User knowledge in housing energy innovations

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Energy innovation as a communication challenge

Energy means different things to different people. Studies have found that people do not know much about household energy use (Eurobarometer, 2006). While such findings suggest that more public education is necessary, they can also be criticized for exhibiting a 'deficit model' (Irwin and Wynne, 1996) of lay knowledge concerning energy. It is assumed that because lay people do not have the same kind of knowledge as experts do, they know nothing. Other authors consider the problem of energy knowledge from the opposite perspective (Shove, 1998). Experts simply frame energy use in different terms – often ones that are distant from ordinary households' concerns. They fail to understand why households behave 'irrationally' because they fail to grasp the logic of energy use.

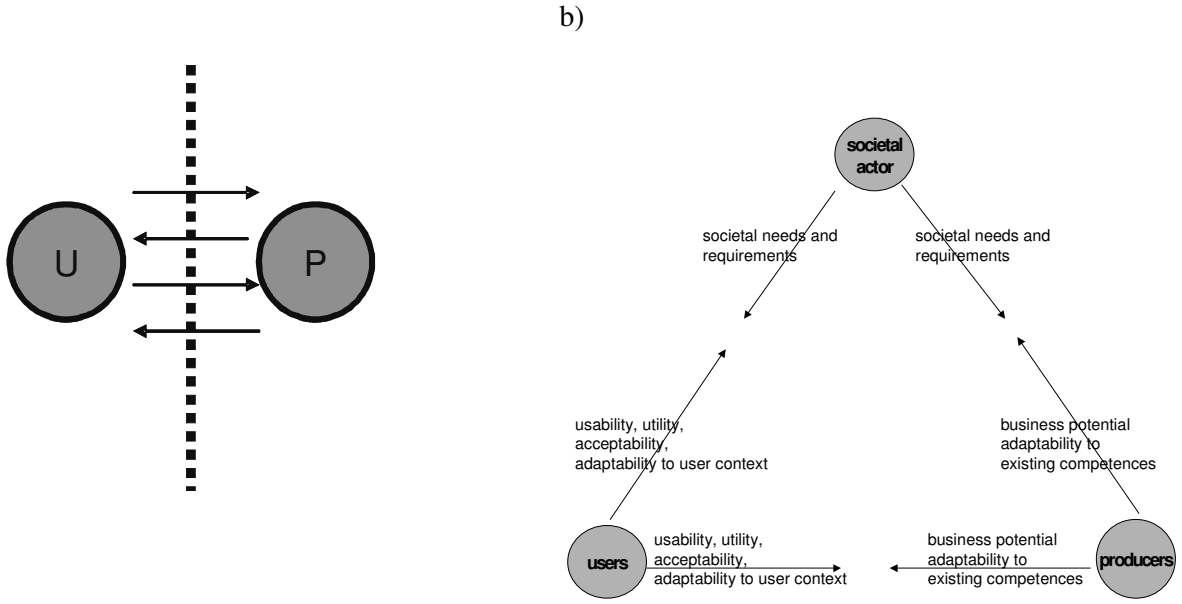
The exchange of energy efficiency knowledge among experts and lay people reflects a fundamental problem in product innovation. Von Hippel (1998) has termed this a problem of "sticky information": information about users' needs and manufacturers' capabilities is highly contextual, tacit and difficult to transfer from one site to another (von Hippel, 2005). This problem slows down the product innovation process – many rounds of information exchange are needed in order to establish facts and clarify perspectives (Figure 1a).

The problem of "sticky information" is further complicated in the case of societal innovations such as energy efficiency (Kivisaari et al., 2004). Here, societal actors like public energy agencies have their own perspective on the innovation, which differs from those of the users and producers. The societal actor will thus need to try to communicate with both producers and users in order to promote its own knowledge and understand the requirements and competencies of the market actors (Figure 1b).

A frequently proposed solution to this problem is intensified interaction between the world of designers and the world of users. This can consist of *designer participation in the user context*, *user participation in design*, or *user innovation*.

Designer participation in the user context: Designers may go to visit the users at home or at their workplace, and use ethnographic observation to understand the users' world. A number of design tools have also been developed on the basis of ethnographic or field observations, such as contextual design and empathic design. We are not aware of direct applications of ethnography-based design tools in the field of sustainable innovation. But, for example, Chappels and Shove (2005) have made extensive use of field research to investigate and problematize the concept of "thermal comfort".

Figure 1. (a) Von Hippel's (1988b) view of the problem of 'sticky information' in product innovation and (b) the particular problems in societal innovations (based on Kivisaari et al., 2004)



User participation: Participatory design in the workplace has a long tradition in Scandinavia, and has recently also evolved to encompass a broader range of users. User participation means that users join designers "at the drawing board", for example by participating in "user groups". This approach has been applied, for example, by Spaargaren et al. (2006) to identify how well a variety of sustainable innovations fit into their everyday life and social practices. Similarly, Hoffman (2006) and colleagues have used user workshops to identify development needs in a sustainable product concept.

