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# TRANSLATING SUSTAINABLE BUILDINGS – THE USE OF NETWORKS TO IMPLEMENT PASSIVE HOUSES IN SWEDEN

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## Summary

This paper has the aim to show how and why a sustainable building concept is implemented. The case study chosen is a sustainable building concept called the Passive House (PH). The research presented in this paper was conducted in a Swedish setting and explored PHs in the state of implementation. Implementation is studied as a process, in which the concept is translated by different actors. The translation approach reveals how power structures operate in the building process, how decisions are made and thereby why certain technologies are accepted or rejected. The original concept of the PH was developed in Germany in the 1990's. When the PH concept was implemented in Sweden, the technologies were translated by different actors in order to engage other actors in fulfilling the goals of the project. For some actors the project became a tool to fulfil an overall goal of sustainability in society (this was the goal of the public funding body). To others, PHs were means to reach the dream of a dwelling in an attractive neighbourhood (the residents), or the challenge to build the densest house in the country (the builders on site). A conclusion is that it is possible to use other incentives then pure profit in the short run, when implementing a sustainable innovation like the PH.

## 1. Introduction, aim and objectives

Energy is of major importance in society, influencing many aspects of our daily lives. We depend on energy to keep us warm, heat our food, run electrical appliances, etc. At the same time, energy-related emissions constitute a major environmental load. Any major reduction of carbon dioxide emissions will require an improvement of energy efficiency measures of the building stock. The housing sector accounts for approximately 40 percent of total energy demand in Western European countries, including Sweden, and fossil fuels are used to produce heat and electricity for housing (Swedish Energy Agency 2007). Goals for a reduction of the energy use in dwellings are set both politically and within the housing sector itself.

A Passive House (PH) may reduce the energy demand for heating in dwellings by 80 percent (Feist et al 2005). Germany has been the main market for houses with passive design, where a limit of 15 kWh per square metre per year has been set for household heating. This is achieved because the dwellings are extremely air tight, have thick insulation and rely mainly on passive sources of heating, for example solar heating through window panes and heat surplus from humans and domestic appliances (Schnieders 2003). In 2001 the PH concept became seriously established in Sweden, when twenty terraced PHs were erected in Lindås Park in Göteborg. This was the result of a four year research and building process, called "Houses without Heating Systems", with the aim to develop PHs for a Nordic climate. This building project has then been followed by several building projects with a PH concept. This paper will focus on Lindås Park, and two projects following Lindås Park: Bottnevägen in Göteborg and Oxtorget in Värnamo.

The overall aim of this paper is to show how a low energy house concept, the PH, was introduced on the Swedish context. The processes behind the implementation of low energy concepts are important to explore since Sweden, among many other countries, has targets on reduced energy use to achieve in the near future. Additionally, bridges and barriers for further development and dissemination in Sweden are recognised. The research objectives are to explore how the processes were facilitated by stakeholders and investigate what resources they used to achieve an implementation. To establish PHs in the building sector it requires that actors in their network accept new ideas and technological solutions. In this paper the PH building processes is analysed by using network theories emphasising drivers behind implementation in socio-technical networks.

### 1.1 Methodology and theoretical framework

The research field of Science and Technology Studies (STS) provides theories and concepts suitable for research aimed at understanding and explaining a socio-technical system. Socio-technical systems, which buildings are, comprise professional actors, end users like the home owners or tenants, and artefacts. Translation is a theoretical concept used in the transdisciplinary field of STS which focus on the negotiations between stakeholders in the application of knowledge. The socio-technical system of PHs includes organisations, participation, building design, building material and technology for heating and hot water etc.

The analytical tools used in this paper are drawn mainly from the work of Michel Callon (1986a; 1986b; 1987; 1991). The works of Callon show how innovations are disseminated and implemented in the hands of engineers and he has developed a concept of translations within the framework of actor-network theory (ANT) (c f Latour, 1987). Translations are used by actors to engage other actors in fulfilling the goals of a certain project. This process-oriented concept reveals the dynamics of power and how people and artefacts become involved in the process. According to ANT people and artefacts are nodes in a network with different connections between them. Furthermore, Callon suggests technologies and applications are representations of different discourses or policies.

