Framing energy standards: The role of artefacts

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Abstract

This paper investigates how building designers deal with energy requirements during planning of a renovation project. The study takes a practice approach to investigating design processes and is based on ethnographical fieldwork conducted by the author. The study suggests that energy standards, such as the low-energy class 2015 outlined in the Danish building code, do not get adopted as they are, but the standards are stretched and pulled by the stakeholders to fit interests in the project. Furthermore, the study discusses the role of artefacts in an engineer's attempt to enrol others in energy concerns.

Introduction

Existing buildings are seen by many researchers as well as practitioners as the key to reduce CO2 emissions. The existing building stock is responsible for 40 percent of the final energy consumption in Europe (Energy Efficiency Financial Institutions Group, 2015). There is great potential in reducing energy consumption in existing buildings. Up to 75 percent of the buildings today are build during a time period, where building regulations only required minimal or no energy-saving precautions (*ibid.*). In Denmark, the share of residential buildings is above 70 percent (Enerdata, 2015). The large amount of residential buildings with possible very low degree of energy-saving precautions means that there is a high potential of reducing energy consumption by renovating existing residential buildings.

December 2012 was the European Energy Efficiency Directive 2012/27/EU enforced and Member States were required to submit National Energy Efficiency Action Plans to the European Commission in 2014 (Enerdata, 2015). As preparation for the Energy Efficiency Directive introduced the Danish Energy Agency two new, optional low-energy classes in the building code (Danish Energy Agency, 2016). On 1 January 2016 became one of the energy classes, namely the low-energy class 2015, minimum requirement for new build (*ibid.*). The Danish building code require new, residential buildings to comply with an energy performance of 30 kWh per square meter per year, plus 1000 divided by the heated floor area. Additionally, the building code contains an optional building class 2020, where the total energy demand for the whole building must not exceed 20 kWh per square meter per year. When renovating residential buildings, the building code require energy improvements where it is cost-effective. When renovating a residential building, the building owner can choose to comply with the U-values and linear thermal transmittance stated in the building code, or to comply with an energy performance of 110 kWh per square meter per year, plus 3200 divided by the heated floor area (Danish Transport and Construction Agency, 2016).

This study investigates how energy requirements are accomplished on a renovation project during planning and design of the renovation works, and how various interests modifies the energy requirements. As a standard must all buildings comply with minimum requirements in the building code, but this study examines the making of the specific requirements on the renovation project. I

take on a practice-based approach supplemented by concepts from the sociology of translation to investigate the present study.

Theoretical framework

This investigation stems from an interest in *practice* and how work is 'accomplished'. Inspired by an ethnographic approach, my interest revolves around how stakeholders perform certain tasks on a renovation project. My interest especially concerns how stakeholders produce materials and objects and strategically use them to convince people about something. As point of departure, I take practices, which allow me to get descriptions of how the stakeholders produce and circulate materials relevant for the issue at hand. Here I will elaborate on the theoretical frame of this study. The study builds on a practice-based approach by adopting concepts from the sociology of translation. First I will sketch out some of the features in a practice-based approach, and afterwards, I will outline some of the concepts I use in my analytical description.

The study of practice has been developed into several approaches among research scholars over the years (Nicolini, 2012). The approaches have been labelled practice idioms, practice standpoints, and practice lenses, and all imply a sensitivity towards seeing the world routinely made and re-made in practice using tools, discourse, and human bodies (*ibid.*). By taking a practice standpoint, researchers are able to highlight the mundane work activities among professionals. Focus of such a standpoint is especially on mundane routines and conflicts, because it is in these situations that displacements and interests unfold. Practice approaches take on a processual view on organisational matters, which practice-oriented scholars study by examining various ways of ordering. The approaches contribute with a sensitivity towards the continuous routinization and re-emergence of various accomplishments that establishes and maintain work practices.

