Designing a “green” building: expanding ambitions through social learning

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Published in: *Building Research & Information*, 42 (5): 591-601. 2014. DOI: http://dx.doi.org/10.1080/09613218.2014.905168. Check with the journal for a final version of the text.

Abstract

This paper analyses the making of a building called Miljøbygget, where ambitions in terms of environmental friendliness expanded, and it was also considered as green by outside observers. This process of expanding ambitions is examined to describe its main features as well as its context, primarily based on in-depth interviews with main actors in the project. The analysis departs from two theoretical concepts; translation which highlights how new knowledge is brought in through efforts to make it relevant, available and effective and social learning, the collective act of the project team of tinkering, discovery and analysis to improve the green features of the building. The paper outlines the processes through which a fairly moderate energy efficiency ambition is transformed, first into stricter energy efficiency goals, then into broader environmental aims. The resulting innovation is labelled an ambition-enhancing, experience-based, and enthusiasm-driven process of social learning in the project team, marked by interpersonal trust, including trust regarding competence and contractual relations.

Additionally, translation efforts, bringing new knowledge into the project, were important. The conclusion discusses some policy implications.

Keywords: building industry, green buildings, social learning, translation, green innovation

Introduction

This paper analyses the making of a building that was called Miljøbygget (English: The environmental building), where the ambitions in terms of environmental friendliness initially were fairly moderate but came to be expanded, and the outcome was also seen as green[1] by outsiders. This process of expanding ambitions is examined in order to describe its most important features as well as the context surrounding it. What initiated the unplanned dynamics that took place, what motivated the actors involved, and how may one make sense of such innovation processes in the building industry?

Processes of expanding ambitions are important to study because of the present concerns regarding environmental and climate issues, including sustainable use of energy. Also, the challenges of constructing green buildings are considerable (see, e.g., Rohracher, 2001; Guy & Moore 2005; Pitt, Tucker, Riley & Longden, 2009). These include motivating clients, improving technologies and methods, appropriate training, and developing incentives (Häkkinen & Belloni, 2011; Hoffman & Henn, 2008).

The context of designing green buildings is ambiguous. There is political pressure to improve environmental features, above all to reduce the energy consumption of buildings. This is reflected in stricter building codes, which mandates the implementation of energy efficiency measures. Moreover, building codes are constitutive to building design practices (Hojem & Lagesen, 2011; Imrie, 2007; Imrie & Street, 2009), and many builders as well as building industry actors see no reason to go beyond these standards (Ryghaug & Sørensen, 2009).

The latter, conserving effect of building codes is often explained by a pervasive pressure to cut costs. Architects as well as consulting engineers claim that most of their clients – but not all – are unwilling to pay extra for going beyond building codes (Ryghaug & Sørensen, 2009; Hojem & Lagesen, 2011; Tøsse, 2013). Häkkinen and Belloni (2011) argue that the situation with respect to costs is ambiguous. Fear of higher investment costs and unforeseen expenses is an important barrier to green buildings, but energy-efficient buildings may also offer major cost savings during operation. There may be additional economic benefits as well, like increased market value. Regardless, it seems that environmental concerns increasingly are taken on board by builders and the building industry (e.g., Moe,

2006; Gluch, Gustafsson, Thuvander & Baumann, 2013). This is also reflected in the growing interest in passive house standards (Müller & Berker, 2013).

There are other drivers and barriers for green building (Häkkinen & Belloni 2011; Pitt et al., 2009), like client understanding. Clients have a significant impact (Brandon & Lu, 2008; Winch, 1998), and their requirements related to sustainability may stimulate green innovations (Hojem & Lagesen, 2011). Thus, there is a space for green design even though the context is ambiguous. This paper explores one possible outcome of such a situation that provides knowledge about the challenges and opportunities with respect to the planning and doing of green innovation in the building industry.

Many factors may influence the capacity for innovation, like company culture, resources, management, learning and interaction as well as the role of external actors (Manley, 2008). For example, the project-based mode of action with its temporary work coalitions and the "tyranny of project" has been argued to be an obstacle to innovation in the building industry (Koch, 2004; Hardie, 2010; Jacobsson & Linderoth, 2010). In addition, the time frame of a construction project may be too short for explorative innovation (Hartmann, 2006).