Translations are part of the creation of actor networks and it includes stages of *problematisation*, *intressement, enrolment* and *mobilisation* (Callon 1986b). By problematisation Callon acknowledged that engineers with definitie goals of implementing a new technology make themselves indispensible to the project. They define the problems and present solutions in which they are the key part. Therefore part of problematisation is the definition of *obligatory passage points* which include these solutions. In the next phase of translation *intressement*, actors are locked in their designated roles in the project, determined by the key actor. In the phase of *enrolement* the roles are connected in a network of actors and technical solutions, and in *mobilisation* these actors are trained to represent the idea of the project and the collective acts. To conclude, *translation* is the process in which new networks are formed as a result of new connections between actors and technologies. In his work, Callon discovered how engineers in France who were committed to introduce an electrical car in the 1970's worked as *engineer-sociologists* as they addressed both technical aspects of the new vehicle and social and organizational aspects of the project (Callon 1987). The theory of translations will be applied to the PH development in Sweden.

Energy-saving actions are often seen as the consequences of informed rational action on the part of individual decision-makers, which is criticised by Guy and Shove (2000). They mean it is necessary to understand the social structures and the social networks within these decisions are made. Shove highlights the social and institutional context in which decisions concerning acceptance of innovations and sustainable energy solutions are made (Shove 1999:1107). Following studies of STS-scientist such as Callon and Bijker she emphasis that decisions concerning for example implementation of energy efficiency measures and how we use energy are made in social contexts. Practitioners identify and make energy-related decisions within different networks and different contexts according to Shove: "what qualifies as a reliable, cost effective, worthwhile energy saving measure in one socio-cultural domain might count for nothing in another" (Shove, 1999:1109). Applying this perspective technology is formed and developed in networks in which actors meet and negotiate concerning various ideas and issues. The implementation of the PH concept can be expected to be wrapped up and shaped by social processes and built on knowledge, routines, institutions, methods established in networks. When technology is transferred methods and measures are seldom directly transferable, but can be picked up and "domesticated" in different spheres (Silverstone et al 1992, Lie & Sørensen 1996, Sørensen et al 2000). It is possible to identify and visualize new opportunities and new methods for different networks.

The existing networks in the building sector have been named Old Boy Network (Björklöf, 1986) and consist of earlier study and working friends. These networks are important for the spread of innovations, because they are used to solve upcoming problems and to strengthen social relations. The actors have easier to accept innovations presented by other actors in the network and usually innovations are spread by informal phone-calls within the networks. One reason for this is because of the time pressure in building projects and the result from this process is that colleagues act as "filters" that select and value innovations (Björklöf, 1986).

Case study methodology is about following a project in the real life context (Yin 1994) and has been the guiding principle for the empirical work of this research. Some researchers in methodology has emphasised the importance of finding the boundary between the project and the context in case study research (Merriam 1994), while others encourage inductively determining the scope of the research (Ragin 1992). Building processes, like the ones described in this paper, are complex projects with several organisations and different people involved in different parts of the project's timeline. This notion calls for an inductive approach which in this case has been applied using a social context inspired actor network analysis (se next chapter). The *case* can be described as *the implementation of Passive Houses in Sweden*.

In case studies so called thick descriptions are preferred (Geertz 1993). A thick description will not only include stakeholders' actions but the context as well. Firstly, to capture the network of actors involved in the project, information in documents from the building processes and from interviews with stakeholders were used. The documents were mainly collected from the Swedish council for building research, which co-funded

the Lindås Park project. For the Bottnevägen and Oxtorget projects documents were provided by the developers (the housing companies owned by the municipalities in Göteborg and Värnamo). Also documents from the municipalities in Göteborg and Värnamo, about the spatial planning processes were used to describe the context of the case. For the later stages, minutes from the construction companies and articles in newspapers provided important information about how the projects proceeded. From the documents, key stakeholders were identified and interviewed about different aspects of the building processes. The purpose of the interviews was to gain more information about the context of the projects and especially learn about how and why decisions about different parts of the projects were made. The data was originally collected for a PhD project (c f Glad 2006). In this paper, the data from these case studies has been re-analysed by applying network theories focusing on the translation of passive houses in Sweden.

