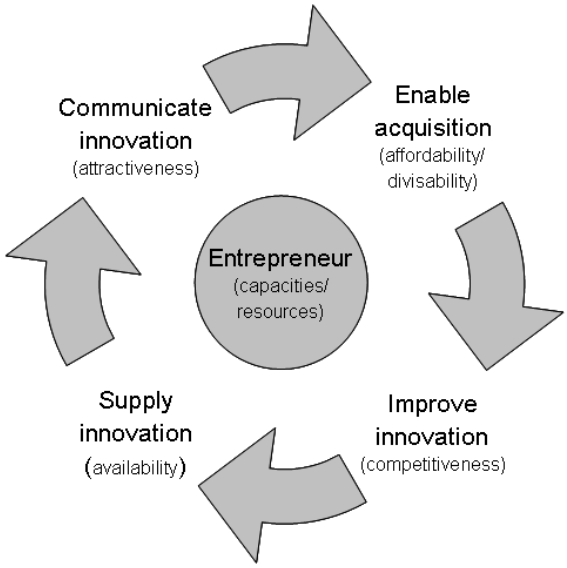

Figure 2: *Integrated analytical framework for innovation diffusion (interpretation based on: Miller 2009).*

A real challenge lies in combining structural technological and system changes (like social and innovation-oriented entrepreneurship as illustrated in Figure 2) with cultural and behavioral changes (like sustainable consumption), possibly by means of intermediary functions or new networks.

Based on a theoretical framework of sustainable consumption Peter Tom Jones and Vicky De Meyere (2009) proposed the 4E-model (see Figure 3, the model has its roots in Stevenson and Keehn 2006; Defra 2008) to explore effective strategies to change behavior towards sustainable consumption. This model can be useful when the research explores actions of the network regarding sustainable consumption.

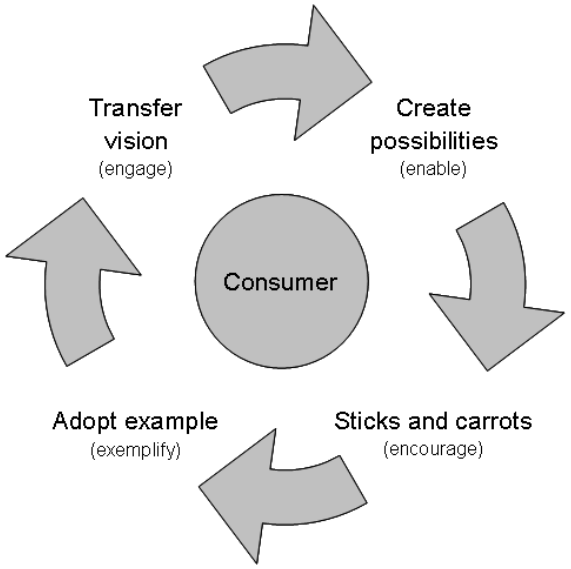

Figure 3: *The British 4E model provides an overview of a mix of complimentary instruments that can change consumption behavior: 'enable', 'encourage', 'exemplify' and 'engage' (interpretation based on the study by Jones and De Meyere 2009).*

In order to analyze the case study the research combines both models from Figure 2 (viewed from the supply side) and Figure 3 (viewed from the demand side).

Selection of a case study

In practice, the promotion of energy efficiency has long been the mandate of national governments and energy utilities. Nowadays, also in the framework of larger 'climate' or 'sustainability' agenda's, a lot of intermediary organizations already work on energy efficiency (Heiskanen et al. 2009), including a variety of governmental and nongovernmental organizations, public-private partnerships and regional or sectorial networks.

In the field of construction of highly energy-efficient housing different authors (Ornetzeder and Rohracher 2009; Mlecnik 2003) noted that nowadays new interest organizations focusing on passive houses shape the socio-technical system by mediating between producers and the policy level and by building systems to transfer these new technologies and practices into the mainstream building sectors. In the case of Austria, the evolving niche of highly energy-efficient passive houses seems to have the potential to profoundly transform existing construction practices (Ornetzeder and Rohracher 2009). Therefore a passive house related SME network was selected for further study.

