SME networks for highly energy-efficient housing: opportunities and challenges in the growth market

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Abstract

This study is concerned with the widespread diffusion of energy-efficient innovations in the construction sector, in particular the role of SMEs and SME networks in innovation in the Belgian context of the passive house development. It aims to assess opportunities available to SME networks, in particular those promoting highly energy-efficient or nearly zero-energy housing, as well as the barriers they face, when dealing with a growing market demand.

The research uses key elements of the theory of network development and innovation diffusion to analyse a descriptive Belgian case study (Passiefhuis-Platform vzw), which can be considered a successful example of an SME network targeting actors concerning high energy-efficiency in the construction industry, using the passive house concept as an integrated approach. Data collected between 2002 and 2010 were gathered by document search, participant observation and action-based research including interviews.

A literature research discusses the importance of SME networks with a focus on innovation diffusion, and networks for the promotion of energy efficiency. The research then analyses the adopter categories responsible for technological and process innovation in the Belgian network, in particular the characteristics of the adopters regarding size, activity and membership of the network. Also the changing network activities are illustrated. These results allow analysing how the network was able to cross the gap between market introduction and early adoption. Further, the paper shows how the role of the SME network is expected to change in the growth market.

The study concludes that an SME innovation network, involving actors from different disciplines on a local level, and focussed on an integrated passive house approach, can be a foundation for market emergence. For such networks it is important to define coherent strategies in each subsequent phase (innovation, early adoption, late adoption) to bring about behaviour change in both supply and demand. A strong focus on future clients and micro-enterprises is needed to kick-start innovation, while larger companies contribute in an early adoption phase. In order to face the growth market, policy-related quality assurance is needed. The role of motivated agents – like SME network employees – is imperative for steering decision processes in each phase. Regarding the relevance of SME networks to facilitate market adoption of highly energy-efficient housing, phase-related incentives are needed to support such networks.

Introduction

The political, economical, social and technological importance of SMEs (see for example: EeB 2009) and high energy-efficiency (see for example: EPBD 2010; EPBD 2002) in the construction sector is widely acknowledged. Many energy-efficient solutions are available within the construction industry, and an important question is why these innovations are not widespread. This study is concerned with the more widespread diffusion of energy-efficient innovations in the construction sector, in particular for the realization of single-family owner-occupied houses. It is known that high energy-efficiency can be achieved

in new houses (IEA SHC Task 28) as well as renovations (IEA SHC Task 37), but often these achievements do not reach beyond demonstration projects. Demonstration projects provide a good learning opportunity (Femenias 2004), but innovation is needed beyond products and technologies (van Hal 2000). Also, it is acknowledged that the role of actors can be different in different innovation phases (market introduction, growth market, volume market) (Rodsjo et al. 2010).

The research in this work focuses on the development, importance and opportunities of SME networks in order to achieve a more widespread diffusion of highly energy-efficiency housing, as well as the barriers they face. 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 network structures and social innovation, since these are known to form a 'locus' for the introduction and diffusion of new technological solutions (see for example: Hellmer et al. 1999; Weyer et al. 1997). The problem of transfer of network structures to implement certain goals of sustainable development is a relatively new research field (see for example: Ornetzeder et al. 2005, also for a discussion on network analysis and network and cluster definitions). Nevertheless there are some parallel research fields, most exemplary on innovation diffusion (Alänge 1998, Dosi 1991, Gatignon and Robertson 1985, Rogers 2003), which can help examining innovation network barriers and drivers, and innovation-decision processes. In this theoretical framework, it can be useful to provide a better understanding how individual change in SMEs can result in collective change, like in SME networks. Also it is useful to provide a better understanding which type of actors lead to innovation, how innovation networks develop, function and contribute to a transition, and how detected barriers can be solved in order to ensure a future role of an SME network and the introduced innovations.

Research approach

MAIN RESEARCH QUESTION

The main research question in this paper is: *How can SME networks respond to challenges in the growth market of highly energy-efficient housing?*[1]

Several authors have defined the term SME network according to their scientific background. In this paper a focus is set in particular on the value-creating possibilities of (customer-oriented collaboration between) SMEs that are typically involved in the construction of highly energy-efficient single-family owner-occupied houses, like construction and HVAC contractors, architect's offices, supplier firms and energy consultants.

In order to investigate this question the work defines several subquestions, taking a regional innovation platform as a representative case study for empirical research.

1. To answer the main question, subquestions were defined such as: What are theoretical insights considering SME networks for the promotion of energy efficiency? What type of companies and activities led the market introduction? What were preconditions for early adopters to join? What challenges were detected in transition to the growth market? How did the SME network respond to these challenges?

