THESIS FOR THE DEGREE OF LICENTIATE OF ARCHITECTURE

INTERPRETING THE SUSTAINABLE HOME

BRIDGING DISCOURSES ON HOME AND SUSTAINABILITY IN THE HOUSING SECTOR

PERNILLA HAGBERT

Department of Architecture

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2014

INTERPRETING THE SUSTAINABLE HOME

BRIDGING DISCOURSES ON HOME AND SUSTAINABILITY IN THE HOUSING SECTOR

PERNILLA HAGBERT

Department of Architecture
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Chalmers Reproservice
Gothenburg, Sweden 2014

INTERPRETING THE SUSTAINABLE HOME

BRIDGING DISCOURSES ON HOME AND SUSTAINABILITY IN THE HOUSING SECTOR

PERNILLA HAGBERT

Department of Architecture, Chalmers University of Technology

ABSTRACT

How we design, build and maintain our homes are increasingly seen as instrumental to the environmental, social and financial impact of the built environment. By examining perspectives on and interpretations of sustainability in housing development, with a focus on discourses within the Swedish housing sector, the aim of this Licentiate thesis is to explore and provide an account of contemporary conceptualizations of the sustainable home.

Along with theoretical developments, empirical insights from interviews and focus groups conducted with actors in the housing market (developers and architects), as well as within academia (researchers and students) are presented. A series of pilot studies explore the two areas of study, relating to discourses regarding two particular cases that are portrayed as the 'frontline' of sustainability in housing.

The empirical material indicates that outspoken aims of radically challenging the normative and resource intense ideals of the modern home generally appear to be lacking in new market-led housing development, with a rather unilateral interpretation of sustainability in eco-efficient or generally vague terms. It is suggested that a holistic perspective is required in the alignment between how different actors perceive housing development, and what is sustainable, where the academic case presented gives points for further discussion.

In conclusion, a need to visualize ideals and various conflicting images of home in the housing sector is emphasized. This provides a point of departure for positioning sustainability in housing, introducing less resource intense ways of residing that also consider issues related to equality and diversity in the built environment.

Keywords: architecture, home, sustainability, housing development, residential design, domestic resource use, systems approach

LIST OF PAPERS

This Licentiate thesis is part of on-going PhD work, which will cover a larger empirical area, and is primarily based on the work outlined in the following papers:

PAPER I

Hagbert, P., Mangold, M., & Femenías, P. (2013). Paradoxes and Possibilities for a 'Green' Housing Sector: A Swedish Case. *Sustainability*, 5(5), 2018-2035

PAPER II

Hagbert, P. & Femenías, P. (2014). Sustainable homes, or simply energy-efficient buildings? Manuscript, submitted to *Journal of Housing and the Built Environment*.

Earlier version: Hagbert, P., Femenías, P., Nyström, M. & Zuber, G. (2013) BEYOND GREEN - the unsustainable home in the environmentally adapted building. Paper in the proceedings of the *10th European Academy of Design Conference - Crafting the Future*, 17-19 April, 2013, Göteborg

PAPER III

Bannova, O., & Hagbert, P. (2014). Experiments in mapping human factors for sustainable design and living. In R. García Mira & A. Dumitru (Eds.), *Urban Sustainability: Innovative Spaces, Vulnerabilities and Opportunities* (pp. 117-130). A Coruña: Institute of Psychosocial Studies and Research "Xoan Vicente Viqueira".

ACKNOWLEDGEMENTS

This thesis for the degree of Licentiate at the Dept. of Architecture at Chalmers University of Technology presents doctoral work funded by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning; Formas.

As part of the strong research environment Homes for Tomorrow, this work is supervised by Assistant Professor Paula Femenías and Professor Maria Nyström. Their knowledgeable guidance, support, direct input and mutual collaboration has been invaluable in taking my first trembling steps into the world of research.

Beneficial feedback has also been provided by Professor Greg Morrison and other senior researchers and doctoral students from the departments of Architecture, Civil & Environmental Engineering, and Product and Production Development at Chalmers. Thank you all for the advice and discussions that have followed me through this first half of my PhD endeavour.

I would like to particularly acknowledge the research support from, and collaboration with: fellow doctoral students Mikael Mangold, Sara Renström, Olga Bannova, Anneli Selvefors, and Robin Hardner; Visiting Professor Larry Toups; reasearch intern Guillemette Zuber; HSB, through Anna Olofsson and Sanna Edling; the SusLab NWE network, particularly the partners at the RCA; and finally, all participants in the here presented studies.

Special gratitude is also extended to my doctoral colleagues at Chalmers Architecture for their enthusiasm and the mutual encouragement we've exchanged along the treacherous path that is research within the broad field of architecture: Lisa Bomble, Sigrid Östlund, Anna Maria Orru, Johanna Eriksson, Katja Finger among many others.

Many others have of course provided me with outlets for discussion, rants and inspiration, both friends pursuing architecture in practice and those outside of the field - my appreciation for you and the work you do is vast. Julia Bahnér, my political champion and fellow academic. Brian W. Jones, my combatant and partner.

Last but not least, to quote the most eloquent compliment ever given to me, by one of the greatest teachers I have ever encountered: credit to my parents and my upbringing, for leaving me with a never petering urge to question.

Thank you.

CONTENTS

1. MAPPING CHALLENGES

introduction

1.1. BRIDGING DISCOURSES

The scholarly merit of pursuing research on the, oftentimes regarded subjective, notion of home is occasionally contested in the context of result-oriented research. In one sense, the issue has been all but exhausted by decades of interpretative and narrative accounts of the attributions given to space and place (Moore, 2000). Yet home, and the imagery of home, continues to be one of the strongest connotations in everyday life, as well as the market development of the built environment.

Conversely, sustainability sciences are gaining scholarly acclaim (Komiyama & Takeuchi, 2006). Meanwhile, the buzz of the political concept of sustainable development renders the term rather vague, without depth or actual momentum as shortcomings of international agreements undermine the potential impact of efforts on a global scale. In the context of the built environment, parallel conflicts between for example growing wealth and inequality, a convenient modern lifestyle and the need to reduce overall resource consumption, or strengthening resilience and community in adapting to changing needs for mobility, remain in the framing of sustainable housing (Lovell, 2004; Brown & Bhatti, 2003; Raco, 2007 and others).

In this Licentiate thesis, investigating interpretations of the sustainable home, it is argued that merging and contrasting discourses on home and sustainability in the housing sector is of value to the overall objective of providing knowledge relevant to the development of [more] sustainable residential environments. These discourses include, but are not limited to: aspects of technological development; lifestyle and behavior; modernity; consumerism; housing market mechanisms; social integration; architectural quality; planning processes; resident participation and democracy; salient values and norms; construction processes; human needs and aspirations; among others. Difficulties arise in attempting to bring these discourses together, as they appear to have widely differing or even oppositional agendas to be integrated, and where theoretical development has lagged behind (Brown & Bhatti, 2003).

To investigate the relevancy of the concept of home on for example sustainable resource consumption is here considered to be an essential part of understanding how we can adapt to and drive emergent technical and design solutions that more adequately address the convergence of sociocultural and global resource perspectives. This includes employing an integrated perspective based in bridging,

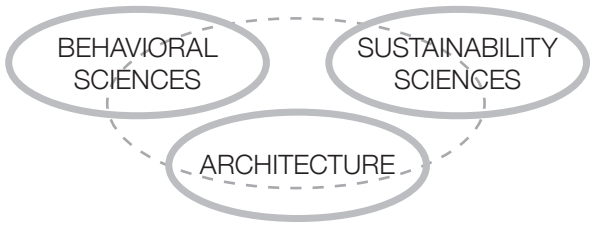


Figure 1. Bridging disciplinary boundaries for integrated research on the sustainable home

or even transcending, disciplinary discourses (Després, Vachon, & Fortin, 2011) - simplified in figure 1. For architectural research, knowledge dissemination within the building sector is highly relevant. In addition, this thesis is nonetheless also directed to policy-makers, and to those who must be considered the ultimate stakeholders in the built environment: the residents, as citizens and users.

1.1.1. Complexities of sustainability in the built environment

As we face a multitude of crises, ranging from climatic to social, an interlinkage between societies, economies and people is based on the exploitation and distribution of resources, whether natural, politico-economic or socio-cultural. Systemic connections between a diverse global population, a largely uncontested strive for profit in a growing number of societies, and a renewed concern for a finite planet, are often simplified into a triple bottom line of corporate morality (Norman & MacDonald, 2004).

How we organize society relates to the built environment in which this organization takes place, shapes and is shaped by. Our understanding of the world is dependent on these structural and organizational processes, supported by resources: land, water, materials and energy, as well as time and human ingenuity. The structural factors of how we design, build and maintain our homes are increasingly seen as instrumental aspects of the environmental, social and financial impact of the built environment. The impact of the conceptualization of home, as one facet of how we construct relationships and meaning with the built environment, is moreover here argued pertinent to acknowledge in the perspective of global resources and emerging conflicts regarding their availability, distribution and consumption.

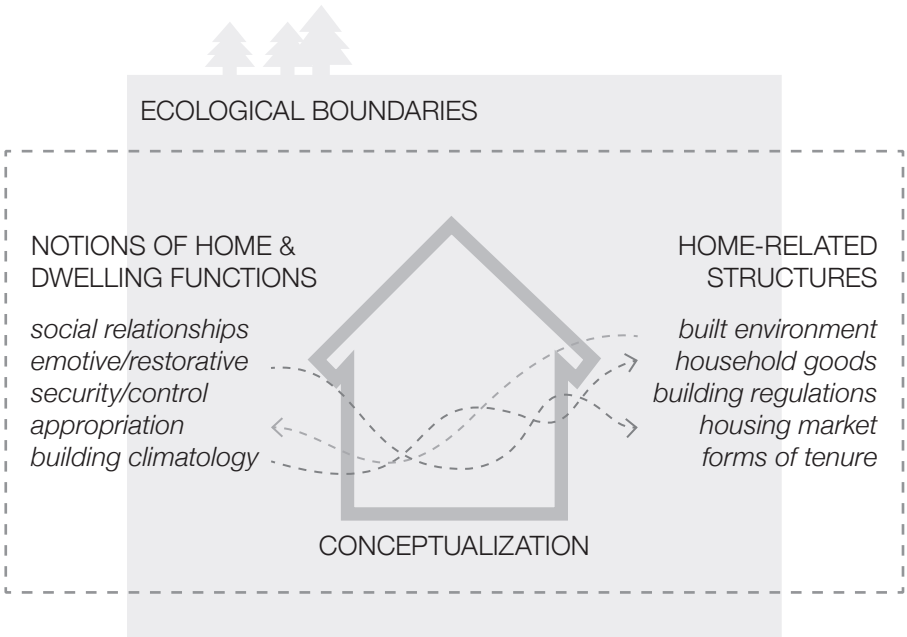


Figure 2. Conceptualization of home, dependent on various parameters and system boundaries

A simplified systemic perspective on this process in relation to the multiple associated discourses on home is illustrated in figure 2, outlining some of the commonly considered parameters of the notion of home and dwelling functions, and the more concrete organizational structures surrounding housing. The mindset(s) that encompass this projection from notions to physical or organizational structures is relevant to explore in itself, but even more important to reassess and map in the context of systemic boundaries, where absolute ecological boundaries put limitations on this process, and are here suggested to demand an ultimate system override.

1.2. BACKGROUND

1.2.1. Research context

The Formas funded trans-disciplinary research environment 'Homes for Tomorrow' supports the development of new technologies, materials and spatial structures that radically reduce domestic resource and energy intensity. The research environment

encompasses senior researchers and doctoral students from the departments of Architecture and Civil & Environmental Engineering, in the formation of several sub-project groups. Through this research environment, connections across disciplines are made, particularly with the division for Water Environment Technology, and doctoral student Mikael Mangold (collaborator on paper I).

The work presented in this thesis is part of the architectural research sub-project group 'Systems Design'. Besides the work of the two senior researchers at the department of Architecture - Professor Maria Nyström and Assistant Professor Paula Femenías - the particular sub-project context involves collaboration with doctoral student Olga Bannova (co-author paper III), and Visiting Professor Larry Toups from NASA (contributing with a systemic perspective on 'human functions'). The focus of the sub-project is three-fold; exploring societal influences upon home design, psychological responses to design accommodations and lessons from extreme environments. While the latter two focus areas are addressed by the research work of other sub-project members, this thesis primarily deals with the first-mentioned.

1.2.2. Contemporary housing development

The energy and material intensity of residential buildings is significant, and about 40% of the total energy use in Sweden is used in the sector 'housing and services' (Energimyndigheten, 2013). Environmental adaptation and a transition towards a sustainable development of the built environment is needed at a faster pace if we are to meet national energy goals set for 2020 and 2050 by the Swedish Environmental Protection Agency, Naturvårdsverket. Besides reducing the energy and resource use in the construction and user phases of new residential buildings, substantial efforts are also needed in the existing housing stock. This includes addressing the resource intensity of modern ways of dwelling, but also issues related to equal access and diversity in the housing market.

Several demographic, normative and regulatory trends can be noted to influence the conception and production of housing. The focus is here on a Swedish context, although similar patterns can be observed across a European, or even global, scale. A general growing individualism and a shifting demographic, for example due to an

aging population, or increased global mobility, have an influence on the demands on housing. The number of Swedish single-person households continues to increase, and today accounts for about half of all households (SCB, 2012). In the Swedish context, the current discourse on housing development is focused primarily around the lagging production rate (and suggested related causes). A perceived housing shortage in larger urban areas is framed not only as a social issue, but also as a threat to continued growth in regions faced with a particularly urgent stated shortage (Lago & Linde, 2013), underlining a financial market focus. There is especially a need of small rental apartments of 1 to 2 rooms plus a kitchen in metropolitan areas (Boverket, 2012). Lago and Linde, CEOs of two large Swedish housing companies, express that the rise in number of single households puts a further strain on this shortage, as they are assumed to "consume a larger living area per person" (2013).

Larger rental apartments are nonetheless also reported to be in shortage, as families out of choice or necessity settle in urban areas. It could be suggested that neither the existing stock nor contemporary housing development sufficiently meet the housing needs of the population as a whole. Groups that are less financially visible in the housing market are especially disadvantaged, and affordability remains a challenge in market-led development. Swedish households spend a large portion of their disposable income on housing, seen in a European comparison (Boverket, 2010). Nevertheless, this should also be put into the context of the general residential quality and level of standard this expense assures.

Sweden has a rather young housing stock, with about 60% built after 1960 (SCB, 2012). As was the case in many [primarily Western] European countries, Sweden saw an overall high rate of development and improvement of living conditions during the 20th century, including spatial standards. The portion of residents living in what is considered a high standard of space has increased significantly. In the mid 60's less than a tenth of the population lived in what was considered high spatial standard. Today around 40% of Swedes have extra rooms to spare (SCB, 2012). The disparity between those living in cramped conditions and the part of the population who continues to see an expansion in floor area is nonetheless worth to address in relation to resource distribution and use.

1.3. AIM AND RESEARCH QUESTIONS

The thesis bridges precedent research on the concept of home and sustainability in housing (further outlined in chapters 2 and 3). By examining perspectives on and interpretations of sustainability in housing development, the aim is to explore and give a descriptive account of contemporary conceptualizations of the sustainable home. The general research questions posed are therefore:

1) How is sustainability interpreted and/or realized in contemporary 'frontline' housing development and research?
2) What role is given to the concept of home in discourses on sustainable housing development?

1.3.1. Methods, material and limitations

Through a series of empirical studies, looking at the discourses among groups of what are here identified as key actors in the creation of residential environments, the material presented revolves mainly around two particular cases considered to be relevant for giving a snapshot of current development and research in Sweden. The thesis focuses broadly on domestic resource and energy consumption and socio-cultural values, yet does not address larger questions of climate change, or go into specifics of housing affordability or issues of homelessness.

The research is based primarily on a qualitative approach, with an emphasis on interviews and focus groups. Discussions are based in a Western context, with the reservation that the addressed topics are contextual, and acknowledging the in some aspects unique prerequisites of the Swedish housing situation.

The focus of the work presented here, time-wise and publication-wise, has been on discourses within the housing market (particularly case area one, the urban redevelopment of Kvillebäcken in Göteborg, corresponding to papers I and II). In addition, discourses among researchers in a particular research project focusing on new technologies, materials and spatial structures to radically reduce residential resource and energy intensity (case area two, the SusLab NWE project which Chalmers is part of), and elaborations of educational approaches in relation to a planned experimental housing facility (HSB LivingLab, corresponding to paper

III), are explored in order to see how a sustainable housing development is perceived and driven in academia. Continuous observations of policy discourses furthermore enrich the discussion, and contribute to the on-going research, where residents' perceptions provide additional material, not presented in the scope of this Licentiate.

1.4. THEORETICAL PERSPECTIVES AND CONCEPTS

1.4.1. Ontological starting points

If looking at Popper's (1972) notion of falsification as a way of approaching the truth, the concept of verisimilitude, 'truthlikeness', and what is certain can be perceived from an absolute perspective or from a social-constructivist point of view (Berger & Luckmann, 1966), where the constructs of certainty or truth are relative to the positioning and the context – and thereby do not exist outside of that, in a vacuum. Ontologically, from a constructivist stance, it is here proclaimed (or rather maneuvers within the notion or acceptance) that there are multiple socially constructed realities, shaped by issues of injustice (social and factual), power balances or political justifications, and human discrimination. This Licentiate work relates to critical theory in that it is reflexive, and more or less clearly accounts for its own social origin and purpose, in the acknowledgement and aim to address ideological barriers and perceptions (Groat & Wang, 2002).

The 'objectiveness' of [positivistic science] research is that there is such a thing as truth even when no one has yet defined it. This thesis is more interested in the *concept* of truth, which by definition is the formulation about the thing or phenomenon in question – not the actual thing (of course, this relates to Heidegger's 1967 inquiry of "thingness", yet it is important to state that the work presented here does not ascribe to phenomenological thought). Perhaps this is part of the research paradigm architectural research finds itself in, where the formation, criticism and reformation of something is as intriguing and applicable a research topic as the actual something.

By engaging in mainly qualitative research, questions of validity are nonetheless relevant to reflect briefly on. Validity is in this thesis conceived in the context of 'construct validity' (Kvale, 1995), an understanding of the social construction of knowledge, and validation of outcomes among the research community.

> The present understanding of validity starts in the lived world and daily language, where issues of reliable witnesses, of valid documents and arguments, are part of the social interaction. (Kvale, 1995:21)

1.4.2. Key concepts and theoretical assumptions

A key term used throughout the thesis is *conceptualization*. This signifies an ability to visualize a yet abstract (simplified) thing or system. The conceptualization of home, as it is used here, entails the understanding, perception and imagery of *home* - itself a complex concept (further explored in chapter 3), but also the process of formulating concepts into a physical form. Entailing both vision and present interpretations.

Throughout the thesis, the terms of *housing* and *dwelling* are used. These are distinguished from the concept of home both in abstraction and range, with housing referring to the physical and organizational structure of one or several dwellings, which in turn is used both in the sense of a place of residence and the act of inhabiting.

From the perspective of actor-network theory, an *actor* or 'actant' is defined in the active sense as someone or something that acts, or more passively, which others act upon (Latour, 1996). The term actor is here used to signify any entity (individual or organizational) participating in a process, here limited to housing development and processes of creating physical conditions for dwelling and or social meaning in the built environment. It is recognized that additional actors might be relevant to acknowledge, yet the focus here is on discourses within specific groups - with the reservation that other actors are to be covered in future research. *Discourses* are defined as the written and spoken expressions within certain groups of actors, but also the built environment, which forms a general frame of reference (Fairclough, 2010). The work is further based in theories of social *practice* (Bourdieu, 1977; Reckwitz, 2002), focusing on agency in daily life. This relates to precedent research on everyday, home-related practices and sustainability, particularly domestic resource use (Shove, Chappells, Lutzenhiser, & Hackett, 2008; Gram-Hanssen, 2011).

Sustainability (discussed further in chapter 2) is used to signify theories and efforts regarding the balance between environmental preservation and global social development. It is related to a belief in the need to reduce overall consumption of

resources, through a reduction in demand above all, and the importance of linking consumption to a socio-cultural dimension (Sanne, 2002; Thorpe, 2010). This ties into theories on an absolute decline in resource depletion and environmental degradation, the inadequacy of efficiency measures alone (Huesemann & Huesemann, 2008) and the problematic framing of progress in ecological modernization terms (Spaargaren, 2000; Jensen & Gram-Hanssen, 2008). Although financial implications of the housing sector are only briefly discussed, theories and criticism of de-growth - the equitable downscaling of both production and consumption, enhancing ecological conditions as well as human wellbeing in a longer time perspective - provide a basis for argumentation (Schneider, Kallis & Martinez-Alier, 2010; van den Bergh, 2011). Especially related to the resource and energy intensity of modern society and home environments as a facet of conspicuous consumption (Gram-Hanssen & Bech-Danielsen, 2004; Jackson, 2005).

1.4.3. Academic context

The conceptual aspects of home are regarded more or less explicitly within the housing industry and by those involved in creating the physical, legal or financial premise for dwellings. As the housing sector is governed by both explicit and implicit consensual ideals and oftentimes conflicting images, architects along with other making disciplines are in a position to visualize, give meaning, or perhaps most importantly – contend these sectorial norms in a larger perspective of policy, academia and the general public.

The concept of home is a general theme, not limited to architecture or the production of residential environments. Precedent research on home can be found within various other disciplines such as psychology, environment-behavior studies, sociology, anthropology and ethnology. This does not mean that the subject has been avoided within the realm of architecture; housing research is a large field where architectural scholars take part. In architectural practice it is however often viewed as closer linked to the physical, functional or aesthetic parameters of residential design, an unspoken, tacit knowledge. Nonetheless, home as a concept is a subject relevant to an architectural knowledge production in that the profession holds a key

understanding in the creation of residential environments, in a physical sense as well as in influencing the potential imagery and meanings ascribed to the built form.

This thesis positions itself in a still under-explored gap in knowledge between the disciplines occupied with either studying the concept of home, or the environmental consequences of lifestyle and residential environments, as illustrated in figure 3.