Architects are commonly given responsibility for functional and aesthetical aspects as well as the totality of the building (e.g., Guy & Farmer, 2001; Owen & Dowey, 2008; Fischer & Guy, 2009). Thus, the architect's role has often been perceived as a conductor of the involved actors' knowledge and as a coordinator of the project as a 'whole' (Ryghaug, 2003). However, architects may lack the professional authority needed to enrol other actors into engaging with sustainable designs (Kongsli et al., 2008). When architects consider aesthetics the core of architectural practice, this may marginalise green issues (e. g., Cohen, Wilkinson, Arnold & Finn, 2005; Owen & Dovey, 2008) and call on other professions to take the lead. Occasionally, consulting engineers enter this role (Kongli et al., 2008; Hojem & Lagesen 2011). In this paper, the role of the involved professional actors and their intentions are considered important to the dynamics of expanding green ambitions (see also Hill, Lorenz, Dent & Lützkendorff, 2013).

There are also challenges with respect to which criteria to fulfil when one wants to design a green building. There are several well-established assessment frameworks (Berardi, 2012; Cole 1999; 2012; Retzlaff, 2008; 2009); BREEAM (Building Research Establishment Environmental Assessment Methodology) seems to the best known (e.g., Pitt et al. 2009) but was officially introduced in Norway as late as in October 2011.[2] Previous Norwegian studies suggest that the making of green buildings largely have been shaped by local preferences and available competence, in addition to building codes (Moe, 2006; Kongsli et al., 2008).

To summarise, the making of a green building like Miljøbygget, transcending the relevant building codes, should not be expected to be a straightforward and standardised process in terms of criteria, technological preferences, and leading actors. Rather, as already suggested, this project appeared to develop into a dynamic process with expanding green ambitions. The paper studies the actual features of this process and how it may be characterised, following Rohracher's (2001) suggestion of employing socio-technical perspectives. Such perspectives are particularly useful to identify the heterogeneous features of innovation activities and how they unfold over time.

Socio-technical perspectives: Translation theory and social learning

What kind of socio-technical perspectives may be usefully employed in the analysis of the process of designing a green building? Seeing this as an innovation activity, it could be instructive to study the role of new techno-scientific knowledge, including new objects. To what extent is the dynamic of expanded ambitions produced through the introduction into the building project of new knowledge and new technologies? An alternative could be to focus on the processes of social learning – the local discovery and enactment of potential improvements within the project team of a given sociotechnical entity like a building – taking place over time as part of the design and construction efforts. To what extent do expanded ambitions result from social learning related to local action and reflection?

The paper pursues both approaches, since they highlight different but potentially complimentary aspects. The concept of translation is used to study the processes of bringing new techno-scientific knowledge into the project. It is taken from classic actor-network theory (Callon, 1986; Latour, 1987) but somewhat modified for the purposes of the paper. To study translation means exploring how techno-scientific knowledge may be made interesting, relevant, available and applicable in the Miljøbygget green building project. Human actors as well as objects may contribute to such translation (Latour, 2005; Tryggestad & Georg, 2011), bringing outside knowledge resources into the project. The analysis of the increasing ambition dynamic will focus on two types of situations where translation could be important. First, if the project made use of research scientists supplying new knowledge. Second, if the project was influenced by the introduction of new technology or objects.

The social learning approach is grounded in the idea of social shaping of technology (Williams & Edge, 1996) but introduces a focus on local socio-technical changes emerging over time from learning by doing and using. Thus, social learning is a temporal process where given technologies or knowledge may

be changed, reconfigured or further developed from the experience of the involved actors. Learning may take place among experts involved in a particular innovation effort as well as in their interaction with users who also may contribute to the innovation (Hyysalo, 2009; Sørensen, 1996; Williams, Slack & Stewart, 2005). Consequently, this kind of social learning differs from organisational learning through communities of practice, where the main objective is to share and enhance individual competence through legitimate peripheral participation (Lave & Wenger, 1991). In the approach made use of in this paper, social learning entails collective discovery and negotiated as well as managed enactment of new practices or ideas about such practices – here, with respect to design and construction of a green building – Miljøbygget. This should be helpful in characterising the innovation process related to green design, not least since social learning may cause the expanded ambitions resulting in the green building.

Further, the paper is primarily concerned with the social learning that takes place among the main actors in the design and construction process and their ambitions with respect to energy efficiency and other environmental issues. These actors do not constitute a community of practice where they individually learn from each other or from the most experienced expert. Rather, social learning with a focus on socio-technical practices implies that the actors collectively form a learning community that does not offer legitimate peripheral participation (cf. Lave & Wenger 1991). What such a community learns is usually how to apply a given technology, often in new ways that may improve, e.g., energy efficiency. In this paper, the concept of social learning is used to analyse how the building actors collectively – possibly orchestrated by the builder, the contractor or others – develop their understanding of how to design a green building.