As a case study, the research qualitatively investigates how an SME network, focused on passive house development, emerged in the Belgian Flemish Region. In 2002 a governmental agency decided to support a thematic innovation platform for SMEs in the construction industry during four years (IWT 2007, Mlecnik 2003) to stimulate thematic innovation in the regional construction industry. The main goal of the network was the diffusion of the passive house concept and technologies in the Flemish Region. Today, the network has shown strong growth and its influence reached even into policy development. While the word 'passive house' was regionally unknown in 2002, today it is an official word in Belgian federal income tax reduction law, hundreds of passive houses are being built every year in the Flemish Region and dozens of companies offer specific products, systems and services for a newly developed regional market of highly energy-efficient housing. Meanwhile the Flemish 'Passive House Platform' (PHP) has evolved from 18 founding members in 2002 to more than 300 members at the end of 2008, of which 158 can be characterized as enterprises, organizations and institutes.

To answer to the research question it can be important to have a rather complete view of the introduction and development of the case study (network PHP), including qualitative details that might be of importance in decision-making and replication of the network initiative. The paper is based on action-based innovation research by the author in the framework of a thematic innovation stimulation project (IWT 2007). Participatory observation in the set-up of the network led to permanent follow-up of the emergence and change of composition of the network. To provide empirical data, introductory interviews were performed amongst the founding and emerging members of PHP (2002-2006), focusing on: What are the characteristics of the member? What is expected from the collaboration with the network? What kind of information and initiatives are needed? What are the observed needs for the future?
The following section analyses the innovation-decision process for the set-up of the SME innovation network.

Limitations of the research
In social sciences the qualitative analysis of case studies has a long tradition, usually because more quantitative approaches are not sufficient or can even lead to wrong descriptions of the encountered phenomena (Ornetzeder et al. 2005). Unlike quantitative approaches of network research, which are usually more focused on interpreting the importance of relationships between members in a network or analysis of clusters, qualitative network research is more focused on interpreting the importance, actions and consequences of the network as a whole.
Organizational innovations tend to have a very specific emergence history which is highly related to local context and side conditions in a social context, which can limit the way a model can be transferred to another region or social context. The action-based research was conducted during the emergence period 2002-2006 of PHP, so starting conditions might be different today. Notably, the European context of energy performance of buildings legislation has changed. Also, interviewees were chosen in function of their relative importance to the introduction and development of the network, which can induce a high focus on the 'innovator' view. It is noted that, meanwhile for addressing the growth market, activities and business model of the examined case study have changed. The growth of the network from innovation to volume market is discussed in another paper (Mlecnik 2011).
The research does not to attempt to conclusively answer what a passive house SME cluster is, or is not, but to review and integrate experiences which may help in understanding the importance of mediators and SME networks as a liaison between sustainable consumers and innovating enterprises. Note that local success of a transfer process of a business model is highly dependent on motivation and competences of the lead actors, resources and social capital generation. However, the business model of the network 'Passiefhuis-Platform' (PHP) is known to have been transferred to other regions, for example to the Walloon Region (with the emergence of the 'Plate-forme Maison Passive') and to the Czech Republic (with the emergence of the 'Centrum Pasivniho Domu'), which makes it worth while to study more deeply.

ANALYSIS OF THE CASE STUDY

Emergence
Exemplify
The discussions between enterprises during the foundation phase of PHP clearly indicated a wish to achieve more sustainable construction on the regional level, based on examples from (and comparison with) other countries. Previous studies (SENVIVV 1998, CIR 2000, Eurima

2003) indicated that for example thermal insulation quality of buildings in the Flemish Region was amongst the worst in Europe. In 2002, there was also no concern from policy to set higher energy performance requirements: the Flemish Region was just confronted with the implementation of the European Performance of Buildings Directive (EPBD 2002) and just started re-inventing energy calculation procedures in collaboration with industry. At first, the EPBD policy approach led to distrust in the fashion of the typical 'circle of blame' (see Figure 1).