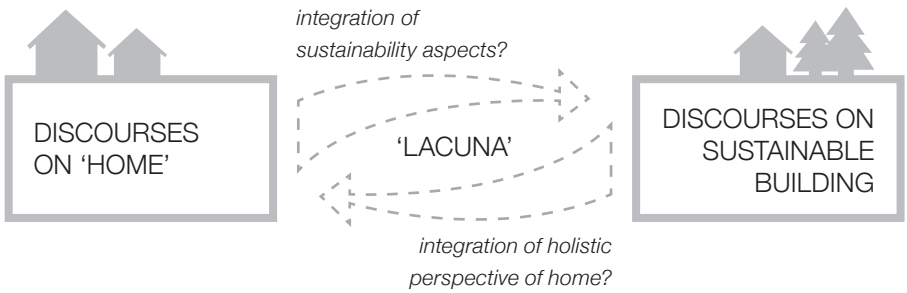


Figure 3. Focus of the research, the identified 'Lacuna' - knowledge gap

Within research on the meaning of home, the issue of sustainability and more specifically, the resource consumption linked to the image of home has not been of particular scholarly focus (Mallet, 2004). Even though social aspects of varying kind have been explored in numerous configurations, the subject of reevaluating or redefining home in relation to reducing resource consumption is, perhaps due to its politicizing nature, lacking. Sub-fields looking at environmental attitudes and the psychological deficiencies caused by deteriorating natural environments, for example eco-psychology, look at place attachment and home in relation to the threats posed to these, but does not to a full extent address the conceptualization of home as a key part in the environmental strain of modern built environment. Similarly, within sustainability discourses, the conceptualization of home appears underexplored in the development of resource efficient residential solutions. This Licentiate thesis is based in the perceived relevancy to provide more focused knowledge on the conceptualization of home in relation to a sustainable development of residential environments, with an emphasis on theoretical exploration, supported by empirical insights focusing particularly on the housing market and academia.

1.5. THESIS STRUCTURE

The thesis is structured into three main parts: an overview of precedent research and the current situation provides a theoretical framework (first part), complemented by initial empirical material (second part), and presented together with scientific papers relating to the research work (third part).

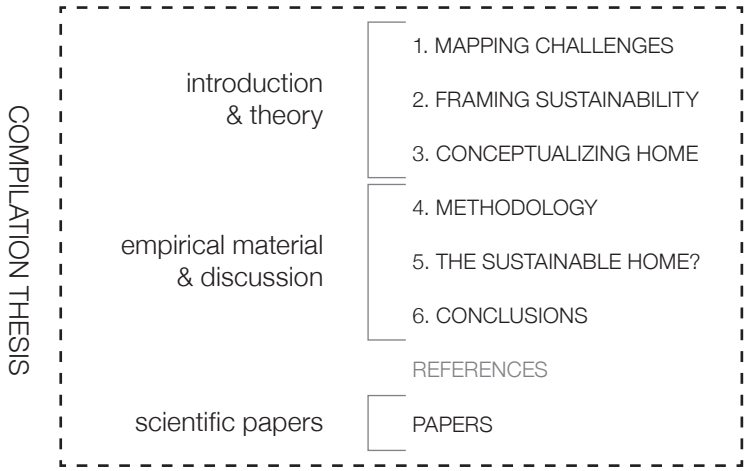


Figure 4. Structure of the Licentiate thesis

First, this introductory chapter is concluded with a summary of the papers. This is followed by Chapter 2, in which theoretical outlines of sustainability in housing are presented. The framing of sustainable development in relation to efforts within the built environment is described, and societal, environmental and household implications are explored. Chapter 3 presents a review of the research on the concept of 'home': the meaning and significance ascribed to home; norms, ideals and preferences related to housing development; and introduces an analytical model, placing discourses on home in relation to two main dialectics; identity-communality and need-desire, as well as a resource dimension.

In Chapter 4, on methodology, the approach and research design employed is detailed further. The cases that the research revolves around, are presented and the methods applied in the studies are recounted. Chapter 5 proceeds with a report of the collated results from the empirical studies, and discusses these in

relation to the theoretical framework and analytical model. Conclusions from the material presented in the Licentiate as a whole are then drawn in Chapter 6, outlining implications of the main findings and proposing recommendations for further research and particularly the forthcoming PhD thesis. A full bibliography is given, and finally the scientific papers complete this compilation thesis. Figures are original, by the author, unless otherwise noted.

1.6. SUMMARY OF PAPERS

Paper I: Paradoxes and Possibilities for a 'Green' Housing Sector: A Swedish Case

This paper is one out of two publications based on studies conducted in case area one - Kvillebäcken. Semi-structured interviews with representatives from the companies developing housing in Kvillebäcken provide the empirical material for this paper. The main research question posed revolves around the perceived drivers (and indirectly, also barriers) in a sustainable housing development. The paper indicates the paradoxical situation developers find themselves in. Theoretical and practical issues are discussed, relating to the unclear interpretation of a sustainable development within the housing sector, the terminology used, and the influence of different actors on what is built.

Abstract: As global and local visions for sustainable residential environments are increasingly supported by policies and concrete practices in construction, the Swedish building and housing sector is seeking to mitigate its environmental impact as well as assume a greater social responsibility. The overarching policy objectives set to concretize what a sustainable housing development entails however tend to rely on equivocal terminology, allowing a varied interpretation by key industry practitioners. Though in line with an ecological modernization paradigm in policy, the promotion of a market-driven environmentalism in housing faces multiple challenges as varying interests and perspectives collide. Supported by empirical findings of a semi-structured interview study conducted with housing developers in a new 'green' urban district in Göteborg, Sweden, theoretical frameworks surrounding the paradoxical path towards a sustainable housing development are presented. Inconsistencies between outspoken ambitions; social

dimensions; and the framing of efficiency in new housing are discussed. Possibilities for the housing sector are given in the recognition of new forms of development, where a systemic perspective is required in the alignment between how industry, policy and the market perceives housing development and what is actually sustainable.

Paper II: Sustainable homes, or simply energy-efficient buildings?

Originally written and accepted to the 10th European Academy of Design conference and presented by Hagbert in Göteborg, April 2013, the paper was then significantly rewritten and submitted to the *Journal of Housing and the Built Environment*.

This paper is also based on empirical material from the Kvillebäcken case and the interview study with developers, yet presents complementing parts of the findings, including the addition of valuable insights from a workshop with architects. Perceptions of residential sustainability and housing development among developers and architects in Kvillebäcken are further investigated, focusing on the physical form of the resulting dwellings. The paper focuses on the ambitions expressed in relation to what is being built, and discusses implications of current housing norms.

Abstract: Environmental consideration within the Swedish construction sector can no longer be considered marginal. It is here discussed whether the same commitment is extended to facilitate deeper dimensions of sustainability in the provision of housing, beyond simply energy efficient residential buildings? The paper presents the case of a multi-family 'green' residential area called Kvillebäcken, currently under development in Göteborg, Sweden. An empirical study is primarily based on interviews with the seven housing developers building in the area, and further complemented by insights from a workshop with architects involved in the project. Thematic issues identified in the inductive data analysis relate to household demand and spatial norms, as well as standards and notions of comfort. It is argued that the interplay between and overlapping of these aspects influences the creation of holistically sustainable residential environments, with a focus on implications of modern ways of dwelling. The paper shows that interpretations of sustainability in market-led housing development do not radically challenge the normative and resource intense contemporary ideals of the urban home, and that the realization of goals undertaken in the case of Kvillebäcken is generally dependent on economic

considerations and market assessments. In conclusion, the paper emphasizes the need to formulate an integrative approach to more holistic sustainable residential environments.

Paper III: Experiments in mapping human factors for sustainable design & living

This paper was co-authored with doctoral student Olga Bannova. A peer-reviewed abstract was presented by Hagbert at the IAPS (International Association for People-Environment Studies) International Network Symposium in A Coruña, Spain, in June 2013. After another peer-review process the full paper was accepted and published in a post-conference book in the spring of 2014.

The paper focuses on initial findings from user studies with students in case area two - the research project SusLab NWE, and the related planned HSB Living Lab facility. An educational approach to developing sustainable residential strategies and future professional practices is outlined.

Abstract: This paper explores architectural design considerations regarding challenges of sustainable living, drawing parallels to extreme environments, in relation to user-centered design research conducted by researchers at Chalmers University of Technology, University of Houston and NASA. It further discusses application in the context of a Sustainable Living Lab, to be built as student housing on the Chalmers campus. Extreme environments are here defined as places that pose significant complications and risks for people to maintain their usual everyday activities with a certain level of physical and psychological comfort. The research addresses the need for integrated solutions, and the conscious development of sustainable strategies based in an understanding of human factors and residential practices. The paper presents a theoretical and methodological background for a proposed experimental 'design/build/live' approach and results from initial studies with students on user perceptions and ideation. Findings indicate that an optimization of spatial or material use can be found for example in a reassessment of activities perceived as private or shared, as well as the spatial compatibility of different functions, informing the design of facilities and building systems, as well as social organization and demands for supporting systems. Perceptions on changing practices towards shared use, and the value of co-creation processes for enabling sustainable living practices are emphasized.

Paper collaborations not included in this thesis

Femenías, P., & Hagbert, P. (2013). The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living. *Technology Innovation Management Review* (November 2013: Living Labs), 15-21.

This paper was published in the TIM Review 2013 November special issue on Living Labs and presents a formulation of a strategy and rationale from an architectural perspective in the case of the SusLab project (case two). It discusses innovation in the housing sector and the development of new concepts of residing with a reduced resource and energy intensity, through the use of design experiments in a collaborative full-scale lab environment. The article has been selected for inclusion in an e-book in the "Best of TIM Review" series.

Mangold, M., Morrison, G., Harder, R., Hagbert, P. & Rauch, S. (2014). The transformative effect of the introduction of water volumetric billing in a disadvantaged housing area in Sweden. *Water policy 16*(3).

This paper presents research conducted by doctoral student Mikael Mangold. The paper discusses the social implications of resource sustainability interventions, specifically looking at individual metering and billing in a low-income residential area. This builds upon an on-going scholarly collaboration and research support between Mangold and Hagbert.

2. FRAMING SUSTAINABILITY

theoretical outline of sustainability in the built environment

This and the following chapter aim to provide theoretical outlines and a framework for the empirical material and discussion that is pursued in this thesis. In this chapter, four sections give a brief overview of the large field of sustainability studies within housing, but naturally not everything is covered. A more in-depth inquiry into issues of housing affordability are for example not given, but is nonetheless considered an important aspect to carry into the reasoning lifted in the analysis of the empirical material and discussion presented in chapter 5. The following sections address a general orientation within the field of sustainable development; an understanding of social aspects within the framing of sustainability in the built environment; the complexities of policy and building practices for 'sustainable housing'; and finally a deeper look into household consumption, lifestyle and home-related practices.

2.1. SUSTAINABLE DEVELOPMENT

Sustainable development is a broad term, offering multiple interpretations and applications in use today, also in sustainability science research (Wiek, Ness, Schweizer-Ries, Brand & Farioli, 2012). The definition used here is mainly based on the outline of this in essence political concept by Kates, Parris & Leiserowitz (2005), in referring to an equitable balance between what is to be developed (societal advancement), what is to be sustained (natural and social capital), and linking this to a time perspective. As expressed by Vanegas, DuBose, & Pearce (1996), the dynamics of sustainability requires flexibility among different actors. It also depends on a will to consequently modify approaches, as environmental changes, shifts in human needs and desires, as well as potential technological advances might alter the conditions. Contextualizing actions in a long-term perspective of uncertainty is one aspect - what is regarded as a sustainable strategy today might not be in the future.

While preservationist movements based a growing concern for the environmental impact of human endeavors in an ecocentric and 'deep green' advocacy (Merchant, 2005), current sustainable development discourses tend to take an anthropocentric perspective (Gagnon Thompson & Barton, 1994). With a post-colonial understanding (Loomba, 2005) of social development, the global community moved towards how to sustain this development within limited ecological boundaries.

For the research presented in this Licentiate thesis, it becomes a question of how human aspirations for development are set, and whether we have the tools in place to meet the current needs, let alone the needs of the future (WCED, 1987). We are not adequately meeting the pressing global housing needs of today, with almost one billion people living in slums, a number constantly rising (UN-habitat, 2014). We simultaneously see mortgage crises and real estate bubbles reoccurring on a regular historical basis (Agnello & Schuknecht, 2005), making a case for the unsustainability (in the literal sense suggesting an instability over a long period of time) of the way we build, manage and finance our homes in the 'developed' world spanning ecological as well as societal systems.

2.2. THE DESIGN OF SOCIETAL SYSTEMS IN HOUSING

The political concept of sustainable development stresses the centrality of societal implications. A demand on resources (energy, material and land), in both a direct and indirect sense, leads to conflicts on how these should be extracted and distributed on both global and local scale (Martinez-Alier, Kallis, Veuthey, Walter & Temper, 2010). This entails an examination of the current organization of societal systems and discourses on social development. The following sections in this chapter offer support that environmental considerations are addressed to various extents, yet a social dimension of sustainability is often overlooked (Vallance, Perkins & Dixon, 2011; Jensen, Jørgensen, Elle, & Lauridsen, 2012).

The societal development dimension is debated - as is of course the need and rate of environmental preservation. One way of approaching a definition is to lift two main aspects; a welfare perspective as well as the long-term sustainability, or problem solving capacity, of a society (Wistrand et al., 2011, Olsson, 2012). Basic concepts such as equity, participation and social cohesion, and awareness of sustainability as a whole are often used (Murphy, 2012), or more straightforwardly grouped into 'development sustainability', 'bridge sustainability'[1] and 'maintenance

1 Lifestyle and social change aspects can be linked, or 'bridged', to potential synergy effects in environmental sustainability.

sustainability' (Vallance et al., 2011). Social sustainability can also be seen as the process of development within communities itself, that ultimately supports a positive, harmonious social condition (McKenzie, 2004). The right to adequate and affordable housing and the development of sustainable residential environments is increasingly recognized as an imperative task in mitigating environmental degradation and strengthening social capital (Maliene, Howe & Malys, 2008). Yet definitions and indicators of a socially sustainable development of the built environment are hard to identify (Lindén, 2007).

In an increasingly market-oriented society, property development tends to focus on wealthier socio-economic segments (Hedin, Clark, Lundholm & Malmberg, 2012). The current market system could from this perspective be identified as a linear resource-growth model, where complexities of socio-technical transitions are simplified to an assessment of willingness to pay for 'green' solutions. Mainstream measures for sustainability should be understood in the context of middle-class norms (Bradley, 2009). The type of paradigm shift going from a linear to a cyclic way of thinking that Vanegas et al. (1996) call for is then a major challenge not only in regards to technological advances in the housing sector, but also the social structures behind or brought on by them.

Social sustainability in urban planning is often envisioned as the attractive, 'livable' city with diverse and functionally mixed environments. The social and functional monocultures of the industrial housing boom in many European cities are thereby dismissed in favor of mixing housing of various types, sizes and forms of tenure, as well as residential and commercial functions (Dempsey, Bramley, Power & Brown, 2009). Through socio-economic diversity among households, the intention is to spur local and social opportunities as well as counteract urban segregation (Barton, 2000).

Discussed in terms of 'bridging' social and ecological sustainability, the importance of social interaction, resident engagement and community support in the immediate residential environment is often upheld, as well as aspects of stability and safety (Dempsey et al., 2009; Vallance et al., 2011). Besides socio-economic development, mixing functions and allowing for a larger freedom of choice in

settlement is also suggested to have a potential to reduce transportation needs, thereby further minimizing environmental impact (Barton, 2000). The success of such deliberate planning and design for social mixing, and the intended outcome of increased social capital, is however inconclusive (see for example Buys, Godber, Summerville & Barnett, 2007).

2.3. A LOW-CARBON/LOW-ENERGY BUILT ENVIRONMENT?

An assumed decrease in easily accessible fossil fuels, points towards finding alternative strategies to uphold current industrial expansion (Murphy & Hall, 2011). This calls for a transition to renewable energy sources as well as an overall reduction of energy demand, while still enabling global opportunity for social development. Carbon emissions from buildings are expected to increase significantly if nothing is done (IPCC, 2014), relating to increased wealth, lifestyle changes and urbanization.

Environmental consideration has over the past decade increasingly been part of the general agenda in the Swedish building sector (Gluch, Gustafsson, Thuvander & Baumann, 2013). In part, these efforts are driven by anticipated EU wide regulations regarding energy performance, along with national goals for energy use in new buildings and environmental preservation, and local policies in metropolitan areas trying to steer development. The building industry has lobbied for streamlined regulations and the disbandment of such specific local requirements (Brogren & Wellhagen, 2012). The reassessment of municipal ambitions in favor of a national revision of environmental targets in new buildings is outlined in a government report (Hedlund, 2012) as well as by the Minister of Housing (Attefall, 2013).

Adopting a life cycle perspective is set as a key task in order to mitigate carbon emissions within the sector (Malmqvist et al., 2011). The discourse on 'sustainable housing' indicates a belief in the creation of residential environments with a lower impact on global climate change (Lovell, 2004). Eco-efficient innovation in building performance and a belief in optimization is anchored in a widespread belief in technical solutions. This is also to a large extent conveyed to the public. According to Gifford (2011) a belief in 'techno-salvation' can however act as a barrier to instigating pro-environmental behaviors that minimizes further strain on resources.

Barriers to 'green' building practices are not necessarily found in technological advancement, but have been identified on individual, organizational or institutional levels, involving all actors, ranging from limitations in terminology used to regulative obstacles (Hoffman & Henn, 2008). Critics of growth-based development argue that efficiency and technology alone are not enough to solve present and upcoming challenges of ecological preservation (Huesemann & Huesemann, 2008; Turner, 2008). Working with for example policy addressing the rebound effects of energy efficiency measures highlights a need for parallel efforts (van den Bergh, 2011).

Lifestyle and behavior changes in developed countries are assumed to be able to significantly reduce energy use in buildings (IPCC, 2014). Moving beyond technical solutions nonetheless remains an essential challenge in a prevalent building industry and research perspective (Schweber & Leiringer, 2012). The same applies to an ecological modernization paradigm of internalizing externalities - associating consumption with a price - in order to reduce household resource consumption (Spaargaren, 2000; Jensen et al., 2012). The question is whether low-energy and "green" housing actually equals less energy and resource intense ways of dwelling?

2.4. HOUSEHOLD RESOURCE CONSUMPTION

2.4.1. Environmental impact of households

Domestic resource and energy use constitute some of the challenges in the aims to meet targets for reduced emissions and to avoid extensive resource depletion. 'Housing and services' accounts for about 40% of the total energy use in Sweden, mainly in terms of heating and hot water (Energimyndigheten, 2013). The demands of a modern dwelling and lifestyle go beyond the resource intensity of the residential buildings themselves, corresponding to societal factors and norms. On a residential level, consumption of household goods and home improvement, resource-intense residential practices and the view on private versus shared space and functions, convey a normative discourse and perception of households' demands and needs.

To reach an environmentally sustainable residential development means finding ways to reduce household consumption in absolute terms, in alignment with arguments that we need an overall reduction of all consumption of resources,

whether it be renewable or not (Vanegas et al., 1996; Jackson & Michaelis, 2003). This statement is becoming generally accepted among those engaged in the field. That it further points towards the need for a reduction of consumption *per capita*, in order to allow for more equal distribution of available resources is however perhaps perceived as more controversial. Despite advances in efficiency in the building process and operation phase, an absolute reduction of resource consumption is still needed. With the improvement in efficiency per square meter, a rebound is instead seen in the production of more square meters, and an increase in residents' demands (Vale & Vale, 2010). While the average space per capita in Sweden has grown during the 20th century (SCB, 2012), we are still faced with a housing shortage. As the Easterlin paradox discusses the correlation between economic growth and happiness (Easterlin, 1995), it would perhaps be just as interesting to relate this to housing, square meters per capita and well-being (Moser, 2009). Or as Jackson (2005) puts it - how to solve the sustainability riddle of "living better by consuming less".

A growing individualism in society puts focus on the above outlined issues. Across Europe, shifting demographics and an increasing number of small households put strain on existing and future housing resources (Clarke, 2004; Kabisch & Haase, 2011). This has implications for absolute resource demand, both directly and indirectly (Liu, Daily, Ehrlich & Luck, 2003).

2.4.2. Lifestyle and sustainable home-related practices

Lifestyle and behavior are identified as important indicators of residential energy and resource use (Gatersleben, White, Abrahamse, Jackson & Uzzell, 2010; Sunikka-Blank & Galvin, 2012). How we inhabit our homes and the significance we give them (as explored further in chapter 3), is a part of how we formulate an understanding of the world and ourselves in it. Kennedy & Krogman (2008) point towards social practice theories in understanding and changing lifestyles and routines in favor of more sustainable residential practices. By analyzing everyday practices and activities within the home, we can build an understanding of energy and resource use (Aune, 2007) as well as how we can adapt to, and drive policy and housing development that more adequately considers a global resource perspective.

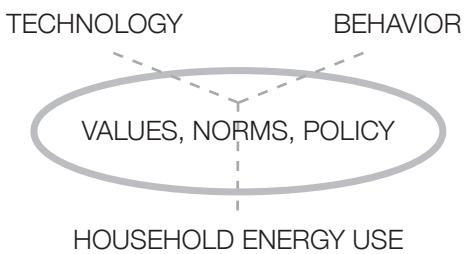


Figure 5. Understanding factors of household energy use

Several aspects are brought up in the attempt to understand and promote pro-environmental behavior (Steg & Vlek, 2009). Abrahamse, Steg, Vlek & Rothengatter (2005) describe the range of precedent research on behavioral interventions targeting specifically household energy use, categorizing them into two strategies: antecedent and consequence. These could be compared to 'upstream' or 'downstream' interventions for breaking habits, as suggested by Verplanken & Wood (2006), where working with for example legislation is compared to measures such as informational campaigns. Abrahamse et al. (2005) suggest combining strategic interventions on different levels to reduce energy use. As technological, societal, financial and cultural changes can inform the ability, motivation, and opportunity for individual action, it is important to acknowledge all aspects.

Lockton, Harrison & Stanton (2008) address the role of design in the approach to change practices, emphasizing the need for this type of strategic thinking to be extended to all stakeholders working with sustainable innovation. In order to radically reduce energy and resource use, the development of efficient technology or targeting individual perception and ability is only one aspect when discussing how to strategically challenge the impact of household consumption, as a product of residential practices rather than an origin of them (Strengers, 2009). According to Lockton et al. (2013), 'energy use' is a rather blunt term, in that people rarely set out to use energy, but that it "is a side effect of solving everyday problems". How residents' understand and conceptualize energy in the home environment is for Lockton et al. a relevant question in order to inform design solutions that can help reduce the energy it takes to fulfill these needs.