## 2 Lindås Park – A Passive House initiative in Sweden

The PH development in Sweden can be divided into different periods reflecting driving forces within different groups of stakeholders. The first period can be defined as a consequence of the oil crises in the 1970's when the need for low energy housing in Sweden was acknowledged both by the Swedish government and academia. Consequently, funds for experimenting and demonstrating low energy systems in buildings were provisioned by Swedish research councils. Also, techniques for low energy designs were taught at the universities. The Gothenburg University became an informal centre for low energy systems where Sweden's first professor of building services engineering Enno Abel encouraged students to adopt a holistic approach in their future professions (Abel & Elmroth 2007). Thus, the 20 terraced houses erected in Gothenburg in 2001 were not the first attempt to introduce houses with passive energy in Sweden. In the late 1970's and early 1980's, several experimental housing projects were carried through (Swedish Building Research Council 1991). But there were only a few follow-ups and no market introduction mainly because an excess of electricity supply due to the building of several nuclear power plants in the 1980's. The architect who initiated the Lindås Park project in the 1990's, Hans Eek, had been involved in some of the experimental low energy projects earlier, both in Sweden and in Germany, and thought this concept would have potential in Sweden (Glad 2006).

To suit the Nordic climate in Sweden, the German standard had to be adjusted to suit Swedish climate (Wall 2006). This required research on some of the technologies. For this purpose, three Swedish research institutes, the Faculty of engineering in Lund, Chalmers University of Technology and Swedish National Testing and Research Institute (SP), together with Hans Eek's, the architect's office EFEM, applied for funding from a Swedish research council. Similar to what Björklöf (1986) stated, the researchers involved in implementing this radical new concept knew each other before and had previously been engaged in different environmental projects together. In 1997 the group of researchers received funding for the development and improvement of building components, the ventilation system and the design of the building.(Glad 2006) This marks the start of a second period of PH development in Sweden, which is characterised by a sustainability context rising in the 1990's. Sustainable development became high priority in Sweden and research funding for environmentally sound energy systems was available. What attracted attention from the funding body was how the PH concept promised low energy housing without adding extra costs. This was offered something new to the industry and was the main reason for governmental funding.

The same year, the municipal owned housing company Göteborgs Egnahems AB, decided to get involved in the project and take on the role of building proprietor. Major developers on the Swedish market was approached by Eek but rejected the idea. The CEO of Göteborgs Egnahems AB was interested because he expected the company could learn a great deal from this project. Göteborgs Egnahems AB involved a construction company, PEAB, and different consultants at an early stage of the project since the idea was that practitioners and researcher with a more theoretical approach would develop a joint understanding of PHs in a Nordic climate (Glad 2006). The researchers made data simulations of different window areas and scenarios with different household sizes and time spent indoors (Wall 2006). They set the standards referring to a "normal" family as consisting of two adults and two children, all of whom spent a certain amount of time at home using different appliances, and the amount of electricity a normal household in Sweden is expected to use. Other parts of the energy concept included air-heat, which had been debated in Sweden since the 1980's and was partly forbidden in 1994. In 1999 the regulations around air-heat were loosened, but it was still controversial among experts in the energy sector (Harrysson 1999). In the Lindås Park project a reheater of 900 W was installed in the air-to-air heat exchanger to provide a back-up during cold periods, a method referred to as "the reinvention of air heating" (Feist et al 2005).