> *"The great promise of the practice lens is that of explaining social phenomena in a processual way without losing touch with the mundane nature of everyday life and the concrete and material nature of the activities with which we are all involved." (Nicolini, 2012, page 9).*

One central aspect of the current study is the role of artefacts and materials in practices. Practice-oriented approaches have always been attentive to the material dimension of practices. Knowing is seen as a social and material activity. For example, Gherardi and Nicolini (2000) suggest that organisational knowledge is relational and mediated by artefacts. Seen from a practice perspective, knowledge cannot be separated from the artefacts. The only way knowledge can be shared with others is if the knowledge is performed through a set of practical methods involving inscriptions in objects, human bodies and discourse, which only can be partially articulated (Nicolini, 2012). When it comes to objects, materials and technology, Nicolini argues, then they need to be studied 'in practice' and with reference to the practices in which they are involved. Even if practices are performed in isolation, without any contact to other humans than the one performing the practice, then the mediation of materials, objects and technologies still situate the practice historically and make it a social phenomenon. The social is then mediated by the objects and materials.

Taking a step further into the mediating role of objects and performativity of materials, the sociology of translation (ST) is proposing another type of sensibility in the study of practices. The sensibility proposed by ST scholars is to notice the messy practices of relationality and materiality of the world (Law, 2009). Material entities are not just part of our practices, but also change our practices when humans are confronted with the material entities, also called nonhumans (Latour, 1988). Nonhumans are delegated characters that play a certain role that can imply a certain political interest. From an ST perspective, nonhumans are not just tools for human action, but nonhumans imply certain political interests and can possibly discriminate certain actions from humans, as well as from animals and other actors. Additionally, by adopting an ST lens, knowledge always takes material form. Law (1992) give some examples on how knowledge constitute material entities, such as talk, conference presentations, papers, preprints or patents. Material arrangements are therefore important aspects of knowledge production as well as work practices.

The underlying assumption with regards to material entities is that materials are not passive components of our work practices, but some materials are being used actively to convince others about the importance of certain concerns. Callon (1986) describes this process as translation and sketch out four moments of translation, where actors undergo various persuasion mechanisms. If the persuasion is successful, an actor is able to mobilise other actors in his or her project. Translation is a key concept in ST and involves the definition of actors by the circulation of intermediaries among those actors involved (Callon, 1991). Intermediaries play a vital part in the definition of actors, because actors are defined from what they do or what they put into circulation.

> *"Actors define one another by means of the intermediaries which they put into circulation." (Callon, 1991, page 140).*

An intermediary is something or someone which/who transports meaning or force without transformation (Latour, 2005). Intermediaries do not do anything. Their input is their output. Mediators, on the other hand, transform, translate, distort, and modify the meaning or the elements they are supposed to carry (*ibid.*). Mediators are defined by what they do – because they do something. Most of the time, mediators are the interesting entities to observe, because they shift and displace actors, ascribe roles to others or allure others to act in certain ways.

Another aspect of the present study is the agreements made on the renovation project among the stakeholders and what the stakeholders expect from each other. To explore this aspect, I draw on Callon's (1998) notion of framing, which he borrows from economic theory and extends to sociology as well. Framing is the process in which stakeholders agree on a frame within which their interactions will take place and which courses of action that are open to them. For a period of time, the stakeholders are interconnected by expectations set in the frame to how the role of each participant is expected to be. But sometimes the agreement fails, leaving the frame impossible to achieve or the frame is deliberately transgressed by the actors, leading to overflows (*ibid.*). Overflows leave the frame permeable to the world outside. Callon argue that the constructivist sociology view of overflow is that they are omnipresent and that framing is rare and expensive to establish. The notions of framing and overflow will be elaborated in the case.

Case description

This article is based on an on-going ethnographic study investigating what happens when energy requirements 'come into' design and planning of energy renovation projects. The empirical basis of the study is fieldwork conducted by the author in the course of six months, beginning in September 2015. The author followed architects and engineers in planning and designing renovation of four apartments blocks located in a suburb to Copenhagen, Denmark. The client, a social (non-profit) housing association, emphasizes that the project in question is an 'energy renovation project', because the aim is to lower the buildings' energy consumption more than required in the existing building code. In going beyond compliance, the client in this way deems the project to be ambitious project energy-wise. The buildings being renovated are all rented out by the housing association. Within housing associations of this kind involving the residents in the design and planning of the project is mandatory. So the client has gathered a steering group of residents to follow the project from initiation until they move into the new apartments.