CASE STUDY

As a case study, the research qualitatively investigates how an SME network – focused on passive house development and launched in the Belgian Flemish Region – developed. In 2002, the Flemish Agency for Innovation by Science and Technology ('IWT') decided to support a thematic innovation platform for SMEs in the construction section, entitled 'Passiefhuis-Platform' or 'PHP' (IWT, 2003), and this for a period of four years. This led to the emergence of a multidisciplinary network – involving architects, engineering offices, contractors, suppliers, installers, non-profit organizations, motivated individuals (users), and so on – with a focus on the promotion of the passive house concept in the Flemish Region (Mlecnik 2003; Mlecnik 2011) in order to stimulate thematic innovation in the Flemish construction industry. 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 each year in the Flemish Region and hundreds of companies offer specific products, systems and services for a newly developed regional market of highly energy-efficient housing. Compared to other European countries, Elswijk and Kaan (2007) noted that the Belgian passive house development is now rapidly following the development in leading countries like Austria and Germany.

RESEARCH METHODOLOGY

The first subquestion is directed with literature search exploring recent findings in the theory of innovation diffusion and related fields like sustainable consumption, social entrepreneurship and clustering/ networking.

The case study is analyzed with action-based research conducted during a long period (2002–2010) to be able to cover the evolution and change of viewpoint of Passiefhuis-Platform (PHP). Participatory observation led to permanent follow-up of the change of composition of the network. Further reports, books, leaflets, e-mails, websites and internet fora produced by PHP were analysed. To provide further empirical data, regular interviews were performed amongst the founding members of PHP and a selection of companies that joined the network in a later stage (2007–2008), focusing on: What are the characteristics of the member? How is the collaboration with the network? How is information obtained during a building process? What kind of information and initiatives are still missing? What are the observed needs for the future?

To answer the subquestions related to the case study the paper examined what the characteristics are of, and differences between, the innovators and early adopters, by examining for example socio-economic status, personality characteristics (for example environmental behaviour of SME managers) and communication behaviour. These results use data collected from a questionnaire with both open and closed questions, set up and distributed to all company members in 2008–2009 focussing on: perceived characteristics of the promoted innovation concept (relative advantage, compatibility, complexity, trialability and observability); type of innovation-decision (optional, collective, authority); communication channels (e.g. mass media or interpersonal); nature of the social system (e.g. its norms, degree of network interconnectedness, etc.); extent of change agents' promotion efforts. In total 38 interviewees provided useful information to the questionnaire. They represent dif-

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ferent types of companies that were categorized in micro-enterprises, small and medium enterprises, large enterprises and others (knowledge institutes, non-profit organizations, …).

LIMITATIONS OF THE RESEARCH

Organisational innovations tend to have a very specific emergence history that 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. Also, local success of a transfer process highly depends 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 the case in detail.

In order to support the transfer of regionally successful models it is important to study not only the specific conditions of the emergence of examples but it is also necessary to gain more general knowledge about the development and stabilisation of relevant entrepreneurial networks (Ornetzeder et al. 2005). The emergence of PHP is described in (Mlecnik 2011). This paper focuses on the stabilisation phase.

The research does not to attempt to conclusively answer what a passive house SME cluster has to do, or 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.

Theoretical findings

SME NETWORKS

Several authors have dealt with case studies why networks appear regionally and what relevant policy and other side conditions are for success (for example: Brenner and Fornahl 2003, Camagni 1991, Ornetzeder et al. 2005). According to experiences in industrialized countries, the SME cluster concept has been shown to be an efficient instrument for strengthening regional and national economies, but its applicability for improving the competitiveness of participating SMEs has yet to be fully examined (Karaev et al. 2007). In general, literature shows that there are some studies that discuss issues for clustering of SMEs with similar activities, but that not much is known about clustering of SMEs from different professions, in particular the construction sector.

Networks are known to be able 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; Porter 1998; Ornetzeder et al. 2005). On the other hand, Lutzenhiser (1994) discussed that changing organizational environments offer opportunities for innovation, but stabilizing network connections can also inhibit technical change and slow its transfer.

It is difficult to precisely determine which factors are prerequisites for cluster or innovation development and which are appearing as a result of the clustering process (Karaev et al. 2007). Regarding the need for education of enterprises, social networks are known to engage in the development of their own innovations, for example in the development of related service or product packages (see for example: Hellmer et al. 1999; Pyka and Küppers 2003), which allows them to bridge partial offers of individual enterprises and reach new clients. DeBresson and Amesse (1991) noted that networks of innovators can be important for setting standards, which can act as a major entry barrier and exclusion mechanism.