User innovation: Users' own inventions and innovations can be a direct source of commercial products. Von Hippel and colleagues have found that at least in some product groups, a large proportion of users invent and customize their own products (von Hippel, 2005). Alternative energy is a technology in which user innovation has traditionally had a significant role (Jamison, 2001). As contemporary examples, Ornetzeder and Rohracher (2006) have analysed two Austrian cases of user innovation in solar collectors and woodchip boilers.

The Motivoittaja project – introducing a user-friendly low-energy housing concept

As a case study on the role of user knowledge in the introduction of energy innovations, we consider a recent Finnish project aimed at promoting 'low-energy housing'[1]. In 1999, Motiva, a state-owned company responsible for promoting energy efficiency and renewable energy, launched a project aiming to mainstream and 'normalize' the concept of low-energy housing through a technology procurement competition and labelling system (called 'MotiVoittaja') targeted at the producers and consumers of prefabricated detached homes.

Low-energy housing as conceptualized in the project refers to a set of different technologies. The technologies include increased thermal insulation, low-energy windows, reduced air leakages,

[1] The case study is based on earlier research (e.g., Halme et al. 2005). This research has been complemented by document analysis, analysis of construction-oriented Internet discussion sites and an interview with a representative of Motiva, the project manager. More details and references are available in Heiskanen et al. (2007) as part of the *Create Acceptance* project funded by EU FP6.

recovering heat from exhaust air, extracting energy with heat pumps, passive solar energy and building orientation. A key aspect is a systems view of designing a house. Design is based on a thorough understanding, control and utilization of the energy flows within a building.

The Motivoittaja project sought to promote the diffusion of the low-energy concept through a technology procurement competition. Technology procurement is an instrument for stimulating innovation through a targeted acquisition process. An influential buyer or group of buyers formulate the requirements, and market transformation is further influenced by support activities. In the MotiVoittaja project, the award was designed to function as a label of endorsement, allowing prospective customers to identify 'certified low-energy houses'. Moreover, Motiva assembled an 'initial buyer group' of prospective homebuilders willing to make a commitment to purchase a 'MotiVoittaja' house.

The competition was launched and administered by Motiva Ltd. The other key partner was the Finnish national technical research institute, VTT, which had been intensively involved in developing low-energy housing technology with an emphasis on user benefits. Motiva and VTT also tried to take into account the consumers' expectations on the basis of previous experiences of problems in adopting low-energy housing. The construction process is stressful for consumers. Few consumers are interested in experimenting with new technologies in this situation – hence, a third-party 'label of endorsement' might increase consumers' confidence. The underlying belief was that homebuilders are increasingly consumers of ready-made products. The product should be easy to identify and purchase, and it should convey other than energy- and environment-related benefits, such as comfort and healthy living (Halme et al., 2005).

A jury of external experts was invited to determine the winners. The competition was published in 2000 and the winners were announced in 2001. The initial response was positive, with 20 entries into the competition. Eight of the entries were awarded with the MotiVoittaja label, and two were awarded retrospectively. The energy consumption of the awarded designs ranged from 60 to 130 kWh/m^2, but was at least 35% less than average. Motiva and the jury were quite happy with the cost level achieved: the construction costs were 1300-2000 euros per m^2 of living area.

Four of the 10 companies awarded the label actually offered their winning design for sale, and three were still offering a "MotiVoittaja" house in 2006. The housing manufacturers were somewhat disappointed with the sales performance: they had expected a more enthusiastic market response and more deals with the initial buyer group. The project largely failed to promote commercial models marketed specifically as low-energy housing and to establish a widely acknowledged set of criteria for this type of housing. Yet in general, one can conclude that the targets of raising awareness of low-energy housing and mainstreaming the concept were actually fairly successful.

User representation and participation in the project

User were present at various stages of the project. The forms and intensity of user participation is described briefly in the following.

Planning, criteria-setting and selecting the winning entries were conducted by experts: the project managers, the expert evaluators and the jury involved in the competition. There were, however, two user representatives in the jury. In particular, the representative of National Association for Detached Housing Construction represented the homebuilder's perspective in the project. Moreover, the project managers and the jury made an effort to address some of the homebuilders' (perceived) concerns related to low-energy housing, namely costs, convenience and indoor air quality.

Formal communications: Most of the communication on the project followed a top-down model. Communications were directed at the trade and daily press and other media. The project received extensive media coverage and favourable press. However, the project managers themselves were of the opinion that more efforts should have been placed in communications after the competition.