Engage

For some companies, this knowledge-action gap was a driver to discuss more effective strategies and business opportunities for sustainable housing, like for example in the IEA SHC Task 28 (2006). Several enterprises defended that to bridge this gap not only a 'circle of trust' – alternatively a 'green circle of naming' (Buck, 2008) – is needed, but also a broader conceptualization of actions for win-win situations and a more appropriate interpretation of knowledge, for example from neighboring countries. A Flemish engineering office, familiar with sustainability issues and studies, was keen on setting a higher energy performance standard in order to promote their services. Instead of trying to steer people's behavior by the (still non-existing) EPBD, they argued that it is necessary to enhance people's knowledge about the existence of solutions. They argued that in order to translate energy consciousness into consumer action, people not only need to know about the state (and energy coefficient) of the houses, but also about the root causes of the problem like insufficient thermal insulation, leaky construction details, improper use of solar gains and (health problems due to) lack of ventilation. It was observed that some non-profit organizations in the Flemish Region promoted for example renewable energy systems (ODE-Vlaanderen vzw) or sustainable construction materials (VIBE vzw), but that the root causes were insufficiently addressed by these promoters.

Enable

Keeping the root causes of the problem in mind, visions and socio-environmental possibilities and strategies towards change were developed. The engineering office played a key role in providing competences and resources for this development, using a small but subversive unit within the larger organization - what Rogers calls a 'skunkworks': an especially enriched environment that is intended to help a small group of individuals design a new idea by escaping routine organizational procedures (Rogers 2003: 149). An existing but dormant non-profit organization (Energie Duurzaam vzw) was used to pioneer the development of the social innovation, and an R&D worker was selected and given special resources, working on a crash basis to create the innovation and to find support for it.

Encourage

From innovation diffusion literature it is known that the availability of positive information is important in innovation adoption decisions (O'Neal et al. 1973). Energie Duurzaam collected answers from individual SMEs interested in profiling themselves in best energy-efficiency. The R&D worker could rely on the connection network of the engineering office to find motivated individuals within companies. In-depth interviews with possible key stakeholders led to initial knowledge diffusion, and further persuasion and decision of some companies to adopt an SME network. The adoption process was further formalized in regular meetings between interested companies, in order to gain confidence and to develop a common vision. This common vision – diffusion of knowledge to stimulate high energy-efficiency in buildings - was formalized as a goal for a non-profit organization, to be erected. Instead of

protesting against slow policy development, the psychology of change was defined as a framework including positive community building, and positive feedback loops as strategies.
Once a proposal for a common vision was developed and set into statutes of a non-profit organization, it was presented to a larger group of possible stakeholders, including companies from the sustainable building sector, as well as traditional building companies and prominent building research institutes. As expected, traditional companies and even the building research institutes were at first reluctant, but the decision was left to them if they wanted to join the movement. However, to join the movement, they were asked to formalize their intent and write consent to stimulate innovation for high energy-efficiency by means of a letter signed by their director.

Competences/ resources
A first barrier to tackle was the exact meaning of 'energy efficiency' in order to attract competences. It was obvious from the different discussions that the enterprises wanted to distinguish themselves from companies that care less regarding energy efficiency. So most companies agreed to set a higher standard, even compared to 'low energy', such as a factor four energy reduction, or even including other sustainability criteria. The engineering office proposed to examine the example of the passive house concept as a high energy-efficiency target, since they recently discovered that in Germany hundreds of passive houses had already been built, which consumed less than a factor four compared to the proposed new energy performance legislation in implementation of the European Performance of Buildings Directive (EPBD). In further meetings it became clear that the passive house standard was best documented (be it in German) with directly available performance criteria, available technologies for import and diffusion, and available tools for energy calculation (which were still missing for normal EPBD calculation). In this framework the decision fell to adopt the passive house standard as a first concept for promotion during the first years of the non-profit organization.
A second barrier was the funding of the non-profit organization. At the organizational level an energy efficiency network can be conceptualized as commercializing a non-profit organization. Many non-profits remain fearful of commercial operations undercutting their social mission (Dees 1998; Fowler 2000), and this was also apparent in the discussion with possible stakeholders. Many enterprises were reluctant to join formally with possibly large member contributions without a clear view how the organization would be able to support itself. It was formalized that a viable business would be the best option to generate a dependable income to pay for network actions: the benefits energy efficiency networks create are public, but they are nonetheless incurring private costs.
Also, since mostly small and micro-enterprises were interested to develop such a competitive niche market, the organization could not rely on substantial member contributions. Funding opportunities were searched and a resource channel of the Institute for the Promotion of Science through Technology (IWT, Flemish Community) was considered as a viable option. To obtain resources the companies had to engage in stimulating thematic innovation and a substantial number of SMEs (more than 10 according to the grant programme) had to co-contribute. Since this would allow 80% funding for more than 2 full-time employees during four years, the SMEs decided to cover the remaining 20% with membership fees. Further, a distinction was made in membership fees according to the size of the company (small, medium or large enterprise, and later also micro-enterprises as a separate category), to allow the micro- and small enterprises, showing wild ideas and clear motivation for innovation, to participate.
After one year of preparatory work, this action led to the foundation of PHP in October 2002 with 18 members, just before the official IWT funding application was submitted. The