NETWORKS FOR THE PROMOTION OF ENERGY EFFICIENCY

Energy efficiency is not always driven by national governments and energy utilities, but in practice the promotion of energy efficiency has long been the mandate of these actors. Nowadays, also in the framework of larger 'climate' or 'sustainability' agenda's, a lot of intermediary organizations already work on energy efficiency including a variety of nongovernmental organizations, public-private partnerships and regional or sector networks, established by entrepreneurial individuals, environmental NGOs, agencies working on behalf of national governments, partnerships of local groups working on consumer issues, as state-owned agencies, and particularly by partnerships of local authorities, regional agencies, local authorities and universities, and city authorities and municipal utilities (Heiskanen et al. 2009). Though these organisations are frequently different in many respects, including the specificities of their function, they all tend to have energy intermediaries that can be characterised in terms of how they mediate between supply and demand (Heiskanen et al. 2009). In some cases, these mediators initiate efficiency programmes bottom-up and create new organisations.

In the field of construction of highly energy-efficient housing different authors (Mlecnik 2003, Ornetzeder and Rohracher 2009) noted that nowadays new interest organisations 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). In the context of passive house networks, Ornetzeder and Rohracher (2009) explained the successes of the Austrian passive house development using the concepts of bounded socio-technical experiments, technological innovation systems and in particular strategic niche management.

In the Netherlands, researchers have used Rogers' scientific framework of innovation diffusion as a guiding model for market introduction of energy efficiency and sustainable development in the construction industry (Silvester 1996, van Hal 2000). From Rogers' innovation diffusion theory (2003) one expects to be able to classify SMEs into 'adopter categories' (innovators, early adopters, early majority, late majority and laggards) on the basis of innovativeness, for example the degree to which the SME is relatively earlier in adopting the passive house concept than other members. In the framework of this theory the passive house network can be defined as 'diffusion network', with 'change agents' operating interventions.

Note: Innovation and company size: contradictory findings

Sustainability entrepreneurship research and corporate sustainability literature so far have neglected the differential roles of large and small firms in transforming industries towards sustainable development, which might have important policy implications (Hockerts and Wüstenhagen 2010). There is a large body of literature concerning the innovation differences between large companies and SMEs[2], but the results of these studies are inconclusive and dependent on the measurement and interpretation of innovation capacities (Tether 1998). In general, concerning enterprise size and innovation, some authors present small firms as having an innovation advantage, and others present large firms as having an innovation advantage. Of more importance is the perceived evidence that SMEs innovate differently from large companies and should not be regarded as little big business (Bos-Brouwers 2010). Despite differences in definitions, researchers understand that radical innovation within an organization is very different from incremental innovation and that it is critical to the long-term success of firms (McDermott and O'Connor 2002). Some authors argue that small firms are better situated concerning radical innovation and product innovation, while large firms are better at producing material-based (Rothwell and Dodgson 1991), incremental (Sen and Egelhof 2000) and process innovations (Abernathy and Utterback 1988). Research by several authors (for example: Berry and Taggart 1994; Acs and Audretsch 1988) suggests that small firms could be the source of innovation during the earliest stage of a technology's evolution, with the locus of innovation shifting to larger firms in the growth market. Verhees and Meulenberg (2004) suggest that innovations by SMEs are often based on off-the-shelf technologies, concepts and/or resources offered by supplying industries. King et al. (2003) theoretically proposed that small firms, in relation to large firms, are more likely to develop or incorporate new technology following a technological discontinuity, which can result in the creation of new industries.

In general, the real innovation behaviour of firms seems to be influenced by a combination of cultural, institutional, macro-social/economic and technical factors, most notably the degree of (rigidity producing) bureaucracy of the firm (Lutzenhiser 1994). The owner-manager in SMEs is essential for the generation and implementation of new ideas and his/her role is crucial to the innovation process (Docter et al. 1989, Hartman et al. 1994). Further, organizational culture can foster motivation (Hartmann 2006). As a product matures and competition shifts to cost and efficiency, it is possible that in order to achieve business success in the growth market, manufacturing competence can become critical (Tushman and Romanelli 1985). Such competence can be expected to be most common among large firms that excel at process R&D (Klepper 1996). Amorim et al. (2003) underlined that firms of different sizes may find themselves working towards compatible interests when they target different, but related markets.

Analysis of the case study

STARTING CONDITIONS

The emergence of the network has been described in detail in another paper (Mlecnik 2011). The network appeared because of a wish of enterprises to differentiate themselves from mainstream construction by focusing on a high target of energy efficiency. The need for know-how led to the definition of a non-profit organization that would supply information in order to realize highly energy-efficient buildings. Once a proposal for such a common vision was developed, it was set into statutes of a non-profit organisation for the promotion of highly energy-efficient buildings, allowing interested companies to join.

