Abstract

The goal of this thesis is to provide the reader with a satisfactory insight into why we need to study use in energy effective buildings. The building stock is a large energy consumer and is characterized by rigid traditions, lack of innovation, short sighted economical calculations and lacking ambition in public regulations. The fact of the matter is that buildings need to become more energy effective and green if important environmental challenges are to be met. Earlier research into energy efficient buildings show that it isn't enough to only provide technological solution since the occupants may resent the guidelines of use these new technical components presents. In light of this understanding this thesis will explore the theoretical framework presented by science and technology studies (STS) in an attempt to construct insight into how a co-production of user and technology will result in energy effectiveness. Through qualitative interviews conducted at the renovated energy plus house Powerhouse Kjørbo, the thesis analyses users and usage in order to determine whether or not the building is successfully domesticated. This process has been divided into four categories which contains unique circumstances that reveal the domestication process. With such a thorough method of progress the thesis proceeds to the final chapter where a summarized discussion reveals the benefits of this research and the perspective of viewing technology in relation to use. Hopefully, the understandings presented in this thesis can help to provide insight into important considerations when shaping, building and reconstructing a new and more sustainable building stock.

Acknowledgement

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1.0 Introduction

Buildings are an integrated part of our daily lives and they shape our experiences in many aspects of society. A prestigious office or a well kept home is crucial to its occupant`s well being, it supports their daily activities, and it may be a source of personal pride. A building can represent anything from faith, political agendas or functionality. Inger Andresen et al in their publication "*Smarte energieffektive bygninger"* tells us that there are approximately 3.7 million buildings in Norway (Andresen, 2007: 9). Given a total population of 5 million inhabitants, this illustrates that buildings are not only influential but also an integrated part and pose a formidable presence in our social contexts. 1.1 million buildings out of the total of 3.7 are commercial buildings and the Norwegian construction sector had in 2006 a revenue of 230 billion Norwegian kroners or 30 billion USD[1] and had at least 140.000 employees (Andresen, 2007: 9). In their heavy materiality, buildings differ from many daily influences in that they are extremely stable and enduring. Buildings are made of a large number of heterogeneous elements, some of which have a large mass, and embody a lot of energy that has gone into producing them. Moreover, they require large amounts of energy in their daily operation and maintenance, when they are refurbished and even demolitions are often large, resource demanding undertakings (Andresen, 2007: 10). Buildings are supposed to last: their structural integrity and their ability to protect the occupants from adverse climatic influences, be it very cold or very hot, be it storm, snow, ice or heavy rain, protection is their main and most basic function. But how stable are they really, and with such a large societal role and resource demand, how exactly does the building stock influence the environmental challenges which are insisting an increasingly amount attention? At present this is something that is still a relatively new challenge. Another important point that contributes to the challenges surrounding buildings is the fact that though many new buildings are being constructed, buildings tend to have long lifespans, which means that any changes introduced now in the ways buildings are constructed will only slowly trickle through the building stock with buildings built long ago dominating the image for many decades. This underlines the urgent need for going beyond the construction of new buildings looking into the refurbishment of existing buildings when turning the construction sector in a more sustainable direction.

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[1] Currency value is not representative for 2006. Exchange value represent 01.05.2015, so number may vary. (https://www.google.no/webhp?sourceid=chrome-instant&ion=1&espv=2&es_th=1&ie=UTF-8#q=230%20nok%20in%20usd&es_th=1)

1.1 Environmental challenges of the building stock

The European Commission has concluded that if global warming is to be contained, developed countries will have to cut 80 to 95% of their greenhouse gas (GHG) emissions by 2050 (Gansmo, 2013: 1). Approximately 40% of the energy consumption in developed nations is the result of use and attributes of the built environment (Gansmo, 2013: 1). In Norway, the building sector is responsible for as high as 50% of national energy end use (Bye, 2008: 14). This is why there is a broad consensus that it is important to explore ways to reduce emissions and find new and improved ways of managing existing buildings and the constructions of new ones. A study found that in France 90% of the buildings in 2020 and 60% in 2050 are already built with similar numbers in the UK. This illustrates that there is a need for innovation not just when it comes to new buildings but also in renovating the existing building stock (Gansmo, 2013: 2). We have indications that energy use of non-residential buildings has been steadily rising even though there are multiple possibilities to ensure buildings' energy efficiency. This trend has been attributed to more energy related to comfort, larger areal per person and the increase of technical installations (Bye, 2008: 14). This steady rise in energy consumption is even more surprising since office buildings should have more professional procurement and management which provides the right circumstances for the necessary economic and technological investments as long as they pay out. Why is the energy demand of buildings rising despite cost efficient and mature technical alternatives? To answer such a question it is important to understand what influences the motivation and perspectives of the building industry.

1.2 Escalation of consumption

Office buildings in Norway that were built before 1931 have only one third of the energy consumption of the buildings produced after 1997, this is in spite of more regulations and an increasing public awareness on energy consumption (Andresen, 2007: 7). The Norwegian building and construction sector has over the last 30 years increased its energy consumption more than any other sector (Andresen, 2007: 9-10). Bye (2008: 14) argues that there have been drastic changes in the allocation of resources in construction and/or modifications of buildings where the builder and constructional entrepreneurs have strengthened their relative positions. He states that the focus on production, construction and investment have come to dominate on the expense of function, total maintenance cost and, environmental

factors. (Bye, 2008: 14-15). Knut H. Sørensen and Marianne Ryghaug (2009: 10-11) describe the increase in consumption and the lack of energy efficiency as *meta consumption*. They argue complementary to Bye that energy efficiency is not realised because of (1) that there is shortage of demand for energy efficiency. New buildings are often the result of shortsighted and trivial economical arguments connected to the construction phase and lacks an extensive view of the building as a whole both in terms of economy and eco friendliness. (2) Passive public regulations with apparent preferences towards information and economic incentives at the expense of direct involvement and more strictly constituted regulations. Sørensen og Ryghaug emphasizes this because of the dominant position the state holds as construction developer and owner. (3) The last influence of inefficiency is attributed to the conservative culture within the construction sector. Sørensen and Ryghaug point to multiple factors demonstrating this practice such as expired economical calculations, design of contracts, preferences towards cheap solutions, a low level of innovative activity and the architect's dominating esthetic preferences (Andresen, 2007: 11). These challenges indicate an urgent need for more research on how to design, construct, install, use, maintain and reshape the concept of buildings as a whole if to tackle the environmental challenges that the building stock clearly poses.

1.3 Research question

> *" Buildings don't use energy, people do"[2]*

Today's situation with an increasing awareness and need for more energy, efficient buildings and measures to improve the existing building stock have resulted in ambitious projects from different sectors and relevant interest organizations. Innovative and environmentally friendly solutions are in demand, this provides opportunity and a need for a restructuring of existing practices associated with all aspects of buildings. This need to examine and reevaluate the many aspects connected to buildings such as design, construction, chosen materials, technological solutions, use and management have prompted the exigency for collaboration and interdisciplinarity. Such a constellation of expertise can be found in the initiative of the *Powerhouse* alliance. The Powerhouse alliance is comprised by many of the leading Norwegians actors in their respective fields. Their goal is to establish energy plus houses that can both support the ambitious environmental

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[2] Janda, Kathryn B. 2011 - *Buildings don't use energy: people do*

goals set by energy plus house standards and at the same time maintain competitiveness in a commercial setting.[3]

Such a project have the ambition to establish a paradigm change in many different aspects, such as how we build and consume energy but also how users of these new buildings learns, interacts and imposes meaning and symbolism in their social environment. This is paramount if these new forms of buildings are to receive the necessary societal momentum to halt the environmental impact of the building stock. This means that if the goal of establishing a new era of buildings is to succeed, builders cannot only occupy themselves with technological solutions, they need to be aware of how users will react to all aspects of this ambitious undertaking.

So how do user activities relate to a building's energy effectiveness? In previous investigations researchers have problematized the existing parameters for measuring energy efficiency. They argued that energy efficiency usually have been restricted to measuring tools such as KWh per square meter. This is however insufficient since it does not take into account user needs, user valuing or even the building's adaptability. The article "*Managing Smart in Smart Grid*" exemplifies this with how to measure the optimal energy usage in a hotel. Is it possible to reflect efficient energy use in a hotel that host a variety of different use into such a constricted understanding? The British scheme for assessment of the life cycle greenhouse gas emissions of goods and services, construes a measurement based on the function and usage by defining a "standard room". But, it is important that one remember and take into account that a hotel offers services beyond that of only what Rønning et al (2013) describes as a traditional overnight stay. By this understanding one must assess all aspects of hotel management and the different activities within a building if one is to understand the energy usage. And only through comparing buildings that have a relatively same operative use can one receive insight in how to successfully determine whether or not a building is energy efficient. (Rønning et al, 2013: 47-49)

Figure 1 shows the energy consumption at 39 different office buildings. The blue line shows the energy use of each employee in the hours the buildings are in use. The green bars shows kWh/m^2 .

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[3] http://www.powerhouse.no/om/ (18:33 24.05.2015)
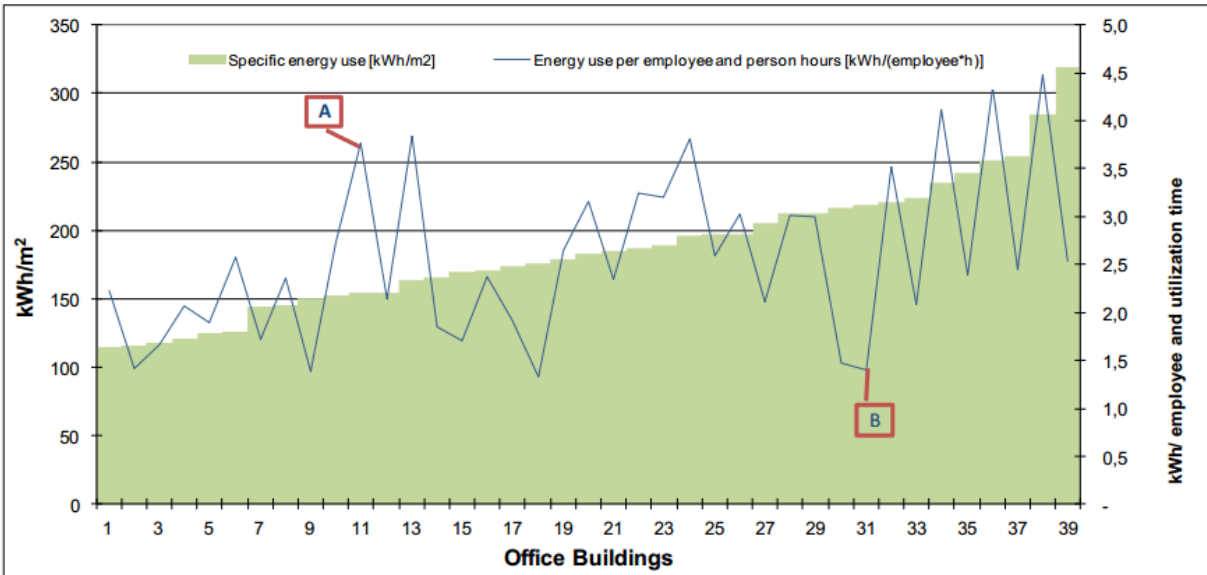
What Rønning et al discovered was that even though building A has a lower kWh/m^2 output than building B, it was far less energy effective when studying the actual usage. This means that a building even though it is designed for energy efficiency could still lose a large amount of effectiveness by not being well adapted to its users and their activities. (Rønning et al, 2013: 47-49)

The realization that effectiveness is not only a product of the chosen technologies and the way they are implemented, but that it also is strongly associated with the synergy between the user and technology and how use is unfolded has led to this thesis` research question:

  - *How can an understanding of the user and usage in relation to technology benefit the goal of an ambitious investment into energy effective buildings?*

To answer such a question and to reveal actual conditions, the *study of science and technology studies* (STS) can provide valuable discernment of how to view the intricate relationship between the human actor and their activities and technologies. There are many nuances that need to be examined and definitions that are to be made apparent for such a task to prove productive. Therefore, it is important to show the different angles of which this scholarly tradition could prove beneficial. The insight provided by STS can help to reveal whether or not energy efficient innovations in the building sector are consistent with the user's ability to learn, interact and accept their new milieu. The research in this thesis is based on the

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[4] http://ostfoldforskning.no/uploads/dokumenter/publikasjoner/708.pdf

investments already started through the Powerhouse project and their focus on energy plus houses as their chosen technological solution as it would provide a more stable and manageable framework to undertake such an exploration into the subject.