3. CONCEPTUALIZING HOME

theoretical outline of the meanings and ideals of home

This chapter builds upon chapter 2 in providing a theoretical outline for the thesis. The chapter consists of four sections. The first three give a review of precedent research on the meaning attributed to home; the commodification and material intensity of home; and the constructs surrounding the ideal home. A final section presents an analytical model that serves as a point of departure for investigations regarding a conceptualization of the sustainable home that are only started in this thesis, but that also provides a basis for further work.

3.1. THE MEANING AND SIGNIFICANCE OF HOME

In contrast to a positivistic strive for established scientific definitions in concrete and verifiable terms (Popper, 1972), architectural research, depending on the topic, rarely uses the notion of an outspoken set of laws [of nature] as a main point of departure. Seemingly 'abstract' constructs such as home do pose a difficulty in testing knowledge relating to this topic quantitatively. A perception of abstraction further suggests a lack of one 'true' common definition that is generalizable and replicable in a Cartesian sense (Wang, 2006). Yet such constructs hold a dynamic measure, that is here argued to be of value for knowledge production in a global age, where the *why* of human endeavor is as justified a question as *how*.

Home has and continues to be an influential part in human interaction, ranging from the physical manifestation of the concept in built form, to social constructs and theoretical platforms surrounding it. The meaning and experience of home has been a subject of inquiry in various fields during the past decades. Home has been explored from both an individual interpretive and societal constructivist perspective (Després, 1991; Birdwell-Pheasant & Lawrence-Zúniga, 1999; Moore, 2000; Manzo, 2003; Mallett, 2004). Although few truly integrative interdisciplinary approaches can be found in earlier research (Després, 1991), recent work bridges the divide between various scientific traditions in shaping an understanding of peoples' relationships to their residential environments (Perkins, Thorns, Winstanley & Newton, 2002).

3.1.1. Home as individually interpreted or commonly constructed

Personal connotations of home are used to describe or define various aspects such

as home, at-homeness or homeliness at different times and scales. Addressing the imprecision of the concept, Rapoport (1995:25) questions the development towards:

> "vague, subjective, and emotive terms in ways that can mean whatever users want them to mean at any given moment."

In this respect, home is oftentimes used too broad and too liberally, as Rapoport suggests dropping it in favor of other terms or concepts that more appropriately articulate intended expressions with less ambiguity.

The dynamic nature of the concept could however be argued to be of an evolutionary value, if understood to encompass a complexity of dimensions in the form of people-place relationships (Manzo, 2003) and cultural expressions. Applicable in seeking to [re]conceptualize home from a resource perspective, questions arise that deal less with particular individual interpretations and more with the collective image of home as it is conceived, portrayed and upheld.

Saunders and Williams explore home as the vital interface between society and the individual; "the crucible of the social system"(1988:85). As a socio-spatial entity (Easthope, 2004), socio-psychological interpretation (Després, 1991), or contextually based social dimensions (van der Klis & Karsten, 2009; Tester & Wingfield, 2013), the understanding of the meaning of home to link society, social relationships and household proposes socio-cultural constructs that inform and are informed by notions of identity and well-being, along with the material and structural properties of people's homes. Considering underlying societal factors of the representation of home is essential for the assumptions made here. In this aspect, the larger socio-political milieu in which home is part of (as underlined by Manzo, 2003), parallels the personal and emotive meanings of home, as they are understood and portrayed in subjective individual definitions.

3.1.2. Conceptualizing home as a societal expression

By studying the processes surrounding home as a conceptual and material entity in both research and practice, the influence on the environmental debate brings the potential for new perspectives and negotiations of home as an expression of societal

values and attitudes (Benjamin, 1995). Furthermore, this also relates to the negative and contrasting experiences of home (Moore, 2000; Manzo, 2003).

Connotations of the 'good home', as created by market, media, research and policy – inform the general opinion in relation to these various discourses. The variation in subjective individual definition of home is in this perspective to be regarded as secondary to structural and organizational prerequisites, and a normative understanding of the current housing situation (especially in a Swedish context of shortage). However, individual interpretations are not to be overlooked, as they serve as a reference for how mainstream conceptualizations and social constructs of home are discussed, manifested and subsequently to what extent they are contested in various discourses as well as in the built environment.

Within previous research on the meaning of home, an ecological dimension has not been of particular scholarly focus (Coolen, 2006). Socio-cultural implications, and especially issues of deprivation of home have on the other hand been subject to more extensive research (Perkins et al. 2002; Chiu, 2004; Kellett & Moore, 2003). It is here argued that to explore the concept of home in relation to the environmental and social impact of current housing development is key in understanding how we can adapt to and drive policy and practice that more adequately consider a global resource perspective, in accordance with the research of Chiu (2004), Gram-Hanssen and Bech-Danielsen (2004), Støa (2008), Aune (2007), among others.

3.2. HOME AS A RESOURCE INTENSE COMMODITY

Relating to norms of the 'good home', natural or social resources compete with perceived value in short-term financial gain. The ideals of home, such as comfort, imagery as identity, or financial attribution have both an indirect and direct impact on resource demand. The finiteness of global resources in absolute terms however calls for a decrease in relative demand. Without infringing on the emotive and societal assets of home, this would suggest exploring the construct of home in relation to these absolute limitations.

With the rise of capitalism and the industrial age, conceptualizations of dwelling and house came to represent and subsume new politico-economic and techno-social

ideas. As the domestication of the word home also shifted the general meaning from native place to refer to dwelling or house, concepts were entangled (Moore 2000). The concept of the domestic home can be said to have developed from and with industrialist movements, evolving into the comfortably efficient Modern home still perpetuated as the ideal, where Bourgeois principles of intimacy and privacy mixed with the technological advances and rationalization of the 19th and 20th centuries (Rybczynksi, 1986; Benjamin, 1995; Moore, 2000). The idea of domesticity largely replaced pre-industrial community-oriented connotations with an in some respects introvert, family-oriented commodification of home.

The home has come to symbolize both individual and cultural identity, where physical needs are weighed against social and emotional aspirations embedded in the concept (Gauvain & Altman, 1982; Lawrence, 1987; Hauge & Kolstad, 2007). This perception of need and/or desire, with a normative conceptualization of home as meeting a range of personal and social demands, makes up an important part of how environmental, structural, legal and social preconditions are addressed and accepted in the context of home.

The emotional properties of the concept, as personal interpretations of the meaning of home, can be seen as imaginary representations (Mallett, 2004). As the image of place gains importance (Easthope, 2004), an awareness of this imagery relating to home is not only noticed in household consumption and home-related commodities (Gram-Hanssen & Bech-Danielsen, 2004), but also in the very construction and sense of home as a commodity – an emotional, social or restorative "product". In a globalized economy these representations, underlying collective definitions, and manifestations of home extend with political and financial structures. In the context of emerging economies, where an intensified use of resources is tied to financial development, Rapoport (2008:28) observes;

> "as the resources available increase even housing becomes less culture specific. /…/ with prosperity images of modernity and of difference (which currently are those of US suburbia) begin to dominate..."

The way home is commonly represented by media and advertising in a Western

politico-economic context emphasizes material properties through consumption and private ownership. The relation between home-ownership and place attachment, feelings of at-homeness, has however been found to be weak (Windsong, 2010). The framing of housing itself as a commodity is obvious in the current housing market, yet made all the more clear through the interlinkage of mortgaging structures and financial systems on regional as well as global levels. The cyclic nature of housing bubbles (Agnello & Schuknecht, 2005) emphasizes the limitations of a market interpretation of housing to be anything but another facet of the built environment in terms of investment, revenue and demand/supply. A perspective on housing as a human right is thereby, and can in this interpretation only be, disregarded.

An emphasis on the material dimensions of home is further underlined by van der Klis & Karsten's (2009) work on the meaning of home among commuters. Yet as Tester & Wingfield (2013) explores, the meaning of home should also be understood as contextual, proposing that although it is constructed using the same aspects as commonly reported in precedent research, residents in public housing emphasize the social dimensions of home, suggesting other dimensions to be subordinate.

3.3. DEMANDS AND DESIGN OF THE 'IDEAL HOME'

3.3.1. Housing preferences and comfort

The topic of housing preferences is one area of housing research that continues to be well pursued (Coolen & Hoekstra, 2001). The mapping of preferences among current and future residents is also a major task among companies working within the housing market, with everyone from architecture firms, housing associations to construction companies conducting extensive surveys, market assessments or trend analyses, often by help of third party consultants (such as Tyréns, 2012). The representativeness of preferences are complex, partly in the distinction between stated and actually revealed preferences and choices in housing (Coolen & Hoekstra, 2001), but also the target groups and types of residents encompassed by market assessments (as suggested by Manum, 2006, in the context of Oslo, outlining the dissonance between the supply and the actual demand of the large groups of residents not visible in the housing market). Willingness to pay is used as a measurement (Tyréns, 2012),

although does not explicitly relate to human needs and motivations beyond financial prioritization in a current market system.

A question is by extension also how useful preferences are in saying anything about actual quality in the home environment, which in itself can be argued to be a relative term. Moser (2009) for example points out that overall residential satisfaction is to be understood as a complex overlay of factors, where a strong social connection to a neighborhood might overshadow subpar individual physical conditions. The human ability (or inability) to adapt is an interesting topic to explore further, and provides a baseline for explorations in sustainability, yet also proves a challenge in moving towards sustainable practices (Gifford, 2011).

A modified hierarchy of housing needs (as according to Lawrence, 1987) brings in aspects such as comfort, socialization, self-expression and aesthetics along with notions of shelter and security; factors connected to the well-being of home. These factors are conceived to fluctuate over time, where needs established (and fulfilled) at one point might become unsatisfactory later. Notions of comfort, convenience, and expected material standards, should furthermore be connected to a normative context (Wilhite et al., 1996; Shove, 2003; Shove et al., 2008), where social structures, individual differences along with 'objective' measures influence perceptions of overall comfort.

3.3.2. Status, individuality and trends

Social status, as an element of human motivation, is particularly explored in social psychology. Moser (2009) references the WHO definition relating quality of life to people's notion of standing, in relation to the larger societal systems of which they are apart, along with individually conceptualized aspirations, hopes and considerations. Although some universal minimums are set on a global level, such a perspective of relativity entails that the individual and/or societal frame of reference is key in how and when personal expectations and social comparisons are met. Although relating to car use, Steg (2005) provides a categorization of instrumental, symbolic and affective motives that are relevant to regard also in discourses on home, with status being one key factor of choice, as well as dimensions of conspicuous consumption.

Home as a social arena presupposes as well as enforces the formulation and perception of cultural ideals and discourses on home. The particular representation of status through individual possessions is of a communicative nature, where the comparative element of identity in this respect assumes a distribution in available resources to distinguish the self, or the group, from the larger societal context. Although social standing is judged in multiple ways depending on context, physical and locational realities suggesting socio-economic or cultural distinction from others are acknowledged in the perception and reflection of identity, with resource implications on a residential planning scale (as explored by Stedman, 2002; Gram-Hanssen & Bech-Danielsen, 2004; Hauge & Kolstad 2007).

The meaning ascribed to home as being able to act upon and modifying one's dwelling (Després, 1991) is supported in contemporary Swedish trends, outlining the importance for residents be able to "make their mark" on their dwelling and pick individualized options (Tyréns, 2012). The home as a center of activities (Després, 1991) is further connected to the identified patterns of daily activities as well as the social dimension of these activities (van der Klis & Karsten, 2009). The kitchen is particularly perceived as encompassing the social dimensions of home, where the reported demand for a personalized kitchen - yet one that is large enough for socializing - is also pointed out as something people are willing to pay for (Tyréns, 2012). The open floor plan is framed as an ideal in contemporary housing development (Willén, 2012), yet the limitations in use begs the question of for whom these dwellings (specifically apartments) are built, and the notion of majority or minority preferences (Manum, 2006), as well as implications for building performance - where good sound insulation is reported as important (Tyréns, 2012).

3.4. AN ANALYTICAL MODEL

Based in the theoretical material presented here, some conclusions regarding the focus of precedent research, contemporary practices, interpretive meanings and industry discourses on home are made. This section positions the thesis in the theoretical development put forward. This is also explored vis-à-vis the empirical material presented in the next part of the thesis. An analytical model, illustrated

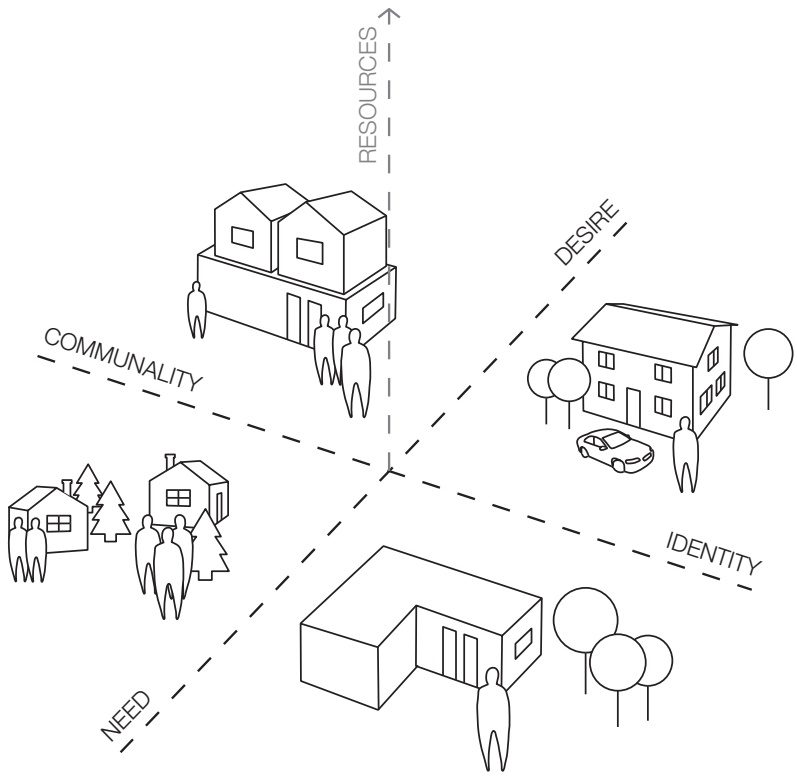


Figure 6. Placing interpretations of home in relation to prevalent dialectic & resource dimensions

in figure 6, provides a point of departure for placing and potentially informing the discourse on the sustainable home, as a framework for reflecting on what aspects and contradictions between different dimensions of home appear important to consider.

Two dialectics identified in the theory on home, outlined in the previous sections of this chapter, are here explored more in depth. These reflect the understanding of home from a social, cultural and political viewpoint, as well as in a motivational, emotive and individual sense. The first is the interplay of the physical 'needs' of dwelling and the social and emotional aspirations, or 'desires', embedded in the concept of home, based on Maslow (1954). The second implies the tension and mutual assumption of an individualistic symbolism of home as self-identity, yet relating to a cultural communality and social identity as expounded by Gauvain et

al. (1982). Discussing these two dialectics in a resource perspective, this Licentiate explores a new formulation of theoretical knowledge and empirical insights within this model, to also serve as a basis for further research.

3.4.1. Need and desire

To understand the needs connected to the concept of home, basic assumptions are made concerning how activities and functions connected to dwelling are prioritized, valued and accessed. In Maslow's (1954) hierarchy of needs, pure necessities for human survival are separated from higher aspirations or desires, suggesting that when lower level needs are satisfied, new level needs become salient. Housing as a physical reality and home as a cognitive concept could more or less be analyzed respective to all of Maslow's levels, although contemporary global housing discourses range from settling the primary needs of billions of people living in what is universally (in a Western-normative understanding) deemed sub-standard conditions, to residential speculation and home-related consumption alluding to fulfilling higher motives.

While Maslow's original model of human motivation has been criticized and developed, it serves as a backdrop for a discussion on where in a need/desire dialectic we place a sustainable conceptualization of home. The Brundtland definition of sustainable development (WCED, 1987) speaks of a dimension of human development with both social and financial connotations. Current understandings of this development promote a 'green economy', which assumes that human motivational forces to consume are central (business as usual fitting Maslow's outlook in a mid 20th century consumer boom era). This neglects measures of self-transcendence beyond the hierarchy of needs. A part of the deep green environmentalism movement advocates a more or less enlightened state of post-consumerism, possible to extend to the commodity of home and the spatial and material norms implied.

As suggested by Max-Neef (1992) in his human development model – rejecting a linear hierarchy – satisfiers should be differentiated from needs in that for example shelter is not a need per say, but rather a satisfier of the need for "subsistence". In this perspective, home could be understood as a satisfier meeting several of the identified human development needs, but not necessarily in the physical manifestation of

housing. Much of contemporary design (practice and theory) struggles with a supposed conflict between perceived need, practical circumstances or functionality, and desire - often conceived as a 'higher' concept (the desire of the designer or the desire of the user materialized or remaining metaphoric). These normative terms reflect a societal differentiation between demand, or motivation driven by 'necessity', and pursuits driven by constructs 'beyond pure necessity' - human exploration if you will. Weighing needs against desires and giving them shape and organization is fundamentally what adds complexity to architecture and the built environment.

This is relevant to a resource dimension, as there is not a clear delimitation in what constitutes a "basic need" or "higher aspiration" in the discourse on the human development dimension of sustainability, where satisfiers do not per se equate resource and energy consumption, but are often normatively portrayed and reproduced as such[1]. By re-conceptualizing home (cognitions connected to home as a mental construct) rather than housing (home consumption and physical structures) in this context, the dialectic need/desire is increasingly relevant to consider.

An essential issue is the persuasion of the continued satisfaction of expanded aspirations. The parts of the global population whose most fundamental needs have been met would seen in Maslow's motivational logic be as prone to expand on human development needs as those lacking basic forms of shelter or secure tenure, leading to a subsequent exponentially larger demand on resources needed to fulfill these. This becomes problematic as individual needs and desires even in an individualistic society are weighed against those of the group or community in the light of global environmental and social implications of residential ideals.

3.4.2. Identity and communality

Gauvain & Altman (1982) explores the social-physiological features of homes and the opposing interests of guarding one's individuality against external pressure, while simultaneously seeking belonging. This further emphasizes home in the

1 This could be compared to the perspectives on household resource consumption as a consequence, not an outspoken intent of home-related activities, put forward in 2.4.2.

shaping of identity, both in relation to self and to social or cultural identification. The commonly constructed meanings of home to reflect one's own ideas and values, as well as an indicator of personal status (as outlined by Després, 1991) display this relativity. Formed in relation to the external, the identity of home is created within and in tension with place, the built environment and the manifestation of embedded social constructs. When relating to home, this suggests going beyond the physical specifics, as a repository for meanings attributed to the objects and activities of home (Després, 1991). The importance of home to both individual and collective identity is multifaceted. Additionally, as socio-emotive factors inform spatial activities, these activities in turn inform the way home environments are shaped. This raises the question of how abilities to actively shape environments to express collective or individual identity are restricted due to various social and economical barriers, and how constructs of power and discrimination limit the distribution of resources.

To widen the engagement and understanding of home in people's relation to their immediate environments as well as the collective, the place of home as a component of communality becomes relevant. In an era of increased global uncertainty, the notion of place coherency is however challenged, considering both economic and climatic changes of physical realities along with the societal organization of established place (Easthope, 2004). A globalized notion of self translates also onto the concept of home, polarizing as well as allowing fluency, where countermovements turning both towards and away from conventional conceptualizations of home can be found. It is relevant to study what this mobility and new types of 'creative nomads' means in terms of resource intensity. A shift from the bound dwelling to a dynamic placing of self, community and home -related functions in multiple interchangeable locational contexts is not naturally equated with a communality or shared resource use.

If spatiality of place diffuses in a globalized world where social relations are expanded, the "placeness of home" in a similar manner becomes more systematically dependent on such place-related notions as community (analog or digital), financial allocation and politico-ideological constructs. This implies varying levels of resource and energy intensity in placing home within the communal or the individual appropriation of resources as enforcing identity.

4. METHODOLOGY

research design and methods

The Licentiate work should be understood as a series of pilot studies, exploring qualitative research methods (Alvesson & Sköldberg, 2009) in order to approach the research question and whether or not the previously outlined knowledge gap is in fact 'researchable'. The empirical results presented in the next chapter of this thesis are based on two parallel areas of investigation, and the corresponding studies that were conducted. The methodological framework with which this research was approached is described in the following sections, along with a more detailed account of the studies conducted.

4.1. RESEARCH DESIGN

The purpose of the research presented in this Licentiate thesis, as previously discussed, is to explore and give a descriptive account of a contemporary conceptualization of the sustainable home, mapping challenges and potentials. This is done through examining various perspectives on and interpretations of sustainability in residential environments, focusing on analysis of discourses (Johnston, 2002) among relevant groups of actors, illustrated in particular cases. The intention is to build upon this in further PhD work, in order to offer a prescriptive narrative of alternative conceptualizations of home, incorporating holistic strategies for the development of sustainable residential environments.

In design research it is relevant to explore an interpretative research process, often by abductive reasoning (as discussed by Martin, 2009). This approach has been

Figure 7. Empirical and theoretical development

employed here, where the act of wondering - typical for critical thinking - precedes observations, challenging paradigms of what research is and could be.

Through continuous theoretical analysis of the research material (topical discourses and empirical insights included) as well as literature review of precedent

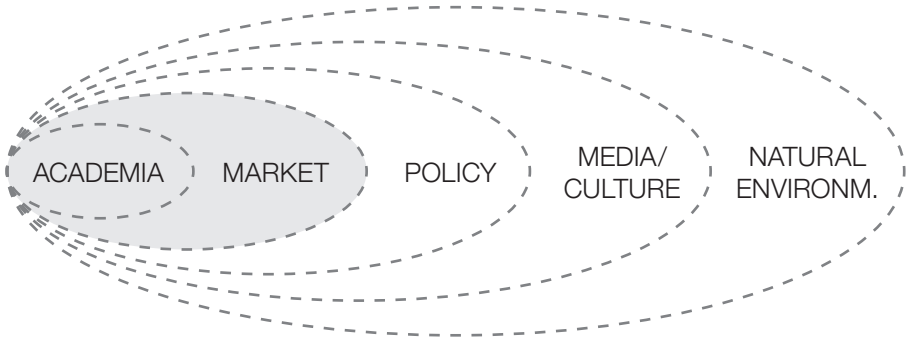


Figure 8. A quintuple helix model of knowledge creation, adapted from Carayannis et al. (2012)

and on-going research, a broad perspective was sought. Positioning the thesis in a 'quintuple helix' understanding of knowledge creation (Carayannis, Barth & Campbell, 2012), discourses within industry - here framed as the housing market (case area one) - and academia (case area two) are explored to formulate an account of contemporary [sustainable] housing development. An overview of discourses within policy, as well as general culture and media based public discourses also provides a basis for discussion, although is not represented in the empirical material. Precedent research on media representations of sustainable building (Femenias, 2004) is furthermore acknowledged.