The design team consist of employees from an architectural office and an engineering office. The architectural office won the renovation project through a competition in 2013. After the competition, the engineering company became subcontractor to the architectural company in delivering the renovation works. The overall distribution of responsibility between the two companies is that the architects focus on conceptualising the project in the early design phases, while the engineers are to focus on the phases detailing the project and the tendering process. As a consequence, the architects' influence is strongest during the disposition phase in which the project proposal is further developed, whereas the engineers focus on detailing the building installations in the main project phase. During my fieldwork, the project went from being in the project proposal phase, to approval of the municipality, and further to the main project phase. The engineering company provides different engineering services and expertise within ventilation, pluming, construction, electricity, fire regulations, acoustics, as well as energy and indoor environment. Additionally, the engineering company had in 2013 bought up an architectural company so that they could also deliver architectural services. As a result of all the competences gathered in the engineering company, the company hosts the design meetings in the renovation project, because it is easy, when needed, for the design team to fetch people with the necessary technical and architectural competences for the meetings.

The renovation project involves planning renovation works for four apartment buildings. Additionally, the client has chosen to extend one of the building block in the length with an extra staircase, plus extending every housing block in the height by an extra storey. This means that the project both involves renovation works and new build. The project has to comply with both requirements in the building code for new build and renovation, which makes the project complicated. As a way to go around this complication, the design team chose to make sure that the design specifications they follow both comply with requirements for new build and renovation. Initially, the client wanted the building to comply with passive house standard, but this was later on deemed by client consultants (other than the current design team) to be expensive. So instead, the client asked for compliance with low-energy class 2015.

The fieldwork was carried out as non-participant observations during a selected number of design meetings and through semi-structure interviews with key persons, identified by the author. The purpose of the observations was to register how design choices were made and to see if and how energy requirements influence changes in design. Four meetings were observed, all design team meetings, meaning that both architects and engineers were present. The meetings took place in August and September 2015, as well as in February 2016. By being present at these meetings allow me to register the interactions among stakeholders as well as their material objects. For the purpose of the study, an interview with the engineer responsible for energy-related issues in the renovation project was paramount. A second interview has been conducted with a representative of the client to get an insight into the client's motivation for raising the bar with regards to the targets for the renovated buildings' energy performance. The choice of making the renovation ambitious was, however, not made by the client alone, but was made together with the municipality and a steering group consisting of residents. The interviews lasted approximately one and a half hours, while the design meetings sometimes took up whole days. The meetings were recorded by taking notes, which were re-written after the meetings to keep details from the situations and add bodily gestures and other impressions from the meetings. The interviews were audio-recorded, and the parts pertaining to energy-related issues were afterwards transcribed.

Analysis

The analysis is presented in three parts. Firstly, I will investigate how the design team members frame energy requirements, and how their practices lead to various overflows. Secondly, I will look into how the engineer with responsibility for energy concerns on the project try to convince the other team members in following the energy specifications, he set out. Thirdly, I will elaborate on how various project concerns are interwoven and influence each other.

Framing and overflows

In the renovation project, the building owner and the building consultants have agreed to lower the energy consumption of the existing building corresponding to the low-energy class 2015. In the present part of the analysis, I look at how the stakeholders are framing their mutual agreement about reaching low-energy class 2015. First, I will elaborate on the framing of the compliance with the energy requirements on the project, and afterwards, I will elaborate on some overflows that have happened within this framing.

Callon (1998) talks about 'bracketing' when actors perform framing. Bracketing means that the actors close out the outside world and agree upon certain terms in which their interaction should be led. Simultaneously, the outside world is not totally cut off, because the outside world still has some bearing on the agreements. In the case of the renovation project, the connection to the outside world is for example the energy requirements in the building regulations. As the quote underneath indicates, the renovation project is required by law to comply with certain U-values, as well as airtightness and integration of ventilation system with heat recovery. But in the project, the participants agree on complying with low-energy class 2015 and a bit more, which indicates a 'bracket' compared to the requirements, they otherwise should comply.