A study of domestication of use derived from an STS perspective can also provide meaningful insight in the user relations to the paradigm change that is energy plus houses. And further elaborate how this inquiry will provide applicable knowledge to unite technological constellations and user perspectives in such a way that they provide societal momentum and successful domestication. The thesis still requires a tactile example from the Powerhouse collaboration to which a study could take place. So this analysis will apply the theory of domestication of technology to explore how the technological artefacts implemented in the energy plus house of the renovated Kjørbo project is accepted or not accepted by its users. The STS-perspective will provide insight in such fashion that it is possible to avoid linear or deterministic perspectives (Aune, 2007: 3). It is important to note that while there are many different technological aspects and solutions to Kjørbo this thesis will treat the project as whole within the framework of domestication. This study's approach to gathering data will be qualitative interviews with users that also reside in Kjørbo, but also some of those that have been involved in the planning, building and or operating of the building after completion.

- *Is the renovated plus-energy office building of Kjørbo as a technological artefact domesticated?*

With this inquiry in mind, I will try to examine how the different technological components of the Kjørbo building is accepted practically, symbolically and cognitively to a complete a domestication process. Challenges will be the multi-function nature of Kjørbo as a technological object. Kjørbo also presents itself also as a composition of different solutions and approaches. And it is still a project in its commissioning or enrollment phase. Kjørbo also presents a rather unique position regarding its users. The users at Kjørbo are interesting because many of them are *expert users*. What this means is that they hold disciplinary authority in aspects significant to buildings. Some of these expert users were also heavily involved with the design and the ongoing enrollment phase. So how does this fact impact the user viewpoint on the chosen solutions and operativeness?

1.4 Structure and the way onwards

In this thesis I will first provide an account of my theoretical understanding of buildings and the user. Then I will present how the theory of domestication offers insights into how use relies on the social aspect of technologies in order to fully benefit from their potential. The thesis will then go on to provide a description of the methodology used here and the strengths and weaknesses of the data gathered. Then, based on this theoretical and methodological framework the thesis will present findings from the interviews. In the conclusion the main results are presented and used to provide applicable societal insight.

2.0 Theoretical approach

The theoretical approach in this thesis will mainly draw on the domestication theory of how use of how new technologies becomes integrated into our daily routine. In addition complementary views on innovation from actor network theory will be provided. This chapter will also provide insight into the understanding of buildings as technological artefacts and user perspectives related to buildings and their properties. It should also serve as framework of understanding from which a domestication process can be better understood. This should provide the necessary backdrop for an in depth understanding of the conditions present at Kjørbo.

2.1 Buildings in a theoretical understanding

Buildings are not static components removed from the passage of time, the context of their existence, the designers' idea of the intended users or their activities or indeed the actual users and their constant negotiations with the building. Robert Bye explains the nature of a building in duality between the design with regards to intended use and the actual use changing and evolving through a building's life cycle. In this understanding a building is never complete but exists in a continuous interaction between its users and their activities. Bye points out that the word *building* is both a verb and a substantive and therefore captures well the insight of how to view a building (Bye 2008: 12).

Stewart Brand (1994) in his book "How buildings learn" elaborates that buildings goes through large changes in their lifetimes. These changes can be manifested through rebuilding, renovating, annexes being added or other user adaptations. Brand claims that the flexibility of a building is determined in the design phase (Brand, 1994). The design phase can be seen as predictions of the building's use and users. But as Bye elaborates these predictions are problematic as expected use and actual use are seldom aligned. This is a result of the changing nature of a building. Bye argues that the design phase can be seen as planners installing properties from their own experience and expertise or through the needs expressed from those intended to use the building. This view of design invites the view of technological determinism on the given properties installed and that the users will passively adapt to the chosen solutions (Bye, 2008: 12-13). Bye argues that buildings with a focus on energy efficiency, technological components tend to be more and more run through automatisation. This means that user influence is

diminishing and the control over settings such as temperature, lighting and ventilation is increasingly in the hands of maintenance. Following Brand's view on buildings and users as able to learn, Bye suggests it is more suitable to say that buildings and users hold certain skills rather than static properties (Bye, 2008: 12-13).

This focus on process gives way for a more active user role. Seen from this perspective, the building is never truly complete. Instead the building-user relation is a process of learning where different skill sets develop, and where changes in the relationship between designers, users and buildings occur (Bye, 2008). Buildings are therefore objects that are being constantly interpreted, which makes them a subject for narrative understanding and representations. (Gieryn, 2002). Bye argues that designing a building and its use is a process of interaction between human actors and the given materials, where the building continuously is being constructed and deconstructed both materially and semiotically, and where the passage of time influence both (Bye, 2008). By this logic and argument, changes in the sociocultural and the materialistic conditions will influence the understanding of what a building encompasses, but also how the building can best serve the users that resides within. This process is described by Bye as a learning process where designers, builders, end users and the building itself develop certain skillsets. Bye therefore defines a building as a hybrid collective, this means that a building can be seen as a socio-technical ensemble where it is comprised by a varied composition of actors or actants (Bye, 2008).

2.2 Users and usage in a building context

In order to understand the user we need to be aware of the many differences and nuances that the term encompasses. So, what is a user? Rohracher elaborates that the user term appears to be heterogeneous and will display a large diversity when it is contextualized. He exemplifies this with the relation between as specific technical installments e.g., a ventilation system and how first the installer is a kind of user within the instalment phase and when complete the user changes to the resident user and/or the maintenance user (Rohracher, 2003). This illustrates the fact that depending on context a technology can have many different types of users. But even with this form of categorization it does not provide a complete outlook of the users. Rohracher explains that even within the residential user group there might exist important differences and he emphasizes the imperative of not blindly generalising the users as a homogeneous social group. The user group may

well include a variety of e.g. different perspectives, social background, ideas, wants and needs (Rohracher, 2003). Also in this thesis there is a need to distinguish between different kinds of users in relation to the Kjørbo building. They are categorised into the *expert-user* which is a user with relevant expertise, the *user* whose expertise is not directly involved with the project, *maintenance users* are referred to as merely maintenance, and two more types which can be defined as *designers* and *installers/constructors*. This will be elaborated further where relevant. Kjørbo is unique in many respects, but as will be shown later, also when it comes to what encompasses the different categories.

Bye draws on *actor-network theory* (ANT) and explains that both users and buildings can be seen as a co-production of diverse and complex relations between humans, information and technology. Buildings are in Bye's perspective filled with ingredients that are from a different time, place and by many different people. He draws on Bruno Latour when he explains that any phenomenon may be seen as an event where actions are skewed, articulated and translated. Applied to buildings this is also the case with attempts to stabilize the building as a hybrid collective (Bye, 2008). To generalize this argument, it presents the user in a wider context where his or hers actions and views become a form of translation between the human actors and the objects.

In order to support successful hybridization Bye argues for the importance of user involvement from an early stage. As argued above buildings are the result of many different components that are producing relations between the objects and users (Bye, 2008). The building is part of the users' own narrative through which it is constructed and reconstructed. This narrative is influenced by interacting with the building, between users and the surrounding context (Bye, 2008). The point is here that the user is being presented through their own narrative, which is important to the success of a building. This is why a successful building is presented as a stable hybrid collective by its users (Bye, 2008).

Previous research from the social sciences into users, buildings and energy consumptions have showed that improved technical solutions to improve energy efficiency have been relatively successful, but that these improvements depend on factors such as cultural acceptance of the technology, processes of learning, appropriation of technology and domestication (Bye, 2008). This is why Bye concludes that in order to change energy consumption it is not sufficient to only implement technological solutions or just focus on user behaviour. This is because a user's primary goal is what Bye calls *comfort steering*. To be able to control comfort is in this context the end users perspective of a satisfactory work

environment (Bye, 2008). When technological solutions primary aim is controlling the energy output it is easy to understand why it can come into conflict with the users comfort steering, particularly if it is not properly optimized and domesticated. Another challenge regarding the users comfort steering is that there is no clear definition of what every user finds suitable for their needs. In a building some user might find the temperature to be too high while others find it to be too low. Bye argues that this always will leave some of the users unsatisfied when the control of the environment is left to centralized steering (Bye, 2008). This is one of the most important challenges to tackle if one wishes to apply automatic control of the technological systems that are being studied in this thesis.

In the chapter "Analysis" this thesis will describe what measures have been taken at Kjørbo to ensure user satisfaction and how they have dealt with the challenges tied to comfort steering and at the same time attempted to maintain their ambitious environmental goals. Buildings are as technological artefacts able to steer users and at the same time users are able to steer buildings. This illustrates the fact that in order to be efficient, buildings and users needs to be compatible. And in order to achieve this compatibility when the understanding of buildings and users relationship is in flux, requires a great deal of flexibility. The flexibility of Kjørbo will then also provide valuable information towards its success as being a sustainable and energy effective building.

2.3 Domestication of technology

Technologies are becoming more and more integrated in our daily lives through the continuous exposure and engagement with technological objects, not the least in buildings that increasingly resemble 'walk-through machines' (Gieryn, 2002). Sørensen claims technologies influence us physically, mentally, emotionally and morally. This does not mean that we accept all technologies, and many are still subject to controversies. Sørensen exemplifies this with how many hours you should let your kids watch TV or whether you should drive or use public transportation. The controversies surrounding technologies are a stark reminder that they are in development and that their meaning and usage are not constant, and therefore subject to change (Sørensen 2005: 40). This is also why some see technology as an imposed force, though as exemplified, this is not necessarily the case. It is important to be aware of powerful social motivators that influence use or non-use of certain technologies. Sørensen argues that non-use is an example of the actor`s choice, but that non-use also might take a lot of effort as some technologies

are so integrated into social life that it might be seen to be at a discord with "normal behaviour". According to Wyatt (2003) non-use is primarily the cause of the user not finding the technology advantageous, interesting and/or they active try to work against it. On this basis Sørensen demonstrates that technologies or sets of technologies in a social context can both be challenged as well as enforced. How technology is enacted by human agents in everyday life is both complex and ambiguous according to Sørensen (Sørensen, 2005: 41).

It is in this exploration of usage that the concept of *domestication of technology* is applicable. *Domestication* as a theory argues that people through use build their own practices, cultures and ways of handling technology. The use is studied not only from individual to individual, but also in relation and the interrelations between individuals and groups. Sørensen also argues that most technologies create social institutions that display their own infrastructure, regulations, collective repertoires and repositories that project a certain form of action and meaning from its users. This is why it is imperative that when we study and analyse the enactment of technology, as it is a multi-sited and multi-actor approach (Sørensen, 2005: 40).