The existing knowledge-action gap and the lack of resources for the organisation were drivers to discuss more effective strategies and business opportunities. It was known that substantial grants could be obtained for stimulating innovation in SMEs. To obtain resources for the network in such an application a substantial number of SMEs had to co-contribute financially with (membership) fees. Initially, these (membership) fees were expected to cover in total 20 % of competences and resources for 2 full-time employees[3]. In discussion with the construction sector, a distinction was made in company (membership) fees according to the size of the company (small, medium or large enterprise, and later also micro-enterprises as a separate category). In order to join as a full member, potential members were further asked to formalize their intent and write consent to stimulate innovation for high energy-efficiency by means of a letter signed by their director.

PHP was thus formally established in October 2002 with 18 founding members. These included 14 enterprises, and opportunity was left for individuals and related non-profit organizations to join as a member. Traditional companies and even the building research institutes were at first reluctant to join. Mainly micro- and small enterprises joined the network from the beginning, demonstrating ideas and clear motivation for innovation. The number of founding members, the inclusion of a large enterprise as opinion leader, and the transparency and multi-disciplinarity of the organisation, 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 an integrated building approach, including a contractor, a climate system provider, an installer, an architect, an engineering office and an individual representing possible owners.

2. It can be discussed whether number of employees or annual turnover are suitable definition parameters for SMEs. In general, now in the European context, SMEs are defined to have < 25 employees and an annual turnover < 50 million EUR (or < 43 million EUR annual balance). According to Flemish (IWT) criteria, a small enterprise has < 50 employees and an annual balance < 10 million EUR.

3. Later this was reformulated to 3 persons: 1 full-time equivalet (FTE) administrative manager + 0,5 FTE architect + 0,6 FTE netwerk co-ordinator/ energy expert. Nowadays, PHP counts about 10 FTE.

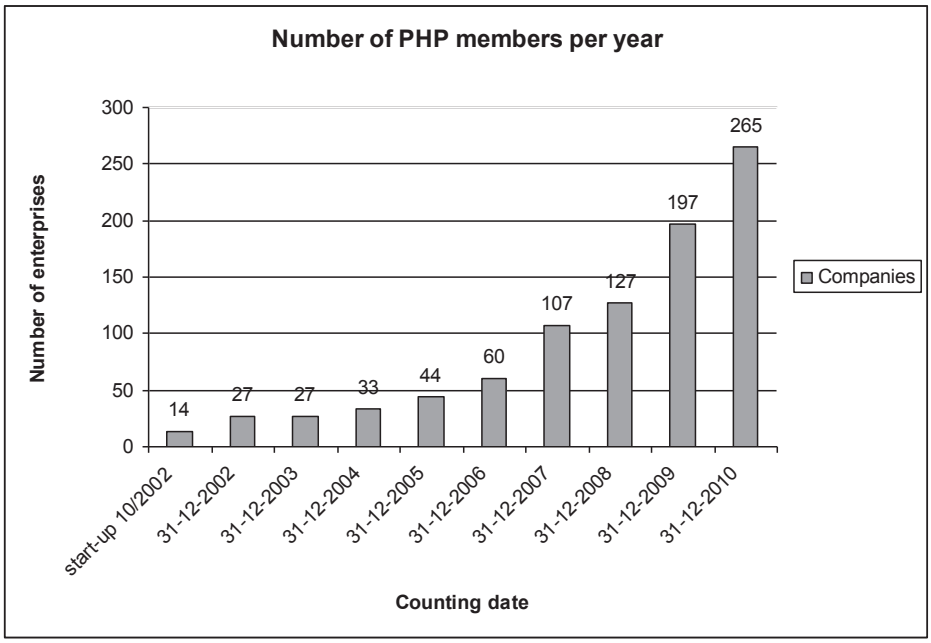

Figure 1: Evolution of number of member-companies of PHP (status 31 December 2010).

THE CHANGING COMPOSITION OF THE NETWORK

Figure 1 shows that the PHP enterprise network has indeed increased throughout the years and was able to attract dozens of new company members each year.

While membership numbers have increased, the relative shares of medium and large enterprises have not changed significantly. Figure 2 shows that the platform is still dominated by micro-enterprises with an annual turnover of less than 500,000 EUR. In comparison, the initial construct of the network also consisted of mainly micro-enterprises. This can be explained partially because the majority of the construction sector consists of SMEs, and the membership fee for each group was defined per category[4]. It can be remarked that of the four large enterprises that joined from the beginning (2002–2003) one joined with a small business unit, and two deleted their membership in the market introduction phase after a few years.

THE INNOVATORS

The questionnaire results allowed detecting and analysing characteristics of the innovators. In both open questions in the interviews and closed questions in the questionnaire, the innovators 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. They were prepared to champion the passive house concept against resistance and to clear bugs and setbacks that accompany innovation. This group includes mostly micro- or small enterprises, e.g. the passive house design and engineering offices, contractors, installers and suppliers involved in the first demonstration projects.