> *"Building code 2015 has some requirements for new build, but also has some requirements for renovation. And requirements for renovation are all about U-values." (Interview with engineer, February 2016).*

The requirements have over the course of the project changed: First to low-energy class 2015, then to energy class 2020, and then a hybrid between the two classes. The shifting between energy classes was due to estimates of the costs tied to achieving them. First, 2015 was deemed by the client to be sufficient, but then they saw a possibility to achieve 2020 on the whole building. After negotiating with the design team, the energy specification landed on a hybrid between 2015 and 2020. During his investigation of the energy requirements on the project, the energy specialist from the design team brought the notion of passive house back into the project. The passive house standard was initially the wish of the client in early project stages, but was turned down because it was deemed to expensive. The fact that the engineer brought the passive house standard in again has, in his opinion, pleased the building owner. The two documents, or actors, the building regulations and the passive house standard are two links to the outside world, which for a while set some of the conditions for the framing.

A part of the framing was the mutual agreement of having an energy specialist in both camps: One sitting by the building owner and another sitting by the design team. Each energy specialist was chosen internally by the building owner's organisation and the design team's organisation respectively. The role expected by them was to address every energy-related concerns in the renovation project. The design team for example, waited the design team members for the energy specialist to enter the project team, before investigating the energy-related concerns in depth.

> *"We could easily end up making a Be10[1] [calculation], regardless of its limitations. Because that is what the Danish Building Research Institute says is alright. And if they say that it is alright, then our back is covered. Then we have done what can be expected of us and what can be required from us." (Interview with engineer, February 2016).*

The design team members want to make sure that they comply with the building regulations on energy matters, but also that it is possible to achieve low-energy class 2015 or higher. The other design team members had similar expectations of energy specifications based on their previous experiences on similar renovation projects. Another example of how previous experiences play a part in the framing of energy requirements is how to estimate the number of days with high indoor temperatures in the apartments. Even though, there is legitimate calculation methods to 'prove' how many days the occupants will feel high degree of heat in their apartments exist, the energy specialists are 'allowed' to base their assessment on assumptions and previous experiences.

[1] Be10 is a software programme for calculations of energy demands in buildings. The software is developed by the Danish Building Research Institute and the Danish building code refer to the software when specifying how to document compliance with the energy requirements (Danish Transport and Construction Agency, 2016).

"Fundamentally, we estimate ourselves from our experience with other similar buildings; where will we get problems with high temperatures?" (Interview with engineer, February 2016).

The framing of interaction is sustained by some kind of physical framework, for example the building, stage and curtain in the framing of a theatrical play (Callon, 1998). In the case of the renovation project, the physical framing of energy-related concerns is visible in the detail drawings. During planning of detail drawings, the project participants make space for energy-related concerns. They know that they should make room for a thick layer of insulation and a massive tin box of a ventilation system, because they are parts of the means to reach low-energy class 2015. Therefore, the physical framework of the energy-related concerns is also, to some extent made visible in the work of the design team.

In the above section, I have outlined some of the artefacts - calculations and drawings - that it seems that the project participants have framed their interaction in regards to energy-related concerns. In the next section, I will elaborate on some of the overflows from the framing that the project participants have experienced.

One of the aspects in the clients' framing is the handover of responsibility for energy-related concerns to energy specialists by the other project participants. But the energy specialists were only involved in the project very late. Leading to 'bad' decisions, seen from their point of view.

"According to me, somebody should, when they first came up with this fantastic idea for the statics, that they then had sat down and analysed, 'okay, what do we do then? What is it that can be done?'" (Interview with engineer, February 2016).

The late involvement of energy specialists has, in their understanding, a negative effect on ensuing design decisions. The decision, for instance, to have concrete columns in the architectural expression of the façade has a great impact on the 'energy efficiency' for the façade as a whole.