Domestication of technology as a theory has in a large degree drawn upon inspiration from two primary sources. The first one being *actor-network theory*. ANT originated as an attempt to produce what Sørensen describes as a semiotic approach to the study of technology. One of the significant inspirations that ANT produced was a concept that presented the idea that designers incorporated their vision of the user in technological artefacts. In this way the designers tried to define actors through their concept of the world into artefacts. This phenomena is called a *script*, scripts are how technical objects produce boundaries of action together with actors and space of which they are supposed to confine their activities (Sørensen, 2005: 45). The script can in this way be seen to be the framework of existence and function for both technical and social aspects imagined by the designer. However, ANT also says that the user may challenge scripts. The user is often trying to mold, override, create and/or remove inscriptions. In this regard the designer is making *programs* to ensure that user is following their script while the users are producing *anti-programs* in an attempt to circumvent (Sørensen, 2005: 45). Sørensen argues that a domestication perspective may add a more concrete approach to what he describes as a rather abstract ANT vocabulary (Sørensen, 2005: 48). ICT or *information and communication technologies* in media studies is the second big theoretical influence. Silverstone created a theoretical approach to the understanding of the use of technology by defining and analysing four dimensions of a household's enactment of technology. The

dimensions Silverstone and his colleagues elaborated were appropriation, objectification, incorporation and conversion. They concluded their study with the finding that moral economy influenced the economic circulation of ICT artefacts in such a way that it was paralleled by a system of meaning that included transactional properties (Sørensen, 2005: 45).

Domestication were named thus because it was seen as a process where a technological artefact went from something unknown and wild to a more controlled, known and stable state. Sørensen elaborates that in the process of domestication, it is not only the enactment that are subject to change, also people and their socio-technical relations may alter. Sørensen therefore conclude that domestication is more than merely a socialization of technological artefacts. In its entirety domestication is a co-production of both the social and the technical (Sørensen, 2005: 46). There are three main features which decide whether or not a technology is successfully domesticated. The first element is the *practical;* this refers to the routines and practices that emerge through use. The second is the *symbolic*; Sørensen describes it as the construction of meaning. It is worth noting that the symbolic aspect may be a construction of meaning to an artefact, but it can also be a construction of meaning of the user and/or the relationship between the user and the technology in relation. The third element of domestication is *learning* or the cognitive; this refers to how a user learns to know the technology both symbolically and practical (Sørensen, 2005: 47). It is important to note that these features of domestication happen within the four dimensions inspired by Silverstone and the domestication of ICT.

Berker (2011) applies the dimensions *acquisition*, *objectification*, *incorporation* and *conversion* to the domestication of buildings. The dimensions are overlapping. Acquisition explains the action of taking control of the building and this process is made up by juridical and economic factors. Berker also stresses the importance of change and expectations of change in users and meanings in context of the act of acquisition itself (Berker, 2011: 260).

Buildings may contribute to defining new relations between object and user. Different qualities of the buildings may be acknowledged while others are ignored or not understood. Therefore when the context of the building changes the building changes as well and becomes *objectified.* Berker exemplifies this by the importance of the physical placement of a TV in the home and how the use differs if the TV is placed in the living room compared to the bedroom. This also illustrates that there are multiple routes to a domestication process (Berker, 2011: 260-261).

The third dimension *incorporation,* shows us how a building's physical structure and installations when incorporated into our daily lives, may change, create or remove routines. How well existing and new routines coexist or cooperate are indicators of the success of domestication and potentially the script of the artefact. Embedding new routines is a conscious decision and requires motivation; therefore Berker comments that objects that oppose existing routines or have no effect often results in non-use or bad performance (Berker, 261).

The last dimension of the domestication of technology is *conversion*. This is when the user has accepted the building as his or her "own" building. Something that used to be new and strange has transformed to become something familiar and dependable (Berker 2011: 261). Berker concludes that if this semiotic approach is observed, domestication describes how the negotiations in the different dimensions between scripts and anti-programs play out practically, symbolically and cognitively. Through empirical observations and an analytic approach to the use of technologies in day to day basis he explains that domestication adds a normative dimension that claims, if a building and the user have mutually accepted each other in the aspects of practicality, symbolism and the cognitive the technology is domesticated. All three aspects have to be accepted for the domestication to be complete. (Berker, 2011: 261)

A simplistic summary of domestication can then be explained as the process from the wild to the tame. And the prerequisites for this process are the user's acceptance of the object practically, symbolically and cognitively. The process is then familiarised through the four dimensions elaborated as the acquisition, objectification, incorporation and conversion. If the prerequisites is then met during the four dimensions or phases the domestication is complete.

2.4 Domestication with focus on Kjørbo

How well does the domestication theory fit Kjørbo? Is it suitable to deal with such a complex artefact that consists of countless technologies? Traditionally domestication has been used to deal with more concrete and often household or personal technologies. STS in general has also according to Harald Rohracher in his article *"The role of users in the social shaping of environmental technologies"* been predominantly focused on the design phase of technologies and actors, institutions or what he calls general socio-technical systems. These needs to be viewed in synergy to in how they shape, stabilizes and socially embed innovations.

(Rohracher, 2003) In such a context this thesis' investigation of user and usage of Kjørbo there will be a larger emphasis on the diffusion stage than the design phase.

When studying Kjørbo as a technological artefact there are some things we need to aware of in a domestication perspective. Among the most notable things are the fact that it contains multiple solutions to different problems and that it was designed by many of the same people that now have become its users. So if the assumption from ANT is that the designers encompasses their world view into the script of the technology and that the designers is also the users it might be harder to detect potential challenges or resistance. The same technologies might generate different levels of use or non-use based on the competence and or opinions of others.

2.5 Housing and organizational cultures

Støa and Aune describe housing culture as a multidimensional phenomenon that can be analysed from many different perspectives, such as technical, social, architectural and socio-economical. Housing cultures is best understood when it is interpreted in relation between the physical, socio-economical, ideas and values. Together such a combination of different understandings provides insight into the housing culture as a socio-technical network. In addition the concept of *coproduction* provided by Sheila Jasanoff combines the allegedly objective areas of nature, technology and policy with the more subjectively areas such as culture, values emotion and politics. (Støa & Aune, 2012) Støa and Aune argue that the perspective of housing cultures is well suited to provide a supplementary viewpoint to the domestication process and that it could be viewed as a co-production of the built environment, social organisation, local practices and everyday life. Housing culture is something that varies from time, geography and society and therefore needs to be empirically presented either in general characteristics or from a case to case basis. (Støa & Aune, 2012)

In the context of this thesis a non-residential building is the main case. The specific Norwegian housing culture as described in relation to domestic energy use by Aune (2007) will most likely spill over to the users' expectations for comfort at their workplace. To have it 'good and warm' ('godt og varmt') is at the same time an expression about energy consumption and a definition of what makes a good home. For non-residential buildings, in addition to these spillovers from domestic settings, organizational cultures are a factor relevant for the building's use. It will

therefore be important to view how the coproduction of organisational culture at Kjørbo presents itself during the empirical analysis and how it could further promote the insight into the domestication perspective.

3.0 Methodology

This chapter aims to provide an overview of the methods used in order to gather relevant data. It will first provide a relatively short introductory to the qualitative method and how this thesis relies on its framework. Secondly it will argue why I have chosen interviews as format of gathering data and what qualities that they are expected to contain. The chapter will end with an anecdote of the actual process of preparing and completing the interview. This should provide a satisfactory review of the data collection and in what framework those data are understood.

3.1 Qualitative method

Qualitative method has generally been connected to research that involves a close contact between researcher and the ones that are being studied, often in observation through participation or/and interviews. Tove Thagaard explains that qualitative methods are still in development and that the principals of the method are based on explicit definition of procedure. Thagaard emphasizes the actions of procedure during the gathering of data and an analytic structure from which an interpretation of results emerges (Thagaard, 2010: 11). Interviews are according to Thagaard important base to receive knowledge of how individuals experience and interpret their situation. She also points out that qualitative methods are well suited to handle personal and sensitive subjects (Thagaard, 2010: 12). This is important to this thesis in the regard that the domestication process is revealed both through both collective and individual experiences. Thagaard argues that interviews are a good method to provide insight in interview objects experiences, points of view and self-understanding. Qualitative methods emerge from gaining insight into the phenomena that we study and the interpretation of data is paramount. This is why qualitative methods are connected to interpretation theories like phenomenology, hermeneutics and symbolic interactionism (Thagaard 2010: 12, 14).

There are challenges with the qualitative method that are important to highlight as they play an important factor and are crucial for understanding data, analysis and conclusion. Thagaard emphasis the problematization of the concept of *data* in qualitative research. Since data is gathered in e.g., an interview in relation between researcher and interview object the data is not something that exist as Thagaard puts it "out there", removed from the researcher's understanding of the reality that is being studied. Thagaard argues that to a degree the data is being constructed by

the researcher during his or her research (Thagaard, 2010: 30). This is an important point to problematize and be aware of, and demonstrates the condition of the data that is used in this thesis. But at the same time this means that the data that is gathered provides a form of flexibility during its accumulation. In other words Thagaard explains that the researcher is able to steer the data gathering process towards the topics that reveals themselves as the most relevant. This differs from the more linear models of quantitative methods were the gathering of data is usually completed before the analysis begins (Thagaard, 2010: 30-31).

3.2 Interviews

Thagaard explains that the purpose of choosing interviews as foundation for data is primarily to get extensive and elaborate information. Interviews are also well suited to gain insight in a person's experiences, feelings and thoughts. According to Thagaard there are different views on what exact data an interview actually reveals. She elaborates that in the *positivistic tradition* the interview object through their description of experiences, information, knowledge and opinions, which reflects past experiences, represents the basis of data. The researcher is in this regard viewed as a neutral or as neutral as possible recipient of that data. The second perspective *constructivism* stands in stark contrast to the positivistic view. The constructivist view emphasizes the meaning of social interaction between researcher and interview object and how both together constructs knowledge and insight through the process of the interview (Thagaard, 2010: 87). This thesis aims to draw on both traditions as this might encompass a broader understanding of how the data is gathered and analysed.

There are many ways to structure an interview and the structure will dictate what data you could expect to find and what usage it can provide. Thagaard divides the structure into three main categories. The first one being the *loosely structured interview* which only encompasses main topics and allows for digressions and for the interview object to bring up their own subjects. The second being the *relatively structured interview* that focuses more heavily on an interview guide, this perspective has the advantage of comparisons between interviews. The last and the most used according to Thagaard is the *partly structured interview*. In this format the themes of questions are already mainly been established before the interview, but the order of the questions is loose and adaptable to the situation. This format also establishes to opportunity for the researcher to be flexible to each interview-object's qualifications or prerequisites. Thagaard argues that it is also important

that the interviewer establishes the opportunity for the interview-object to present their own topics if relevant (Thagaard, 2010: 88-89). During the interviews conducted in this thesis the partly structured interview is the most closely associated with our procedure.

3.3 Gathering of data and interview process

In this study after a month of preparation through desk study in which I collected the publicly accessible information about the case building I began gathering data through the format of qualitative interviews. The interviews were conducted together with William Throndsen, who was commissioned by the Norwegian Research Centre on Zero Emission Buildings (ZEB) to evaluate the building. As we were aware that interview informants were diverse in terms of involvement and types of knowledge we were forced to approach the interview guide in a nonlinear fashion. We constructed an interview-guide that contained important categories to ensure a necessary framework of questions.

William Throndsen and I discussed and constructed a basic interview plan with a focus on the building as an experience from different user, maintenance and designer perspective. We tried to include both universal and more technical perspectives in an attempt to encompass as many different views as we could without steering the interview too much to our preconceived impressions. We had from the very start a goal of letting the interview objects dictate the topic as much a possible and still be within the theoretical framework of domestication. Since domestication is such an individual and complex process it was important to let the interview objects explain their own view of the building without to much guidance. This way we were able to uncover different viewpoints on many of the same subjects. We conducted seven interviews with eight different interview objects. They covered everything from strategy, management, design phase from both a user and technical perspective, maintenance, technical experts and project and user evaluation. These different insights were necessary to establish a fundamental framework from which a domestication perspective could be analysed. The interviews varied from between 40 minutes to an hour in length, and all included both general talking points emphasized by us the interviewers and specialized topics elaborated by the interview objects. This rather loose structure revealed itself as informative since all interview objects had interest in the building and different views were highlighted as result.