A theoretical background and state of the art of the field takes departure in previous work on the concept of home (Hagbert, 2010), outlined in the previous chapters. The ambition for this Licentiate was to build upon previous research skills by undertaking and testing a myriad of methods. By diagramming the research design in accordance with Wang (2007), ways of knowing - the strategies used - and the tactics for arriving at this certain way of knowing are mapped. In figure 9, the primary strategy is set in a rectangle, while meta-tactics – informing clusters of research tactics - are shown in circles. The tactics used to explore two case areas are presented. The focus on 'market' discourses in the particular case of Kvillebäcken, described in section 4.2., was given significantly more time than the case within 'academia'. Cases were used to give relevant snapshots, rather than to generalize results (Ragin & Becker, 1992).

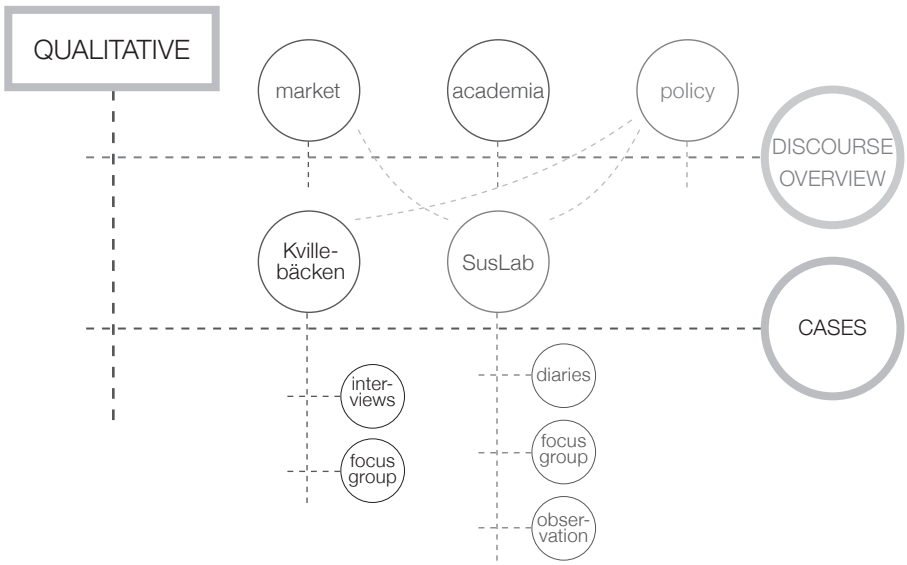


Figure 9. Diagram of research strategy, based on Wang (2007)

4.2. CASE AREA 'MARKET'

4.2.1. Context: Kvillebäcken

The case of Kvillebäcken is considered relevant for studying the discourse among actors within 'the market' (here delimited as housing developers, real estate companies, consultants and others involved in shaping the built reality of the housing market), as it is an on-going development, branded as a "new green district".

Within the next few decades the center of Göteborg is envisioned to expand across the river Göta Älv incrementally, mainly on renewed brownfield sites. Kvillebäcken, which provides the case for the first empirical insights (corresponding to papers I and II), is one of the early developments within a larger general plan. The project is run by a consortium consisting of the seven developers - privately or municipally owned - as well as the municipal owned development company Älvstranden Utveckling AB, together with the municipal planning office.

Upon completion it will comprise of 2000 apartments in a central urban location, making it a significant example of the contemporary understanding of sustainable urban development. The previous miscellaneous low-rise small-scale industrial

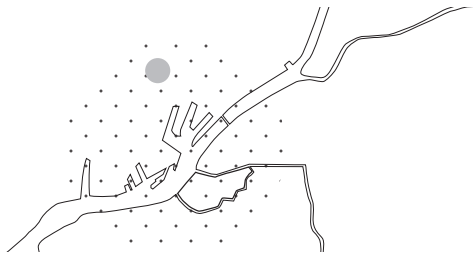


Figure 10. Kvillebäcken (grey) in relation to the river & future expansion of the city centre (dotted)

character of Eastern Kvillebäcken was demolished and a new grid structure master plan established, split into four phases of execution: three residential and one business phase. Each developer has been allotted a part or set of blocks. Building heights will range between four to sixteen stories and the intention is to create a diverse architectural expression within a dense building mass. Space for various types of businesses and services will complement the residential units, providing the area with daycare facilities, offices and so on.

The project aims to be a model for sustainable urban development and Kvillebäcken will be one of the first districts in Göteborg that is built according to the city's local environmental demands, for example requiring a max of 60 kWh/m^2 delivered energy, surpassing the national regulations on energy use. The consortium established a mutual vision in the form of the "Kvillebäcken treaty", stipulating that the developers agree to transform Kvillebäcken into a "socially, economically and ecologically sustainable urban district". In order to elaborate what this means more specifically in this area, a program for Sustainable Development in Kvillebäcken was also created (Kvillebäckskonsortiet, 2011).

4.2.2. Outline of study and research questions

Overall study design was intended to explore Kvillebäcken, an area that is advertised as a 'green' housing development, where several actors within the sector are involved. The purpose of this study was to map perspectives on sustainability and the development of homes within the housing market (the supply side), focusing on key practitioners identified to be relevant to the research: developers and architects.

Research questions explored in the case of Kvillebäcken were:

1) How is sustainability (relating to design and housing concepts) interpreted and realized in the development of Kvillebäcken - what terminology is used?
2) What are the perceived drivers for a sustainable housing development?

4.2.3. Semi-structured interviews with developers

An interview study was carried out primarily in May and June of 2012 (with the exception of one interview, held in January 2013) with representatives from the marketing or development departments at the companies developing housing in Kvillebäcken - seven interviews (eight participants) in total. The first six interviews were held in English as research intern Zuber participated, with the support of Hagbert or Femenías. The final interview was held in Swedish. Possible language barriers must be taken into account, although is not deemed to have a major impact on the results. It should be noted that one interview included two respondents. The presence of a secondary researcher in most of the interviews might also have influenced the flow of the interview sessions, yet provided an analytical rigor.

An interview guide (see appendix) was designed containing three main sections: a general introduction to the company and the types of dwellings they build; the perceived stance on innovation within the company; and identified drivers for innovation and development of housing concepts. The interviewer kept to the interview guide as far as possible, following the same sequence of questions and progression of the three sections throughout the interviews. However, minor variations naturally occurred due to the length and focus of the respective interviewee's response (Kvale & Brinkmann, 2008). The interviews were recorded in full and transcribed relaying the full content of the interviews, though not the manner in which responses were given. The material was then coded, using markers on three levels: content relating to the company/sector in general or to Kvillebäcken in specific; content belonging to identified reoccurring main themes of the interview; and content specific to subthemes that might or might not be reoccurring throughout the interviews. In line with grounded theory (Glaser & Strauss, 1967; Alvesson & Sköldberg, 2009),

emerging patterns were analyzed in depth and in relation to the material as a whole.

In order to visualize observed patterns, a quantitative text analysis was conducted with the help of doctoral student Mangold. A bias emerging from the interviewer's wording was mitigated by adding the words most frequently used by interviewees as well as interviewer and subsequently comparing the ratio.

4.2.4. Focus group workshop with architects

As expressed by Kitzinger (1995) a focus group is appropriate for when you want to examine how ideas develop and are applied within a specific group context. A focus group (Kitzinger, 1995; Rabiee, 2004) was conducted in December 2012 with eight participants during two hours. Invitations were sent out to the in total five architectural offices that worked on the Kvillebäcken project for the seven different developers (two offices worked for two developers each), and at least one representative from each office participated in the focus group. The group was homogenous in the respect that all are middle-income architects employed at mid to large offices, yet heterogeneous in terms of age and gender (three women, five men).

The session was structured into two parts. First participants were divided into smaller groups of two or three to discuss a series of questions regarding the perception of sustainable development within the housing sector; significant components or aspects of sustainability identified; as well as norms and alternative housing concepts. The second part took the form as an open focus group more specifically addressing the role of the architectural profession in a sustainable housing development. Although the outspoken aim was not to discuss Kvillebäcken specifically, the discussions where quite naturally provided with anecdotes from the particular project. The session was recorded in writing by three participating researchers and analyzed according to emerging themes in the notes.

4.3. CASE AREA 'ACADEMIA'

4.3.1. Context: SusLab NWE

Another highly relevant area to explore is what could be conceived as front-line research on sustainability in home environments. This 'case' is an ongoing

involvement and as such is less rigorously empirically explored in this Licentiate, yet was deemed of importance to include in the overall presentation and discussion. It revolves around the EU Interreg funded research project SusLab NWE (Sustainable Living Labs, North West Europe), a collaboration between research organizations in the Netherlands, the UK, Germany and Sweden, where Chalmers University of Technology is one of the partners. Through the establishment of an international infrastructure of built facilities, [Sustainable] Living Labs, innovative products, processes or systems that contribute to reduced residential resource and energy consumption are tested and developed.

The SusLab project is structured into three phases ranging from early insight studies with residents, full-scale living lab studies, to implementation in the larger housing stock and in new housing development. By developing user-centered and participatory design research methodologies, in parallel with technological advancement, the project explores how home-related innovations are perceived and to what extent they enable sustainable living practices among residents. By extension, the project looks to improve the rate of success and speed with which such innovations are taken up and commercially disseminated in the building sector.

The Homes for Tomorrow research environment is the lead for the research undertaken in the Swedish SusLab project. Although the research group is multidisciplinary, it should be noted that the context of the research is a technological university, with a majority of engineering researchers. The architectural research team is comprised of two senior researchers at the department of Architecture, a Visiting Professor from NASA and two doctoral students.

The physical structure to be built in Göteborg, called 'HSB Living Lab', is developed by Chalmers in collaboration with HSB - one of Sweden's largest housing organizations - and Johanneberg Science Park. The building will be located on Chalmers main campus and provide student housing, accommodating about 25-30 students and guest researchers on three floors in total, including facilities like an exhibition area, a common laundry room and various meeting areas within a footprint of about 400 m^2. Due to a temporary building permit units are designed to be flexible, with a possibility to also change the layout during the ten-year

permit to adapt to new research projects. The idea is for the Living Lab to provide a unique facility where researchers can test and develop new materials, construction techniques, spatial layouts, technical systems, products and in-home services, enabling co-creation with the residents based in continuous user feedback and sensor technology throughout the structure.

4.3.2. Outline of study and research questions

By examining the discourse in the SusLab project in large, this on-going study gives a snapshot 'from within' academia. It is based in a brief overview of readily available material from the partner institutions, as well as in observations, recordings and notes from meetings and workshops attended (between researchers, and with other stakeholders involved) and by engaging in user-centered design research with students in the context of the HSB Living Lab. The main interest was to reflect on the role of academia (research and education) in setting the agenda and framework for future research and practice in the field of sustainable housing. Research questions were:

1) How is sustainability in home environments interpreted in the SusLab case?
2) How are conceptualizations of home (design, functionality and overall concept development) explored in relation to this?

4.3.3. Participatory observations at research meetings

Data was collected in the form of recordings from two workshop occasions revolving around definitions of sustainability at SusLab NWE partner meetings in Delft (March 2013) and Göteborg (June 2013), and through note-taking at various meetings and workshops during more than two years of involvement in the SusLab project, including the process surrounding the HSB Living Lab at Chalmers in particular. A shallow analysis of written documents and presentations given within this framework also adds to the material. Although not comprehensive, and far from extensively analyzed, the material provides some preliminary insights from the research conducted and the formulation of research agendas for sustainable homes.

This study follows an action research approach (Fröst, 2004) in that it is based on

finding insights through a collaborative process. The role was that of an architectural researcher, providing complementing competency to researchers from other disciplines. By contributing to general ideas on the sustainable home, this of course implies taking part in defining this concept in the research environment. This entails a complex situation as an 'action researcher within research', but is also conceived of as a 'meta study' of the SusLab project (and particularly the HSB Living Lab) itself.

4.3.4. Diary study/focus group workshop with students

The Living Lab concept poses a potential for residents to co-create strategies for sustainable practices in their own residential environment. As the HSB Living Lab will be built as student housing, insights into how students engage in and negotiate daily activities and home functions are valuable in informing new solutions that address the environmental and social impact of everyday life.

A diary study was undertaken in collaboration with doctoral student Olga Bannova in December 2012, with students at the Architectural Department at Chalmers University of Technology as well as the University of Houston's College of Architecture (n=19). Templates were distributed, asking participants to fill in the activities they engaged in during one day. Attention was given to account for differences in activities undertaken on weekdays versus on weekends. The diary template outlined the amount of time spent on the activity, materials or space used, skills or routines associated with the activity, social characteristics (something they would do in private or collectively) and points for optimizations.

Two workshops were at Chalmers held in December 2012 and May 2013. The first workshop (six participants, one of which male) revolved around the students' self-reported activities and understanding of home-related functions, derived from the diaries. Through an inductive process, using simple means (post-its, a flip-chart, markers), the students self-organized their discussion. The process was documented in writing as well as with photos of the completed post-it mapping. The second occasion had two female participants (one from architecture and one from industrial design engineering), rendering the focus group aspect invalid. It instead functioned as an in-depth session discussing issues and ideas for the HSB Living Lab facility.

5. THE SUSTAINABLE HOME?

results and discussion

This chapter presents and discusses main findings from the two case areas outlined in chapter 4, with the intention to provide a basis for further research. It is important to consider that the respondents in the presented studies are citizens and residents themselves, and that the type of qualitative research undertaken here cannot say if they are typical representatives of the general group of actors they are here identified to belong to. Bearing this in mind, there are however conclusions to be made from how different actors formulate and approach the topic of sustainability in housing, and the aggregated insights obtained provide valuable input to the description of an interpretation of sustainability and the concept of home in contemporary housing development and research. The results are first briefly summarized for each case area. This is followed by the perceived implications of the findings, positioned also in relation to the analytical model presented in 3.4. Full results are available in the scientific papers that conclude this thesis.

5.1. SUMMARY OF RESULTS

5.1.1. Market: Kviillebäcken

The studies undertaken in the case of Kvillebäcken (paper I and II) explores an issue that is of national, as well as European or global relevance. In a neoliberal vein, a partly or fully deregulated housing market is increasingly assumed to take the responsibility of housing provision in Sweden (Turner & Whitehead, 2002; Lind & Lundström, 2007). In this context it is of interest to study how 'the market' (here used to refer to those actors involved in the 'supply'-side of housing on the market today, including but not limited to housing developers, real estate companies, technical consultants among others) regards questions of sustainability and what concept (or image) of home is conveyed in new housing development[1].

The interviews and workshop (described in 4.2.3. and 4.2.4. respectively) can be seen as providing specific insights in the Kvillebäcken case, but also broadly addresses

1 This includes municipal housing companies, as these operate under a new Swedish law from 2011, enjoining them to adopt 'businesslike principles', as the result of a market-led interpretation of EU directives on competition.

perceived developments in housing and sustainability in general. The findings are here related to the two research questions. The first regarded the perception and realization of goals for a sustainable housing development (with a focus on the design and conceptualization of home) among developers and architects in Kvillebäcken, including the terminology used. The findings related to this first research question can be split into two main aspects, with a series of subset issues that were revealed (corresponding primarily to paper II, and in parts also to paper I):

Regarding the *interpretation of sustainability in housing,* it appears that:

- a focus on consumption, comfort and convenience in dwelling remains largely unchallenged
- a focus on efficiency measures is prevalent, particularly new technology that allows for a maintained or improved dwelling standard
- a consideration of equal opportunity on the housing market is inadequate and that visions of diversity are not translated into what is built
- further considerations of holistic social aspects are lacking

Regarding the *development of housing* (including design and concept development), it seems that:

- innovation within the sector is low when it comes to the design of new forms and ways of dwelling[2]
- the sector is adapting to a growing individualism and rise in single households, with subsequent limitation in market scope and increased costs
- resident engagement or co-creation remains underexplored or limited

The interviews reveal that several of the companies try to implement low-energy or even passive house standards in the housing they build in general, supporting the trend of such measures within the sector. However, the focus appears to be

2 A study of apartment layouts in Kvillebäcken however shows a disparity between companies - the larger private 'build-and-sell-developers' tend to build more streamlined and heterogeneous than the others.

on technical innovations and market-set standards. Although a clear objective in Kvillebäcken is to enable a lifestyle change among residents, more radical solutions or strategies challenging the energy and resource intense modern home and current ways of dwelling are not apparent. Developers are working on how to meet sustained residential norms with efficiency measures, with an emphasis on easily measurable indicators of environmental impact.

Despite initial goals regarding diversity in Kvillebäcken, the interviews generally point towards the market necessity of streamlining apartment types and sizes towards smaller 2 or 3 room units. Generally, competence in social issues appears to still be low within the sector. Opportunities to explore more innovative designs to optimize resource use or address new types of household configurations are according to the participating architects lacking.

The second research question revolved around the perceived drivers for housing development, (corresponding to the material presented in paper I). The structure of the interviews suggested a more general understanding of drivers, yet exemplifies in the case of Kvillebäcken. Categories of drivers, as expressed by the interviewees, and that emerged in the analysis could be organized in the following order:

- Economy and the current market system
- Residents as customers and market trends
- Policy, including building regulations and local directives
- Potential alternative developments

The interviews as well as the architect workshop reveal that economic issues and the current market system is of a general concern - something that is further supported in the quantitative text analysis of the interviews (see paper I for a detailed outline of this), with 'the market' being spoken of more often than for example the environment or social values. Economy is considered an underlying driver for many of the innovations or housing concepts that the companies work with.

The role of the resident is further highlighted in the findings, mainly as a consumer of the product offered - the finished apartment for sale or rent. Focus on what is perceived as social values or general quality of life for residents is partly

discussed, with some companies working to improve opportunities for interaction and creating greater value for the residents. A distinction should nonetheless be made between companies building for sale or those building for own property management, where the relationship to the resident as a customer differs.

Following laws and regulations are not surprisingly perceived as unavoidable, but the companies in different ways emphasize that this is not necessarily a sole imperative for pushing new housing concepts. The market development - what can be sold/rented out - is a key factor. The notion that laws or national policy regulating contemporary Swedish construction is holding housing development back is nonetheless prevalent among some of the interviewees, as companies correlate an alleged increasing regulatory strictness with rising production costs.

The interviews furthermore indicate that especially restrictions aiming to reduce environmental impact are discerned as of growing priority within both local and national government. With stricter demands put on developers wishing to build, they have to adjust to stay competitive. It appears it is these types of local or national requirements, rather than customer interest, that drive development in these issues.

The companies developing housing in Kvillebäcken report observing each other and the overall market development, rather than outspokenly working with their own concepts in opposition to the mainstream. As one interviewee puts it:

> "I think the whole construction and developer business are like [a school of] fish, mainstream, no one dares to do anything else, I would say."

In summary, the studies conducted in the case of Kvillebäcken indicate that the market on its own is not necessarily delivering holistically sustainable residential environments, but rather work from a partial interpretation of sustainability and within a current normative conceptualization of home.

5.1.2. Academia: SusLab NWE

By examining the discourse in the particular case of SusLab NWE, and by engaging with user-centered design research with students in the context of the HSB Living Lab project, this on-going study gives a snapshot 'from within' academia. The main

interest was to reflect on the role of academia (research and education) in setting the agenda and framework for future research and development of housing. A presentation of the main themes as they have emerged over the course of this study is interwoven with points of discussion, that are then lifted in the following section outlining general implications. As the scientific publication corresponding to this case area (paper III) focuses on educational aspects of experiments in residential design, the unpublished results relating primarily to interpretations of sustainability and how this relates to assumptions of home in the SusLab project are here elaborated more in depth. Two main areas can be noted in the study of the SusLab project:

The *interpretation of sustainability* pursued in this research project appears to:

- be supported by market notions framed in terms of innovation and growth
- promote a transdisciplinary approach, yet poses difficulties in arriving at a shared understanding in terms of scale and degree of intervention
- promote a co-creative process to ensure acceptance for new technology

Regarding the relation to *residential environments*, it seems that:

- there is a need for a more experimental reinterpretation of the home
- innovations relate primarily to products, services and systems to increase efficiency and building or appliance performance
- user-based insights are emphasized, although more holistic, systemic perspectives on norms, lifestyles and home design could be pushed further

Regarding the interpretation of sustainable development as it is framed in this type of EU-funded project, it is evident that SusLab is no exception from a general econocentric assumption within a current market system. Real-world collaboration is considered vital in disseminating new scientific knowledge and enabling tangible change, which is a main objective of the project as well as for the research organizations involved. A majority of the partners work close to market on research development through private, public and academic sector networks. One of the partner universities, TU Delft, outspokenly expresses a vision for the university to be a "catalyst of innovation and economic growth" (TU Delft, 2014).

Chalmers' vision includes similar wording. Besides emphasizing the university's role in a sustainable societal development, efforts that create "innovations and leads to growth", in terms of number of patents and start-ups, are highlighted (Chalmers, 2010).

The SusLab objective to work across disciplinary boundaries is also something the partner organizations uphold. The emphasis on trans- and interdisciplinarity to solve pressing societal challenges is prevalent in most high profile research organizations today, and can be found mentioned in some sense or other in the public online material from all the partners. In order to address the challenges associated with global development within ecological limits, it is generally assumed that collaboration in the framing of the problem, the conception of solutions, and application and adaptation in society is necessary. A focus on the values of applied and crosscutting knowledge production cannot be considered unique to the SusLab project, but rather underlines a framing of sustainability in academia as in line with general societal discourses on sustainable development.

When approaching sustainability in residential environments, the aim of SusLab (2014) is to "reduce energy use in the home environment". This is certainly based in a contemporary scientific strive and perceived responsibility to provide new knowledge related to reducing the environmental impact of the built environment. It however also entails a social dimension - including perspectives on the residents' role in domestic energy use, which implies not only an ecocentric motive, but also an anthropocentric approach.