Hans Eek organised the building process around seminars where the PH concept were discussed and where different parts of the energy system in buildings were presented and debated. The seminars were organised mainly by and for researchers and funded by the research council. Parallel to these seminars were planning meetings and these were organised and funded by the construction company. Similar to the case Latour describes in *Science in Action* (1987) and what Lutzenhiser (1993) found in his studies of energy simulations and modelling, the assumed users were disconnected from the planning phase. At an early stage of the project it was planned to include expertise on residential behaviour and also dedicate one of the seminars to behavioural issues. When costs had to be cut, this expertise and seminar were cancelled (Glad 2006). Results from other research show how the involvement of end-users can influence projects in

positive ways and minimising the risk of failure (Wynne 1988). Involving end-users, which would be the residents, was never an option in Lindås Park (Glad 2006).

When the model of *translation* is applied to this case, much of the content in the model can be verified. The concept, including the technologies and how the project was managed, was accepted by the participants. The architect formulated the problem and offered a solution in which he played an important part. The *problematisation* can be described as "we have a problem globally with excessive and unnecessary resource use and the construction industry in Sweden is not acting responsible and is too conservative – PHs is *the* solution" and the *obligatory passage point* being to accept this problem and its solution. A couple of years after the project finished, virtually every participant told the same story about what happened in the project (Glad 2006). The message was repeated within the group and when talking to outsiders, forming consensus about what the project was about. The exception being the construction company, which suffered a financial loss and dismissed the concept based on the financial aspect of the project. According to them, the concept did add extra costs to the project making it an expensive experience for everyone involved.

The domestication process described by Silverstone et al (1992) and Lie & Sørensen (1996) included elements of negotiation when bridges for implementing new technology are built. In the Lindås Park case several parts of the concept were negotiated during the seminars. One example is how the architect insisted of keeping the German PH standard of 15 kWh per square metre per year as a target. The figure was rejected by the construction company who demanded that the target was lowered. The researchers made new calculations and came up with a new figure of 39 kWh, but with a question mark attached to it. Still, the contractor did not accept the target and consensus about the concept were not reached during the planning phase (Glad 2006). At this point, the Swedish PH was an intangible concept described in documents from the seminars and planning meetings and an expression of the participants' ideas of the energy concept. Now, the energy concept had to be transferred to a new context, the building site. How could the concept be domesticated without being accepted by the construction company?

On the construction site, the construction company's representative and head of the project is the site manager. In Lindås Park the site manager was called Gunnar Tejlerdal and he became the missing link in the network for implementing the PHs. Eek and Tejlerdal connected and together they influenced how the rest of the project was carried out. The general ideas of the concept were accepted by the site manager and he was described as seriously dedicated to the project (Glad 2006). According to Guy and Shove (2000). when new technology is domesticated, established methods and the usual routines are challenged. Lindås Park was a project which differed from other projects and both the site manager and the hand-picked construction workers found it rewarding to work with a project which demanded more craftsmanship and meticulous work. However, in the construction process the energy concept would preferably not add any extra costs into the expensive building procedure. But the extra insulation and air-tightness demanded careful craftsmanship and more working hours for the contractor. This in turn resulted in that the construction company suffered a financial loss, and they stated in official reports that the financial aspect of the energy concept did not work. During the years of planning and building, the architect and project manager marketed the concept via mass media with the message that houses could function without a heating system, meaning little or no extra costs. The message was presented in the present tense as if the concept was already realised and worked as expected. In general, the project was presented in positive way and very little criticised (Glad 2006).

Guy and Shove stated that the "techno-economic view of energy efficiency" is predominant in our western societies (Guy and Shove 2000). According to this view decisions made by people to act energy efficiently is a result of having the right information, being aware of the benefits, the price is "right" and there are no conflicts of interests. An example of this view is the evaluation from SP Technical Research Institute of Sweden (Ruud & Lundin 2004). During two years, the energy consumption in Lindås Park was measured and the result showed the energy consumption being higher than expected, 69 kWh per square metre per year. This was explained partly by unexpected household behaviours, for example a demand for a higher indoor temperature and the use of extra heaters to keep the temperature up. According to the assessment, the residents did not have enough information and there was a conflict of interests between the desire to have a relatively high indoor temperature and save energy.