number of founding members, the inclusion of a large enterprise as opinion leader, and the transparency and multi-disciplinarity of the organization, created a highly visible signal towards the construction industry with diverse media attention. PHP was erected to be the first multidisciplinary organization in the construction industry involving members such as architect's offices, engineering offices, distributors, materials producers, system providers, installers, contractors, and so on. It was decided that the management can change as rapid as the expected evolution: every two years a number of members of the management board would be chosen amongst the members. A first management board was selected to represent and guard the holistic approach, including a contractor, a climate system provider, an installer, an architect, an engineering office and an individual representing possible owners.

First steps

Concerning the motivation of the innovators to join the network, the interviewees mentioned to be vision driven expecting to get a jump on the competition, not by lower product cost, but by faster time to market, more customer service, or some other business advantage. As a result of the emergence trajectory, they were prepared to champion the passive house concept against resistance and to bear bugs and setbacks that accompany innovation. The innovator group included mostly micro- or small enterprises, e.g. the passive house design offices, engineering offices, contractors, installers and suppliers involved in the first demonstration projects.

In contrast to the single-issue focus of other existing organization in the Flemish Region - for example ODE-Vlaanderen and VIBE - PHP started from a holistic perspective on what has to be done. Instead of fear, guilt and shock as motives for action, hope, optimism and pro-activity were stimulated by developing an attractive vision for future innovation, focusing on the many examples of SME innovation developments in for example Germany and Austria. Thus, like in Austria (Ornetzeder and Rohracher 2009), passive houses in the Flemish Region have been very much developed in a bottom-up fashion without central steering but requiring a high degree of coordination and intermediation processes, with similar initiatives for the development of technical guidance, dissemination of information, development of certificates and quality assurance, and so on.

Table 1 illustrates that the general elements of the social marketing activities of the employees of the network during the first years included innovation specific information provision, the approach to include more enterprises (especially SMEs), the reinforcing of innovation as well as building up a regional and communal identity towards possible clients.

Compared to Austria (Ornetzeder and Rohracher 2009), a stronger focus was put from the beginning on providing innovation directly to SMEs. In the first two years the collective action was stressed, promoting the integrated holistic approach of the passive house concept. It was made clear to the individual companies that they could benefit by using the passive house concept as a 'coat-hanger' for their own products, systems and services.

Considering both the entrepreneur and the consumer perspective, in the first years 'engage' and 'exemplify' were clearly the main focus since the market had to be introduced. For most companies, 'exemplify' meant that the passive house technologies and solutions had to be demonstrated. This was tackled by the employees of the network by organizing a small conference and technology fair soon after the erection of the platform. This enabled companies to network and brainstorm about possible demonstration projects. Two holistic demonstration projects were kick-started by individuals from the leading engineering office, who decided to build their own house in the passive house standard. As consulting engineers they could rely on their opinion leadership in order to convince architects and contractors to participate in their project. Once the demonstration projects were available, construction site

and building visits convinced other actors. In the mean time, bus tours were organized by the network to visit key demonstration projects and companies in nearby Germany.