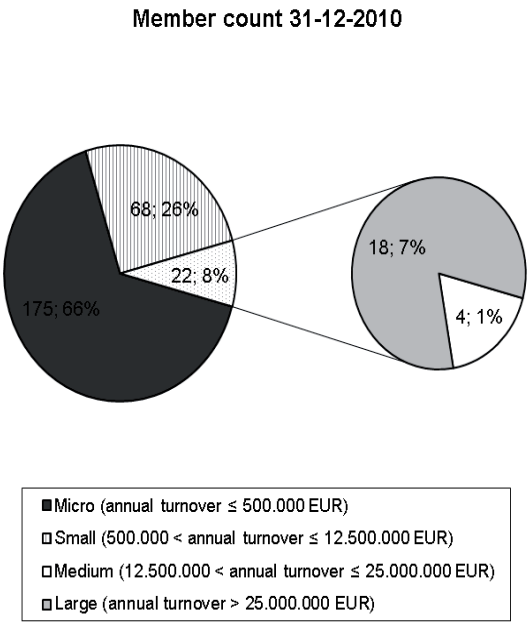

Figure 2: Distribution of PHP enterprise members according to company size (status December 2010).

Some innovators accepted a radical discontinuity between the old methods and new ones. E.g. one of the founding companies of PHP was a seller of air-conditioning transforming his business to sales of heat recovery systems; another heating installer transformed his business to selling passive house windows.

Figure 3 shows that a few innovating companies redirected their products and services almost completely towards the passive house concept. The research noted that a majority of interviewees (both innovators and early adopters), although they wrote consent to promote passive houses, consider passive house technologies as a trigger to have more activity in the low energy housing market, not necessarily only passive houses. In

4. The membership fee system was proposed by the management board as an answer to the general assembly's request to take into account the limits of financial capacity and risk-taking behavior of each enterprise. Current annual membership fees for companies vary from 345 EUR to 2,760 EUR (excl. VAT). In the introduction phase the enterprise membership fees were limited between 600 and 2,400 EUR, making distinction only between small, medium and large enterprises. However, 600 EUR was perceived as too high for micro-enterprises.

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2008, large enterprises were either in the exploring phase or addressing low energy solutions, while some micro-enterprises had already shifted their products and services completely to passive houses.

THE EARLY ADOPTERS

Characteristics of a group of 'early adopters' (Rogers 2003) or the 'early market' (Moore 1999) could be found based on the questionnaire results. These early adopters first change behaviour after evaluating the results of the innovators. Many larger companies appear in this group (about 24 % of the respondents), and many small enterprises that try to find a new niche market are involved. Those companies expect to get a head start on other companies/ late adopters. They learn from the innovators to redefine their business opportunities using not so much radical innovation, but more incremental innovation. For example, an architect involved in a demonstration passive house project developed a spin-off company providing 'insulation and air tightness services'. A former employee of a carpentry business involved in a demonstration project developed his own company to build passive houses. A company providing I-trusses for floors examined the opportunity to use these trusses for passive house walls.

The fact that larger companies are slower to adopt is in line with Rogers' (2003) statement that the more persons involved in making an innovation-decision, the slower the rate of adoption. A personal interview showed that it is individual persons in a few large companies that kick-started a process to convince their management to join the SME network or the development goal. One means of speeding the rate of adoption is to alter the unit of decision so that fewer individuals are involved. So it was also noticed that passive house initiatives started by business owners tend to be adopted faster than initiatives started by middle management or administration personnel. The greatest innovation response to passive house network effort occurred when opinion leaders and micro-enterprises adopted.

Technological innovation often results when the resources of a small firm are combined with those of a large one (King et al., 2003). For example, a former employee of the larger company involved in the innovation of I-trusses for passive wall construction, now delivers whole building systems for passive houses through his own company, in collaboration with the larger supplier. Some larger companies felt the need to contact innovators to help them in their own product or system development. For example, an architect of a demonstration project helped a large supplier company to design a building method using traditional building products. Another architect involved in a demonstration project helped a large project developer to redesign and standardise their building system towards passive houses. Some large companies joined forces with innovators and/or other large companies to present an integrated concept on the building market (for example the 'massive passive' concept, the 'healthy building' concept, the 'multi-comfort house', and so on).

Incremental innovation can for example also be seen from product related passive house developments by large individual companies, like the 'multi-comfort-house' (thermal insulation related) and the 'massive passive house' (brick related). Whereas these companies tried to attract competences, unlike the innovators they could provide considerable resources to diffuse the concept using their own products and systems as a reference. In general, this created a growth of the group of early adopters, and considerable market increase, also for the innovators.