Projects like Lindås Park are sometimes referred to as "demonstration projects" and has since the 1970's been funded by governments and international bodies. However, knowledge from demonstration projects often fails to disseminate, since the knowledge available is usually "incomplete, un-reflected and not very trustworthy" (Femenías 2005:220). An explanation for this can partly be found in the fact that assessments are usually carried out by stakeholders involved in the projects who are usually biased. This was the case in the Lindås Park project since SP played an important part in developing the energy system for Lindås Park. A comprehensive analysis conducted by independent researchers shows that the operational and embodied energy for the Swedish PHs are close to half of a conventional comparable dwelling. The extra costs amounted to 20,000 Euro accourding to the Göteborgs Egnahems AB. These researchers stated that the pay-off period of 19,5 years was reasonable (Karlsson & Moshfegh 2007).

## 3 Bottnevägen low-energy houses

Conventional developments take time to plan for and build, and the PH is not an exception. On the contrary, PHs require more time for planning and building and more energy is used in this phase than normally. Energy is embodied in the material used and also in the work by builders on the construction site. In this case, the Lindås Park project was to be evaluated and the energy use was measured for two years. Other developers awaited the results from the evaluation but many showed interest in Lindås Park and during the years of measurement approximately 1500 visitors came to the site on study tours, including many developers (Glad 2006). The building proprietor of Lindås Park, Göteborgs Egnahems AB, stated they had positive experiences from Lindås Park, but still they decided not to build more PHs. Instead, they choose to change the concept and concentrate on a low-energy concept, implemented in the Bottnevägen project and without any targets for the energy demand, government funding and involvement of researchers or architect Eek. (Glad 2006) This could to be defined as the start of the third development period of PHs in Sweden constituted by the involvement of end users in the design process.

Ivory (2004) concluded that in construction projects architects are often the ones pushing innovations, and if end users are consulted they usually act rather conservative. In the Lindås Park project, architect Eek was an important driver for implementing the energy efficient innovative concept but the architects involved in the Bottnevägen project had chosen other innovative ideas as their trademark than energy efficient technology. The perception by the architects was that the PHs in Lindås Park were too dark because of the depth of the houses and they wanted to bring in more daylight into the new development. For the Bottnevägen project, the residents in Lindås Park influenced the energy concept based on the communication with Lindås Park residents, Göteborgs Egnahems AB concluded that a more flexible heating system was needed to satisfy the needs of the end users. Unlike Lindås Park, the goal for Bottnevägen was not to build a house with as low energy use as possible, but to satisfy the needs of end users. This could be achieved within the framework of a low energy concept, but not a PH concept. While the official statements from the architect and researchers were that most of the residents were satisfied and with minor improvements the PH concept could work even better (cf Eek 2002, Ruud & Lundin 2004, Isaksson 2005). But Göteborgs Egnahems AB dismissed the PH concept partly based on information collected from residents in Lindås Park and on their interpretation of the assessments. Another experience was that it is difficult to predict household behaviour and figures for heating demand could easily be miscalculated. Therefore it was decided from the start of the Bottnevägen project that the terraced and semidetached houses would have a heating system and no goals for low energy consumption were set. Some parts that were taken for granted in the former project, for example windows with extremely low-emittance glass or solar panels for hot water, were not implemented in Bottnevägen (Glad 2006). Not being part of any funding scheme or research project, a comprehensive assessment of this project is not likely to happen.