The transcribing process provided valuable insight and overview of the data material. From this process and the starting point provided by the interview guide four main topics of investigation emerged. These themes were chosen because they establish different angles of perspectives from which to view the domestication process at Kjørbo.

4.0 Energy-plus-house, Kjørbo and the Powerhouse alliance

It is important that this thesis explains the different surrounding components for the analysis so that the reader can better understand the context of what is being discussed. In that regard this chapter aims to introduce to most imposing aspects such as a short account of what the Powerhouse alliance is, of who it is comprised and their goal. It will also briefly present this thesis' base of understanding related to what an energy plus house is. Last it will try to provide the reader with a short introduction into the different technical aspects of Kjørbo and BREEAM as a one of the focus areas of the project.

4.1 The Powerhouse alliance

The Powerhouse alliance began at the Zero conference in 2010 when the company Hydro and partners at the environmental organization Zero asked for interested parties to build an energy-plus-house. (Kvartalet+)[5] This received great interest and after a few months the Powerhouse alliance were established. Today this multi-sector collaboration is comprised of seven integrated parties with a large width of expertise and represents many of the leading companies in their respectable fields in Norway. These seven comprises of Entra, Skanska, Snøhetta, Asplan Viak, Hydro/SAPA and Zero. Entra is the owner of the Kjørbopark and have been initiator to establishing Kjørbo as an energy-plus-house. Entra describes themselves as one of Norway's leading real estate companies with focus on developing and managing energy efficient buildings.[6] Skanska was founded in 1887 and is one of the world's leading company's in project development and construction groups and at Kjørbo they served as the project's total entrepreneur[7] (Kvartalet+). Snøhetta is an international architecture firm established in the late 1980's with offices in Oslo, Norway and New York, USA. Their role in the Powerhouse projects is to communicate an understanding for environment, sustainability and sociocultural aspects as part of their strategy and an emphasis on mapping a projects opportunities in the design phase.[8] Asplan Viak is a Norwegian

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[5] Kvartalet+ is a news magazine published by Asplan Viak - (http://kvartalet.asplanviak.no/utgivelser/1-2014-rehabilitering/

[6] http://entra.no/about (18:33 24.05.2015)

[7] http://group.skanska.com/about-us/skanska-in-brief/ (18:33 24.05.2015)

[8] http://www.powerhouse.no/partnere/snohetta/ (18:32 24.05.2015)

consulting firm that emphasizes the need for a holistic approach to their projects.[9] Hydro and SAPA are aluminium companies that have been key in delivering and creating aluminium based solutions to Kjørbo.[10] The last fully integrated partner in the Powerhouse alliance is the environmental organization Zero. One of their prime ideals is to focus their work for the solutions they support and not for the ones they don't. [11]

4.2 Ambition and the concept of energy-plus-house

"Powerhouse Kjørbo is, to our knowledge, the first refurbished office building in the world that will be energy positive considering the lifespan of the building."[12]

The specific ambition in the Kjørbo project as Camilla Moneta, architect and project leader from Snøhetta tells it in the magazine Kvartalet+, was to create the first building in Norway which produced more energy than it used, and at the same time try to gain the highest form of classification in sustainable building the BREEAM-NOR Outstanding. The two building blocks that were renovated into the Kjørbo Powerhouse project were to have one tenant but still contain the flexibility of future changes. At the same time the building should be a modern, comfortable and relatively cost effective. (Kvartalet+)

An Energy-plus-house as defined by the Powerhouse alliance is a building that produces more renewable energy than energy consumption over a 60-year horizon of the building's life cycle. Into the equation is the operation of the house, production of building materials, transportation and judicial transfer of the building. (Kvartalet+) An energy plus house should also solve two challenges at once, it should provide clean renewable energy and at the same time operate as energy efficient as possible to maximize it's potential. The principal idea behind the energy-plus houses should is to make the building stock a part of the solution, and by that logic solving multiple problems at once[13].

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[9] http://www.powerhouse.no/partnere/asplan-viak/ (18:32 24.05.2015)

[10] http://www.powerhouse.no/partnere/ (18:32 24.05.2015)

[11] http://www.powerhouse.no/partnere/zero/ (18:32 24.05.2015)

[12] http://ipaper.ipapercms.dk/AsplanViak/Powerhouse/Powerhousebrosjyreengelsk/ (18:35 24.05.2015)

[13] http://www.powerhouse.no/plusshus/ (18:32 24.05.2015)

4.3 Kjørbo's technology and BREEAM

"BREEAM addresses wide-ranging environmental and sustainability issues and enables developers, designers and building managers to demonstrate the environmental credentials of their buildings to clients, planners and other initial parties"[14]

BREEAM claims to be the world's foremost environmental assessment method and rating system for buildings. BREEAM have had more than two million registered buildings for assessment since it was launched in 1990. BREEAM declares that they set the standard for most satisfying practice in sustainable building design, construction and operation. BREEAM have become one of the most recognized and applied method of measuring a building's environmental performance. BREEAM argues that their method of assessment uses recognized measures of performance that are constructed up against established benchmarks to assess a building's specification, design, construction and use. (Breeam.org)

The technological components at Kjørbo will be in this segment be described short and presented from a designers perspective to provide the reader with an introductory impression of how they are comprised and their ambition. The discussion of how these components work in relation to the user and usage will be further elaborated and discussed in the following chapter.

Kjørbo as referred to in this thesis will only deal with the part of the complex that is renovated within the Powerhouse project even though it is connected to a larger construction. The new facade of the building is constructed with a 30cm isolation layer, the windows has a low U-value which is determined to 0.8W/m2. The roof has a thickness of 40 cm and the leakage is calculated to be less than 25%. This indicates that Kjørbo has a thick roof and robust walls. In addition Kjørbo have a large solar panel system on its roof to provide energy and ten energy wells. Kjørbo manages its ventilation based on demand. This enables a larger degree of control. Kjørbo is also installed with automated lighting control. Exposed concrete was chosen because of the thermal capacity, but it also poses challenges for the acoustic performance of Kjørbo. This meant that Kjørbo couldn't use the most optimized methods of acoustic technological solutions, but instead had to rely on more creative options like baffles in roof and textile floors to name a few (Kvartalet+).

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[14] http://www.breeam.org/about.jsp?id=66 (10:25 24.03.2015)

5.0 Analysis

5.1 Introduction to data and source material

In this analysis of the interviews conducted at Kjørbo I have divided the material into four categories that will serve as framework for the presentation. The four categories will be structured is such a way that they will try to reveal whether or not Kjørbo as a technological artefact is domesticated by its users. *Working technical aspects* is the first category in this empirical review. Here I'll look into which technical systems that work, why they work and for whom they do work. The second category is *challenging technical systems* and here I will explore the different issues and obstacles which such an ambitious building experiences. By the very nature of trying something new and by many regarded as extreme there are bound to be opposing priorities. How Kjørbo as a project has managed to handle this challenge will to a large degree confirm its status as either a success or a failure in regard to a domestication perspective. The third perspective of the analysis is the *social aspect*. This perspective will try to illuminate how social norms, -institutions and -infrastructure affects how different users view technologies and the effect of those technologies. It will also attempt to show how these influences accumulate to a form of *user-contract* that has both positive and problematic consequences for Kjørbo as a technological artefact. The last aspect to be included in this analysis is the *societal framework,* which aims to illuminate structures that affects how users view Kjørbo and its technologies, and the basis for Kjørbo to gain momentum in society as a whole, which again can be translated back into the domestication process.

The four categories will be analysed and discussed within the domestication perspective, and thus the focus will be on the how the use or non-use reveals itself through the interviews. The framing of this analysis will be in the three sets of acceptance, the practical, the cognitive and the symbolic that are necessary for a technology to be accepted (Sørensen, 2005: 47). I will try to summarize the domestication process to each aspect to ensure the necessary insight required to achieve an overview of the thesis question.

5.2 Working technical aspects

First I want to look at the working technical aspects, because they may reveal priorities and thus more likely to show the designers view. The interviews revealed lighting, sound, air quality, temperature, aesthetics and functional design as the most dominant technical aspects. Though they all agreed that the building in general were in working condition and that most of the technical aspects were operating as intended, they were far more concurring on the best working aspects than the poorest. It seems like there exist far more discrepancy between the problematic aspects than the more successful ones. In other words the interviewees agreed more on what worked the best and to a lesser degree on what were more problematic or challenging.

[Norwegian transcribe script]
d - ...hvordan erfarer folk å være i bygget? Litt sånn generelt.
i1 - *Nå er jeg kanskje litt inhabil, i og med at jeg har vært såppas mye involvert. Men, jeg har jo hatt en teknisk oppfølging av bygget nå etter vi har tatt det i bruk. Så jeg har jo inntrykket av at de fleste er rimlig godt fornøyd, det fungerer greit, med tanke på temperaturforhold, luft, klimamessig. Har jo vært litt ankepunkter mot litt lysstyring som, jeg vil ikke si det ikke fungerer, men det halter litt. Det er litt, men det er noe på gang for å få bedret det.* (Interview 1)

This is how the project leader at Kjørbo for Asplan Viak commented the building as a whole when asked how people in general experience the building. As seen by his comment he have continued to test and work with the building after completion. His comment also reveals that he regards the temperature, air quality and climate as more successful components than lighting. But, as he states the lightning issue is not something they accept as a non-working part and work around it or ignore it. It is something they try to handle with planning and strategy. This shows dialog between users and designers in such a fashion that the script is still open for negotiations. Whether this is true for all aspects for Kjørbo needs more attention. The project leader continues in the interview to stress the importance to see something through. He uses a term "*ferdig, ferdig"* or *done, done* in the context where he comments that if something is to work it need not only to be physically implemented but that it also requires follow-up work to ensure optimised function. This insight illustrates the willingness to modify and negotiate the already installed components of Kjørbo. This is an important mindset for a project leader if the building as a technology is to be successfully domesticated.

When asked about their experience or opinion of the building as a whole the informants declared a mostly positive impression. And nearly all complimented the climate system as probably the most impressive and functioning aspect. Kjørbo as a prestige project have energy and the environment as its most ambitious goal. How Kjørbo's users see this goal is important. And then it gets relevant what technological aspect most clearly cements this image of Kjørbo? Based on the interviews I would state that it is the climate system that both users and the designers feel mostly signalises Kjørbo foremost ambition. This might be because of the iconic staircase which also serves as the ventilation shaft for the entire building or it might be because it's effect is something all users experiences on a daily basis, but it might also be that this is the element of the building which might be the most impressive technological achievement. As the most technological functional artefact also is the one that might be the most representative of Kjørbo's ideal and symbolism it is natural to assume that this correlation influences user impressions.

[Norwegian transcribe script]
i8 - *...så har jeg jo gått mye i de lokalene her når vi begynte og i sommer f.eks da det var varmt var dette det absolutt beste bygget å være i hele konseptet her. Da brukte vi masse kilowatt med kjøling på de andre byggene, her har vi ikke kjøling. Her kjøler vi bare inntaksluften på ventilasjonsbatteriet så det er ikke noen kjøling ut i lokalene det er bare den luften som vi tilfører. Så her er det veldig stabilt og godt inneklima. Og de trives veldig godt her egentlig. Vi har hatt litt utfordringer med styring av lys, men det ser også ut til å komme på stell.*
d - Så planleggningsprosessen løste egentlig alle problemer med temperatur, ventilasjon og det hele, det var sånn tipp-topp fra dag en da nærmest?
i8 - *Ja, det var det.* (Interview 7)

This citation is taken from the interview with the representative from Entra which is the owner and responsible for operating the building. Here we see that the opinion of both the expert user and maintenance coinciding on the matter of temperature, air, energy efficient operation and the challenges with lighting control. When asked about how to control temperatures since the nature of the building demands (storage of temperature in exposed concrete) slow temperature changes, the maintenance informant explained that it demanded a learning curve and competent personnel, but that it was operating as intended and was remotely controlled by maintenance. He even expressed the opinion that it had been easier than presumed. This means that the acceptance of climate by the Kjørbos users on climate is heavily influenced by the maintenances users ability to control the automatic systems. Further on he told us that he had experienced that if he had

regular (daily) contact with representatives from the buildings he operated and could explain changes in the climate, occupants were almost always ok with breaches on the agreed parameters. In other words users were more inclined towards accepting negative changes if they understood why. This means that Kjørbo's climate system in according to the domestication perspective may be seen as accepted by both the practical and cognitive. I will also argue that with the symbolic effect of being energy efficient, the iconic stairway and pride that the users exclaimed when asked what the building represent and almost all answered *that it was possible* (in context to the perspective that the building is a prestigious technological innovation) would suffice to conclude that also the symbolic aspect is fulfilled, and by that reasoning I could be stated that the climate system at Kjørbo is domesticated in it's present state.