A main focus is placed on the development of innovative concepts by including the end-user to a varying degree. As such, the SusLab project tries to close the gap in research (and perhaps more so in practical application) of sustainability in residential environments by acknowledging the interplay between technology, design and behavioral sciences in order to achieve solutions with a potentially greater impact. This is still an area in need of further research (and subsequently also more funding), and as such the SusLab approach potentially posits the research undertaken at the 'frontline' of sustainable housing. The hierarchy between these however still leans towards a technology-based development, where it has been argued that design

should instead take the lead in order to inform the holistic direction of *why* and *what* is to be developed from a 'Mode 2' approach of applied knowledge production, yet supported by intra-disciplinary, 'Mode 1' expertise on the specifics of the *how* (Nyström, 2002).

The research undertaken within the overall project also vary to what extent they include residents as co-creators of new solutions and on what scale. Product developments, and the evaluation of new in-home services and systems are related to a technological development that is assumed to increase efficiency and building or appliance performance, dependent on the acceptance and adoption among residents.

Bringing together several different types of research groups, spanning from material development, structural engineering, sensor technology to product design necessitates the creation of a common platform. The scale and degree of intervention however poses difficulties in arriving at a shared understanding and definition of sustainability, mirroring those in the field at large. In architectural research, the challenge to provide holistic and relevant research perspectives in the context of the SusLab project also entails how to lift focus from home-related products and technical systems to the overarching questions regarding how the modern home is perceived and reproduced. This further stresses the need to innovate also the way in which we conceptualize sustainability in housing, and experimentations in design and concept development (Femenías & Hagbert, 2013). This includes utilizing the opportunity the Living Lab provides to engage in full-scale studies to test spatial configurations, material and visual implications of different solutions (Nyström & Lorimer, 1993). This is a valuable part of design explorations, informing educational and research development in a field that is closely related to the everyday 'mundane' functions and situations in home environments (Strengers, 2009).

Within the SusLab project, the notion that it is and should be possible to reduce resource use in the home while improving quality of life and maintaining a current level of standard of living is prevalent. A more radical challenge of how we live and the form of residential environments is not a primary question in the overall aim of this particular project, yet is brought in indirectly by specific research being carried out at the partner institutions. The architectural research team associated

with Chalmers formulated it as seeing "the Living Lab as a catalyst to a changed mindset and behavior focusing on upstream paradigmatic changes as a complement to downstream monitoring and evaluation" (unpublished working material within the project). Systems mapping enables an understanding of home-related activities and practices, and the corresponding dwelling functions, and by extension, the space, material resources and energy needed to uphold these.

This approach is moreover reflected in the results from the empirical study conducted with students. The workshop(s) (outlined in 4.3.4.) provide a co-creative input for the particular HSB Living Lab process, an on-going project that will be completed in the coming years in direct association with Chalmers, as one of similar facilities in the SusLab context. Insights from the activity diary survey in both Sweden and the US, and workshops held with a limited number of students provide a preliminary indication of one way in which the conceptualization of the sustainable home can be address. These are presented in correlation to a proposed educational studio environment that would further promote experimentation in design for sustainable residential environments (outlined in paper III). The findings are based on students' qualitative impressions and recollective capacity, yet provide several aspects for approaching the functionality and possible points of development particularly associated with student housing in regards to the grouping of activities; the degree of private or shared use of space and resources[3]; and the corresponding spatial and resource requirements.

Main insights from the first workshop revolve around how participating students (as users and future professionals) conceptualize home-related activities, functions and potentials for a more or less radical reduction of resource use in relation to these, based in the HSB Living Lab context of on campus housing (described further in 4.3.1.). The second session focused on discussions on design assumptions and issues for further development in a proposed educational 'design/build/live' experimental

3 The presumption of collective use versus privacy differed between the students who participated in the studies - most likely relating to cultural and social specifics, as well as their current housing situation.

studio environment (see paper III for details). The key perspectives raised in this study support a user-centered approach, in line with SusLab objectives, but further emphasize the necessity of this in order to:

- map activities and home-related functions to understand spatial links, resources used and social implications
- outline potential optimization of these functions in a resource perspective
- inform necessary social organization and demands for supporting systems

From the survey data, a preliminary spatial compatibility assessment was made (see paper III for more details). It should be noted that a current understanding of habits, for example regarding personal hygiene, remains largely normative. However, as social practices are changing, this also provides new aspects for spatial and resource use within this particular type of student accommodation, with implications on programming, layout and the requirements of such environments. This includes new modes of education (for example a higher degree of group work, new media or technology used influence the type of spaces needed for study) or forms of recreation (with online streaming of music and TV, portable devices offer flexibility in when and where certain activities are engaged in).

Students participating in the first workshop at Chalmers organized a current understanding of the their daily activities by category, ranging from activities that can be considered part of 'basic survival', more 'supportive activities' in order to sustain the household and those activities that contribute to 'life quality'. This was further arranged as activities conducted inside or outside the dwelling unit.

The students then reorganized the activities in relation to a potential 'extreme' condition of optimization with regards to space and resource use (as seen in a simplified version in figure 11), revealing which home-related activities students see as more or less negotiable, and in what way. In this optimization scenario, relationships between activities were challenged, and a previously suggested division between private and shared functions became more blurred. One example can be made for an activity (and basic dwelling function) such as showering, which was

Figure 11. Student proposal for optimization of activities, with redards to spatial relations

argued to possibly be conditional - the participating students could imagine sharing showers, at some distance from their sleeping area, provided they had a wash basin easily accessible closer by. The students did not question the activities themselves (considered part of student living in today's society), but rather saw that they could be achieved in various ways.

5.2. IMPLICATIONS

Some points informing the discourses and identified problems and potentials in the development of more sustainable residential environments can be outlined from the empirical findings. As the work presented is explorative on a more general scale -providing a first step in approaching the research questions for further detail studies -, specifics relating to how and why these problems come about are not reached in the scope of the Licentiate thesis.

First, it is important to reiterate that the concept of home holds an understanding of both basic and complex assumptions and connotations, but also a great evolutionary dynamic. This relates both to social and cultural constructs and the scale of the household/individual. It appears that a holistic perspective on the challenges of developing existing and future sustainable residential environments is dependent on a trans-disciplinary understanding of home. Something that in turn needs to take departure in current interpretations, societal and political-economic systems, current and future technological development, as well as resulting design solutions. This becomes increasingly indispensable when discussing the informed development of residential environments with a radically reduced resource intensity.

As a major actor in the development of the built environment in contemporary Swedish planning, the housing market holds a key role in adopting sustainable practices and pushing a sustainable housing development. The results from the interviews with companies developing housing in Kvillebäcken, the workshop with architects and the reviews of the available development material suggest that a market perspective on sustainable housing development is lined with complexities. The commercialization of home, and the resource consumption associated with notions of 'the good home' also connect to an individualistic and materialistic understanding of the need/desire dialectic.

The findings indicate the range and vagueness in demands in which the housing sector operates, which contributes to a rather restricted and unilateral interpretation of sustainability. This reveals a main implication of the material presented here - in a market dominated sector, if the market doesn't effectively steer the development at a required pace, extent and in an appropriate direction, who will? This thesis does not address where the financial burden for a sustainable housing development should lie, but recognizes the current situation of in Sweden, where housing provision is largely left to the market (Lind, & Lundström, 2007).

It is also necessary to see the limitations of expecting the market to accept an overall societal responsibility. With the lack of a clear general conceptualization of what sustainable residential environments actually entail, in national or local policy as well as within the housing sector itself, market actors are challenged to implement practices and strategies 'on their own'. This would suggest there is a need to develop both policy and practice, with an emphasis on collaboration for a more holistic discourse. Possibilities for the sector could for example be in the recognition of new forms or processes for housing development, and attractive alternatives. There is a need for visionary actors that can challenge contemporary normative design and production of housing. The ambitions are there, yet establishing processes for how to actually achieve such a development remains an essential task within the sector. Although a strengthened collaboration between different actors, such as architects and developers, could be beneficial for this, it is not a given that this would lead to a more explorative housing development.

Figure 12. An interdependent or potentially blurred relationship between the two areas?

There are many different people involved, with different agendas, perspectives and interpretations that come together. The ambition for an academia that is close-to-market offers a possibility to enrich the development of both, in line with Carayannis, Barth and Campbell's (2012) helix model (the integrated relationship of which is illustrated in figure 12). Nevertheless, is it possible for the two to agree on an agenda and interpretation of sustainability in housing development? That is what is attempted in the SusLab project, and particularly in the HSB Living Lab facility, where research and business development surrounding new innovations will be tested. The ability, and need, to distinguish the two, could however perhaps also be discussed as discourses tend to overlap, and is furthermore often dependent on specific individual actors within each area - so also in the case of the HSB Living Lab project where multiple actors are involved in different capacities.

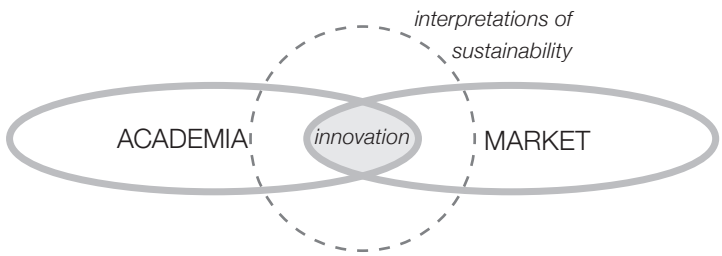


Figure 13. The SusLab approach, finding a common platform for sustainable innovations

Research efforts that are here presented as being at the frontline in the field appear to focus on innovation in terms of the development, evaluation and introduction of solutions (including products, systems, building technology or services) that enable a production of housing with a reduced demand on resources. This academic pursuit

does not necessarily push general processes in developing housing concepts as such (and is perhaps not intended to either). This also responds to the gap in research development, and lack of a contemporary equivalent to the once strong Swedish research tradition on housing, where extensive empirical studies provided a basis for the establishment of norms, both in terms of building regulations as well as social norms and perceptions of the good home. An updated revision and expansion of research on how people actually use their homes, and to what end, is particularly relevant in light of new societal challenges (Nylander & Eriksson, 2009).

The HSB Living Lab could be a platform for exploring these questions, where the potential of involving students as users and co-creators can further open new ways of experimentation in an educational as well as real-life setting. This however depends on what degree of participation is made possible, and how the discourse revolving objectives and research opportunities as the project proceeds.

Being able to visualize ideals and various conflicting conceptualizations of home, and the resource implications of these, is an important part of bringing discourses on sustainability in housing further. In line with the understanding of home within the need/desire and identity/communality dialectics, different conceptualizations of home within the analytical model presented can manifest a range of individual or shared demands and uses of resources.

As evident in the student workshop the question of how home-related functions are ensured, in various ways, through different spatial organizations or optimization. What needs and desires are fulfilled in relation to these functions, and to what degree is this based in an individual identity or communality, sharing resources and spatiality of home? Could they be fulfilled in a different way? Drawing upon a systems analysis approach (Nyström, 2002) appears essential in order to explore this further. Market interpretations of the sustainable home might fall short, particularly in regards to the development of new housing concepts, and research in the field is still fairly piecemeal. At the same time this provokes the need for other interpretations and an assessment of who is given interpretative prerogative - outlining the potential to meet also the demands of future conceptualizations of home, within limited resources.

6. CONCLUSIONS

recommendations and future research

As stated in the introductory chapter, this work is conceived as one part in providing more focused knowledge on the conceptualization of home in relation to a sustainable housing development. The emphasis has been on a theoretical exploration of an identified underexplored gap in knowledge, and an inquiry regarding the conceptualization and production of the sustainable home in relation to certain social and environmental dimensions of modern residential development. An analytical model is formulated in order to position discussions on sustainable conceptualizations of home.

This is supported by initial empirical insights focusing on the interpretations of housing sustainability within the market and academia, in two cases that advertise themselves as being at the frontline in the field. This concluding chapter starts with a summary of the relevance of the thesis in terms of the contribution it provides and the recommendations that could be made based on the work presented. Finally, general reflections and an outlook for further research are presented.

6.1. RELEVANCE AND RECOMMENDATIONS

As described in the theoretical overview provided in this thesis, last years have shown an increase in 'green' residential development in Sweden. Similarly, the discourse in academia revolves around the need for research and education to meet the societal challenges we are faced with, also within the built environment. It nonetheless appears that the sector still has far to go and large-scale environmental adaptation of residential environments remains a dire task in the future. Furthermore, a contemporary development does not adequately meet general housing needs (relating to a current shortage, issues of affordability, diversity and equal access etc.), and feeds into unsustainable financial systems.

An increasing number of studies suggest going beyond technical solutions to solve both environmental and social problems related to the way we build and use our residential environments. There is a need for major behavioral changes, supported by solutions and processes that enable more sustainable ways of living, relating to multiple dimensions of the concept of home. With demographic shifts and trends, and individualized home-related consumption needs to be address.

The energy and material intensity of residential buildings is significant. How we view the home and what it means to reside has a large impact on the energy and resource use of our residential buildings, for example regarding floor space per capita. Residential practices and conceptualizations surrounding for example energy and comfort, or the type, size and use of dwellings that are produced are key aspects in reducing environmental impact. By challenging the interpretation of sustainability in residential environments, it is relevant to also address alternative ways of residing that can reduce long-term demands on energy and materials, as well as land for urban development.

In the empirical material explored in this thesis, it appears that even though the need and potential for innovation is emphasized, the discourses within market and academia in the particular cases presented show an overall lack of more holistic, experimental perspectives that address also notions of home and a radical reassessment of contemporary ways of residing. Some insights provide basis for assuming this is an ambition that is simply not yet put into practice, and it could be suggested that incorporating a more integrative approach is perceived by several actors to be key in bringing a sustainable housing development forward. However, the reported drivers within the discourses explored appear to largely adhere to a current system understanding, implying potential lock-ins that hinder cross-cutting development in the field. This thesis therefor points towards the need to find ways to enable an alternative housing development where reinterpretations of the sustainable home can be explored.

Reassessing the very research problem, the way in which it is positioned and the general visions set by the research project, is a natural part of the work towards a paradigm change of sorts, not only within the architectural profession and research discipline, but also in the trans-disciplinary discussions held within the mixed research environment this thesis work is part of, composed of engineers, psychologist, architects and others. Contextualizing the research is essential to discussing the 'deep green' sustainability of the research being done and the expected results and applications of the innovations or reconfigurations produced. As according to Vanegas et al (1996);

"Achieving true sustainability will require a paradigm shift that brings together sustainable technologies for built facilities as total systems."

From this perspective, it is here argued that we cannot simply adjust our residential buildings - or the people who inhabit it - to new technology within essentially the same built environment. This would perpetuate a sort of status quo rather than push residential development and lifestyle changes from a genuinely new perspective on sustainable societies. The theoretical reasoning presented in this thesis points towards the need to explore ways of for example living smaller, more together and in less material overflow – essentially sharing resources in a better way and rethinking what the 'good home' is and could be. This is something that effects people directly and will demand changes on several levels. It is evident that policy needs to steer this development and set absolute limits on the amount of energy, material and land resources used in both new residential construction, as well as renovation of the existing housing stock. A key aspect is to shift the focus, one example being to explore resource use per capita rather than per square meter[1].

The need for attractive alternatives in order for residents to adopt new ways of residing should however also be emphasized, which poses a challenge for the housing sector as well as society as a whole. The role of academia, both in terms of new research and education of future professionals in the sector, is important as a collaborative, explorative platform in order to push development further. By combining knowledge on residential quality, a holistic design perspective and the objectives to radically reduce the resource and energy intensity of new (and existing) residential environments, the potential for architectural research and practice to actively contribute to this development is underlined. A systems design approach and evolution of the concept of home is essential, and a much needed complement especially in a housing market focused on a techno-centric aspect of sustainability. The practical application of the research presented here is in that sense just as much to raise questions as it is to give any defined answers.

1 A focus on per capita use however is not without complications in terms of issues of equity, implications for social relations and pure practical concerns on how to measure.

6.2. REFLECTIONS AND FUTURE RESEARCH

Just as we discuss climate adaptation of the built environment, it is relevant to explore how we can adapt the concept of home to an expected scarcity or reconfiguration in extraction and distribution of global resources. Future research needs to bring together the aspects of individual demand, spatial norms and expected standards related to a contemporary housing development put forward in this thesis, as well as explore implications for market and policy. Continued studies on discourses within other groups of actors on the housing market and in what way these can influence development will be valuable. It appears that in a current market situation, where the companies building housing are driving the standards and concepts offered pretty much in the mainstream, the opportunity for experimentation is limited. New actors on the market can be one part of the puzzle, but the potential of people themselves, as citizens and residents with agency, to interpret, influence and shape the sustainability discourse, is a perspective worth investigating further. The sustainable home is naturally more than 'sustainable building', and require a reconceptualization of how we give meaning to and the practices connected to residential environments. Holistic approaches are needed; where a sustainable housing development calls for a systemic understanding, beyond individual needs, social markings of identity, unilateral market interpretations or simply efficient buildings. Positioning the sustainable home in the analytical model presented here entails avoiding to infringe on the emotive and societal values home fulfill, yet suggests exploring the construct of home in relation to the absolute limitations of ecological boundaries. This provides a completely different starting point than the current preferences and ideals of the modern home and will be a challenge for future research on sustainability in housing development.

REFERENCES

bibliography

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology, 25*(3), 273-291.

Agnello, L., & Schuknecht, L. (2005). Booms and busts in housing markets: determinants and implications. *Journal of Housing Economics, 20*(3), 171-190.

Alvesson, M., & Sköldberg, K. (2009). *Reflexive methodology: New vistas for qualitative research.* London: Sage.

Attefall, S. (2013). "Kommunala särkrav fördyrar boendet". *Dagens Nyheter*, 2013-09-25. Retrieved 16 December, 2013, from www.dn.se/debatt/kommunala-sarkrav-fordyrar-boendet.

Aune, M. (2007). Energy comes home. *Energy Policy, 35*(11), 5457-5465.

Barton, H. (2000). *Sustainable communities: the potential for eco-neighbourhoods*. London: Earthscan.

Benjamin, D. N., Stea, D., & Arén, E. (1995). *The Home: Words, Interpretations, Meanings and Environments*. Aldershot: Avebury.

Berger, P., & Luckmann, T. (1966). *The social construction of reality*. New York: Anchor Books.

Birdwell-Pheasant, D., & Lawrence-Zúniga, D. (1999). *House Life: Space, Place, and Family in Europe*. Oxford: Berg.

Bourdieu, P. (1977). *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.

Boverket. (2010). *Boendekostnader och boendeutgifter – Sverige och Europa*. Karlskrona: Boverket.

Boverket. (2012). *Bostadsmarknaden 2012-2013 – med slutsatser från bostadsmarknadensenkäten 2012.* (Karlskrona: Boverket).

Bradley, K. (2009). *Just environments: politicising sustainable urban development,* (PhD Thesis). Stockholm: KTH.

Brogren, M., & Wellhagen, B. (2012). "Kommunala särkrav fördyrar energisnåla hus". *Dagens Nyheter*, 2012-10-29. Retrieved 16 December, 2013, from www.dn.se/debatt/kommunala-sarkrav-fordyrar-energisnala-hus.

Brown, T., & Bhatti, M. (2003). Whatever Happened to 'Housing and the Environment'? *Housing Studies, 18*(4), 505-515.

Buys, L., Godber, A., Summerville, J., & Barnett, K. (2007). Building community: collaborative individualism and the challenge for building social capital.

Australasian Journal of Regional Studies, 13(3), 287-298.

Carayannis, E., Barth, T., & Campbell, D. (2012). The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship,* 1(1), 1-12.

Chalmers. (2010). *Vision, goals and strategies - choice of path.* Retrieved 18 April, 2014, from www.chalmers.se.

Chiu, R. L. H. (2004). Socio-cultural sustainability of housing: a conceptual exploration. *Housing, Theory and Society, 21*(2), 65-76.

Clarke, J. (2004). Living alone in Britain. *Geography Review, 17*(5), 2-5.

Coolen, H., & Hoekstra, J. (2001). Values as determinants of preferences for housing attributes. *Journal of Housing and the Built Environment, 16*(3), 285-306.

Coolen, H. (2006). The meaning of dwellings: An ecological perspective. *Housing, Theory and Society, 23*(4), 185-201.

Dempsey, N., Bramley, G., Power, S., & Brown, C. (2009). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable Development, 19*(5), 289-300.

Després, C. (1991). The meaning of home: Literature review and directions for future research and theoretical development. *Journal of Architectural and Planning Research, 8(*2), 96-115.

Després, C., Vachon, G., & Fortin, A. (2011). Implementing Transdisciplinarity: Architecture and Urban Planning at Work. In I. Doucet & N. Janssens (Eds.), *Transdisciplinary Knowledge Production in Architecture and Urbanism: Towards Hybrid Modes of Inquiry*, (pp. 33-49). Dordrecht: Springer.

Easterlin, R. A. (1995). Will raising the incomes of all increase the happiness of all? *Journal of Economic Behavior & Organization, 27*(1), 35-47.

Easthope, H. (2004). A place called home. *Housing, Theory & Society, 21*(3), 128-138.

Energimyndigheten (2013). *Bostäder och service*. Retrieved 18 April, 2014, from www.energimyndigheten.se.

Fairclough, N. (2010). Critical discourse analysis : the critical study of language. Harlow: Longman.

Femenías, P. (2004). *Demonstration projects for sustainable building : towards a strategy for sustainable development in the building sector based on Swedish and Dutch experience*. (PhD Thesis), Chalmers University of Technology, Göteborg.

Femenías, P., & Hagbert, P. (2013). The Habitation Lab: Using a Design Approach

to Foster Innovation for Sustainable Living. *Technology Innovation Management Review* (November 2013: Living Labs), 15-21.

Fröst, P. (2004) *Designdialoger i tidiga skeden - arbetssätt och verktyg för kundengagerad arbetsplatsutformning.* Göteborg: Chalmers University of Technology.

Gagnon Thompson, S. C., & Barton, M. A. (1994). Ecocentric and anthropocentric attitudes toward the environment. *Journal of Environmental Psychology, 14*(2), 149-157.

Gatersleben, B., White, E., Abrahamse, W., Jackson, T., & Uzzell, D. (2010). Values and sustainable lifestyles. *Architectural Science Review, 53*(1), 37-50.