Another issue creating an overflow is the shifting of energy targets required from the building owner. During the course of the project, the energy targets have changed from passive house to low-energy class 2015. Even though this appears well-defined – with 30 kWh per square meter per year – this requirement can be interpreted in many ways.

"There has not really been any clear passage on what the energy requirements have been on the project. They [the client and residents] have referred to the building regulations for 2015 for example. And as you can see, I have quoted them for writing 'roughly' or 'on par with' 2015 without specifying anything fully definite what it is about." (Interview with engineer, February 2016).

This lack of accurate energy targets has contributed to a confusion among the design team members how to comply with the requirement set out by the building owner. During framing, members often establish rules within their interaction have to follow and what is expected of them (Callon, 1998). In this case, the rules are vaguely co-produced together with building owner and design team and therefore lead to confusion on the renovation project.

> *"Framing cannot be achieved by contractual incentives alone, because it is bound up with the equipment, objects and specialists involved in the interaction." (Callon, 1998, page 255)*

As the quote above indicate, framing is not only established by means of contractual arrangements, but is being hold together by the actors and their interests involved.

Mobilisation of design team members

The engineer with responsibility for energy and indoor environment noticed when he entered the design team that the definition of energy requirements on the renovation project was not as clear as he had expected. From his point of view, if the design team wanted to make sure that they comply with the energy requirements set out by the client, then the team had to develop some more concrete requirements. Instead of talking about complying 'roughly' with low-energy class 2015, then they in the engineer's view needed some more exact figures to work with.

> *"There have been various intentions during the project. The purpose of this note was actually to hold on to – okay, what is it that we do?" (Interview with engineer, February 2016).*

The engineer not only produced a note, but he also convinced the other members in the design team, as well as the client, municipality and residents, that his suggestion was the way forward. He circulated the note among the relevant stakeholders for their approval and in this way shifted the stakeholders' framing of the energy requirements. The note was acting as an immutable mobile (Latour, 1987). Their framing went from references to low-energy classes 2015 and 2020 to concrete figures indicating U-values of building components, airtightness and degree of heat recovery from the ventilation system. In the quote underneath, the engineer explains how the other design team members reacted on the note, he had written.

> *"They said, 'then, let us present it for the client and for the municipality.' And then we presented it [the note on energy requirements] for the client, and afterwards for the municipality. 'Well, you should just be aware that we want to be ambitious with regards to energy targets.' When I presented the note for the construction engineer, he said, 'it cannot be made. We cannot make a façade with 0,15 in U-value on this project.' So I had to knock that one down as well. And then we take it [the discussions] continually." (Interview with engineer, February 2016).*

The engineer not only circulate his description of the concrete energy requirements, but also explanations of how to achieve for example the U-values, he has concretised. In the quote above is the construction engineer not fully convinced, but the energy engineer confident to convince him at some point. The note in this example is produced with a view to shift the framing of the design team members and mobilise them in the interests of the energy engineer.

Interwoven design concerns

The thing that receives most attention from the design team during design meetings is the detail drawings. A detail drawing is a junction of various design concerns gathered in one drawing. The procedure for talking about any detail, be it how ducts are passing through a wall or how static forces from the roof is running through the exterior wall and down to the foundation, is to go through the conditions for the detail at hand. Every designer, who wants to move the other participants' attention to some issue, begin to draw up the conditions surrounding the issue. If we take the ducts passing a wall, mentioned above: First the architect, for example, draws the wall and note that it is a concrete wall. Then the next solid condition, a concrete structure for flooring, which rests on the concrete wall. In this way, the static and structural conditions are highlighted. Possibly, the architect draws a line in another colour around the wall and flooring structure just to indicate the interrelatedness between them. The architect then draws the suspended ceiling and indicates the space for ventilation ducts going on top of the ceiling, but underneath the flooring structure. This way of presenting design issues to the other design team members is a common one on the renovation project studied here.