The technical aspects of Kjørbo are to a large degree automated. This includes both lighting and climate. In the climate aspect as discussed above this has been relatively painless as the users have been rather satisfied with the standardised parameters set by the designers (and users in consultation) and further optimized by experience from maintenance that run the day to day operation. The lighting has had some difficulties that will be further elaborated in the next section. Windows have an automated sun screening that needed some considerations but ultimately were changed to better suit the needs of the users. When asked how much users could influence temperatures, the interviews revealed that the designers preferred pre-agreed standards over user impact because of the tendency to leave settings at the extremes and therefore squander or waste some of the energy saving potential.

5.2a Working technical aspects in a domestication perspective

When looking at the working technical aspects the practical or the behaviour in relation to the technologies is not at first very apparent since much of what the interviews revealed as working technical aspects were the big automated systems over which users have little or no direct control. They do have the opportunity to override the sun screening and some places to open a window but as stated by one of the interviewees this is mostly for a psychological effect. He also expressed the opinion that if these technical components were to function optimally they were best left to automatisation. The practical in the working technical aspects is then understood by how successfully the users see these automated settings and whether or not they try to find their own ways to better accommodate the surroundings to suit their needs. The interviews did not show any user solutions that were at odds

with the technological systems (anti-programs) and combined with the overwhelming positive response of the large general systems it is safe to assume that the practical aspect is integrated to a satisfactory level.

The cognitive or the knowledge the users have of how to operate or coexist with the given technologies is made apparent through the fact that all the informants that were interviewed expressed more than average knowledge about the building they occupied. This may come from their expertise as expert users but also as a form of genuine interest in the building as a project that they feel symbolizes the company they work for. This perspective also shows that users agrees with the symbolism these technologies represents and also imposes their own values to match what the building represents, which is closely tied together with what their company projects as their *company social responsibility* (CSR).

5.3 Challenging technical systems

When considering the challenging technical systems at Kjørbo the most prominent are the lighting and the acoustics. The technological components of Kjørbo in our perspective can be seen as either solutions that are changeable that can be tweaked and modified in response to user feedback and the ones which are more permanent and needs to be cancelled out by other installations if not working properly. Parameters for light and temperature are technological elements that can be discussed and optimised with relative ease since they are more or less designed to incorporate these properties. However acoustics is harder because this is a technology that when implemented modification has to be to install more of the same properties and when this collides with elements of another technology, the project have to make priorities in which they deem more important. Acoustics suffers greatly when there is a need for much of the thermal energy to be stored in large quantities of exposed concrete.

[Norwegian transcribe script]
i6 - *Ja, eksponert betong det var en forutsettning for prosjektet og det er klart at alle akustikkere river seg i håret når man hører sånne ting, eksponert betong er noe vi ikke vil ha, hvertfall ikke i himmeling, da er det vanskelig å få til gode forhold, og det har vi jobbet mye med, men det er klart at også andre ting har kommet inn i dette prosjektet her, og det er blant annet det at det skal bli på en måte et ikonbygg, et designbygg. Vi skal vise det frem etterpå, derfor så må*

løsningnene som velges også. De må være estetisk gode, og de må henge mere sammen med resten av bygget. (Interview 5)

This means that the acoustic considerations at Kjørbo have been at odds with one of the core features of what makes Kjørbo a prestige project. This is also to a certain degree true about lighting as increased use means more energy consumption. The difference is however that lighting can be compensated with optimization and modification work, this is less true with acoustics where you have to deal with defining feature which is at complete odds in regard to purpose. Though it needs to be said that there have been attempts to compensate this through e.g installation of baffles.

[Norwegian transcribe script]
i6 - *...NS81-75 er bibelen for oss akustikkere. Og det ble også pekt på her i prosjektet at det var, det var vel noen som brukte ordene ekstreme akustiske krav. Som det jeg stilte krav til, viktig å være klar over at det er ikke noe ekstremt ved det som er minste krav til teknisk forskrift. Det er ingenting ekstremt ved det. Alle kravene som er stilt her i Powerhouse er klasse C i NS81-75 og det er minstekrav.*
d2 - Er de oppnådd da?
i6 - *For det meste, i alle kontorer og møterom sånn som her.* (Interview 5)

It is interesting to see that when most of the interview objects were asked what the weakest part of the Kjørbo experience had been so far they answered the lighting. It also worth mentioning that sound and acoustics when mentioned by the users and maintenance were marginalised compared to the impression of the relevant expert-user. So even though this might be Kjørbo's weakest point according to this particular user it seems also to be drastically less important to the other users. It was also mentioned that users dealt with the sound challenges through different methods, some used headphones other arranged seating to accommodate personal taste or considerations. This fact can also be seen as informed users feeling that direct user measures is sufficient to justify a relatively problematic situation, or it could be the result of energy efficient symbolism triumphing over comfort steering. But it is also important to be aware of the fact that different users may have different preferences when defining comfort steering as Rohracher states when he explained the fact that users comes from different backgrounds. Just as the building is made up from components from different sources so are the users.

[Norwegian transcribe script]
i3 - *Det er for lite sensorer i forhold til det at lyset skal gå av, det skal være så lite lys som forsvarlig egentlig. Og så er det en del programmering som ikke er god nok, så nå har vi gjort en del tilltak som ble gjort i går faktisk, sånn midlertidig, vi*

har økt intervallene på når lyset går av på bevegelse. Det er det som er gjort nå. Sånn at de ansatte ikke skal oppleve at det blir mørkt mens de sitter og jobber. Vi regner med at etter tre kvarter så må alle ut og hente seg en kaffe eller opp og gå litt, og hvis de ikke beveger seg på tre kvarter så bør de gjøre det. Så det kan være et signal om at nå må du opp og gå litt. Og så skal det utarbeides en plan nå for å få snudd noen av armaturene for å få sensorene på riktig side. Vi må bytte noen av armaturene for få det til, vi må ha flere bevegelsessensorer. (Interview 3)

As lighting seems to be both the most sought after challenge to fix and maybe the easiest for the designers to change to better accommodate user needs as opposed to acoustics, both Asplan Viak and Entra have made clear efforts to try improve conditions. This process (not yet concluded when the interviews took place) is a result of the building's energy goals, expert-user know-how, user forums and maintenance considerations. An enrollment procedure like this to ensure optimized changes in both design and user acceptance seems to be one of the strongest elements of the domestication process at Kjørbo and provides a form of *user-contract* that will be further discussed in the following social aspect of Kjørbo.

5.3a Challenging technical systems in a domestication perspective

The challenging technical perspectives at Kjørbo are few but they comprise key elements for user satisfaction. From the interviews it is clear that both the users and designers felt that these was addressed in mostly a satisfactory fashion. Whether or not the emphasized focus on lighting despite acoustics is the result of practicality over need is hard to know, and would require further investigation on a later stage.

An important question that need answering in relation to two of the aspects of domestication in relation to Kjørbo's automatization design is just how does users learn and practically interacts with technologies they have seemingly no control over? As discussed in relations to the working technical aspects this thesis argued that the acceptance of automatization and the lack of user modifications in either behaviour or technology could be seen as successful domestication. But how are we to understand and indeed see lack of acceptance in the more challenging technical aspects? Bye (2008) argues the need to see the user as an actor with certain skills rather than properties, so how does these skills become apparent in an automated environment? The interviews explained that the user have access to a feedback system where users can report their opinions and provide feedback to a user-representative. He or her then communicates these viewpoints through

monthly meetings with the designers and/or to maintenance. This indicates that as long as the feedback system proves efficient and is in it's own right successfully domesticated it could provide the necessary qualities to be viewed as the practical, cognitive and symbolic output for users in relations to the challenging technical aspects. The combination of user-feedback and energy considerations has together agreed on attempting new settings to better suit the activities of the building. Such as baffles and modifying the light timing settings. It could therefore be argued that such a feedback system could translate into Bye's understanding of skill sets.

[Norwegian transcribe script]
i8 - *...Det går på utforming, det er også viktig å tenke på i en sånn prosess at ja vi skal spare engergi, men hvis dere da igjen er leietakere og hvis du tenker på hva vi bruker i energi på et standard kontorbygg i dag kontra hva det koster å lønne dere og ha kontor arealer, hvis vi drifter på en sånn måte at det alltid er litt for kaldt eller litt for varmt, så begynner dere å prate om hvor fryktelig dårlig miljø det er, og dere vil yte mye mindre fordi at dere kanskje da blir alt for varmt eller kaldt. Og den produktivitet nedgangnen den er utrolig mye dyrere enn det du sparer på den energien. For sparer du to prosent på energien så er det bare promille av de kostnadene du får når du får forminsket produksjon på de ansatte. Så det er også sånn at vi har et sånt dilemma at alle ønsker jo, vi har et målkrav som driftsansatte at vi skal bruke lite energi, vi skal oppnå reduksjon og sånn, og bli klappet på skulderen hvis vi når det, men du kommer til et stykke da leietakeren begynner å klage, så i Entra har vi klart å redusere veldig på energibehovet i alle bygg, men vi begynner å nærme oss en sånn grense at det er ikke mye å hente før leietakeren begynner å bli misfornøyd så da må vi bruke tilltak og da må vi begynne å bruke penger på bedre fasader og sånn på byggene våre for å oppnå det ønsket om å få redusert energi.* (Interview 7)

In this citation the maintenance user explains how the centralised control is managed. He argues that even though his task is to optimize the energy consumption of the technical systems he fully recognize problems that might follow an over zealous pursuit of that goal. He further explains that if the building is too concerned by its energy output it could reflect the end-users ability to execute their work properly and their production efficiency might suffer. And that such a situation would be even more expensive for the tenants. At the end of the statement he informs that they have soon optimized these automatization at the buildings he his managing and if they were to further improve energy efficiency they need to improve other technical aspects the buildings they are managing. The citation is taken as a general premise from Entra as proprietor. But it illustrates the strategy of running the Kjørbo building as efficient as possible from their

perspective. It could be argued that this is a dangerous way forward because through automatisation it removes the direct user influence.

In Bye's thesis he studies what he dubbed "*Automatiseringens forbannelse*" or the curse of automatisation. In his empirical review there were problems such as the users not understanding the automated systems due to lack of information and adaptability to user needs. There were also anchor points towards the chosen technical solutions in the design phase. (Bye, 2008) But the problems and challenges presented by Bye are not apparent at Kjørbo. This thesis argues that this is the result of topics such as a far more rigorous and careful enrollment phase, expert users also serving as end users, a successfully domesticated feedback system where the users feel their needs are being met or at least taken into consideration, established parameters which constitute a *user contract* which is arguably still open for negotiations. The last point will be further elaborated in the following chapter. But, these key elements of social enrollment and dialog between user and maintenance establishes Kjørbo as rather stable hybrid collective and proves the building's flexibility within the agreed framework. Whether or not the building would prove just as flexible and stable if one were to remove the prestigious status and the expert users is hard to predict, but at current status the challenging technical aspects of Kjørbo is well within the successful parameters set forth by the domestication theory.