To summarise, the process of designing a specific building – Miljøbygget – with expanding green ambitions is analysed. In particular, the paper investigates decisions regarding goals and criteria and the role of participating actors. In doing so, the analysis draws on two concepts. First, translation theory is used to highlight the potential role of new knowledge or technology that originates outside of the project. Second, the concept of social learning is employed to help understanding the process of expanding ambitions developing goals and criteria internally in the project and how this is related to the collective discovery of new practices to improve the green qualities of the building, or ideas of such practices. An additional aim is to reflect on the effects of the context on this kind of process of designing a green building and wider implications of this, in particular with respect to green innovations in the building industry.

Method

The research reported in this paper is based mainly on in-depth interviews with key actors in the five main building industry companies involved in constructing Miljøbygget in Trondheim. The decision to study the process resulting in this building was based on its appointment as Building of the year 2009 in Norway. This award was above all due to a predicted consumption of energy that would make Miljøbygget the most energy efficient office building in the country at the time. The paper is not concerned with the technical specifications as such. In that respect the building is probably too old to be interesting. Rather, it is the particular qualities of the process of designing and constructing Miljøbygget that deserves attention. Above all, it has proved instructive to investigate the temporal dynamics of the environmentally related goals, reflected in the expanded ambitions in the project.

The following were interviewed for the study: from the builder the project director; from the architects' office the project manager; from contractor X the project manager who had the overall responsibility for the project, and the engineering manager who was in charge of the practical engineering aspects of the construction project. In addition, three engineers were interviewed from two different consulting engineering companies (CEC); one from CEC 1, engaged in the pre-project phase and two from CEC 2 who were involved in the project work. A follow-up telephone interview with the builder's project director was carried out in September 2011.

The interviewees were asked about how they and their companies became involved in the project and their role in shaping it to become green. Further, the interviews were focused on how green qualities were understood and how relevant indicators were identified in the project. In addition, the interviewees were asked to describe how and by whom green aspects were integrated in the project, from the initial tenders through contracting and in the actual building process. Thus, the interviews covered the main aspects of the design process from the translation (bringing new knowledge and technology into the project) as well as the social learning perspective, the latter emphasising activities within the project team. The interviews were conducted between October 2009 and February 2010 and lasted 60 to 90 minutes. They were taped and transcribed in verbatim, with quotes translated to English by the authors.

Retrospective interviewing raises problems regarding validity, since memory may be biased and some incidents may be forgotten. However, the interviewees provided detailed information with a high level of internal consistency, and the main facts have been checked with written sources.[3] Also, the interviews took place shortly after the building was finished. Thus, the accounts provided should be sufficiently accurate for the purpose of this paper.

The analysis has been inspired by the concept of abduction (Dubois & Gadde 2002). This means to use theory as a tool of discovery – here, the concepts of translation and social learning – while still being sensitive to new theoretical observations emerging from coding the data. This moving back and forth between theory and empirical analysis has resulted in a conclusion that partly draws on translation and social learning but with additional ways of characterising the actual process of designing Miljøbygget as a green building. Given the emphasis on temporality in social learning theory, the empirical narrative has been structured in a chronological fashion. Thus, the paper continues with the prehistory of Miljøbygget.

Developing a green design

Miljøbygget is a six floor 16400 m^2 office building that was completed in September 2009, after a two-year construction process. It began as a turnkey contract of 215 million Norwegian kroner (NOK) [approx. EUR 27 million]. In a turnkey contract the essential design emanates from, or is supplied by, the Contractor. Eventually, Miljøbygget became, with an estimated energy consumption of 83 kWh/m^2/year, the most energy efficient office building in Norway at the time of completion. In 2013, it was still considered a thoroughly green building with a focus on a range of environmental factors besides energy efficiency, like building materials, construction waste management, etc.[4]

As noted in the introduction, besides the building codes with requirements regarding energy efficiency, builders and building industry professionals have considerable discretion with regard to criteria for green design. It is known from previous studies that often, one or more environmental enthusiasts promote some green design criteria, which are decided through processes of negotiations within the project (Moe, 2006; Kongsli et al., 2008). This paper asks about the character of this process. How did the criteria for energy efficiency and other green concerns develop through expanding ambitions? What was achieved through translation, bringing in new knowledge and technology, and project-based social learning?