In the Bottnevägen project, the PH concept lost important parts of the network involved in the Lindås Park project. This third period of development involved end users but lost the more radical researchers and architects and thereby the original concept. The *problematisation* in this project was not about excessive energy use and the conservative construction industry but about how to get end user satisfaction within a low-energy house concept. The focus shifted from the professionals to lay people and their experience and knowledge about the PH concept in Lindås Park. This raises the question of whether the concept became more sustainable or if some important parts of sustainability were lost in the Bottnevägen project? It is possible to argue that some ecological sustainability was lost, since the Bottnevägen low energy house concept is likely to use more energy than the PH concept, but since experience from a new social group was included in the project and influenced the Bottnevägen concept, the concept became more socially sustainable.

The context in Gothenburg, the city where both the Lindås Park and Bottnevägen projects are found, is significant because of the presence of a particular urban regime called “the Spirit of Gothenburg” (Sydow 2004). In short this regime is characterized by a network of support in the city of Gothenburg including politicians, the industry, Chalmers University of Technology and University of Gothenburg. This network is enabling for innovations because it includes informal agreements about cooperation and flexibility in organising work and decision-making. The Lindås Park project was unusual development in Sweden since it was initiated by an architect (Green 2006). The way of organising the planning, design and building of Lindås Park was enabled by the urban regime since the locally based building proprietor Göteborgs Egnahems AB, owned by the Gothenburg municipality, accepted the unconventional process and an architect as project leader. In addition, researchers based in the city provided support for the project. In the Bottnevägen project the CEO of the group of companies to which Göteborgs Egnahems AB belongs put pressure to do a follow up, locking Göteborgs Egnahems AB in the leading position for the development of PHs in Sweden. All the local actors in Gothenburg were supportive of the projects and became enroled as spokespersons for the PH concept. The most prominent opponent to the concept was the construction company operating on the national level and not a part of the local urban regime. Similar to the case study on electrical vehicles as presented by Callon (1986a) the network of PH advocates failed to mobilise an important part of the industry and the question remains whether this will disable the transfer of the concept to other contexts? An analysis of the Oxtorget project might answer this question.

## 4 Oxtorget Passive Houses

In contrast to the Bottnevägen project, the municipal company Finnvedsbostäder in the town of Värnamo decided to embrace the PH concept and build four "zero-energy houses" with 40 flats. In addition, the Oxtorget project had the ambition to develop the concept and welcomed researchers and assessments (Glad 2006). In line with the theory of how technology is domesticated through networks of humans, artefacts, knowledge and institutions (Sørenson et al 2000), Finnvedsbostäder invited architect Eek and consultants involved in the former project to help with the concept plan and passive design features. As a result the network for the development and implementation of PHs in Sweden expanded.

From another perspective, the Oxtorget project can be described as an example of how environmental features can be used to negotiate with opponents to a development and building project. In 2002, the municipality in Värnamo made the decision to build dwellings on a site formerly used as a market place for cattle. After the site was abandoned by tradesmen, people from the neighbourhood used the green space as a recreation area and playground for children. When the decision to build on this site was announced, the neighbours dismissed the idea and made an appeal to the spatial planning bodies. In the same year, the managing director of Finnvedsbostäder became interested in the idea of Life Cycle Costs (LCC). Acccording to Finnvedsbostäder LCC could justify investments in more expensive technology if energy efficiency could be achieved during the technology life. Again in 2002, the Finnvedsbostäder yearly study tour went to Lindås Park to visit the PHs there. The managing director as well as the rest of the personnel and board members were all impressed by the concept. The conventional design was appealing to Finnvedsbostäder and even on this rather cold day in the autumn the houses were warm inside.

Parallel to the neighbours in Värnamo making appeals to higher courts, Finnvedsbostäder nourished the idea of LCC and PHs and came to the conclusion that the Oxtorget site would suit the concepts. When the neighbours' appeal to the Supreme Administration Court was rejected, Finnvedsbostäder announced the idea of building PHs on Oxtorget. The opponents to the development did not object to this project although it would imply buildings on their green space. In addition, the local newspaper Värnamo Nyheter decided to publish a series of articles about the Oxtorget project. An analysis of these articles showed how they served as good PR for the project and being generally positive to Oxtorget (Glad 2006). To conclude, the Oxtorget project involved new stakeholders in the PH network. Massmedia was an important stakeholder already in the Lindås Park project, but the LCC concept was new and justified the PH concept as being financially responsible.