Gauvain, M., & Altman, I. (1982). A cross-cultural analysis of homes. *Architecture & Comportement/Architecture & Behaviour, 2*(1), 27-46.

Gifford, R. (2011). The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist, 66*(4), 290-302.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory : strategies for qualitative research*. Chicago: Aldine.

Gluch, P., Gustafsson, M., Thuvander, L., & Baumann, H. (2013). Charting corporate greening: environmental management trends in Sweden. *Building Research & Information, 42*(3), 318-329.

Gram-Hanssen, K. (2011). Understanding change and continuity in residential energy consumption. *Journal of Consumer Culture, 11*(1), 61-78.

Gram-Hanssen, K., & Bech-Danielsen, C. (2004). House, home and identity from a consumption perspective. *Housing, Theory and Society, 21*(1), 17-26.

Groat, L., & Wang, D. (2002). *Architectural research methods*. New York: Springer.

Hagbert, P. (2010). *Home is where*.* (Master Thesis), Chalmers University of Technology, Göteborg.

Hauge, Å. L., & Kolstad, A. (2007). Dwelling as an expression of identity. A comparative study among residents in high-priced and low-priced neighbourhoods in Norway. *Housing, Theory and Society, 24*(4), 272-292.

Hedlund, B. (2012). Ökat bostadsbyggande och samordnade miljökrav – genom enhetliga och förutsägbara byggregler, SOU 2012:86. Stockholm: Regeringkansliet.

Hedin, K., Clark, E., Lundholm, E., & Malmberg, G. (2011). Neoliberalization of Housing in Sweden: Gentrification, Filtering, and Social Polarization. *Annals of the Association of American Geographers, 102*(2), 443-463.

Heidegger, M. (1967). *What is a Thing?* Lanham: University Press of America.

Hoffman, A. J., & Henn, R. (2008). Overcoming the Social and Psychological Barriers to Green Building. *Organization & Environment, 21*(4), 390-419.

Huesemann, M. H., & Huesemann, J. A. (2008). Will progress in science and technology avert or accelerate global collapse? A critical analysis and policy recommendations. *Environment, Development and Sustainability, 10*(6), 787-825.

IPCC. (2014). Climate Change 2014: Mitigation of Climate Change. Retrieved 18 April, 2014, from www.mitigation2014.org.

Jackson, T., & Michaelis, L. (2003). *Policies for sustainable consumption*. London: Sustainable Development Commission.

Jackson, T. (2005). Live Better by Consuming Less?: Is There a "Double Dividend" in Sustainable Consumption? *Journal of Industrial Ecology, 9*(1-2), 19-36.

Jensen, J. O., & Gram-Hanssen, K. (2008). Ecological modernization of sustainable buildings: a Danish perspective. Building Research & Information, 36(2), 146-158.

Jensen, J. O., Jørgensen, M. S., Elle, M., & Lauridsen, E. H. (2012). Has social sustainability left the building? The recent conceptualization of "sustainability" in Danish buildings. *Sustainability: Science, Practice, & Policy, 8*(1), 94-105.

Johnston, H. (2002). Verification and proof in frame and discourse analysis. In B. Klandermans & S. Staggenborg (Eds.), *Methods of social movement research*. Minneapolis: University of Minnesota Press

Kabisch, N., & Haase, D. (2011). Diversifying European agglomerations: evidence of urban population trends for the 21st century. *Population, Space and Place, 17*(3), 236-253.

Kates, R. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is Sustainable Development? *Environment, 47*(3), 8-21.

Kellett, P., & Moore, J. (2003). Routes to home: Homelessness and home-making in contrasting societies. *Habitat International, 27*(1), 123-141.

Kennedy, E. H., & Krogman, N. (2008). Towards a sociology of consumerism. *International Journal of Sustainable Society, 1*(2), 172-189.

Kitzinger, J. (1995). Qualitative Research: Introducing focus groups. *BMJ, 311*(7000), 299-302.

Komiyama, H., & Takeuchi, K. (2006). Sustainability science: building a new

discipline. *Sustainability Science, 1*(1), 1-6.

Kvale, S. (1995). The Social Construction of Validity. *Qualitative Inquiry, 1*(1), 19-40.

Kvale, S., & Brinkmann, S. (2008). *Interviews: Learning the craft of qualitative research interviewing.* Los Angeles: Sage.

Kvillebäckskonsortiet (2011). *Program för Hållbar utveckling i Kvillebäcken*. Retrieved 16 July, 2012, from www.kvillebacken.se.

Lago, A., & Linde, L. (2013). "Bostadsbrist kan kosta Stockholm 660 miljarder". *Dagens Nyheter.* 2013-06-11, Retrieved 6 May, 2014, from www.dn.se/debatt/bostadsbrist-kan-kosta-stockholm-660-miljarder.

Latour, B. (1996). On actor-network theory: a few clarifications plus more than a few complications. *Soziale welt, 47*, 369-381.

Lawrence, R. (1987) *Housing, Dwellings and Homes: Design Theory, Research and Practice*. Chichester: John Wiley & Sons.

Lind, H., & Lundström, S. (2007). *Bostäder på marknadens villkor.* Stockholm: SNS - Centre for Business and Policy Studies.

Lindén, A.-L. (2007). Sociala dimensioner i hållbar samhällsplanering. Working Paper in Sociology, Department of Sociology, Lund University, Lund.

Liu, J., Daily, G. C., Ehrlich, P. R., & Luck, G. W. (2003). Effects of household dynamics on resource consumption and biodiversity. *Nature, 421*(6922), 530-533.

Lockton, D., Harrison, D., & Stanton, N. (2008). Making the user more efficient: design for sustainable behaviour. *International Journal of Sustainable Engineering, 1*(1), 3-8.

Lockton, D, Bowden, F, Greene, C, Brass, C, Gheerawo, R. (2013). People and energy: A design-led approach to understanding everyday energy use behaviour. In Proceedings of EPIC 2013: Ethnographic Praxis in Industry Conference, 15-18 September 2013, London.

Loomba, A. (2005). *Colonialism/Postcolonialism*. New York: Routledge.

Lovell, H. (2004). Framing sustainable housing as a solution to climate change. *Journal of Environmental Policy & Planning, 6*(1), 35-55.

Maliene, V., Howe, J., & Malys, N. (2008). Sustainable Communities: Affordable Housing and Socio-economic Relations. *Local Economy, 23*(4), 267-276.

Mallett, S. (2004). Understanding home: a critical review of the literature. *The Sociological Review, 52*(1), 62-89.

Malmqvist, T., Glaumann, M., Scarpellini, S., Zabalza, I., Aranda, A., Llera, E.,

& Díaz, S. (2011). Life cycle assessment in buildings: The ENSLIC simplified method and guidelines. *Energy, 36*(4), 1900-1907.

Manum, B. (2006). *Apartment Layouts and Domestic Life; The Interior Space and its Usability: A Study of Norwegian Apartments Built in the Period 1930-2005*, (PhD Thesis). The Olso School of Architecture and Design, Olso.

Manzo, L. C. (2003). Beyond house and haven: Toward a revisioning of emotional relationships with places. *Journal of Environmental Psychology, 23*(1), 47-61.

Martinez-Alier, J., Kallis, G., Veuthey, S., Walter, M., & Temper, L. (2010). Social metabolism, ecological distribution conflicts, and valuation languages. *Ecological Economics, 70*(2), 153-158.

Maslow, A. (1954) *Motivation and Personality*. New York: Harper & Brothers.

Max-Neef, M. (1992). Development and human needs. In P. Ekins, & M. A. Max-Neef, (Eds.), *Real life economics : understanding wealth creation*, (pp. 197-214). London: Routledge.

McKenzie, S. (2004). Social Sustainability: Towards some definitions. Hawke Research Institute Working Paper Series No 27, University of South Australia, Magill.

Merchant, C. (2005). *Radical ecology: The search for a livable world* (2nd ed.). London: Routledge.

Moore, J. (2000). Placing Home in Context. *Journal of Environmental Psychology, 20*(3), 207-217.

Moser, G. (2009). Quality of life and sustainability: Toward person–environment congruity. *Journal of Environmental Psychology, 29*(3), 351-357.

Murphy, D. J., & Hall, C. A. S. (2011) Energy return on investment, peak oil, and the end of economic growth. *Annals of the New York Academy of Sciences, 1219*(1) (pp. 52-72).

Murphy, K. (2012). The social pillar of sustainable development: A literature review and framework for policy analysis. *Sustainability: Science, Practice, & Policy, 8*(1), 15-29.

Norman, W., & MacDonald, C. (2004). Getting to the bottom of 'Triple Bottom Line'. *Business Ethics Quarterly, 14*(2), 243-262+345-346.

Nylander, O., & Eriksson, A.B. (2009). *Bostadsvaneundersökning – Så använder vi våra bostäder.* Stockholm: Svensk Byggtjänst.

Nyström, M., & Lorimer, N. (1993). Functions analysis. In the report *Kitchens, Living Environment and Household Energy in Vietnam*, Lund Centre for Habitat

Studies and Hanoi Architectural Institute. Lund: Lund University.

Nyström, M. (2002). Making - Research. *Nordic Journal of Architectural research* (4), 43-53.

Olsson, S. (2012). *Social hållbarhet i ett planeringsperspektiv*. Göteborg: Göteborgs Stad.

Perkins, H. C., Thorns, D. C., Winstanley, A., & Newton, B. M. (2002). *The Study of 'Home' From a Social Scientific Perspective: An Annotated Bibliography* (2nd Ed.). University of Canterbury and Lincoln University.

Popper, K. R. (1972). *Objective knowledge: An evolutionary approach*. Oxford: Oxford University Press.

Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the nutrition society, 63*(4), 655-660.

Raco, M. (2007). Securing Sustainable Communities: Citizenship, Safety and Sustainability in the New Urban Planning. *European Urban and Regional Studies, 14*(4), 305-320.

Ragin, C. C., & Becker, H. S. (1992). *What is a case?: exploring the foundations of social inquiry*. New York: Cambridge University Press.

Rapoport, A. (1995). A Critical Look at the Concept 'Home.' In D.N. Benjamin & D. Stea (Eds.), *The home: words, interpretations, meanings, and environment,* (pp. 25-52). Aldershot: Avebury.

Rapoport, A. (2008). Some Future Thoughts on Culture and Environment. *Archnet-IJAR, International Journal of Architectural Research 2*(1), 16-39.

Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory, 5*(2), 243-263.

Rybczynski, W. (1986). *Home: A Short History of an Idea.* New York: Penguin.

Sanne, C. (2002). Willing consumers—or locked-in? Policies for a sustainable consumption. *Ecological Economics, 42*(1–2), 273-287.

Saunders, P., & Williams, P. (1988). The constitution of the home: Towards a research agenda. *Housing Studies, 3*(2), 81-93.

SCB (2012) *Yearbook of Housing and Building Statistics 2012*. Örebro: SCB-Tryck.

Schneider, F., Kallis, G., & Martinez-Alier, J. (2010). Crisis or opportunity? Economic degrowth for social equity and ecological sustainability. Introduction to this special issue. *Journal of Cleaner Production, 18*(6), 511-518.

Schweber, L., & Leiringer, R. (2012). Beyond the technical: a snapshot of energy and buildings research. *Building Research & Information, 40*(4), 481-492.

Shove, E. (2003). Converging Conventions of Comfort, Cleanliness and Convenience. *Journal of Consumer Policy, 26*(4), 395-418.

Shove, E., Chappells, H., Lutzenhiser, L., & Hackett, B. (2008). Comfort in a lower carbon society. *Building Research & Information, 36*(4), 307-311.

Spaargaren, G. (2000). Ecological modernization theory and domestic consumption. *Journal of Environmental Policy and Planning, 2*(4), 323-335.

Stedman, R. C. (2002). Toward a Social Psychology of Place: Predicting Behavior from Place-Based Cognitions, Attitude, and Identity. *Environment and Behavior, 34*(5), 561-581.

Steg, L. (2005). Car use: lust and must. Instrumental, symbolic and affective motives for car use. *Transportation Research Part A: Policy and Practice, 39*(2–3), 147-162.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309-317.

Strengers, Y. (2009). *Bridging the divide between resource management and everyday life - Smart metering, comfort and cleanliness*, (PhD thesis). RMIT University, Melbourne.

Støa, E. (2008). Urban cottages – rural homes? Challenges towards a more sustainable residential culture and the role of architecture. *Nordisk arkitekturforskning, 20*(3), 59 - 72.

Sunikka-Blank, M., & Galvin, R. (2012). Introducing the prebound effect: the gap between performance and actual energy consumption. *Building Research & Information, 40*(3), 260-273.

SusLab (2014). *SusLab Mission*. Retrieved 18 April, 2014, from, www.suslab.eu.

Tester, G., & Wingfield, A. H. (2013). Moving past picket fences: The meaning of "home" for public housing residents. *Sociological Forum, 28*(1), 70-84.

Thorpe, A. (2010). Design's role in sustainable consumption. *Design Issues, 26*(2), 3-16.

TU Delft (2014). *Vision*. Retrieved 18 April, 2014, from www.tudelft.nl.

Turner, B., & Whitehead, C. M. E. (2002). Reducing Housing Subsidy: Swedish Housing Policy in an International Context. *Urban Studies, 39*(2), 201-217.

Turner, G. M. (2008). A comparison of The Limits to Growth with 30 years of reality. *Global Environmental Change, 18*(3), 397-411.

Tyréns (2012). *BoTrender*. Retrieved 16 December, 2013, from www.tyrens.se.

UN-Habitat (2014). *Housing & Slum upgrading*. Retrieved 18 April, 2014, from www.unhabitat.org.

Vale, B., & Vale, R. (2010). Domestic energy use, lifestyles and POE: past lessons for current problems. *Building Research & Information, 38*(5), 578-588.

Vallance, S., Perkins, H. C., & Dixon, J. E. (2011). What is social sustainability? A clarification of concepts. *Geoforum, 42*(3), 342-348.

van den Bergh, J. C. J. M. (2011). Environment versus growth - A criticism of "degrowth" and a plea for "a-growth". *Ecological Economics, 70*(5), 881-890.

van der Klis, M., & Karsten, L. (2009). Commuting partners, dual residences and the meaning of home. *Journal of Environmental Psychology, 29*(2), 235-245.

Vanegas, J. A., DuBose, J. R., & Pearce, A. R. (1996). Sustainable technologies for the building construction industry. Paper presented at the Symposium on Design for the Global Environment, Atlanta.

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing, 25*(1), 90-103.

Wang, D. (2006). Prediction in theoria: towards an interdisciplinary range of theories related to architecture. *arq: Architectural Research Quarterly, 10*(3-4), 263-273.

Wang, D. (2007). Diagramming Design Research. *Journal of Interior Design, 33*(1), 33-43.

WCED (1987). *Our common future*. New York: Oxford University Press.

Wiek, A., Ness, B., Schweizer-Ries, P., Brand, F., & Farioli, F. (2012). From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. *Sustainability Science, 7*(1), 5-24.

Wilhite, H., Nakagami, H., Masuda, T., Yamaga, Y., & Haneda, H. (1996). A cross-cultural analysis of household energy use behaviour in Japan and Norway. *Energy Policy, 24*(9), 795-803.

Willén, M. (2012). *Berättelser om den öppna planlösningens arkitektur: En studie av bostäder, boende och livsstil i det tidiga 2000-talets Sverige*. Lund: Sekel.

Windsong, E. A. (2010). There is no place like home: Complexities in exploring home and place attachment. *Social Science Journal, 47*(1), 205-214.

Wistrand, L. et al. (2011). *Social konsekvensanalys: Människor i fokus 1.0.* Göteborg: Göteborgs Stad.

APPENDIX

INTERVIEW GUIDE - DEVELOPERS IN KVILLEBÄCKEN

Introduction

-Short description of the study, focusing on multi-family residential development.
-Clarification of terminology, the interview revolves around innovation in standards and concepts; e.g. the concept of what a 'home' is, the size (of the rooms, of the flat), the materials, the equipment (washer) and the common facilities.
-A user perspective is highlighted, and not in-depth technical aspects of innovation.

1- About the company

1.1- Type of company

-Which type best describes your company? (Single-family housing builder/ property owner? Multi-family builder/property owner?)
-How many dwellings do you build/sell/rent every year?
-What kind of housing do you mainly build/sell/rent?

1.2- Market area

-What is the geographical market area you work within?
-What is the general interest in innovation within the market you work with?

1.3- Standards and concepts offered

-Do you have any special concept for the new dwellings you build?
-What are your standards for new housing regarding size, materials, equipment, and common facilities?
-To what degree do you consider environmental and sustainability issues when defining these standards?
-How have they changed over time?
-How do you think these standards will evolve in the future?
-In the case of Kvillebäcken, were any standards imposed by the city?

2- About innovation in the standards and concepts offered by the company

2.1- Innovation policy of the company

-Do you have a company policy concerning innovation in the standards and concepts offered?

-Are you interested in innovations that… make the houses you build more affordable? More comfortable? Supporting sustainable living?

-Is there something written in your business plan regarding innovation?

-Is your company encouraging individual initiatives and ideas concerning innovation in the standards and concepts offered?

2.2- Innovation decision maker

-How many people within the company would you say work with standards and innovation? Do they constitute their own department (which one)?

-Who within the company decides on the introduction of an innovation in the standards and concepts offered?

- What is your precise role in the organization?

2.3- The introduction of innovation process

-What is the process for implementing a new innovation within the company? Do you have to convince partners or investors when you want to innovate?

- How long does it take to implement a new standard or concept?

- How do you introduce or communicate innovations to future consumers?

3 - Drivers of innovation and changes in standards and concepts offered

3.1- Trends and market - consumers

-What are your sources of information and how do you gather this (observing market trends, consumer surveys)?

3.2- Laws, regulations and policy

-What influence does laws and regulations, the objectives of planners - local or national policy - have on changes in standards?

3.3- Alternatives proposed by the company itself

-Is the company implementing own ideas/alternatives, outside the mainstream?

3.4- Conclusion

-Which of the drivers would you say is/are the most important to consider, regarding innovation within your company?

PAPER I

Hagbert, P., Mangold, M., & Femenías, P. (2013). Paradoxes and Possibilities for a 'Green' Housing Sector: A Swedish Case. *Sustainability*, 5(5), 2018-2035

Sustainability **2013**, *5*, 2018-2035; doi:10.3390/su5052018

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

Paradoxes and Possibilities for a 'Green' Housing Sector: A Swedish Case

Pernilla Hagbert [1,*], Mikael Mangold [2] and Paula Femenías [1]

[1] Department of Architecture, Chalmers University of Technology, Göteborg 41296, Sweden; E-Mail: paula.femenias@chalmers.se

[2] Department of Civil and Environmental Engineering, Chalmers University of Technology, Göteborg 41296, Sweden; E-Mail: mikael.mangold@chalmers

* Author to whom correspondence should be addressed; E-Mail: hagbert@chalmers.se; Tel.: +46-736-277-220.

Received: 1 March 2013; in revised form: 3 April 2013 / Accepted: 25 April 2013 / Published: 6 May 2013

Abstract: As global and local visions for sustainable living environments are increasingly supported by policies and concrete practices in construction, the building and housing sector is seeking to mitigate its environmental impact as well as assume a greater social responsibility. The overarching policy objectives set to concretize what a sustainable housing development entails, however, tend to rely on equivocal terminology, allowing a varied interpretation by key industry practitioners. Though in line with an ecological modernization paradigm in policy, the promotion of a market-driven environmentalism in housing faces multiple challenges as varying interests and perspectives collide. Supported by empirical findings of a semi-structured interview study conducted with housing developers in a new 'green' urban district in Göteborg, Sweden, theoretical frameworks surrounding the paradoxical path towards a sustainable housing development are presented. Inconsistencies between outspoken ambitions; social dimensions; and the framing of efficiency in new housing are discussed. Possibilities for the housing sector are given in the recognition of new forms of development, where a systemic perspective is required in the alignment between how industry, policy and the market perceives housing development and what is actually sustainable.

Keywords: sustainable development; housing; building sector; developers; equivocal terminologies; social capital

1. Introduction

The concept of sustainable development has come to encompass various interpretations, ranging from political discourse to pragmatic approaches regarding how to meet the challenges of global development within what progressively is understood as finite ecological limits. On both a local and global level, the establishment of visions and targets for environmental or societal governance effects and relies on all sectors to outline and facilitate measures to reach these goals. The building sector—and the myriad of supporting sectors connected to it—is a main contributor to the environmental stress and resource depletion of modern society [1,2]. Conversely, major social and financial implications of the built environment should also be considered, as playing a key part in human development and economic growth [2].

Aims and policies for an environmentally and socially considerate urban (re)development bring focus not only to material values and financial indicators, but also the complexity of regulating a holistic sustainable development within a current market paradigm, as seen in a Northern European as well as global context [3–9]. With a lack of regulatory precision and clear national policy support, responsibility is shifted to the building sector. This paper addresses the question whether the sector, with the focus on a developer perspective, can be expected to pursue a holistic agenda and deliver sustainable living environments accordingly.

With an increased urbanization putting further demand on the creation of new urban living environments, the push towards greening housing development in particular can be seen in an emerging interest and increasing demand for 'green' certified or labeled buildings [10,11]. This is illustrated in the development of new 'green' urban districts in metropolitan growth regions around Europe. An acute housing shortage, as in the Swedish context, along with a subdued investment capacity due to the recent recession, is seen as a direct impediment to further development—a situation similar to that of many growing urban regions around the world.

Since the latter part of the last decade, sustainability has increasingly been part of the general agenda in the Swedish building sector [12,13]. This development is mainly driven by anticipated regulation for European Energy Performance, along with national energy/environmental goals, and local environmental policies in metropolitan areas. It is further supported also on a global scale by an increased competence for these issues within the sector, a push for certification systems, and the formulation of green strategies among housing developers around the world, as a response to a growing market for such competitive distinction both nationally and internationally [14]. However, while energy efficiency, and in part environmental preferences regarding material choices are considered, the social dimension of sustainability as well as other impacts of the built environment on ecological systems is still overlooked [3,15].

Particularly the discourse on 'sustainable housing' indicates a belief in the creation of living environments with a lower impact on global climate change [16]. The overarching objectives set to concretize what a sustainable development entails however tend to rely on rather equivocal terminology [17]. This imprecision allows varied interpretations to be made by industry practitioners, and subsequently constitute a potential challenge in implementation, which is addressed in this paper.