Initially, Miljøbygget was to be the third of five construction stages in an area in Trondheim, Norway, called Teknobyen [Technocity]. The builder's project director stated that already in the early planning stages there were ideas about developing the Teknobyen-area in a technological innovative and environmentally conscious way,

What was implied in this stated ambition, and how was the ambition dealt with?

The Norwegian context is ambiguous with respect to encouraging green buildings. Building professionals complain about clients lacking interest in superseding current building codes as well as cost restrictions (Ryghaug &

Sørensen, 2009; Hojem & Lagesen, 2011). Current policy is mostly concerned with climate issues, prioritising energy efficiency and providing some economic incentives to increase the level of energy efficiency beyond the requirements of the building codes. Thus, green design has been given some attention in Norway (Kongsli et al., 2008; Hojem & Lagesen, 2011), and Müller & Berker (2013) note an increasing interest in low energy buildings.

In this case, the builder remained interested in green issues on a general level and decided to organise an urban ecology seminar with representatives from the local government, scientists and other experts.

> We ended up discussing how the buildings should look. How should they be located? (…) [We] decided that we should use the qualities of nature and the natural environment (interview with builder's project director, 01.12.09).

The measures considered as indicators of environmental friendliness at this stage of the project included blending the building into its environment with regard to topography and infrastructure (sound and exhaust pollution from cars were among the environmental problems to be addressed) and technological solutions like natural ventilation. But, as the builder's project director pointed out, it was all "a bit raw and incomplete" and clearly less ambitious in terms of green qualities than what the Miljøbygget project came to be. However, it represented a point of departure for the ensuing process of social learning in the project team.

Early on, the builder wanted an office building, which would exceed the energy consumption requirement of TEK07 of 165kWh/m^2/year. This reflected the context with energy efficiency as a political priority. Therefore, the tender specified a maximum energy consumption of 150kWh/m^2/year. This choice was motivated by the builder's idea that to take extra measures to reduce energy consumption was the right thing to do from an environmental perspective.

In addition, they had seen indications that the market was ready for more sustainable buildings:

> The plan was to build a well-functioning commercial office building. (…) Good flexibility. Economical. Commercially attractive. Such criteria, but not specifically a building with low energy consumption, beyond existing requirements. We did have some focus on energy consumption, but not beyond what you find in other building projects (interview with builder's project director, 01.12.09).

Regardless of the focus on energy consumption, the planned office building had to attract renters, who might be more concerned with factors like a flexible layout and rental costs. At this stage, most builders would probably have chosen to abandon the goal of 150kWh/m^2/year and gone for well-known solutions to keep costs at bay. This would have limited the space for both translation and social learning.

However, the scenario of an energy efficient office building with low energy costs for renters was considered attractive, and this ambition was laid down in the tender.

In 2005 architect office A won the tender for the architectural component of designing a low energy office building; however, environmental concerns beyond those relating to energy efficiency were still not a defined part of the project:

> The tender did not put emphasis on environmental aspects (…). Still, we did include such aspects in our description of the project, like space efficiency and how we planned to design this building [with regard to green features] (interview with architect, 11.11.09).

Thus, the architect included some other qualities to be expected from a green building, thus inviting translation activities and/or social learning.

In 2006, the Norwegian energy directorate, Enova, introduced a programme called Forbildebygg [Model Buildings]. This was designed to promote passive and low-energy buildings. Enova was concerned about the lack of good case examples of such projects and saw a need to improve relevant competence in the building industry. Implicitly, this was an argument in support of both translation activities to bring in new knowledge and technology and social learning among building industry actors. The directorate also hoped that the development of innovative and cost-effective energy solutions would attract the building industry to improved energy efficient design. The program would fund up to 40 per cent of extra costs incurred to reduce a building's energy requirements beyond the prevailing regulation (TEK07).[5]

The discovery of this program confirmed the decision to build a low energy office building and to apply for financial support. The efforts to write the application resulted in a further specification of the energy efficiency criteria that were to be applied. Thus the process of social learning and increasing ambitions with respect to energy efficiency was stimulated by external policy-making. Initially the builder only articulated a rather vague goal of making an environmentally friendly and energy efficient office building. However, the Forbildebygg programme and the consequent application produced more outspoken ambitions, to which the paper now turns to inquire about the performance of translation and social learning.