*Problematisation* in the Oxtorget project differs from the Lindås Park and Bottnevägen projects because dissimilarities in contexts. In Värnamo, the neighbours became part of the translation process and put pressure on the development for Oxtorget and forcing the building proprietor Finnvedsbostäder to think outside the square and expand the concept agreed on for the Oxtorget precinct. The problem was not defined at the global level, but at the local level where a green area was threatened. However, the PH concept offered a solution to both problems and the greening of the development proposed for Oxtorget made the project more acceptable for the neighbours and the local community represented by the Värnamo local news paper. I would propose that the Oxtorget project is an expansion of the network set up for the Lindås Park project. Virtually every part of the concept was copied and transferred to Värnamo and no parts were dismissed. Technologies used in Lindås Park were transferred to Oxtorget and actors involved in Lindås Park were consulted and influenced the final design of the buildings.

## 5 Conclusions and discussion

Network theory and the translation model offer important knowledge about how sustainable technology can be transferred between different contexts. The main purpose of using this approach is to reveal power relationships in the PH development in Sweden. The network for PHs in Sweden expanded between 1997 and 2005 and continues to expand as more actors embrace the idea. Recently a PH centre was established in the home town of the architect who initiated the Lindås Park project. In Sweden, the main opponents to PHs have been researchers specialising on the indoor climate and major national developers. Air heating is in general controversial in Sweden because bad experience in the past and the opposition from researchers can be framed within this debate and not against PHs as a concept. Since the innovativeness and sustainability efforts of major developers in Sweden had been heavily attacked in official reports from the government, statements from these companies were not credible and little notice was taken to the objections. These companies might have power in other contexts but their influence over the passive house development in Sweden has so far been limited. The Swedish government has in different ways supported the PH concept and governmental bodies have set up programmes to promote PHs and arranged seminars about low energy housing. It is a clever move to form liaisons with groups of stakeholders who will benefit from the PH concept, like building proprietors who will own the buildings and pay the energy bills in the future. Such building proprietors are for example housing companies owned by the municipality, which accounts for 22 percent of the total housing stock and comprise, as a group, the second largest owner of houses in Sweden. As long as the end-users are ignorant about how much it is possible to save on energy costs during the life-time of a building, and about the predictions of rising energy costs, the major developers are able to build conventional and resource consuming houses. The importance of municipal owned energy companies as driving forces for innovations on the energy area is part of the urban regime in Gothenburg

and many other cities in Sweden which emphasise the importance of keeping the municipalities as actors on both the energy and housing market.

When the PH concept was implemented in Sweden, the technologies were translated by the initiating architect in order to engage other actors in fulfilling the goals of the project. Although driven by different incentives, the concept was the solution. A common denominator among several actors was the will to avoid unnecessary use of limited natural resources in housing. Many actors were representatives of public bodies, both on the national level with the research council offering financial support, and on the local level with the housing company owned by the municipality. Also researchers from universities and research institutes were funded by the research council and thereby representatives of public bodies. An overarching goal for public activities is sustainable development and all actors mentioned expressed concern about the environmental aspect of sustainability. The notion of environmental sustainability was transferred to other actors during the building process and the builders on site adopted the idea. The general idea of sustainability was translated into the work of the builders and became extraordinary craftsmanship including the goal to attain the densest building in the country. The three housing projects in this case study were located in attractive neighbourhoods adding an important value in the world of estate agents: location. This was a way for the building proprietors to hide extra costs for the PHs. Residents in Lindås Park stated they chose these houses because of their location and attractive design. The low energy concept added extra value to their dwelling but was not the primary reason for their decision to buy a PH. To conclude, the PH concept included many different parts which can be translated to meet different needs in the building sector which include other values than profit in the short run.

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