The procedure on presenting design issues is an example of how architects, and engineers for that matter, zoom in on an issue and in the next moment zoom out to consider the whole building. This movement is studied by Yaneva (2005) in architectural practices. An issue is never an isolated entity. Opening up one issue often lead to a myriad of associations to other issues and concerns. In the quote below, an engineer is telling about how an issue concerning penetration of the insulation material in the exterior walls can, from his point of view, lead to low U-value for the whole wall. As the quote indicates, dealing with insulation material in the exterior walls is not only an energy-related concern. Statics, architectural visions and constructional details also play a part in the issue.

> *"There have to be some columns and which should give a certain [architectural] expression in the façade. It is not all of the columns that are needed constructively speaking, but they must be kept in place anyway, and there must be some foundations and stuff like that. The balconies have to suspend from the facades. Which means that the forces must be partly led into the house. In the existing walls. That is, there have to be some mountings, which go through the insulation. It should be designed so there will be as little as possible heat loss through them. It would be something like sitting with the construction engineers and sketch on it. Telling them that stainless steel is better for the penetrations than ordinary steel, because they channel the heat worse." (Interview with engineer, February 2016).*

The procedure for presenting and discussing design issues among the design team members shows how various concerns on the renovation project are interconnected.

Discussion

This study examines architectural and engineering practice during planning of a renovation project, and role of artefacts in setting energy specifications on the project. But how can we understand the role of artefacts in architectural and engineering practices? For starters, we have seen that the energy specifications presented in the Danish building code is prone to interpretative flexibility (Pinch & Bijker, 1984). Design team members frame the requirements differently and the targets for final energy demand in the building have shifted during the course of the project. Artefacts play an important part in the shifting and displacement of energy targets, but how can we understand their role? On basis of the current study, the artefacts take on various roles as either intermediary or mediator. For example, the Be10 calculation, which was only briefly mentioned above, play out as an intermediary in the establishment of energy specifications. The building code refer to the calculation method, but the interviewed engineer express that it is has its 'limitations'. In this way, he disregards the software as being able to help them define the energy specifications on the project. The calculation could be used for showing that the project complies with requirements in the building code, but it does not seem to shift the engineer's view of the energy targets on the project.

Other artefacts play another part. They shift and distort the framing of the design team. Two examples are the detail drawings and the note produced by the engineer. These two artefacts transform, to some degree, the design team's idea of the energy targets. During planning of the renovation project, detail drawings play a vital part for the design team members, because the drawings gather various project concerns and relate them to each other. When the design team members are discussing a detail, insulation thicknesses or performance of ventilation systems are brought forward. Either they refer to the engineer and his speciality, or they discuss how it could be constructed. The detail drawings change the design team members' attitude towards energy concern, but also other project-related concerns. Another important artefact in this story is the note that the engineer produced. The note specifies the energy targets that the design team wants to achieve. The note shifts the design team members' approach to the energy requirements set out by the client. The note makes the requirements more concrete and the design team members can easier relate to them. After mobilising the others in accepting the note as the way forward on the project, the design team, and the client for that matter, all can turn to the note if any confusion about energy targets arise. The note has become a spokesperson (Latour, 1987) or obligatory passage point (Callon, 1986) for the energy concerns on the project.

These findings indicate that energy standards are not just adopted on the renovation project, but artefacts as well as people transform them as they incorporate them into their project. Like many other project-related concerns, the energy concerns have to be modified to the current project conditions. So how can we understand the role of artefacts in establishing and continuously transforming energy targets on renovation projects? Which constellations or webs of people, artefacts, competences, contractual arrangements, building codes, and much more constitute these energy demands?

Concluding remarks

This study suggests that artefacts play an important role when building designers frame energy requirements during planning of renovation projects. As mediators, artefacts shift building designers' framing of energy targets and establish connections between energy-related concerns and other project-related concerns. If we want to understand how energy demands in renovation projects are established and transformed during the course of the projects, then we have to be attentive to how artefacts and people interact. This study recommends further research in the area of design practices and the role of artefacts within the construction industry.

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