Developing a green design through social learning

From the interviews, it was evident that the decision to pursue energy efficiency beyond the building codes in the design of the building was the result of social learning within the project team – the collective experience of finding new ways of

using existing technology to improve the energy efficiency of the building and thus finding it realistic to expand ambitions. The possibility of economic support initiated a process where the builder faced challenges to provide the technical specifications needed for the application. According to the builder's project director and the architect, the Forbildebygg programme's criteria for energy efficiency in buildings were not clearly defined:

> We faced some challenges with Enova and their guidelines (…). The energy calculations, should it be about net energy use or gross energy use? Or is it defined by the commercial need for energy? Bought energy? (…). So there were a lot of unclear factors (interview with builder's project director, 01.12.09).

Since the project at that stage lacked relevant competence to answer all these questions, a consulting engineering company already known to the builder was hired to work with the Forbildebygg programme application and defining the initial environmental and energy requirements of the contracts. This involved decisions about how the energy goals should be met and the relative importance of insulation, control technologies, etc.

During the process of hiring a contractor, the initial project team had several meetings discussing how the energy efficiency goal could be achieved, including interviews with potential contractors:

> Throughout the contracting period we had meetings and interviewed the potential contractors: how are you going to solve this? How will you make sure we reach the energy consumption goal? So it permeated everything (…). The builder had, in addition to the regular contracting meetings, meetings devoted only to questions regarding energy solutions and energy consumption in this building. That was unique, both to the contractor and builder (interview with consulting engineer, CEC 1, 19.11.09).

Thus, the project was organised to facilitate social learning, particularly with respect to how energy efficiency might be increased. Still, one might ask if the subsequent developments could be expected to follow the same pattern of emphasising social learning within the design and construction team, that the design process should be "a combined act of discovery and analysis, of understanding and meaning, and of tinkering and the development of routines" (Sørensen 1996:6)? Earlier in the paper, it was also suggested that the concept of translation might be employed to sensitise towards the importance of new knowledge and technology, since the use of this concept means to explore how particular pieces of techno-scientific knowledge among outside actors may be made interesting, relevant, available and applicable in the project. To what extent

did the increased ambitions result from interaction with scientific expertise and new technological objects?

After contractor X won the tender and a turnkey contract was signed at the end of 2007, social learning continued to be the main feature of the project. X had already been party to the earlier stages of the development of Teknobyen and had previously worked with the builder. However, the low level of energy use asked for by the builder was considered a challenge, since the contractor previously had not built buildings with such strict requirements:

> In the beginning, the goal was 150 kWh pr m², which was a little bit lower than the [legal] requirements of 165. And we had no idea what this entailed (…). So we couldn't enter a contract on this premise, as we didn't know if it could be achieved. (…) It was a new technical requirement that nobody had yet built to (interview with contractor's project manager, 23.10.09).

Consequently, the energy consumption measure was set as a goal and not made part of the contract since none of the parties really knew how and if the 150 kWh/m2/year criteria could be met. In this way, social learning about energy efficiency was established on the basis of a hopeful aim. However, technical features such as insulation and other building code features, that were expected to contribute to reaching the goal, were included in the contract. Reaching the goal of 150 kWh/m^2/year was another matter. In this respect, all the interviewed actors emphasised the importance of their collective social learning taking place within the building project. They talked about themselves as a community discovering opportunities and examining possibilities to implement energy efficient designs, in accordance with the temporal development expected from a process of social learning. At the same time they became inspired by this positive experience of actually discovering and learning about new possibilities regarding energy efficiency to bring other green features into the building process. The builder's project director emphasised the dynamic, expanding features of the effort: "The road was built as we went along, in the sense that we discovered new opportunities in collaboration with the contractor" (interview with builder's project director 1.12.09). This may be typical of such social learning in project teams.

How was this dynamic, expansive process possible, given the limiting role of contracts so frequently observed in building projects (Ryghaug & Sørensen, 2009)? While the contract specified certain energy system features, the interviewed actors said that throughout the project they introduced solutions initially not in the contract: "As we went along, we saw other alternative solutions" (interview with consulting engineer, CEC 1, 19.11.09). This resulted in discussions where a multitude of ideas about more energy efficient and green designs were aired. Also,

through the project meetings with the contractor, the original contract was discussed and revised with regard to cost:

> The builder has experienced this as very unique. Normally, what you deliver is exactly what you have included in the contract. However, in this process the builder has been involved and has been able to change or add designs and measures. While they had been designing this building for two years, we came into the project with a fresh pair of eyes and saw opportunities to make further savings, which again could be invested into the product. The building has been optimized (interview with contractor's project manager, 23.10.09).