The pursuit of a societal and humanistic development within ecological limits is stated in parallel to aims calling for and stimulating economic growth, outlining the paradoxes of contemporary

discourse [18,19]. Although in line with an ecological modernization paradigm [20,21], the promotion of a market-driven environmentalism to achieve eco-innovation in housing is, as is discussed in this paper, lined with obstacles as differing interests and perspectives collide. The housing sector needs to cater to a plethora of demands from policy, clients, and investors, of which some are indeed of an environmental or social nature. However, the range in these demands poses a restriction in the possibility to take a more holistic perspective on what is built.

Contributing to a discussion on the interpretative difficulties, and thereby in parts paradoxical development of a sustainable housing sector, the aim is here to highlight the discourse from a developer and residential development perspective. The paper begins with a background to the sustainable development discourse. This is followed by a theoretical elaboration on the current framing of environmental sustenance and economical understanding of housing development. Empirical material is presented in the form of findings from semi-structured interviews with developers in the case of a currently redeveloped urban area in Göteborg, Sweden. Main aspects are outlined: the assumption of an economical and political system in place; a restricted perspective on sustainability in housing; and the role of the resident. The material is used to highlight paradoxes that arise in the usage of sustainable development as a term in the building sector. The paper is concluded with a reflection on the implications and possibilities of this, pointing towards ways forward. Developing both policy and practice, as well as emphasizing collaboration for a more holistic discourse, is proposed.

2. Theoretical Background

2.1. Defining Sustainable Development in the Housing Sector

The complex linkages between resource depletion, climate change and societal development are increasingly acknowledged and discussed as global challenges. Mid and late 20th century preservationist movements based a growing concern for the environmental impact of human endeavors in an ecocentric and "deep green" advocacy, also notable in early sustainable housing projects [12]. With the dimension of a post-colonial global understanding—calling for an equal opportunity for societal development—the discourse in the global community evolved towards a definition of how to sustain such a development. Recent discourse, on the other hand, has focused on merging a contemporary growth paradigm with environmental preservation or regeneration and societal prosperity within the term "green economy" [22] (evident also at the Rio+20 earth summit [23]). In the building sector a green growth is proposed primarily through, but not limited to, strategic development within expanding urban areas, streamlined building and planning processes, and by the strengthening of an emerging market for eco-efficient industry strategies, services and clean-tech products.

In sustainability sciences, it is common to start in epistemology and the definitions of sustainable development. Kates *et al.* [24] define development targets to be, among others: equity, equal opportunity, wealth, the productive sector, consumption and social capital; meanwhile sustaining resources, the environment, places and cultures. These are relevant dimensions in reference to the study presented here. The definitions are used to point to the challenges, but also the possibilities in the transition towards a sustainable housing development. One such paradox that applies on a general, as well as sector specific scale, is the inconsistency of sustaining life support resources while developing

consumption, if developing is synonymous with increasing [25]. Other sustainability definitions present relevant targets for the building sector, as it is a large contributor to the development of productive sectors. The sector could also take a more active role in developing equity and equal opportunity in the housing market, as well as the creation of social capital, if given opportunity [3].

There is, however, a risk that the ability of the housing sector to produce a more holistically sustainable and resilient built environment is overlooked due to unilateral interpretations of the above outlined definitions. It could further be restricted by short-term goals given by imprecise public opinion and fluctuations within the economic system. Long term economic development and resilience is equally difficult to pursue in a current growth paradigm, with a recognized correlation between inflated real-estate markets and economic turns [26]. Critics of growth-based sustainable development further argue that efficiency and technology alone are not enough to solve present and upcoming challenges for ecological preservation [18,19,22,25]. These are key aspects to investigate in the expansion of a "green" housing sector that acts within, and enforces intrinsically normative practices and structures.

2.2. Housing Development

The legislative and political push for development and expansion of living space in Europe in general, and Sweden in particular, during the second half of the 20th century led to higher residential standards per capita both in terms of m^2/person and comfort level (thermal as well as in material terms). Although Sweden early on established a considerably high level of housing standards, the need for improved housing conditions throughout Europe remains a challenge [27]. This further needs to be put into relation to sustainability in new construction and a deteriorating existing stock. With a general trend of diminishing household size and a normative view on the residential standards expected, the individual need of resources remains. Combined with an increased share of single households, this implies a larger total spatial and material demand compared to households where such functions are shared.

Connecting to strong ideological and normative discourses surrounding spatial, material and infrastructure standards, housing development has been a question for much policy and industry benchmarks over the past century, leading to improvements in general health and environmental quality of residential areas. This raises concerns also on what is appropriate or sustainable, and the distribution of consumption and cost. As evident in housing market fluctuations, the notion of development in this context is nevertheless not solely related to a continued improvement of living environments and conditions, but encompasses a dynamic of speculative properties. Mortgaging structures are an integral part of national and global financial systems [26]. The level of indebtedness in relation to disposable income among households have increased in all the Nordic countries during the last two decades, with rising real and nominal housing prices [28]. Production costs per m^2 for apartments in multi-dwelling buildings have simultaneously nearly doubled during the last decade in Sweden [29]. Provision of affordable housing remains a primary issue, and constitutes a main hinderance in the search for equity and equal opportunity in the housing market both on a European and global scale [4,27,30–32]. In a Swedish context, it is important to note that the historic situation has been slightly different than that of other European countries. Subsidies for housing construction and household allowances have been active policy instruments to ensure quality and equality.

However, the prerequisites for this have changed with shifts in housing policy over the last decades [33]. The urgent shortage in appropriate and affordable housing in metropolitan areas is increasingly recognized as a key issue in sustainable urban development, yet a clear national policy is lacking.

2.3. Developing a Sustainable Housing Sector

With global and local visions for the creation of sustainable living environments increasingly supported by policies and concrete practices in construction, the housing sector is seeking to mitigate its environmental impact. Furthermore, private companies are assuming a greater corporate social responsibility, whereas public housing companies are expected to build upon their societal mandate. There is however, as noted above, a gap in the interpretation and hence ambition for sustainable housing. The difficulties that arise in attempting to merge discourses on housing and sustainability are seen in the oftentimes widely differing, sometimes oppositional agendas to be integrated [34].

There are several barriers to the adoption and expansion of green building practices to be found. These can be of an individual as well as organizational or institutional level, involving all actors, and range from limitations in terminology used to regulative obstacles [35]. Going beyond technical solutions is at the same time increasingly viewed as essential, yet remains an important task in an industry perspective where sustainability measures revolve around efficiency [3]. Internalizing externalities in order to reduce household resource consumption, by associating consumption with a price, constitutes a key part of the ecological modernization paradigm [36].

Apart from general concerns about rebound effects of measures focusing primarily on efficiency, a one-sided focus on such parameters can also miss a larger paradigmatic understanding of the impact of the living environments built. This is illustrated in recent findings suggesting that the most significant factor for the leveling out of energy use in Norwegian households during the last two decades is the slower increase in per capita living area, compared to the preceding 20 years [37]. Even though energy-efficiency measures have contributed, the fact that the total living area is not growing at the same rate as population is a main direct explanation. Underlying factors such as demographic changes (including immigration), increased costs or shifting residential preferences are implied.

Pathways towards sustainable development may have been overlooked due to a focus on societal rather than household-scale solutions or behaviors. An important element in developing sustainable practices in a home perspective is to recognize the household not just as units or consumers, but also as active subjects and contributors [38]. If inhabitants are seen as creators of social space, safety networks etcetera, then values are shifted towards facilitating the development of social capital [39].

3. Materials and Method

3.1. A Swedish Case

The material presented in this paper reflects qualitative findings from an interview study with the seven developers involved in the Kvillebäcken case area in Göteborg, Sweden. The project context constitutes the first phase of a general plan to transform a former central harbor area. As a strategy for the overarching expansion of the center of Göteborg, a model for development—the "Älvstranden model"—has been established in order to reduce financial risks for the city, and thereby distribute

infrastructure and development costs among the developers involved. Through the formation of a consortium the project is run by a municipally owned development company—responsible for the general plan—in conjunction with developers as well as the municipal planning office.

Common goals were outlined in a consortium treaty, and elaborated on in a program for sustainable development, where Kvillebäcken is framed as a "socially, economically and ecologically sustainable urban district" [40]. The project aims to be a model for sustainable urban residential development, aspiring for Swedish Green Building Council environmental certification level silver, with gold for energy. It is one of the first urban neighborhoods in Göteborg built in line with the municipality's new environmental demands, including strict energy requirements for the 2000 apartments built.

3.2. Method

By applying a snapshot casing in the Kvillebäcken development process, perspectives among some main actors in the building sector could be picked up, where questions of sustainability are proposed to be at the forefront [41,42]. These perspectives are used to illustrate what key practitioners, in the role as developers, expect, foresee, and overlook in the contemporary sustainable development targets for the housing sector.

The interviewees are respondents as well as informants [43], as the study has a strong inductive emphasis, yet maintains an explicit understanding of sustainable development based in an emerging growth realist perspective [44]. The interviewees give a relevant insight into the particular case, explicitly aiming at being a forerunner for Swedish housing development and thereby relating to similar metropolitan situations around Europe. This case is an illustrative example of an ongoing debate in the global community, although based in a Swedish housing market context.

As part of a larger research project in Kvillebäcken, studies looking at architects' perceptions, as well as insights from differently framed interviews with project managers and property developers are presented elsewhere, but contribute to a greater general understanding of the case. Focusing on the developers' perspective is essential due to the executive role developers are given in the contemporary economic system. Certification and policy rely on developers, yet little focus is given to the sometimes-paradoxical demands developers find themselves amidst when trying to define and pursue sustainable development. The scope of the study has therefor been to acquire and present a developer perspective on sustainable housing. The role of Municipal officials, and the perception of sustainable communities among local politicians, is to be explored further in future research.

A majority of the respondents had direct prior experience within the housing sector, albeit of varying extent in terms of time employed and title previously held. Although the interviews were directed towards representatives from the marketing or development divisions, the flat organizational structure found in smaller companies meant interviews were conducted with higher management or in one case, the CEO (as seen in Table 1). As a result, the respondents held a diverse insight into specific company procedures or policies.

An interview guide was followed containing three main sections (see Table 2). The interview guide was designed to give more or less equal attention to these main sections in order to avoid unilateral focus. The interviewer kept to the interview guide as far as possible, following the same sequence of questions and progression of questions throughout the interviews. However, minor variations naturally

occurred due to the length and focus of the respective interviewee's response, which will have affected the overall division of time (and words) spent on the different sections [45].

Table 1. List of interviewees.

	Company type	Number of employees	Market range	Type of apartments built	Interviewee function
A	Construction, forestry & property dev.group	900	National	Tenant-owned	Project development manager
B	Cooperative real estate organization	1120	National	Tenant-owned	Project & local market manager
C	Private real estate company	180	National	Rental & tenant-owned	Development manager
D	Construction & property dev. group	6000	International	Tenant-owned	Regional manager
	Public housing company	260	Local	Rental	Communication & marketing manager
F	Construction & property dev. group	17500	International	Tenant-owned	Regional manager + Marketing manager
G	Private real estate company	40	Local/regional	Rental & tenant-owned	CEO

Table 2. Interview topics.

1. About the company	2. Innovation in standards & concepts offered	3. Drivers for housing development
1.1. Type of company	2.1. Innovation policy	3.1. Trends & Market
1.2. Market range	2.2. Decision hierarchy	3.2. Laws, regulation & policy
1.3. Standards & concepts offered	2.3. Introduction process	3.3. Alternatives proposed by the company itself

The, on average, one hour interviews were recorded in full and transcribed relaying the full content of the interviews. As part of the inductive process the material was then coded using markers on three levels; content relating to the company/industry in general or to Kvillebäcken in specific; content belonging to identified reoccurring main themes of the interview; and content specific to subthemes that might or might not be reoccurring throughout the interviews. The coding was hence done partly with the interview guide in mind, complemented in large by observing the patterns of themes that emerged when reviewing the processed material as a whole.

In order to visualize observed patterns, a text analysis was conducted, according to the themes revealed in the inductive process (see Table 3) [46]. As common in qualitative research, the framing of the interview questions will have affected the choice of wording or focus of the response, which should be considered in the interpretation of the results [47]. The bias emerging from the interviewer's wording and the varying total word usage in each theme was addressed and mitigated by adding the words most frequently used by interviewees as well as interviewer in each theme and subsequently

comparing the ratio of the words in each theme. To be noted is also that the words "people" and "common" were given extra attention to differentiate usage in a context outside of the thematic group.

Table 3. Words used in thematic analysis, sorted by usage frequency among interviewees from top to bottom (words used in the interview guide in italics).

Interviewee word usage frequency	Resident	Market	Social Value	Environment	Policy
	People	*Market*	*Common*	Energy	Law
	Customer	Cost	Quality	*Environment*	*Regulation*
	Tenant	Companies	Society	Water	Legislation
	Resident	Pay	Social	Sustainability	*Policy*
	Inhabitant	Price	Affordable	Electricity	Government
	Client	Money	Collective	Heat	Municipality
	Consumer	Economic	*Affordability*	*Sustainable*	Rules
	Dweller	Business	Safety	Waste	Authority
	Buyer	Expensive	Security	Efficiency	Tax
		Economy	Collective		

The transcribed material presented here, in the form of anonymized direct quotes as well as general conclusions from the data analysis in its entirety, is used to argue the distinction of a discourse among the developers in the specific case. Particular interviewee's statements are either related to the majority discourse or recounted as expressing a unique minority perspective.

4. Results

4.1. Reported Sustainable Housing Concepts

Several of the interviewees report that their company tries to implement low-energy or even passive house standards in the housing they build. Several municipalities in the region are working with programs and policies for sustainable urban development, requiring developers to formulate sustainability objectives in order to be offered a plot or given the opportunity to build. The energy requirements in Kvillebäcken are therefore not unfamiliar, although intensified by the combination of several subprojects and initiatives. Some interviewees report particular technical or production-related concepts, often in regards to cost, although overlapping with environmental aspects. One of the interviewees describes the company's focus on wooden constructions, taking a holistic perspective on the process from the forest to the finished housing they offer. Another interviewee further underlines the advantage of developing holistic concepts with an environmental objective: "we started to produce our own energy. So we built windmills across the country actually, and next year we are going to be self-sufficient on all electricity to all our properties, that's nice." The same interviewee stresses that the commitment does not end with renewable energy, but to simultaneously reduce total consumption in the houses they build and manage.

Focus on people and what is perceived as social values or general quality of life for residents is partly discussed, with companies working to improve opportunities for interaction and create greater value for their residents or customers (a distinction should be made between companies building for sale or those building for own property management, where the relationship to the resident as customer

differs). To describe how these matters of residential quality are regarded, in relation to more technical aspects, one interviewee elaborates: "it's important for us that people think it's nice to live there, and safe to live and so on. So it's more soft kind of issues that are also important."

Commitment to contributing to a larger societal development is acknowledged as a particular explicit motivation for only one of the interviewees; "we try to be a part of the society and contribute to develop the whole society, not the house. We want to be part of building a city." Transparency is however upheld by the municipal public housing company, as well as adhering to a greater social responsibility and engaging with issues on a personal level, beyond the current private company trend: "we were working with CSR before it was invented."

4.2. Ambitions in Relation to the Market

Many of the objectives put forward in Kvillebäcken focus on social and economical considerations of for example mixing forms of tenure, creating attractive and vibrant environments that connect to the existing urban structure, as well as the importance of a "social quality of life with security and diversity". The aim is for around 25% of the 2000 apartments built in Kvillebäcken to be rental units. In the total multi-family housing stock in Sweden, slightly less than 70% are rental units, a number that is decreasing in favor of an increased share of tenant-owned apartments [48]. Of the seven companies present in Kvillebäcken, one is building solely rental apartments (the municipal housing company), while two others are building apartments of mixed forms of tenure (as seen in Table 1). The majority of the developers are hence building tenant-owned apartments in this particular project, a form of tenure that accounts for about half of the newly built apartments in multi-family housing nationwide [29]. Other alternative forms of tenure are not mentioned.

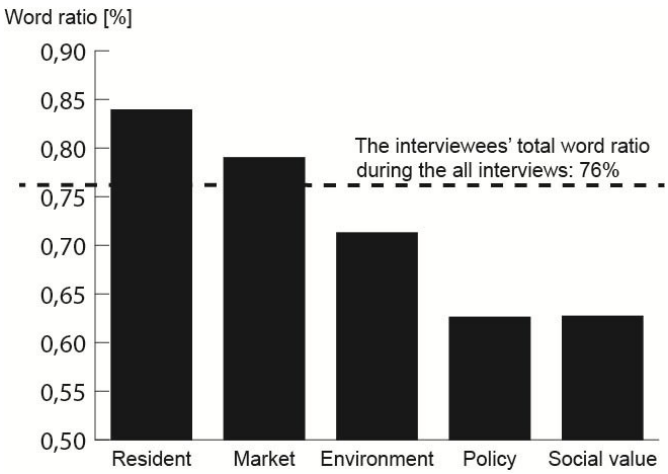
Housing affordability and the cost of sustainable housing in particular is mentioned by several interviewees, with some noting the increased costs associated with the introduction of new technical or material innovations and practices. Some companies report actively working with reducing end costs for the resident. This is stated in relation to either optimizing the building process and maintenance, or in the case of one of the private real estate companies—eating the costs to be able to "sleep at night" knowing they provide good quality housing they would themselves live in.

However, as building rental dwellings is perceived as economically challenging, this is compensated by the assumption of an urgent housing shortage. One interviewee expounds "as we have a situation in Sweden where the demands for housing in the big cities are so high, the need to be very secure in your surveys is not so important. As long as you build one apartment, you have at least 20–25 persons or families that want to live in that particular apartment." Another respondent admits that "as the market is now, it is not necessary [to stand out], and we will be a little bit lazy. Because we know that we will rent all our apartments anyway, /…/ I guess, some day it will come, the market /…/ will be satisfied." This pattern is further illustrated in Figure 1, showing that even though environmental and social issues are at the forefront in Kvillebäcken, economical challenges and competition for customers still occupy a relatively large portion of the words spoken in the interviews conducted (accounting also for potential bias in the framing or wording of interview questions).

The potential difference in the commitment of long-term environmental investments between the forms of tenure is further expressed. Companies that build solely for sale are perceived as less

financially motivated to invest in relationships with residents to get them to keep up the ambitions for the environmental standards in the area, such as practices for recycling or ecological stewardship. Similarly, energy-efficiency measures might be profitable in lowering costs for companies managing the properties as well as residents in all types of dwellings, but has less immediate financial return for those developers leaving the area after it is built and sold. This is an essential aspect of residential development, depending on the dwelling typologies and forms of tenure of apartments built, and the companies building them.

Figure 1. Interviewees' compared with interviewer's usage of words in thematic groups.



4.3. Identified Drivers for Development

4.3.1. Customers and Market Trends

Throughout the interviews it can be noted that residents (as tenants or customers) is an important factor to consider within housing development, and is said to be more and more in focus, exemplified by one interviewee; "what we have been discussing a lot lately, is that we have to think more when we build about who we are building for." Another interviewee says; "we have been discussing that we have to think more about the individual customer." Being able to relate to the individual customer is also expressed by another interviewee: "[We have to consider] the situation for the person who is going to live in the flat: how is the living going to be; is it comfortable and good in many ways. We look at the individual, the person, that's important for us." The same interviewee goes on to say that this focus might even be "more important than the building." This is also visualized in the text analysis shown in Table 3, though "people" is the more frequently used word when interviewees are speaking in general terms of public expectations.

Watching what competitors are doing is one way of staying informed on market changes. Knowing and listening to potential customers is however one of the strongest drivers according to the respondents: "We daily observe the trends and market to see what the consumers want to have. In some projects, Kvillebäcken is such a project, we've involved proposed customers in the product

development phase. It can be done through surveys, forms or interviews in focus groups." Collecting this type of participatory input or feedback is further discussed from the perspective of when in the project it is received. Early interaction might lead to a larger change, whereas less rigorous engagement might result in something of "a little bit cosmetic".

It is proposed that residents are not attracted or interested by innovation per se, but appreciate good quality, comfort, affordability and so on, which might be made possible by new innovations. One interviewee depicts a shift: "you are more demanding as a customer today" and states that "they are picky. Yes, but I mean in a positive way! It is good that they are." That questions of sustainability are becoming increasingly important is concurred among the interviewees, although residents might not be informed about all aspects. This is clarified as when it comes to "these environmental questions, you have to suggest, they don't really know how to demand."

4.3.2. Laws, Regulations and Policy

When asked about potential drivers for development of the housing sector, the interviewees proclaim following laws and regulations as ineludible, but in different ways emphasize that this is not necessarily perceived as the sole imperative for pushing new concepts today. One interviewee says; "The regulations and law, you have to take care of that, but then what the customers say, that's the most important I think." Several of the interviewees nevertheless point to laws or national policy regulating contemporary Swedish construction as holding housing development back, correlating an alleged increasing strictness with rising production costs.

The interviews furthermore indicate that especially restrictions aiming to reduce environmental impact are discerned as of growing priority within both local and national government. As more municipalities intensify the demands put on developers wishing to build, companies have to adjust to stay competitive. As previously noted some interviewees highlight that in the case of environmental concerns it is these types of local or national requirements, more than customer interest, that drives the companies' work with these issues; "Sustainability is a very interesting thing to work with, but not so much because the customer wants it, but because the different municipalities demand it from us."

4.3.3. Developers' Perspectives

The potential conflicts between different drivers identified in the interviews is commented on by one of the interviewees, who sums the situation up by declaring that: "For us, the developer, it's tough, all these demands from the municipality, and the demands from the customer, and the demands from the market that we should have prices so that everyone can buy these apartments. It's a rather tough equation."

A series of possible other drivers than the ones posed within the structured interview questions are offered. Economy and the current market system is evidently of general concern (as Figure 1 indicates) and is highlighted throughout as an underlying driver for many of the innovations or development of the different concepts the developers work with; "most of the time it is economy that sets the standards." This can be either in the form of keeping costs down for the company, or for the customer—or both.

The companies that particularly work with construction concepts uphold the importance of such focused work to improve building methods or key components to rationalize housing production.