5.4 Social aspects

The social aspects surrounding the technologies at Kjørbo emerges the strongest when discussing the buildings environmental goals or the welfare of its users. Not that these two necessarily is at odds with each other but, the balance is paramount for the success of Kjørbo as a technology. The social aspects also show to a degree how the users think about the necessity and acceptance of certain technological parameters that affect their daily routine. This is how the social aspect shows its impact on the symbolism in domestication theory. Knowing and learning how the building works and why the strategy is formed in the way it has, illustrates the cognitive, and operating the feedback/evaluation program indicates the practical acceptance.

[Norwegian transcribe script]
d - Jeg har bare et spørsmål til om lysene, hvordan håndterer dere den prosessen. Altså det virker som om dere sitter en plass mellom kollegaene deres og ekspertene og driftsfolkene. Rent sånn rutinemessig så regner jeg med at dere har…

i3 - *Det er jeg som er bindeleddet der. Jeg får registreringer på den kontordriftslinken, jeg har meldt det videre til servicetorget hos Entra, men jeg har også tatt det direkte til prosjektet. Fordi jeg går også dirkete inn i de kanalene, fordi jeg har jobbet mye i hele prosjektsfasen med de folkene.*

i4 - *Eli har jo sittet i brukerforum hele tiden, fra før vi inngikk kontrakten og på en måte nesten et halvannet år før vi flyttet inn, så var det jo veldig jevnlig brukerforum hvor hun satt sammen med Snøhetta og Skanska, Entra og diskuterte løsninger. Så det har vært et veldig sånn sett, fra et brukerståsted. Eli har direkte, innsikt i hvem som jobber med hva. Men, det er jo veldig greit at man har dette servicetorget som Entra har.*

d - For da var det ikke brukerforum med brukerne, det var at du representerte brukerne opp mot entreprenørene.

i3 - *Ja*

i4 - *Ja, og da hadde selvsagt også Eli et internt brukerforum kan du si. Men, det var på en måte med gruppelederene for å få opp innspill til de forskjellige møtene. Noen ganger var det utvidede forum også hvor det var noen av gruppelederene som deltok, så det var litt forskjellig. Men, ellers så er det denne loggen. Denne kontordriftslinken som fungerer som en salgs helpdesk, men det er ikke it-saker det er mer kontordriftsaker.* (Interview 3)

When studying Kjørbo as such a relatively new building we are fortunate that the technology is still not black boxed (Latour, 1987) and that the design phase is still open to such a degree of insight. This makes it possible to better understand the mindset of all type of users. The part of the design phase we can see in quote above shows that feedback and the concerns of the users have been taken into account in the Kjørbo project at multiple stages. The interviews tells us that the feedback system is materialised as a office help desk that users can report technical issues, but also that the users through representatives have been able to promote their concern in user forums, and that this practise began almost a year and a half before Asplan Viak moved into the premises. The form of user involvement that is found at Kjørbo contributes to define the framework of expectations that users inhabit when they move in.

[Norwegian transcribe script]
i5 - *... Jeg tror at det finnes nok av miljøopptatte leieboere som ønsker å flytte inn i bygg som er litt dyrere, sånn som vi betaler for vår del er det femti kroner mer per kvm i praksis, som ønsker å flytte inn i bygg som er litt dyrere hvis de får en sånn miljøeffekt. Symboleffekten, en ting er den symboleffekten der ute, en annen ting er symboleffekten for våre egne ansatte. Symboleffekten ved å ha folk inne i bygget*

her, ser merkevare byggingen vår i forhold til å ha tusen besluttningstagere inne i bygget som ser hva slags bygg Asplan Viak bor i… (Interview 4)

Asplan Viak shows that they are a company that are willing to pay for the symbolic value of Kjørbo. They are a company that want to express their passion for environmentally sustainable solutions both to their own workers but also to competitors and potential partners. When the users and the designers like in this case are so intertwined it is possible to problematize the willingness to accept the defined framework. The interviews illustrates very clearly a process where the users both through involvement and symbolism have together with the designers created a form of *user-contract* where they have agreed to accept negotiated standards within the given framework of expectations. This as a phenomenon has both positive and potentially negative effects. As far as the domestication process goes, it greatly increases the chances for the users to accept the technological aspects symbolically and to some degree cognitively since they are more likely to learn more when involved. But, it can also hide potential problems as the users might accept problematic technical aspect because e.g., they value the energy focus to such a large degree that they are willing to ignore problems that less idealistic users might not. This would however mean that the user-contract has been so successful it skews the understanding of comfort steering. If this is the case it could potentially provide challenges for the transferability of Kjørbo as a technological artefact.

The foundation of the user-contract as argued seems to be a joint effort between comfort steering and company strategy. At Kjørbo there were few signs of this being a conflict of interest as the users themselves seemed to believe in this ambitious project and were involved in almost all aspects of design, construction and still contributes in the enrollment phase. The only conflict that was salient/made apparent was as described earlier the cases were two technological aspects were at odds with each other. And this was primarily the acoustics.

The following two citations show two different approaches to the user-contract. The first statement presents the pre-agreed framework, which the informant feels is constituted and argues that if the user still isn't satisfied he or her need to solve it on their own. The second testimony shows that the end-users is heavily invested in the success of the energy effectiveness of Kjørbo, but that success can't be at the expense of the working conditions of the employees. In this context it is important to further draw on the understanding of comfort steering presented by Bye. As argued in the theory chapter comfort steering is the primary concern of most end-users, but as problematized above it might be influenced by informed and idealistic

users. This understanding emphasizes the need to understand and facilitate user learning and acceptance.

[Norwegian transcribe script]
i1 - *"...hvis du er blitt enig om noen grenser og du skal holde deg for eksempel over 21 grader og man er der, så glem å kommenter det. Da får man gjøre noe annet. Hvis man fryser."* (Interview 1)

Norwegian transcribe script]
d - Hvilket forhold har dere til energiregnskapet?
i3 - *Det er veldig viktig for oss at det blir som forventet. Men, det skal ikke gå på bekostning av arbeidsforholdene til de ansatte. Så vi må finne balansegangen der, og hvis vi må øke opp noe på belysning som gjør at vi bruker mer energi, så må vi heller da gå i dialog med prosjeket og finne ut om det er andre områder i bygget som vi kan redusere på, og det tror jeg at det er. bare for at vi allikevel finner den rette balansen.* (Interview 3)

It is worth mentioning again that the conflict of interest between comfort steering and energy efficiency is not very apparent at Kjørbo, but it further emphasizes the important point that idealistic users might conceal future challenges to the export value of Kjørbo as a technology. It is also potentially harder to domesticate a technology when the user-contract gets black boxed and the negotiations ceases. The comprehensive involvement of users during the design and building stage and later in the enrollment phase combined with a clear and idealistic goal that encourage pride, forms the basis for the user-contract which in turn helps the domestication process.

It is important to mention that implementing a feedback system in itself is not enough, Rohracher explains that in his study the feedback system functioned as a source of information regarding technical malfunctions. But, that the information became heavily influenced by those who received it. The reason for this is that there isn't always a correlation between the views of maintenance and designers and end users. This became apparent in his study when the technical systems operate within their given parameters and users still complain. The users were then viewed as irrational. The experts in Rohrachers study argued that there were always 10% troublemakers (Rohracher, 2003: 183). Such a view was also present at Kjørbo.

[Norwegian transcribe script]
d - Gjelder det, det er kanskje i størst grad lyset da, det handler om. Og at temperaturer og ventilasjon stort sett er…

i1 - *Ja, det er mindre kommentarer, det har ikke vært noen kommentarer å snakke om der. Iallefall ikke som er noen grunn til å ta hensyn til. Det har vært innafor de definerte grensene. Man har lagt opp til i prosjektet, men det er selvfølgelig noen som synes at det er kaldt når det er 22 grader, og allikevel, og da er beskjeden, "kle på deg". Du behøver ikke å gå halvnaken hvis du fryser når det er 22 grader.* (Interview 1)

But at Kjørbo, the feedback system as argued by the other informants were well integrated and the negotiations of the user contract were open. Such a fact argues that Kjørbo have the necessary flexibility and user considerations to successfully operate their feedback system.

5.4a Social aspects in a domestication perspective

In the social aspects present at Kjørbo this thesis have argued the presence of the term user-contract. It has also empirically shown different aspects where the aspects are apparent. The user-contract of Kjørbo emerges because of two main reasons, the first is the environmental goal accentuated by company strategy and innovative prestige. The second is the nature of the users at Kjørbo, even though it is problematic to view users as a homogenous group as stated by Rohracher the users are nevertheless part of the organization Asplan Viak and that entails certain generalizable characteristics. This means that the user at Kjørbo are in many cases expert users with relevant competence, this fact provide the users with a great deal of insight into why technological design have been constructed the way it has. To summarize, the combination of organisatory ambitious environmental goals and expert user insight with participation in design phase provides the fundament for the user contract at Kjørbo. Such a combination provides a very flexible design phase. One could also argue that the user contract is a statement of co production that has contributed to the housing culture at Kjørbo.

In order to domesticate Kjørbo within the framework of social aspects this thesis argued that it was crucial that a synergy between environmental goals and user welfare not only was established but also maintained. The user contract is an expression for the establishment of this synergy and feedback system could translate into a way of maintaining and negotiate the structure of the user contract.

The empirical data and analysis shows that these two components are well integrated into the hybrid collective that Kjørbo constitutes. And through this integration an acceptance of technologies follows. The prerequisites for domestication as symbolic, practical and cognitive is then completed through the user contract and maintained by the feedback system.

5.5 Societal framework

Societal framework constitutes in this context the surrounding elements that Kjørbo has to relate or deal with in some fashion. These elements can be anything from existing legal parameters, building regulations, market demand and structure, energy prices, public opinion, marketing, politics and economics. These are complex relations that this thesis has no means to fully conclude, but still it is important to convey some key points to ensure sufficient insight, since these influences can have deep impact on multiple aspects in the domestication perspective and the diffusion of Kjørbo as a technology.

[Norwegian transcribe script]
I5 – *Jeg tror symbolverdien av bygget er veldig viktig, jeg synes kanskje vi gjorde en dårlig, vi solgte det ikke bra nok i media, når det åpnet. Det er tross alt en verdensnyhet, og da synes jo jeg at det er synd at det ikke får plass i aftenposten, dagens næringsliv og den typen ting når man ser at, Gunnhild Stordahlen og Rimi Hagen får to-siders oppslag i samme dag for en sånn helseinitsiativ de har tatt... Ett eller annet sted ikke sant, har ikke blitt gjort en god nok jobb sånn at det ble litt for lite oppslag. Litt for bevart hemmelighet, den siger jo inn, men det er ikke allment kjent at vi faktisk i Norge har laget, verdens første rehabiliterte plusshus.* (Interview 4)

I have already mentioned that Asplan Viak is willing to pay for the symbolic value or as one as one of the people interviewed called it the *"Cathedral effect"*. That they accept a higher residential price for what they believe Kjørbo represents. But, the market has yet to acknowledge this as a whole and multiple of the interview objects expressed frustration that the market had yet to adapt to the possibilities that Kjørbo presents. This situation illustrates the points made by Sørensen and Ryghaug in relation to lack of innovation and inefficient practises in the building sector. Some of the examples were how energy companies can take one price when selling electricity and another when buying or refuse to buy all together. Another was how the market calculated prizes per square metre without taking into account

the savings made by energy efficient solutions in their estimate for total cost when deciding what to rent. As Kjørbo is maybe the first renovated energy plus house in the world, marketing is vital if important framework conditions are to change, so to better suit the characteristics of Kjørbo. Because this will influence both public opinion and politics, it might also integrate Kjørbo as part of a bigger solution. This means that if Kjørbo manages to promote itself as a part of the panacea for environmental building issues it will in turn have a strong impact on key elements in a domestication process.