This flexible situation with respect to the contract was definitely a prerequisite of benefitting so extensively from social learning.

In the first meeting called by the contractor, 15-20 people were present, including representatives from the builder, architect, suppliers and the energy directorate Enova. The purpose of the meeting – an explicit social learning event – was to find ways of reaching the goal of 150kwh/m^2/year as well as the other requirements of Enova to provide support from their Forbildebygg programme (see endnote 5). Afterwards, Contractor X's engineering manager sorted all the proposed measures, small and large, into a simple spread sheet that was sent to all participants for feedback. Then an energy consultant was hired to use a new computer calculation programme, Simien, "which made it possible to calculate the cost-benefit of every point on the list" (interview with engineering manager for contractor, 20.10.09). Simien proved to be an important tool:

> [Contractor X] had a goal for their energy account. 150 [kWh/m^2/year]. Then we had to do the calculations to prove that this goal could be achieved. So, when we had done the initial calculations we could start making adjustments. Like better windows, how would that affect the calculations? And other measures to lower the energy consumption of the building. Windproofing, what effect could that have. And so on (interview with consulting engineer, CEC 2, 01.02.10).

Such issues were discussed at regular meetings, where the consulting engineers performed new calculations related to energy consumption:

> We discovered that by going from a U-value of 1,2, which is standard, down to 0,8 we could save 50 000 kwh per year, which would be paid off within five years. The builder was like: 'Yes, let's do it!' So we worked through all the potential measures this way – cost/benefit. So the list was very important (interview with contractor's project manager, 23.10.09).

The energy directorate Enova also played an important role to encourage stricter energy efficiency measures. The builder's project director emphasized that:

> We got signals from Enova, saying 'We'd like to see you take this even further!' When we started constructing in 2007/08, they felt that 150 kWh/year wasn't as ambitious a goal as it could be and had us look at the possibility to get even lower. We took this very seriously and had another go at the energy measures list and did a new round of calculations (interview with builder's project director, 28.09.11).

Since nobody really knew what level of energy saving was possible, the project team engaged in learning by trial and error – typical of social learning with respect to technology (Sørensen 1996). This kind of social learning demands considerable trust among team members, and the accounts of the interviewees clearly suggested that a high level of confidence had been present. There was little mention of failure in the accounts, maybe because the project turned out to be successful.

On the other hand, the proposed measures were calculated by the Simien programme, which led to the inclusion of some suggestions and the rejection of others. Arguably, the programme was important in the management of potential failures since it could theoretically preclude suggestions that could be mistakes. Overall, the Simien programme proved to be an important translation actor. The use of the programme was a translation activity since Simien was a fairly new technology that made use of new scientific knowledge which was important to assess the various energy efficiency options. The contribution from Simien was considered very important by most of the project team. External research scientists were occasionally consulted but did not appear to have made very visible translation efforts. This is in accordance with Hojem's (2012) finding that consulting engineering companies have limited interaction with research communities and suggests that technologies may be the most important translation actors with respect to bringing new knowledge into the building industry.

The successes that the involved actors experienced with respect to improving energy efficiency of the building through their collective social learning led to considerable enthusiasm in the team. We were told that this enthusiasm spilled over with regard to discovering other opportunities to design the building in an even greener fashion. What were these opportunities, and how were they taken care of?

From an energy efficient to a 'green' building

As a turnkey contract, the project had a budget item for energy measures. However, after including the wished-for elements from the energy measures list, the contractor faced extra costs of about NOK 7 mill. [approx. EUR 0,9 million]. In dealing with this challenge, it was important that the enthusiasm for as well as a

moral commitment to making this building project extraordinary had grown among the involved actors:

> We had a designated budget item for energy measures, since we knew that this was something we wanted to work on and would entail extra expenditures for [the builder]. But this sum was soon exceeded (...) Still, we decided to increase our budget with those seven millions, because, as we now had said A, we were committed to saying B (interview with builder's project director, 28.09.11).

Importantly, the contractor also wanted to transcend the contract:

> We saw that we were facing large unforeseen costs for energy consulting, as we were entering uncharted territory. We agreed to look at the energy consulting costs, as they were not part of our initial calculations. And our offer, as this also represented an opportunity for us to learn and upgrade the expertise in our organization, was to cover 50 % out of our own pocket and that they [the builder] should pay 50 %. And we did that. It was a gentlemen's agreement (interview with contractor's engineering manager, 20.10.09).