Target group	*SME network actions*	*Number of actions 2003-2004*	*Number of actions 2005-2006*
Companies and clients	Company and demonstration project visits	70	67
	Technical publications	7	37
	Lectures/ seminars	22	45
	Newsletters	8	12
	Promotional publications	5	43
	Web site actions	1	6
Mainly companies	Networking actions for companies	18	16
	Actions for membership	1	4
	Larger innovation networking initiatives	4	7
	Technology watch (innovation support)	2	8
	Innovation studies	4	7
	Stimulating international cooperation + partner search	5 + 2	10 + 2
	Grant application support	2	9
	Guidance of innovation projects	4	4
Mainly clients	Answering technology questions	300	450
	Guided question transfer	100	60

Table 1: *Activities of the SME network PHP according to year of activity. Based on: (IWT, 2007).*

Media attention of the 'first houses without heating' spurred enthusiasm and requests for providing more information to interested companies and clients. Innovator-clients appeared to be highly receptive to the proposed solution due to their environmental concern. The clients who adopted first were usually from the upper middle class and could reserve an extra budget for realizing the concept. In comparison, later clients wanted to be well informed and followed workshops and visited demonstration projects in order to form an opinion. They usually also rationalized the passive house concept compared to the perspective of another low energy option. However, their final decision appeared also to be highly influenced by other parameters like the experienced comfort during visits of the demonstration project.
After the first four years, the declining media attention for passive houses (gap from innovation to growth market), led to new business development. Figure 4 exemplifies the business model development of PHP, summarizing Figures 2 and 3. Amongst other, a stronger focus was set on quality assurance of passive houses.

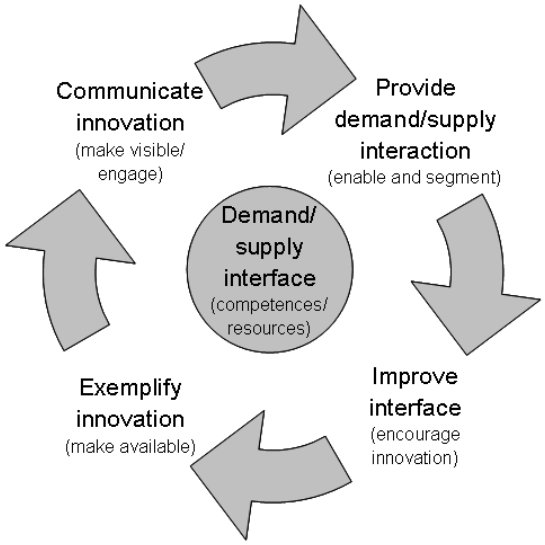

Figure 4: *Business model development of a change agency/ SME network in order to encourage innovation through demand/supply interaction.*

CONCLUSION

The model developed for innovation diffusion studies of SME networks focused on highly energy-efficient housing, and the application of the model on a case study, provide interesting new insights. Member-companies can be engaged by exemplifying opportunities and by positive communication focusing on their shared common meanings, beliefs and mutual understanding. A holistic approach promoting an integrated concept and involving actors from different disciplines on a regional level has the advantage that the SME network can also excel in, for building projects necessary, heterophilous and neutral communication. Innovative passive house technologies and services appear to be suitable as a focus for the emergence of an SME network focusing on highly energy-efficient housing. The role of such an SME network as a 'change agent' and formal gate-keeper between innovation-push and demand-pull, can be envisaged.

For emerging networks it is important to define 'interventions' as coherent objective in the innovation phase to bring about behavior change in order to produce identifiable outcomes and transitions. An SME network for the diffusion of highly energy-efficient housing can emerge on several activities. It can stimulate persuasion and a favorable attitude towards innovation by providing detailed information to both clients and innovating companies. It can help the individual with engaging in activities that lead to a choice to adopt the innovation, for example by providing or directing to further personal training. It can help the individual (or other decision making unit) with the implementation, for example, directing to established or certified professionals. Finally, it can help in providing confirmation when the individual (or other decision making unit) seeks reinforcement of the decision already made. The case study shows that guiding the client or the innovating company through the whole decision-taking process with suitable responses in each step of the decision process can contribute to success.

The study exemplifies that the role of motivated agents from an SME network is imperative for steering innovation-decision processes towards the implementation of passive houses, both for enterprises and for clients. This role could have never been achieved without support by innovation policy that facilitated the set-up of a specific thematic network for innovation diffusion.

ACKNOWLEDGEMENTS

Funding for thematic innovation stimulation during the period 2003-2007 was obtained within the project number 020506 entitled 'Passiefhuis-Platform' by IWT, the agency for innovation by science and technology of the Flemish Community.

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