To cement Kjørbo's status as leading when it comes to green building, the project has vigorously tried to accomplish the standards set by BREEAM. BREEAM is according to itself "*the world's foremost environmental assessment method and rating system for buildings*" [15]. All form of user interviewed at Kjørbo expressed the need for this evaluation, both for outside acknowledgement but also as an internal goal which motivated behaviour.

[Norwegian transcribe script]
i8 - *Ja, vi hadde jo målsettning om å lage verdens første rehabiliterte plusshus og da må du nå BREEAM-kravene også for å få til det…* (Interview 7)

But BREEAM also posed challenges to Kjørbo as one of the designers told us that some of the parameters set for evaluating acoustics lacked expertise and made it difficult achieve. He argued that the phrasing of the requirements were insufficient and revealed what he thought were a rather frightening lack of knowledge.

[Norwegian transcribe script]
i6 - *de kravene som ligger i BREEAM, jeg snakket med en annen akustikker for et annet firma, hadde en liten omvisning her inne og snakket litt om problemstillinger sånn generelt. De hadde støtt på mange av de samme problemstillingene som vi hadde. Og snakket litt om BREEAM, og vi var begge enige om at de som hadde satt kravene i BREEAM, de har ingen fagkunnskap innenfor akustikk og støy i det hele tatt. Det er veldig skremmende. Det står spesielt, den pol8 punktet i BREEAM, ting henger ikke sammen.* (Interview 5)

There were also other standards set by BREEAM were the designers of Kjørbo, disagreed with the given solution, argued that they had chosen a better way of doing things and/or that BREEAM didn't take into account regional differences. The last of these arguments is interesting because it shows the difficulty with making such standardized goals. BREEAM awards extra points for watering of

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[15] http://www.breeam.org/about.jsp?id=66 (10:25 24.03.2015)

flora by watering can instead of hose, this makes sense in a country or region where water is scarce, but Norway is fueled by hydropower and has in no means shortages in fresh water. There are of course other considerations to take into account when arguing the necessity or power savings when it comes to watering the flowers, but the point remain that what seems relevant for being "green" one place may not be as prioritized the next. This could potentially challenge the authority and legitimacy of chosen technologies that make up a building. It seems though that Kjørbo have made conscious decisions with this in mind, one of the designers told us that they had even made some tougher standards than what BREEAM required because their goal were not only the recognition by BREEAM. He argued that the vision lay down by the designers were to make the most energy efficient building they could with the given resources and setting. This translated into not always following BREEAM standards, but they made sure to follow it enough to get the BREEAM outstanding award for the design phase.

The societal framework is to some degree characterized by Kjørbo being a pioneering technology and that much of the surrounding structure is not yet completely suited to Kjørbo. That being said Kjørbo and the Powerhouse alliance have already started to make repercussions in multiple markets. As they have made buyer's demands that pushes the market to adapt to a new and more facilitated approach. On one side the societal framework is something Kjørbo have to deal with and try to adapt where they can and influence where it's possible but on the other it can also serve as a morality boost as the designers and users see their technology as innovating, new and pioneering. One of the informants explained that they had encountered a situation where one of the entrepreneurs had declined to deliver technical components to Kjørbo because of special requirements.

[Norwegian transcribe script]
i1 - *Det var jo hvertfall en entreprenør som takket nei til å være med prosjektet her, hvis man ikke fikk mere levert av sitt eget system, men heldigvis så var det noen andre som var interessert i å være med på det som var angitt og beskrevet og forutsatt i forprosjektet.* (Interview 1)

Such situation could be an aspect of the traditional building sector explained by Sørensen and Ryghaug in their interpretation of why energy consumption have been rising in modern buildings. The statement also indicates that the Kjørbo project have been actively trying to avoid the traditional approach and maybe started to influence the construction sector to think differently.

5.5a Societal framework in a domestication perspective

To put this in a domestication context, from surrounding circumstances it is clear that the users of Kjørbo see the challenges that this framework poses but it would be more apt to acknowledge their view of this task as motivating and somewhat frustrating more than dejected. This perspective influences mostly the symbolic acceptance of Kjørbo but it would be lacking to say that this in turn don't contribute to both willingness to learn and practice that directly relate to the buildings requirements.

[Norwegian transcribe script]
i3 - *En ting som jeg har synes har vært veldig positivt i dette prosjektet, vi har jo egne interiørarkitekter i firmaet og vi brukte jo de, i den fasen hvor vi skulle ta det inventaret som vi måtte ha nytt. Og vi har jo også mye energifolk her og miljøfolk så vi hadde en ganske grundig prosess i forhold til leverandør med dokumentering av at det er miljøriktige produkter. Vi ville ha en veldig streng kravspec egentlig på dokumentasjon fra dem på de produktene vi skulle ta inn i byggene her. Og det er ikke alle produktene, det må vi være ærlige på, det er ikke alle produktene som er helt riktig, men de er på en god vei, men man må lære opp markedet.* (Interview 3)

As exemplified here with choice of interior where the end-users through representatives and expert-users have together gone even further and tried to enhance the environmental gains. This process of user involvement requires the cognitive *know how* of what to look for but also the practical knowledge of the users to be aware of what works for them and how it works, and finally it further establishes the symbolic output of Kjørbo. This process reveals an active process to shape Kjørbo towards the user's daily needs and the environmental goals set by the designers. It also illustrates the point made by Bye that both buildings and users shape each other. In this case the users have shown that the energy efficiency profile of the building have been sufficient for the users to adopt the environmental ambition. It also proves that comfort steering and technical solutions can synergise, but it requires a careful process of user involvement. Such a thorough process provides a tacit example of flexibility in the Kjørbo project, but whether or not this flexibility is a result of the cathedral effect or not requires a comparative and comprehensive study into future Powerhouse projects.

5.6 Summary of data and source material

The technical working aspects of Kjørbo are mostly recognized in a general perspective. This means that users seem to feel that the building as a whole is in good working condition and that all the major technical aspects seem to be in order and working as intended. This differs from the technical problems where the users were far more specific and pinpointed more clearly what they found problematic. This difference is important since it contains a message about the current state of Kjørbo: The building is fully functional and delivers, but as with all new buildings there is still room for adjustments and improvements. These minor challenges are potentially harder to detect by the fact that much of Kjørbos technologies are automated systems with central control and therefore removed from the user influence. This also implies that non-use can be hard to detect since many of the technical aspects of Kjørbo are behind the scenes. Social aspects of Kjørbo are most clearly identified by the 'user contract' that emerges from its ambitious goals, a large degree of user involvement in design and feedback, company profile and organizational culture and finally the very important fact that many of the designers have become users. This 'user contract' brings as argued both positive and problematic components to the domestication process since on the one side solutions gains more legitimacy but on the other they get black boxed and once the implementation process is complete, change or critique can be harder to express. It also provides uncertainty into the transferability of Kjørbo as a technological artefact and raises questions about how flexible Kjørbo would be with less ideal users. The societal context is the last aspect to be analysed within the domestication perspective. Kjørbo is identified by surrounding structures not yet adapted to Kjørbo which makes some process harder and more demanding but on the other side also seem inspirational and further establishes the fact that Kjørbo is innovative which in turn appears to be a symbolic boost for both users and designers.

5.7 Problematization of the transferability of the Kjørbo solution

Kjørbo as a technological artefact has many different characteristics and goals. When designing Kjørbo as a part of the Powerhouse alliance it's purpose was not only to be one project but also a platform that future projects could further build on. This may have influenced the design phase and will surely also be made relevant in future Powerhouse projects. Since Kjørbo is part of Powerhouse it will

reflect on the partner's ability to resolve the challenges they have set forth. It is interesting to see the Kjørbo project as a part of this larger agenda. How does such a viewpoint influence the solutions that are chosen? And maybe the most important question: is Kjørbo as a technical artefact transferable to other building and renovating projects? As follows it would also be important to see what degree of considerations was taken to Kjørbo specifically, opposed general transferable solutions or instalments. This requires an insight to all the different aspects of the Kjørbo project and how likely are they to be compatible to future Powerhouse projects?

The first challenge to Kjørbo as a transferrable technological solution is the fact that it is comprised of many expert users that also are heavily invested in the project's success. On one side this is positive as illustrated it has provided an extensive design phase and a attention to feedback that might be unique. But, problems might also be concealed by idealistic users that could become apparent with different organizations and less suited users. The second challenge is the fact that the market has still to realise the potential in sustainable buildings. In the interviews some of the users expressed frustration that the market was too occupied with shortsighted economical calculations and lacked a comprehensive overview of what could be gained by building energy efficient. But also regulations contributed in the way that they lack incentive and adaptability to innovative solutions such as optimised facilitating for energy producing buildings. The diffusion phase of the solutions chosen at Kjørbo will require a continuing attention to user contract and feedback so the automatic and structural technologies receives the necessary attention to be domesticated by future users. These challenges need attention and considerations if future buildings that draws inspiration from Kjørbo is able to provide necessary flexibility to the diversity of users such an ambition requires.

6.0 Summary and conclusion

This thesis' final chapter will provide a discursive summary of its content, but its most important feature will be the conclusion to the research question in the context provided by the analysis. Finally the chapter will explore what possibilities there are for further research into the field and where there might exist important challenges this thesis have contributed to reveal.

6.1 Summary and Discussion

This thesis began by stating the fact that there are more than 3.7 million buildings in Norway (Andresen, 2007: 9). Powerhouse Kjørbo, the building that we have become so familiar with in the analysis, is only one of them. But this building has the ambition to be harbinger of a far-reaching change in the built environment potentially affecting the whole building stock.

In the beginning I argued that buildings can at first sight seem stable and unchanging, but as soon as one is able to perceive building in a larger context and their changes throughout their lifetime this stable image is soon problematized. The interviews conducted for this thesis have provided a glance into the early phase of the building's life. We saw that already in these first few months of its occupancy, changes have been introduced, partly in reaction to user complaints and partly because of technical problems. Even though a building changes through its whole life, the changes that occur in the early occupancy period is a particularly important time which, when taken seriously, can give a good head start for the changes to come (Way, 2005). The study conducted here shows that the importance of changes in the early phase is well understood by the project team at Kjørbo.

What set Powerhouse Kjørbo apart from other construction projects are above all two things. Earlier I have presented figures that show that the built environment is accountable for up to 50% the Norwegian national energy end use (Bye, 2008: 14). As a plus-energy building Kjørbo does not only not contribute to these 50%, it even has the potential to reduce this number since it produces renewable energy and delivers it to the grid. In the light of research that shows that energy effectiveness has rather been declining than increasing in the built sector, even though there are more technical solutions than ever that are able to deal with this

challenge, Kjørbo is an important exception which might even turn the trend around. Sørensen and Ryghaug (in Andresen, 2007) attributed this negative development to three primary causes. The first one being lack of demand, and the norm that builders often lack extensive overview and instead focuses on short sighted economic gains. Apart from a relatively small grant from ENOVA, Kjørbo is entirely financed by actors from the building sector that see this as an investment into innovation. This shows that at least in this example the construction sector shows the farsightedness that Sørensen and Ryghaug missed. As second reason for the sad state of energy efficiency in Norwegian buildings, Sørensen and Ryghaug describe that public regulations lack ambition and often settle for traditional and orthodox solutions. Again, Kjørbo is an example of ambitions that transcend the existing public regulations; that the government has promised stricter energy regulation from 2020 may have played a role in the Powerhouse Alliance's establishment, though. The third reason given by Sørensen and Ryghaug presents the building sector's conservative proceedings in anything from outdated economical calculations, design of contracts, preferences towards cheap solutions, low level of innovations and architects esthetic inclinations (Andresen, 2007). If their analysis is right, Kjørbo has to fight virtually the whole tradition within the sector to succeed.

This fundamental problematization of all aspects of buildings and their role in a societal ecological setting provided the backdrop for this thesis' research question. Given the results of the analysis that was conducted here Powerhouse Kjørbo appears to have successfully transcended the building sector's conservatism. This makes the case central as it may provide important lessons for the greening of the built environment.