Thus, the contractor also saw the situation as an opportunity to upgrade their competence in a field that seemed to be of increasing importance to future customers. Miljøbygget came to be considered an experiment or innovation activity, with potentially interesting gains for all involved parties. This recognition of the collective social learning seemed to motivate the involved actors to go further in their ambitions:

> I started thinking: Why do we only focus on energy? In the future it won't only be energy that'll be important. We have to include the environment (…). But what is it? I didn't know much about it, so (…) we ended up with an environmental audit [of the building and the building process] (interview with builder's project director, 01.12.09).

The environmental audit, a technology that was introduced following the hiring an external consulting company, proved to be another translation actor, providing suggestions of how to improve the building's green qualities. An example of this was proposals with regard to the construction site, for example to engage with recycling. With the energy efficiency measures, cost-benefit analysis was important. However, when trying to find a unified definition of 'environmental' or green, the project team encountered new challenges. As one of the consulting engineers stated:

> "There's a lot of confusion around different concepts. What's energy use, what are environmental measures, what's … something else?" (interview with consulting engineer, CEC 2, 01.02.10).

When the ambitions expanded through social learning, the understanding of what constituted a green building changed and went beyond energy efficiency.

Besides the translation efforts of the environmental audit, bringing into the project new environmental knowledge, the widened understanding and proposed solutions were often based on initiatives from the involved experts. For example, the architects developed a different design of the façade, using less glass than initially planned for. The architects also wanted the building to visibly represent sustainability by using colours and natural materials like a rock façade towards the highway, to muffle some of the traffic noise. In this manner, the architects tried to use technological elements to visualise the green achievements. The contractor also introduced new measures to meet the expanded green focus, like waste management and the use of environmentally friendly materials, in line with the translation efforts of the environmental audit technology.

The environmental audit proved to be an effective translation actor with respect to features of the building as well as the construction process. Audit requirements meant that the contractor had to meet strict environmental criteria at the construction site. For example, they had to build according to the guideline "Rent Tørt bygg" [Clean Dry construction].[6] To qualify for the environmental audit stamp of approval was demanding, but as the builder's project director said:

> "I wanted to know that we really could do this, to fulfil the ambitions and be able to call this a green building. 'Miljøbyggget' is an impressive title, which commits" (interview with builder's project director, 01.12.09).

Conclusion: the importance of social learning

This paper has studied how to make a green building with features that transcend building codes through a process of expanding ambitions based on a combination of translation – new knowledge brought into the project by being made relevant, available and effective – and social learning in the project team, the collective act of tinkering, discovery and analysis to improve the green features and being encouraged to set new, even stricter aims. With the standard type of turnkey contract, this would not have been possible. Such a contract would require that all the main aspects of a green design could be put down in a formal manner at the very start of the building process, which dramatically would have reduced the space for translation and social learning. This is not to say that green buildings cannot be made through standard contracts, since there are many available suggestions about criteria for them (Cole, 2012). However, the Norwegian energy directorate Enova's Forbildebygg programme clearly articulated a need for space for social learning, from design through construction of green buildings. Social learning but also translation activities contribute to develop adequate competence.

The experience from the case of Miljøbygget provides another lesson. The green design was realised through repeated social learning within the project team to reach energy efficiency goals and later broader environmental aims. This was supported and supplemented by the translation efforts of the computer programme Simien and the environmental audit. However, as we have shown, Miljøbygget was not only an outcome of social learning of the project team from their solving problems. Through the social learning that underpinned the emergent design of Miljøbygget the involved actors discovered that they could expand their ambitions, realise them, and then expand ambitions again. Without such licence to learn, Miljøbygget would never have become an award-winning green building.

How should we characterise this kind of social learning process? It happened in a team context, managed by the builder and the contractor, but in a congenial spirit. A high level of trust between actors was important, indicated by the way the building contract was renegotiated. This renegotiation was also a central prerequisite of the licence to learning. The importance of the policy context, where the Norwegian energy directorate Enova pushed for development of improved competence with respect to more energy efficient buildings, should be recognised as well.

A main feature of the resulting innovation process was the expanding ambitions for the project. Usually, within a project team, social learning with respect to sociotechnical change is geared either to increasing user efficiency (e.g., productivity) or finding new ways of applying an artefact (Sørensen 1996). The process of social learning in the case of Miljøbygget was, as has been argued, driven by repeated experience of achievements, which then fuelled increased levels of ambition. At first, the aims that were related to energy efficiency became increasingly stricter. Of course, this reflected an energy-focused understanding of what constitutes a green building but also a collective recognition that they were able to push the goals to higher levels of energy efficiency. Then, the achievements with respect to energy efficiency inspired the introduction of a wider set of green goals. This role of expanded ambition in a process of social learning has previously been given too little consideration.