Nonetheless, one important communication success was achieved through participation in the Finnish nation-wide Housing Fair events. These are annual events that create a new model housing development each year in a different location, and illustrate novel technologies through demonstration constructions. After the event, the houses are sold to 'normal' families, and the fairgrounds are turned

into a residential area. Motivoittaja was presented as a concept in the 2001 event, and demonstration houses were built for the 2002 event.

Assembling the initial purchaser group: Gaining market commitment from initial purchasers is an important part of technology procurement projects. In this case, purchasers were private consumers, so assembling the group was difficult. Finally, a buyer group of 40 families was gathered. Yet the buyers turned out to be quite reluctant to make binding contracts with the manufacturers. Some were not satisfied with the standard awarded models, and requested so many modifications that the houses no longer met the energy efficiency criteria. The most important initial buyers were also purchasers of Housing Fair houses. Three awarded models were constructed for the Housing Fair and sold before the fair. The families who moved into these houses became the most important showcases for the MotiVoittaja concept.

Informal communications: In the formal communications, the media coverage was quite favourable. The 'unofficial' communication ongoing on Internet discussion forums revealed a more mixed reception. There were divergent opinions on what "low-energy housing" means, and much debate about real-life heating costs. One recurring topic was whether to invest in geothermal heat pumps or increased insulation. This discussion implies that the 'systemic design' idea was not adopted by ordinary homebuilders. There was also some competition between contrasting concepts of ecological housing: one based on traditional construction methods and natural materials, and the other 'modern' one involving well-sealed structures and highly controlled air and energy flows.

Market: By stimulating a market for 'mainstream' low-energy housing, the project attempted to align itself with the (perceived) interests of ordinary homebuilders, and especially the growing group of middle-class people who rely on ready-made market offerings. Yet homebuilders are variegated group. They typically consider a number of different heating and construction options and balance a range of requirements. Prefabricated houses are also not an ordinary industrial product. They are sold in small quantities, and even 'standard' models are often modified extensively. This is problematic when considering energy efficiency from a 'systemic design' perspective: modifications should not interfere with the planned and controlled energy flows.

A survey conducted half a year after the competition revealed that interest in energy conservation and ecological solutions is growing among homebuilders. Homebuilders felt, however, that there is not much reliable information on the topic, and they were confused by the different concepts. Less than half believed that one can halve a building's energy demand with small additional construction investments.

Successful and unsuccessful aspects of the project

In terms of successes, the Motivoittaja project surmounted some communication challenges vis-à-vis users and producers (Figure 2). It managed to raise user awareness of energy conservation. It also managed to address some user issues, such as comfort, convenience, and indoor air quality. But the project seems to have been more successful in communicating with the producers. A large number of these companies became convinced of the future importance of energy conservation in housing, which is reflected in the number of entries in the competition.

Yet the Motivoittaja project failed to address a number of communication issues (Figure 3), in particular vis-à-vis users. It was not capable of convincing the users of the urgency of energy conservation. At the time of the competition, signs of this urgency were not commonly visible. After the competition, the price of energy has steadily risen. More stringent requirements on energy efficiency in buildings have been placed. These developments were on the horizon at the time of the competition, but the project was not able to communicate them convincingly. Moreover, the project failed to dispel the confusion surrounding low energy housing.

The project also failed to address some key features of the user context that would have been important for the project design. These include the diversity of the user base, the desire to participate and "be in the know", and their desire to 'tailor' solutions and to customize their house.

Figure 2. Successful aspects of the communication between societal actor, users and producers in the Motivoittaja project.

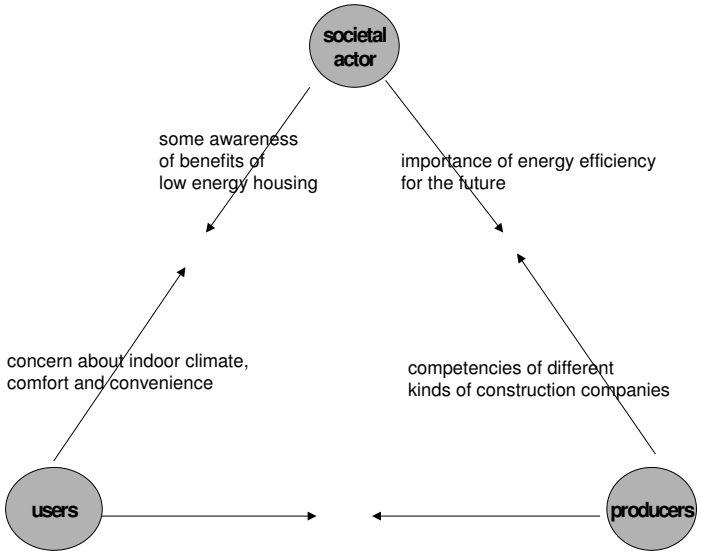
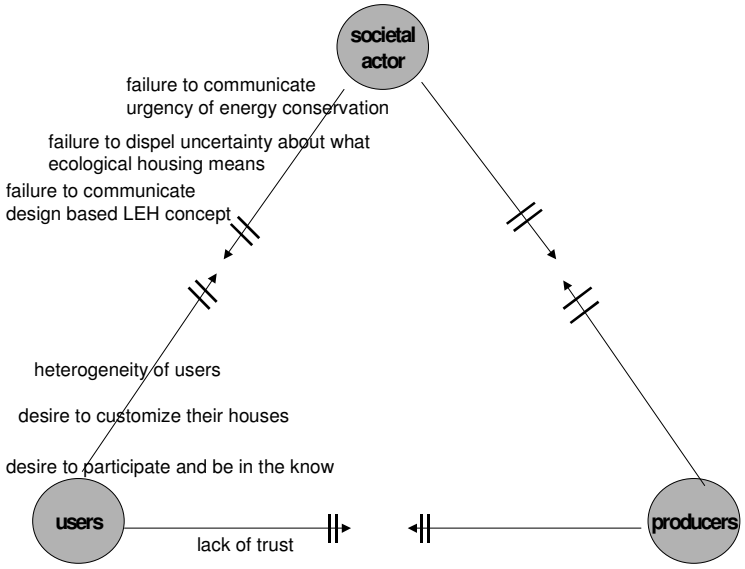