In general, larger companies take more time and seem less flexible to engage in passive house development, but they can provide a large connection network. Also they tend to observe experiences of small companies and wait for strategic decisions in general policy development. Once a policy or grant is in place, they also tend to engage preferably in larger projects, creating even more momentum. In this respect the current recast of the EPBD (2010) is an important initiative that can convince late adopters to move towards nearly zero-energy buildings.

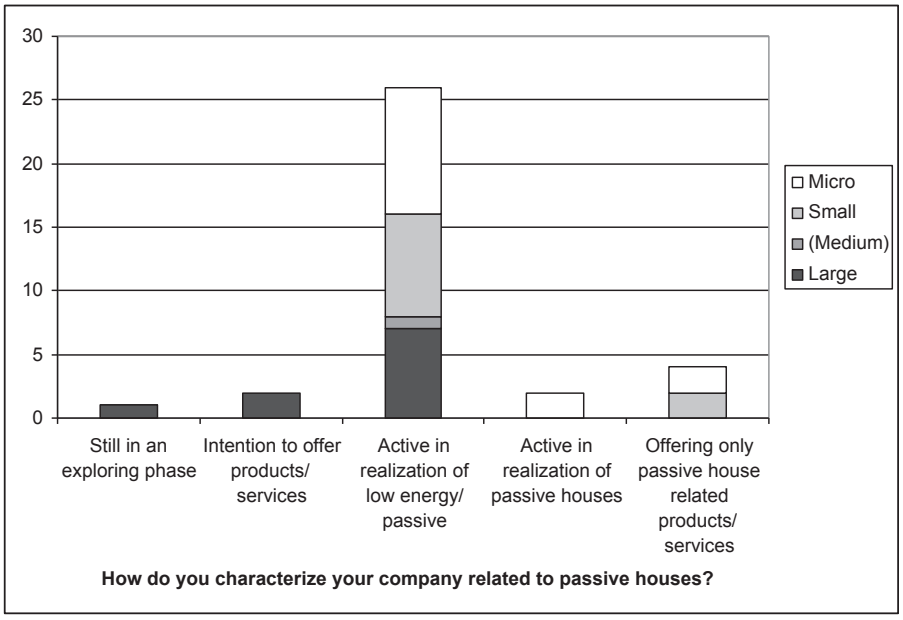

Figure 3: How PHP member-companies related themselves to the passive house concept, according to company size (interviewees December 2008).

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THE CHANGING ROLE OF THE AGENCY

The changing activities of the network during the period 2003–2007 are illustrated in Table 1.

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. General elements of the social marketing activities of the employees of the network included target specific information provision, the approach to include as much actors as possible (especially opinion leaders), the reinforcing of motivation as well as building up a regional and communal identity. Creating high public visibility of demonstration projects was an important focus and such demonstrations proved to be effective when the demonstrator was a respected opinion leader. The network employees sought to raise SME's technical competence and their ability to innovate themselves, as well as to produce communication material that helped the SMEs as well as potential users in evaluating pros and cons of the passive house concept and certain innovations.

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, training, development of certificates and quality assurance, and so on. Compared to Austria (Ornetzeder and Rohracher 2009), a stronger focus was put from the beginning on providing innovation and training directly to SMEs (see Table 1). Instead of protesting against slow policy development, the psychology of change using inclusive positive community building, and even positive feedback loops like those used in dementia care (Mlecnik 2002) were used as strategies. Instead of focusing on change in individual 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 companies that they could benefit by using the passive house concept as a 'coat-hanger' for their own products, systems and services.

The media attention offered to the 'first houses without heating' increased 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 nature of the ownership structure of houses in Belgium probably plays a significant role: most owners occupy or even build their own house, which can lead to shorter decision processes. The clients who adopted first were usually from the upper middle class and could reserve an extra budget for realising the concept. 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. Only recently, a group of clients with irregular flows of disposable income adopted the passive house concept, mainly from a social participation perspective to tackle the threat of energy poverty. In renovation projects, the diffusion of the concept appears to be less obvious: the extent to which the passive house concept can be divided into individual technologies probably influences the rate of diffusion and further segmentation of the SME network activity is required.

In 2005, in order to be able to reach an early adoption, the network launched a 'passive house quality assurance' with the

Table 1: Activities of the SME network PHP according to year of activity. Based on: (IWT 2003; PHP 2007).

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

collaboration of a Belgian Minister. This provided a useful tool in order to convince early adopter clients who were reluctant about the final quality of the innovation. On the other hand – even if the certificate only consisted of providing a statement considering energy use for heating and air tightness – it put pressure on the network to control the quality of demonstration projects. The network had to guard and continuously reflect the criteria put forward, since these were also adopted in grant initiatives proposed by municipalities and energy providers. The detected barriers considering design and quality assurance of innovations have been transformed by the network into service innovations like specific web sites covering building detail design (www.bouwdetails.be), efficient ventilation (www.beterventileren.be), market introduction for renovation (www.lehr.be), as well as the development of certificates and associated grants (Mlecnik, 2010).