The alliance's collaborative nature and collective means presented themselves as suitable candidates for further study. Based on the literature on the relation between buildings, their use and the resulting energy consumption, the thesis argues that if the ambition of the Powerhouse alliance and Kjørbo is to succeed in their endeavours they need to be aware of the argument that ultimately it is not the building that is using energy it is the people. These considerations led to the research question: *How can an understanding of the user and usage in relation to technology benefit the goal of an ambitious investment into energy effective buildings?* To answer this question the theoretical framework of *science and technology studies* (STS) proved well suited. As it provides the necessary understandings to connect technology and use which is paramount for a paradigm change in the build environment. With *domestication* of technologies it was

possible to understand how and why technologies goes from a wild state to being an integrated part of our daily routines thus tamed and domesticated.

Before I could look into the domestication of Kjørbo I had to describe what a building constitutes in an STS perspective. This was important because as already stated buildings are complex and their nature is multifunctional. I referred to Bye who argues that the flexibility of a building is crucial since users are varied and constitutes multiple levels of understandings, practices and symbolic values. But he also states that this flexibility is hard to obtain and near impossible if the users are not included in all aspects of the building, its design, its maintenance and its operation (Bye, 2008). In the analysis, this thesis has argued that Kjørbo in fact has provided this kind of necessary flexibility through extensive user involvement. But I have also problematized the fact that Kjørbo is comprised of many expert users and is influenced by the "cathedral effect". The flexibility then depends on how to view Kjørbo. As a technological artefact defined by its current occupants it is highly flexible, but in a transferrable state where it lacks its prestigious status and expert users, it might prove less adaptable. Still, these objections notwithstanding, according to my interviews Kjørbo has provided sufficient user involvement in accordance with the view presented by Bye.

Bye also explains that designers will construct their technologies in accordance with their own worldview and that this is problematic when you know that users are not a homogenous group (Bye, 2008). This is a very important point that influences all technologies, but how relevant is it when it could be argued that Kjørbo is a technology by designers for designers? Here, the duality of Kjørbo as a single building and as a platform for future buildings is again the deciding factor. Moreover, this duality is also false as the project is not either the one or the other, it exists as combination of both. Bye's argument reminds us that the Powerhouse alliance and Kjørbo needs to be aware of this argument when drawing from their experiences. The open, interdisciplinary and user involving process of Kjørbo needs to be continued if the overreaching goal of energy effective buildings is to be achieved.

To avoid a deterministic approach to the technological components and the user's Bye suggest that it would be appropriate to view the users and the building as holders of certain skills and not properties (Bye, 2008). The analysis in this thesis has shown that the automatisation of many of Kjørbo's technical instalments has made it difficult to observe direct user interaction. How can use be studied, when the interaction between users and technology is removed? The interviews have revealed another user-interaction with the technology that is more indirect: the

office feedback system that is implemented is well suited to allow users to indirectly affect technological systems such as light and climate. This, however, demands a careful and ongoing dialog between users and maintenance staff. The informants displayed a wide consensus that this dialog was both present and well executed at Kjørbo.

Buildings are objects that are being constantly interpreted and narrated through its users. A building's composition of designers, constructors, end users and its installations provide the necessary means to entail what Bye describes as a *hybrid collective.* This means that it is through use a building receives meaning (Bye, 2008). Kjørbo is definitively a complex hybrid collective constituted through several narratives. The relationships can be according to Bye be defined within the social, material and symbolical (Bye, 2008) In the analysis Kjørbo presents itself symbolically as a narrative of environmental sustainability, innovativity and interdisciplinary design process. In a materialistic perspective it can be viewed as a negotiation between priorities and known technical solutions constructed in a new and more energy optimised fashion. As several of the informants argued, it was not the technologies itself that was revolutionary it was the composition and design phase. Socially, Kjørbo presented itself very much as an extension of Asplan Viak's CSR.

After this clarification of what a building is from an STS perspective, we can proceed to the user. Rohracher reminded us that we cannot view the user as a homogeneous group and that the user term encompasses an immense diversity not only regarding individual background but also expertise and their connection with the building (Rohracher, 2003). For this thesis I had to create a framework of user roles from which to analyse different kind of use or non-use. They were the *expert user* that entailed those with relevant expertise; *end users* or *users* are those who reside within the building on daily basis; *designers* and *maintenance users.* In order to optimize use and avoid non-use it is important to be aware of the phenomenon Bye translates to *comfort steering,* which is the user's attempt to ensure a satisfactory environment. Comfort steering is almost always one of the prime considerations of users when they narrate the experience of a given building (Bye, 2008). This introduced another perspective on the building's advanced automatisation: In the interviews I found that automatic steering of technologies to ensure energy efficiency needs special considerations of user involvement if they are to succeed. This is because there was no easy ways for users to practically operate the system that obviously also is the point of automatisation. One of the informants explained that this view derived from the perspective of users leaving e.g., climate setting in their extreme position and therefore reducing the energy

effectiveness. An automated system then needs to involve the user in other ways and that poses immense demands on the symbolic and cognitive acceptance of the technology. At Kjørbo the synergy between automated systems and comfort steering was mainly maintained and renegotiated through two factors: The first was the concept of a *user contract* which this thesis argues is an underlying concept that has evolved from extensive user enrollment, organizational culture and the Kjørbo project's ambition. The user contract can be seen as an unspoken agreement where users commit and take part in the building's ambition, but at the same time the building's energy goals should not come at the expense of user comfort. The second factor was the feedback system that provided a continuous dialog between end users, maintenance and designers. This shows that a feedback system if managed properly can serve as a safeguard for both user satisfaction and energy effectiveness.

A domestication process connects a building with its users. In this thesis the domestication perspective contributed an analytic approach to the material based on domestication's three main categories: practical appropriation, symbolic appropriation and cognitive appropriation. These categories were analysed within four perspectives on Kjørbo, *working technical aspects, challenging technical systems, social aspects* and *societal framework.*

The feedback system at Kjørbo was one of the best examples at Kjørbo for what Sørensen describes as **practical appropriation**. This system provided an institution that supported and regulated use, and it provided the users with a form of proxy technology from which they were able to influence technological performance. Routines, such as maintenance users daily speaking with user representatives about changes in climate settings or receiving user feedback were another example of practical domestication at Kjørbo.

The **meaning of Kjørbo** and what it symbolises for its users can be viewed in two different ways. The first is characterized by general terms and relates to the building as a whole in a societal context. The informants were proud of the building because it was the result of a unique and interdisciplinary design phase; maybe the first renovated energy plus house in the world, within a sustainable economic framework and representative of company CSR. As one of the informants exclaimed when asked what symbol effect the building represents *"Yes, we can!"* (Interview 2). Viewed from a more specific technical perspective this symbolic quality got a bit more nuanced. There was a strong consensus that technologies relating to energy efficiency were well integrated, but there were also some voices that claimed that this priority had been at the expense of other

technical components such as acoustics. The second symbolic perspective relates to the user contract. This informal and unspoken contract secures user comfort, promotes technical optimization and with co-production through feedback and user enrollment produces user inspiration the further enhances energy effectiveness. This last point was illustrated in the analysis when end users themselves took the initiative to provide environmentally friendly products to their offices.

The **cognitive appropriation** at Kjørbo was influenced by the fact that many of the end users are both expert users and designers. This provided the users with an in-depth understanding of how and why technologies at Kjørbo have been constructed in the way that they have. The cathedral effect of Kjørbo as a source of prestige and the fact that it represented Asplan Viak's company profile motivated learning. The lack of anti-programs and negative comfort steering in the context of automatisation indicates that users at Kjørbo successfully contained a satisfactory level of knowledge relating to the building as a technological artefact. It also illustrates that the feedback system is successfully domesticated in its own right.

Domestication can be further understood within four dimensions. These four dimensions are overlapping and transcending, and the three aspects of acceptance could be understood within them. They are *acquisition, objectification, incorporation* and *conversion.* Domestication can be summarized as a process where the thing that is domesticated needs to be accepted practically, cognitively and symbolically and that these categories unfold within the four dimensions.

These dimensions and how they are interpreted depends on which viewpoint is used. As Rohracher states, there are many forms of users and also organisations can also be users (Rohracher, 2003). This means that also Asplan Viak can be viewed as a user in its own right. The process of acquisition is therefore different based on which user that is being studied, the end-users presented in the interviews described their takeover of Kjørbo as a relatively painless process. The expected changes were mostly connected to anticipation of better air quality and a symbolic quality. The process of objectification of Kjørbo defines qualities of the building that are being either acknowledged or ignored. To exemplify it could be said that energy effectivity was a quality of Kjørbo that was being promoted, lighting was being modified and acoustics although by no means ignored, but remained a low prioritized aspect of Kjørbo. As argued in the analysis this was because acoustics and the chosen technical design for effective heat regulation compromised each other. The dimension of incorporation happened at Kjørbo mainly through the feedback system. As this system promotes new routines and in the context of the user contract also provides sufficient motivation. The last dimension is conversion

and it was made apparent by the extensive knowledge of the building by the end users, but also by the fact that the informants claimed that it was a building that were a source of pride and represented the values of the organisation.

The empirical approach chosen in this thesis was qualitative. Qualitative methods are as commented by Thagaard well suited to gain insight into the views and experiences of subjects (Thagaard, 2010). While post occupancy evaluations often rely primarily on quantitative data (e.g. gathered through surveys among the occupants or through measurements of COs values or temperatures) the qualitative data gathered here gave an insight into more subjective matters such as the meaning of Kjørbo and how far the occupants have made the building 'their own'. It is important to remember that in qualitative interviews the data is always to a degree subjective and needs to be interpreted as such. Thagaard explains that in interviews it can be interpreted that the data is being constructed through the gathering process (Thagaard, 2010). This has both positive and problematic perspectives, such as subjectivity, but the process also provides flexibility in such a way that the researcher is more eligible to e.g., redirect the interview in the direction that seems the most interesting. In this sense the process employed here remained open to the concerns of the users and we can be rather sure that the most relevant user-related concerns have been registered by this study.

6.2 Is Kjørbo domesticated?

The starting point of this thesis is the research question: *How can an understanding of the user and usage in relation to technology benefit the goal of an ambitious investment into energy effective buildings?* In order to answer this inquiry this thesis have drawn on the experiences gathered at the energy plus building Powerhouse Kjørbo. Through an empirical review of the interview data studied and analysed in a domestication perspective, this thesis has revealed key elements that can further enhance innovative technological momentum based on user involvement. If the energy plus house of Kjørbo is successfully domesticated it would provide applicable knowledge to further cement its technological composition and thus provide an example from which the ambition of reducing the energy output of the building stock could draw inspiration. *Is the renovated plus-energy office building of Kjørbo as a technological artefact domesticated?* Throughout the analysis and in the discursive summary this thesis have discussed different factors of how the use of Kjørbo has included the three domestication requirements. Kjørbo is a domesticated technology within its own boundaries, but

as a transferrable technology in a diffusion state it is much harder to make the same bold statement. This relates to the ideal conditions at Kjørbo, with its expert users, a building for designers by designers and its prestigious status, which have ensured a comprehensive and persistent state of flexibility. However the process seen at Kjørbo in the design phase with heavy user involvement, interdisciplinarity and the willingness to negotiate through a implemented feedback system must be continued if the goal of a paradigm change in the building stock is to be achieved.

Earlier research and this thesis has shown the importance of studying use and users. With the increase in technical components and automatisation as the chosen solution to greening the building stock, the need for studying users will only become more important if the synergy between the social and the technical is to prove successful.

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Interviews

All the interviews were conducted october 2014 at Kjørbo and transcribed by Espen Brevik Knoll.

Interview 1 - d1
Interview 2 - d2
Interview 3 - d3 and d4
Interview 4 - d5
Interview 5 - d6
Interview 6 - d7
Interview 7 - d8