Figure 3. *Un*successful aspects of the communication between societal actor, users and producers in the Motivoittaja project.



There is also a communication issue between the users and the producers, which neither the Motivoittaja project nor the producers have managed to resolve. This is the lack of trust of homebuilders in the information provided by prefabricated housing manufacturers.

Discussion: approaches to intensifing knowledge exchange among users and experts

Next we consider whether more interaction between users, producers and societal actors might have helped to surmount some of the failures. We revisit the three categories of user involvement presented earlier, and consider the kind of contribution that they could have made to the project.

Designer participation in the user context refers to close ethnographic or interpretive research of the user context by the designers. In the Motivoittaja project, it seems that a better knowledge of the *user context* would mostly likely helped the project to address usability, utility, acceptance and user context issues to a greater extent. In fact, the designers of the project were, to some extent, aware of the diversity of the user base and the complexity of the homebuilding process. More systematic field observations might have reinforced the role of this knowledge in the design of the project. This is a problem that Akrich (1995) has identified: even when there is useful experiential knowledge or market research available, designers' user representations tend to converge around pre-defined project targets.

User participation in design refers to the direct involvement of users in the design of the development and promotion of the innovation. Such approaches (e.g., user groups, focus groups) might have revealed, in particular, the reservations that users have vis-à-vis their role in the Motivoittaja project. Issues that might have come to the surface include the lack of trust in prefabricated housing manufacturers' claims and the users' desire to customize their homes. Moreover, a closer understanding of how homebuilders understand energy use and the concept of ecological housing could have helped the project managers to find ways to communicate the urgency of energy conservation.

User innovation implies a deeper and more fundamental participation by users. Here, users actually come up with solutions that are later integrated into commercial-scale designs. User innovations are not uncommon in low energy housing; in fact, many early models were built by individual users for themselves (see also Lovell 2007). Such concepts are quite variegated, ranging from high-tech solutions with a high input by contractors to quite low-tech self-construction solutions. They are usually closely tailored to individual users needs (Daniels 2007).

The notion of user innovation is partly contradictory to the vision of the Motivoittaja project, which aimed to go beyond individual custom-tailored solutions and to move low-energy housing into the mainstream market. We agree that it is not obvious that even the best users' self-designs are readily transferable to the mainstream market. However, homebuilders accumulate a lot of useful experience during their homebuilding project, and the Internet discussion sites show that they are willing to share their knowledge and ideas with others. The Internet might also offer a solution for systematic pooling of user knowledge. For example Halme et al. (2005) suggested that the Motivoittaja project might have considered an "open design platform" rather than encouraging each manufacturer to come up with its own competition entry.

We also argue that engaging *user innovation,* along with more *user context knowledge* and *user participation* would most likely have also helped the project to communicate the rationale underlying low energy housing. There are two reasons for this: a closer contact with users helps to understand their communication needs, but can also help to access peer-to-peer communication networks, which are highly effective communication channels. Projects aiming to promote energy efficiency (or other societal goals) can benefit from the use of such existing networks by finding grass-roots promoters and "multipliers" (e.g., Brohmann et al. 2006).

Our case also highlighted the issue of *trust*. The users' lack of trust in the producers' communications was one of the problems not fully solved in the Motivoittaja case. Perhaps users would be more willing to engage in experimentation with low-energy housing if they could be directly served by a neutral,

impartial third party (i.e., an intermediary organization). Motiva is an intermediary organization, but one operating on the national level and providing general information. Local intermediaries providing tailored advice and contracting solutions might serve the homebuilders' interests.

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