DISCUSSION: TRANSITION TO THE GROWTH MARKET

The member-companies of the SME network in the case study (the Belgian Passiefhuis-Platform) can nowadays mainly be characterized as innovators and early adopters. Rogers generalised that relatively earlier adopters are larger-sized units (Rogers 2003:298), but this seems not to be the case for the adoption of the passive house concept by innovators. Companies with rapid innovation diffusion towards early adoption of passive house technologies and services can be mainly characterized as micro-enterprises or small enterprises with a tendency towards radical innovation. This can partly be explained by the fact that most companies in the building sector are SMEs and large companies are slower to adopt because of a larger decision-making unit. In an early adoption phase, larger companies play a more important role, providing necessary momentum to cross the innovator/early adopter chasm. A success factor in the early adoption phase appears to be that the SME network links the heterogeneous constituency of experienced and less experienced actors in the construction sector, involves larger companies and defines and supports market segments needed for the growth of the passive house niche.

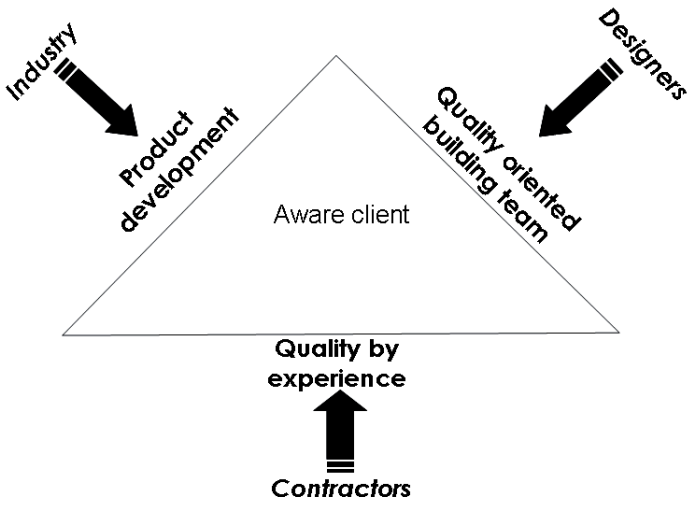

Figure 4. General market introduction business strategy of PHP (developed 2002–2007). *Note that in the early adoption and growth phase Policy will play a more important role.*

After the first four years, the declining media attention for passive houses, led to new business development. New mediation activities of PHP turned out to be closely related to those defined by Heiskanen et al. (2009), with a strong focus on mediation with regional and local policy on one side, and specific technological guidance for enterprises on the other side. To overcome remaining technical barriers, technology-related projects were proposed for funding, but using a more segmented approach, tackling construction issues, installation issues, quality issues and so on. In particular, quality assurance and approval procedures for demonstration projects were high on the agenda, in order to fulfil (policy) side conditions for grant introduction. This approach proved to be successful, with several municipal, regional and federal financial carrots introduced in the subsequent period. However, for project approval the funding agency put significant pressure to collaborate with other major players in the construction sector, in particular the existing building research institutes. Nevertheless the basic business model of the organization developed in the early years, shown in Figure 4, did not generally change. The field of policy development emerged as an extra focus.

Figure 4 shows that core to the SME network is still to make the client aware of the existing opportunities. According to PHP experience, a passive house will not be built unless the client asks for it. In most demonstration projects, even the client had to convince the architect. For most architects the transition towards energy performance requirements led to the set-up of more pronounced teams, usually involving providers and contractors, in order to be able to discuss and implement technological opportunities due to lack of personal competence. The architect-client combination usually pushed the contractor towards providing a certain performance, for example a required air tightness level of the building. This led to a high focus on execution quality for the contractor, necessary for a demonstration project. Only after successful demonstration projects, it appeared that companies were stimulated to provide their own innovation, usually after experiencing questions on building fairs from potential clients and seeing that their market is increasingly put under pressure by the implementation of foreign or more competitive products and systems.

In the current phase, opinion leaders for the volume market have to be addressed with information according to their needs. Therefore, the network currently regards the contacts with the Flemish Energy Agency as crucial and aims high at collective research projects in collaboration with more traditional building actors (e.g. the Flemish associations of contractors). To be able to reach the volume market, the network now engages in co-developing a provincial network of consultants aiming at potential clients. Where previously the network was a project 'certifier', a new Royal Decree on income tax reduction for passive house owners opens a window towards a pool of project certifiers. Other actors in this construction provide short courses for personal training of clients. Also, where previously early adopter-companies could be reached with modular passive house courses – for example on thermal bridges, energy

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calculation, design, renovation, and so on – the network now develops a specialised course for certification of more traditional actors.