Few traces of translation efforts from scientific communities were observed and may be a common situation in the Norwegian building industry (Hojem, 2012). There is no clear explanation why this is so, other than that there seems to be a lack of time and resources to make new scientific knowledge relevant within the kind of time frames characteristic of building projects. However, object-based translation efforts were important to supplement or support the social learning in the case of Miljøbygget. Above all, as noted, the Simien programme and the environmental audit were useful translation actors in making new knowledge relevant to the design choices as well as the actual process of construction. Also,

the availability of improved building technology elements made the resulting features of Miljøbygget possible.

The resulting process of innovation was iterative where practical achievements with respect to improved sustainability fuelled enthusiasm in the project; this in turn motivated even stricter goals towards making the building a green one, and so on. In this cycle of reinforcement, the role of enthusiasm should be highlighted as a link between practical achievements and decisions to go for stricter green criteria. Such practical achievements seem to have played a seductive role, an effect that may be underestimated in cultures embedded in waterfall project management thinking where all important decisions are made at the early stages of planning. Consequently, the innovation process in the case of Miljøbygget could be labelled an ambition-enhancing, experience-based, and enthusiasm-driven process involving social learning and to some extent translation, taking place in a context of interpersonal trust including also trust regarding competence and contractual relations.

It is an interesting policy issue how one may stimulate such processes of encouraging private actors to build green buildings. This paper has argued that the context of green design of buildings is ambiguous but also that the Norwegian government's emphasis on climate mitigation and energy efficiency is an important driver. To some extent, this is also articulated in new and stricter building codes.

However, the Forbildebygg programme of the Norwegian energy directorate Enova was launched to provide financial support to encourage building industry actors to pursue higher levels of ambition with respect to above all energy efficiency. Supposedly, this would make such actors improve their competence to reach such goals. The case of Miljøbygget strongly suggests the importance of facilitating ambitious social learning as wells as translation in order to develop relevant competence. In turn, this requires adequate economic and organisational opportunities. As previously noted with respect to changing the contract for Miljøbygget, both the builder and the contractor made positive assessments of future market opportunities related to green buildings and said such assessments motivated them to use Miljøbygget to develop better competence and new knowledge about green design.

Policy-makers may influence such positive assessments as well as creating more opportunities for the kind of social learning and related translation activities we observed with Miljøbygget. First, programmes like Forbildebygg to stimulate green efforts seem to have a good effect. Second, policy-makers may contribute by requiring that new public buildings should be green and provide space for ambition-enhancing social learning. Third, they could launch long-term plans for making building codes stricter. This will influence building industry actors to

prepare for changes they expect to come, which may encourage more social learning as well as to search for knowledge inputs (Hojem & Lagesen, 2011). Fourth, policy-makers should encourage initiatives to ease the transfer of new knowledge and technology to the building industry by facilitating translation activities.

A final issue is the importance of flexibility in building contract conditions as was observed in the case of Miljøbygget. At least, the accounts of the interviewees suggest that present standard building contract templates should be reconsidered to facilitate the social learning that probably is needed to design and construct green buildings.

Acknowledgements

The research has been funded through Research Council of Norway. We are grateful for the very useful comments from the journal's three anonymous reviewers.

Endnotes

[1] Since the paper is not an evaluation of the outcome of the construction efforts, it uses the actors' own labelling. They shifted between 'green', 'sustainable', 'environmental' and 'environmental friendliness'. However, these concepts may be given different meanings (see, e.g., Cole 1999; 2012). To avoid confusion, the label 'green' is used to designate the relevant activities and their outcome.
[2] http://www.tu.no/bygg/2011/10/17/nytt-miljomerke-lanseres-i-norge. Accessed 18.1.14
[3] http://www.arkitektur.no/miljobygget. Accessed 5.12.13
[4] http://www.arkitektur.no/miljobygget. Accessed 5.12.13
[5] The program required, in addition to energy efficiency achievements, that the projects should be suitable for profiling and demonstration as well as inspiring repetition and possibly providing ripple effects. http://naring.enova.no/forbildeprogram. Accessed 19.09.11.
[6] http://www.rif.no/nettbutikk.html?page=shop.product_details&flypage=flypage.tpl&category_id=10&product_id=40. Accessed 19.09.11

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