Rogers (2003) defines homophily as the degree to which pairs of individuals who interact are similar, and heterophily as the degree to which they differ. Change agent's success in securing the adoption of innovations by clients is positively related to a client orientation, rather than to a change agency orientation (Rogers 2003:375). Change agents usually differ from their clients in many respects, and have the most contact with clients who are much like themselves. The clients that seek contact with change agents usually have a higher socioeconomic status, social participation, higher formal education and cosmopolitanism (Rogers 2003:382). To diffuse the concept to different target groups, it is perceived that better organized homophilous (peer-to-peer) communication involving targeted opinion leaders will be required, e.g. a client's forum for exchange of experiences, real estate organisations addressing real estate agents, architect's associations addressing architects, teachers addressing students, contractors explaining how to build to other contractors.

It can now also be questioned whether dominant innovations will appear as a result of alliances and acquisition activity between small and large firms. In such a case, small firms that persist with competing dominant innovation could be at risk of having a higher possible failure rate (King et al. 2003). It was noticed in the case study that some early adopter companies introduced for the first time large-volume initiatives, while some innovators, especially suppliers, are now confronted with managing this growth and more economic competition. Also, in the volume market mainstream actors can be expected to buy and use innovative products as part of a problem-solving application (Egmond et al. 2006). A few early illustrative examples of this could be detected in the Flemish Region. A large Flemish company, for the moment distributing only natural ventilation systems and sunshades, does not yet see the need to extensively promote specific passive house technology and considers the associated risk to high. A major PVC window manufacturer in Flanders bought a German window factory with passive house windows in its portfolio to solve the problem of fast production for a new niche market.

Conclusion

Nowadays, integrated passive house concepts, involving different innovative technologies and services, offer a new business opportunity for SMEs. An SME innovation network, involving actors from different disciplines on a local level, can be a basis for market development. An interesting insight in this study is the changing role of networks and type of intermediation along the innovation diffusion phases (market introduction and growth market) of highly energy-efficient houses. For networks it is important to define 'interventions' as coherent objective in each phase (innovation, early adoption, late adoption) to bring about behaviour change in order to produce identifiable outcomes and phase transitions.

From the case study experience, some crucial issues could be detected for the introduction of a network. Micro-enterprises are more inclined to innovate and therefore should be a focus target group for introduction of a network. Such a network can appear bottom-up if suitable financing instruments are available, for example (partial) grants for thematic innovation. Multi-disciplinarity of the network is an important driver for integrated approaches, such as providing practical solutions for the realization of passive houses. An SME network can excel in, for building projects necessary, heterophilous communication once its basis is interdisciplinary and its employees promote an integrated concept.

In the market introduction phase the network needs to fulfil the role of change agent, dealing with (fostering motivation for) innovation on the supply side. However, a focus should be kept on stimulating demand as well by providing neutral information related to the client's background, goals and decision processes. Typically, in the market introduction phase, the task of the passive house network representative has been to expose the individual (or other decision making unit) to the existence of the passive house concept so he/she can gain knowledge and understanding of how it functions. The client's motivation to implement passive houses was observed to be the most important driver for innovation.

To reach better adoption of highly energy-efficient housing innovation in the growth phase, increasing demand pressures are needed from clients and change agents. In the case study, the network engaged in quality control of demonstration projects to convince early adopters, and developed quality control of technologies and actors in order to provide some guarantee to early adopters. In order to reach the growth market, innovation-decision processes of different types of early adopters need to be facilitated by change agents. To diffuse the passive house concept to different target groups in the growth market, more homophilous (peer-to-peer) communication involving targeted opinion leaders is needed.

While their actions are important, there are arguably a number of limitations to the impact that small firms can have on the sustainable transformation of industries in the growth phase. Sustainability-related entrepreneurial initiatives within large firms, on the other hand, are also not free from challenges. On the supply side, collaboration is needed between micro-enterprises and other enterprises. At the same time policy needs to address economical incentives to address supply and demand, but notably also to steer the created interfaces between supply and demand.

The credibility of a change agent in the volume market relies on SME network's capacities and resources to transfer independent know-how to a large number of clients and exerting quality control that the applications provided by enterprises are safe and effective. In this framework there is significant potential to improve the interaction between networks and policy. New intermediation processes, like those between networks and policy makers, are intrinsically linked up with the challenges faced by growing socio-technical systems (or technological innovation systems). System changes towards quality assurance in the construction sector interest both public policy and enterprise networks. In order to reach the volume market, the role of an SME network as a 'change agent' and formal gatekeeper between technology-push and demand-pull, focusing on quality assurance, can be envisaged.

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