When asked about ideas within the company that are challenging the common practices within the industry, one interviewee reiterates the choice to focus on a niche within construction; "The biggest thing that you can say goes in opposition to the mainstream is our policy to build with wooden frames in all our projects." Another suggests their company could be said to push housing development by working with industrialized construction, but adds; "I think the whole construction and developer business are like [a school of] fish, mainstream, no one dares to do anything else, I would say."

5. Discussion

5.1. Paradoxes and Possibilities for a Sustainable Housing Sector

The building sector as a large contributor to the development of productive sectors and regions, but conversely also to the resource depletion and environmental impact of the built environment, needs to conceptualize how this equation is resolved within the claim of building sustainable living environments. The results from the interview study support the contention that there is an imprecision in how such a sustainable development within the housing sector is concretized. Varied interpretations are subsequently made, here presented from a housing developer perspective. The main aspects of this interpretation relate to the assumption of an economical and political system in place; a somewhat restricted perspective on sustainability in housing often limited to "green" solutions. However, the role of the resident in driving development is also emphasized, suggesting a possibility for shifting focus.

The housing sector exemplifies the general paradox of sustaining life support resources while attempting to develop—in the sense of expanding—consumption within the dwelling market. The industry's role in developing equity and equal opportunity and the production of social capital in living environments is in part a question for housing developers and in large relates to the complex processes associated with the creation (or redevelopment) of residential areas.

Beyond the gradually more common technical and quantitative requirements on new residential development, the pursuit of a holistic approach to sustainable housing concepts and the reported engagement with social questions emerge as possibilities for the industry to strengthen the role of informing the discourse on sustainable housing development. However, the case presented here highlights some of the paradoxes with pursuing an interpretation of sustainability in the development of an area such as Kvillebäcken, particularly relating to issues of social mixing and forms of tenure, and the limitations in environmental considerations and focusing on efficiency.

In relation to the existing Swedish housing stock, or even the breakdown of newly built apartments, a ratio of 25% of the apartments built for renting is below the national average, although remains notable in the context of contemporary central development projects (reflecting also the pressure on urban development and the current housing market system). This could not per se be considered to significantly further an overall societal development towards equal opportunity. Bearing in mind the on average higher monthly rents of new rental apartments, a question is also who will afford to live in such newly developed areas and whether there will be a substantial socio-economic diversity among residents even with a mix in form of tenure, as systemic and social norms foster indebtedness in striving to own one's apartment.

There is a lack of a holistic alignment of ambitions in this issue, entailing an obstacle for a sustainable housing development, as social and ecological costs of the built environment are not weighted adequately. Although it is recognized that all new construction is high-cost, it is assumed that building "green" is more expensive. A government report commissioned by the Swedish minister of housing to review the obstacles for increased housing production proposes that local energy requirements that go beyond the national guidelines hinders, and thus raises the prize of, construction [49]. Environmental ambitions are thereby put in opposition to overall costs—addressed primarily for developers to stimulate new production (and renovation), as this is further assumed to trickle down to affordability for residents. As with all new innovations in construction, a transition period for knowledge dissemination and competency building within the sector is however necessary, upon which point an assessment of the added costs of green housing construction should be further evaluated. Whether a lowering of requirements would lead to actual lowered housing costs for residents is not conclusive, yet remains a largely uncontested assumption in the political discourse.

The housing shortage especially among rental apartments, as in the Swedish case, further shows a potential obstacle for sustainability in multiple aspects. It speaks against a large investment from the developers in terms of developing social capital or actively working with reducing environmental impact, as the current market situation ensures they will be able to rent out regardless. With minimum norms for spatial and material standard in newly built apartments, the baseline for all new construction still remains high. However, strong local political ambitions for further development are made less prominent in a situation of high demand, considering also the nature of the shortage—rental apartments in urban areas for less affluent groups. The difference in incentives for long-term investments in promoting and upholding sustainable residential practices and social connections with residents between different forms of tenure moreover raises questions of how to overcome obstacles with both tenant-owned and rental apartments for a sustainable housing development.

With municipal and national policy pushing the reduction of particularly energy consumption in new or redeveloped residential areas, the building sector has responded with new products and processes for energy-efficient construction. Policy is however not perceived to be as forceful in clarifying the social dimensions that are required in urban development, making it hard for developers to incorporate these directives. Investing in, and promoting the creation of social capital is not mentioned explicitly in the interviews, but however implied in that relationships with and among residents is something multiple companies work with.

As expressed in the case presented here, the varying demands on and drivers for housing development entail that developers adhere to multiple external policy and customer perspectives as well as position themselves in a competitive market. These oftentimes-conflicting demands pose both obstacles and possibilities for a housing sector that, on top of this, aims to contribute to and take responsibility in an overall sustainable development. In Kvillebäcken, the ambition of the consortium in establishing goals for different sustainability aspects is an attempt to define and concretize these interpretations. The developers' perception of the internal drivers for housing development moreover suggest an obstacle in that the industry after all is competitive, and the possibility to break away from the mainstream is dependent on strong own incentives, supported by a stronger local policy and an interactive customer base.

Developers report following and wanting to satisfy customers' needs, along with the importance put on residential quality of life. That customers are perceived as becoming more demanding could be seen as a possibility for further challenging and developing the housing offered. However, building for customers' demands is not per se sustainable, as the identified demand and residential lifestyle development might not be in line with an absolute optimization of energy and resource use. From a urban and residential development perspective qualitative, attractive and smart spaces where functions—and therefore also energy and resource use—are shared rather than individualized present themselves as necessary to challenge the trend of improved spatial and material standards and the increase in single households. Ensuring an equitable development, where diverse residents are given space and access to influence their living environments, is not a simple task. Especially for developers operating within a market where specifying target groups is an efficient strategy to be able to focus on and offer residential quality as defined in relation to that particular context.

5.2. Ways Forward

Conceptualizing and attempting to concretize what a sustainable housing development entails emphasizes the role of the housing sector in informing the discourse on the development of holistically sustainable living environments, beyond the representation of "sustainable housing". A market perspective on speculative residential construction supposes and results in one type of sub-optimized interpretation of development [50].

In order to avoid paradoxical discourses and sub-optimal progress in the building sector, a holistic perspective on sustainable development including dimensions of social capital and equal opportunities linked with an ecological modernization perspective is needed. This holistic perspective must also entail a systems thinking on multiple levels to take rebound effects and individuals' opportunities for engagement and prioritizations into account. Socio-cultural aspects of the built environment, along with affordability, remain important issues to be incorporated.

A clarification and strengthening of policy is essential, yet continues to be regarded as problematic in a market-environmentalist paradigm. There is nonetheless a need for an alignment between how industry, policy and the market perceive housing development and what is actually sustainable. This goes beyond the contemporary discourse on efficiency—what and how to sustain—and the current social target groups—for whom and what to develop. Such a discourse would move focus from efficiency to sufficiency. By making this shift it is possible to more adequately reach equal opportunity targets on a local scale and address issues of housing affordability in relation to local prerequisites, beyond standard definitions [30].

To provide possibilities to move beyond, the industry can recognize new forms of development. An example is smaller developers with a more local rootedness, which could not only diversify the built environment but also recognize the value in building social capital and long-term economic and social resilience. Opportunities to build homes that increase social capital, while not contributing to increased consumption within the dwelling market, lie in local engagement [38], a sense of "at-homeness", diversifications of existing social structures [51], and collective resource use as opposed to individualized. An important policy tool in reaching the inhabitants is the tenure type and financing mechanisms promoted. Alternative tenure and financing structures can be used to support resource

efficient living, stimulate local engagement and encourage possibilities for social development. One such tenure type is provided in for example cooperative rental organizations. Building varied apartments and facilitating downgrading/upgrading of living space within the organization, building or residential area would further increase the resilience of the area and build social capital.

Although the presented findings refer to a Swedish context, the issues raised can be found in similar urban cases in metropolitan growth regions around Europe and additional comparative studies should be made with international studies. Attention should also be given to mapping the perspective among other actors in housing development, such as policy makers, local officials, builders, facilities managers and end-users as citizens and residents.

6. Conclusions

The range and vagueness in demands in which the housing sector operates contributes to a restricted and unilateral interpretation of sustainability. Lacking a clear general conceptualization, policy formulation within national or local government, as well as within the housing development sector, consequently presents a challenge for implementation of sustainable practices and strategies.

There is for example a direct inconsistency of sustaining life support resources while developing consumption if developing is synonymous with increasing. In the housing sector, this paradox is illustrated in the dependency of a growing market and speculation while working with increasing residential quality, social values and equal opportunities. This is supported by the results from the presented interview study in the case of a "green" residential development. The assumption of a current market structure, along with a limited focus on sustainability, is highlighted, but so is also the role of the resident. Possibilities for the housing sector are given in the recognition of new forms of development, where the creation of social capital and resident engagement is upheld.

The presented material illustrates a national (through a Swedish case), as well as European or global issue. In summary, it is argued that the market on its own is not delivering holistically sustainable living environments, but rather work from an interpretation of sustainability with a limited reach. Instead, local and personal responsibility and initiatives taken within the housing sector can be found to have greater impact on the development of sustainable housing. Developing both policy and practice, as well as emphasizing collaboration for a more holistic discourse, is proposed.

In order to achieve the large-scale impact needed to create more sustainable living environments, an adaptation of multi-level changes through systemic thinking and a holistic perspective is required. This goes beyond the discourse on technical solutions and the superficial understanding of social development, moving focus from efficiency to sufficiency. This holistic perspective must entail various levels, and social dimensions incorporated into the ecological modernization paradigm.

Acknowledgments

The study presented is part of ongoing research work funded by the Swedish Research Council Formas, within the strong research environment "Homes for Tomorrow" at Chalmers University of Technology. The authors would finally like to thank Guillemette Zuber for her excellent work with preparation and data collection.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Spence, R.; Mulligan, H. Sustainable development and the construction industry. *Habitat Int.* **1995**, *19*, 279–292.
2. Sev, A. How can the construction industry contribute to sustainable development? A conceptual framework. *Sustain. Dev.* **2009**, *17*, 161–173.
3. Jensen, J.O.; Jørgensen, M.S.; Elle, M.; Lauridsen, E.H. Has social sustainability left the building? The recent conceptualization of "sustainability" in Danish buildings. *Sustain. Sci. Pract. Pol.* **2012**, *8*, 94–105.
4. Maliene, V.; Howe, J.; Malys, N. Sustainable Communities: Affordable Housing and Socio-economic Relations. *Local Econ.* **2008**, *23*, 267–276.
5. Priemus, H. How to make housing sustainable? The Dutch experience. *Environ. Plann. Plann. Des.* **2005**, *32*, 5–19.
6. Raco, M. A growth agenda without growth: English spatial policy, sustainable communities, and the death of the neo-liberal project? *GeoJournal* **2012**, *77*, 153–165.
7. Winston, N. Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas. *Sustain. Dev.* **2010**, *18*, 319–330.
8. Crabtree, L. Sustainable Housing Development in Urban Australia: exploring obstacles to and opportunities for ecocity efforts. *Aust. Geogr.* **2005**, *36*, 333–350.
9. Xue, J. Limits to decoupling strategies for sustainable housing development: The Hangzhou experience. *J. Environ. Plann. Man.* **2012**, *55*, 1004–1021.
10. Lorenz, D.; Lützkendorf, T. Sustainability in property valuation: theory and practice. *J. Property Invest. Finance* **2008**, *26*, 482–521.
11. Malmqvist, T.; Glaumann, M.; Scarpellini, S.; Zabalza, I.; Aranda, A.; Llera, E.; Díaz, S. Life cycle assessment in buildings: The ENSLIC simplified method and guidelines. *Energy* **2011**, *36*, 1900–1907.
12. Anderssen, I.; Thomsen, K.E.; Wahlstrøm, Å. Nordic *Analyses of Climate Friendly Buildings*. Available online: http://www.nordicinnovation.org/Global/_Publications/Reports/2010/Nordic%20Analysis%20of%20Climate%20Friendly%20Buildings.pdf (accessed on 18 April 2013).
13. Femenías, P.; Kadefors, A. Clients' strategies for driving innovation in low energy building. Paper presented at the Sustainable Building Conference, Helsinki, Finland, October 2011. Available online: http://publications.lib.chalmers.se/records/fulltext/local_145376.pdf (accessed on 18 April 2013).
14. Zhang, X.; Shen, L.; Wu, Y. Green strategy for gaining competitive advantage in housing development: a China study. *J. Clean. Prod.* **2011**, *19*, 157–167.
15. Schweber, L.; Leiringer, R. Beyond the technical: a snapshot of energy and buildings research. *Build. Res. Inform.* **2012**, *40*, 481–492.

16. Lovell, H. Framing sustainable housing as a solution to climate change. *J. Environ. Pol. Plann.* **2004**, *6*, 35–55.
17. Luke, T.W. Neither sustainable nor development: reconsidering sustainability in development. *Sustain. Dev.* **2005**, *13*, 228–238.
18. Verbruggen, H. Dual goal: Economic growth along with environmental improvement. *Stud. Environ. Sci.* **1998**, *72*, 961–968.
19. Turner, G.M. A comparison of The Limits to Growth with 30 years of reality. *Global Environ. Change* **2008**, *18*, 397–411.
20. Mol, A.P.J.; Sonnenfeld, D.A.; Spaargaren, G. *The Ecological Modernisation Reader: Environmental Reform in Theory and Practice*; Routledge: London, UK, 2009.
21. Jensen, J.O.; Gram-Hanssen, K. Ecological modernization of sustainable buildings: A Danish perspective. *Build. Res. Inform.* **2008**, *36*, 146–158.
22. Wijkman, A.; Rockström, J. *Bankrupting Nature: Denying Our Planetary Boundaries*; Routledge: New York, NY, USA, 2012.
23. Stoddart, H.; Riddlestone, S.; Vilela, M. Principles for the Green Economy. A collection of principles for the green economy in the context of sustainable development and poverty eradication. Available online: http://www.stakeholderforum.org/fileadmin/files/Principles%20FINAL%20updated.pdf (accessed on 1 February 2013).
24. Kates, R.W.; Parris, T.M.; Leiserowitz, A.A. What is Sustainable Development? *Environment* **2005**, *47*, 8–21.
25. Huesemann, M.H.; Huesemann, J.A. Will progress in science and technology avert or accelerate global collapse? A critical analysis and policy recommendations. *Environ. Dev. Sustain.* **2008**, *10*, 787–825.
26. Agnello, L.; Schuknecht, L. Booms and busts in housing markets: determinants and implications. *J. Hous. Econ.* **2005**, *20*, 171–190.
27. Rybkowska, A.; Schneider, M. *Housing Conditions in Europe in 2009*. http://www.epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-004/EN/KS-SF-11-004-EN.PDF (accessed on 1 February 2013).
28. *Bostadsmarknaderna i Norden och regionalt*; Boverket: Karlskrona, Sweden, 2010.
29. SCB. *Yearbook of Housing and Building Statistics 2012*; SCB-Tryck: Örebro, Sweden, 2012.
30. Mulliner, E.; Smallbone, K.; Maliene, V. An assessment of sustainable housing affordability using a multiple criteria decision making method. *Omega* **2013**, *41*, 270–279.
31. Beer, A.; Kearins, B.; Pieters, H. Housing Affordability and Planning in Australia: The Challenge of Policy Under Neo-liberalism. *Housing Stud.* **2007**, *22*, 11–24.
32. Choguill, C.L. The search for policies to support sustainable housing. *Habitat Int.* **2007**, *31*, 143–149.
33. Turner, B.; Whitehead, C.M.E. Reducing Housing Subsidy: Swedish Housing Policy in an International Context. *Urban Stud.* **2002**, *39*, 201–217.
34. Brown, T.; Bhatti, M. Whatever Happened to 'Housing and the Environment'? *Housing Stud.* **2003**, *18*, 505–515.
35. Hoffman, A.J.; Henn, R. Overcoming the Social and Psychological Barriers to Green Building. *Organ. Environ.* **2008**, *21*, 390–419.
36. Spaargaren, G. Ecological modernization theory and domestic consumption. *J. Environ. Pol. Plann.* **2000**, *2*, 323–335.

37. Hille, J.; Simonsen, M.; Aall, C. *Trender og Drivere for Energibruk i Norske Husholdninger. Rapport til NVE*; Vestlandsforsking: Sogndal, Norway, 2011.
38. Strengers, Y. Bridging the divide between resource management and everyday life—Smart metering, comfort and cleanliness. Ph.D. Thesis, RMIT University, Melbourne, Australia, 2009.
39. Falkheden, L. Local area as a strategy for sustainable urban development. Case studies of three Danish examples. Ph.D Thesis, Chalmers University of Technology, Göteborg, Sweden, 1999.
40. The Kvillebäcken Consortium. *Program för Hållbar utveckling i Kvillebäcken*. Available online: http://kvillebacken.se/upload/Program-for-utveckling-Kvillebacken_110927.pdf (accessed on 16 July 2012).
41. Ragin, C.C.; Becker, H.S. *What is a Case?: Exploring the Foundations of Social Inquiry*; Cambridge University Press: New York, NY, USA, 1992.
42. Yin, R.K. *Case Study Research: Design and Methods*; Sage Publications: London, UK, 2008.
43. Esaiasson, P.; Gilljam, M.; Oscarsson, H.; Wängnerud, L. *Metodpraktikan*; Nordsteds Juridik: Stockholm, Sweden, 2007.
44. Van den Bergh, J.C.J.M. Environment *versus* growth—A criticism of "degrowth" and a plea for "a-growth". *Ecol. Econ.* **2011**, *70*, 881–890.
45. Kvale, S.; Brinkmann, S. *Interviews: Learning the craft of qualitative research interviewing*; Sage Publications: London, UK, 2008.
46. Thompson, I. Collaboration in technical communication: a qualitative content analysis of journal articles, 1990–1999. *IEEE T. Prof. Commun.* **2001**, *44*, 161–173.
47. Alvesson, M.; Sköldberg, K. *Reflexive methodology: New vistas for qualitative research*; Sage Publications: London, UK, 2009.
48. *Bostadsmarknaden 2008–2009—med slutsatser av bostadsmarknadsenkäten 2008*; Boverket: Karlskrona, Sweden, 2008.
49. Hedlund, B. *Ökat bostadsbyggande och samordnade miljökrav—genom enhetliga och förutsägbara byggregler*; SOU 2012:86: Stockholm, Sweden, 2012.
50. Moore, S.; Bunce, S. Delivering sustainable buildings and communities: eclipsing social concerns through private sector-led urban regeneration and development. *Local Environment* **2009**, *14*, 601–606.
51. Schroepfer, T.; Hee, L. Emerging Forms of Sustainable Urbanism: Case Studies of Vauban Freiburg and solarCity Linz. *J. Green Build.* **2008**, *3*, 65–76.

PAPER II

Hagbert, P. & Femenías, P. (2014). Sustainable homes, or simply energy-efficient buildings? Manuscript, submitted to *Journal of Housing and the Built Environment*.

SUSTAINABLE HOMES, OR SIMPLY ENERGY-EFFICIENT BUILDINGS?

PERNILLA HAGBERT[1]
hagbert@chalmers.se, +46 (0)31 772 24 69 (corresponding author)

PAULA FEMENÍAS[1]
femenias@chalmers.se

[1]Department of Architecture, Chalmers University of Technology
Sven Hultins gata 6, 412 96 Göteborg, Sweden

ABSTRACT

Environmental consideration within the Swedish construction sector can no longer be considered marginal. It is here discussed whether the same commitment is extended to facilitate deeper dimensions of sustainability in the provision of housing, beyond simply energy efficient residential buildings? The paper presents the case of a multi-family 'green' residential area called Kvillebäcken, currently under development in Göteborg, Sweden. An empirical study is primarily based on interviews with the seven housing developers building in the area, and further complemented by insights from a workshop with architects involved in the project. Thematic issues identified in the inductive data analysis relate to household demand and spatial norms, as well as standards and notions of comfort. It is argued that the interplay between and overlapping of these aspects influences the creation of holistically sustainable residential environments, with a focus on implications of modern ways of dwelling. The paper shows that interpretations of sustainability in market-led housing development do not radically challenge the normative and resource intense contemporary ideals of the urban home, and that the realization of goals undertaken in the case of Kvillebäcken is generally dependent on economic considerations and market assessments. In conclusion, the paper emphasizes the need to formulate an integrative approach to more holistic sustainable residential environments.

Keywords: architectural design; household consumption; housing; residential; sustainability

1. INTRODUCTION

Issues of escalated resource depletion, inequity, economic and political turbulence, and the growth of the world's urban population, are increasingly recognized as interlinked challenges on both a global and local scale. A systemic understanding of these problems furthermore outlines their 'wicked' character (Rittel and Webber, 1973).

With the establishment of political incentives and regulations aiming at a more sustainable built environment, along with industry-initiated reforms and innovations, new policies and practices are being adopted. On the whole, environmental consideration in the sector can no longer be seen as marginal (Thuvander et al., 2011). Recent years have shown a rapid development of efficient construction in general, with a push for low-energy buildings in Sweden (Wahlström et al., 2011). Of interest in this paper is whether this is sufficient to reach a sustainable development of the built environment, and if similar efforts are made to facilitate a more holistic notion of 'sustainable homes' (aiming for deeper dimensions of sustainability and conceptual interpretations linking lifestyles and material representations within finite ecological limits). Illustrated in the case of a Swedish urban area, underlying ambitions as well as what is built in the context of contemporary 'green' housing development are here explored.

Conflicts between different perceived facets of sustainability are evident and often clearly illustrated in the expansion of infrastructure, and in urban and residential developments (Campbell, 1996; Godschalk, 2004; Ghanbarpour and Hipel, 2009). While environmental and technical dimensions of sustainable building has predominated the agenda since the mid 1990s, social and cultural dimensions have had more of a recent focus.

The need to go beyond technical solutions to solve environmental problems related to the built environment is increasingly pointed out (WorldwatchInstitute, 2010; Schweber and Leiringer, 2012). In this perspective, major behavioral changes are needed, supported by a provision of residential environments that enable more sustainable ways of dwelling. Several studies have related home-based practices and lifestyles to a resource use related dimension (Hoyer and Holden, 2001; Gatersleben et al., 2010). Yet research on the meaning and socio-cultural concept of home (Mallett, 2004) has not traditionally examined an ecological dimension of such constructs (Coolen, 2006).

The presented work forms an initial part of mapping conceptualizations of sustainability in housing. A qualitative study of a new multi-family residential area - called Kvillebäcken - in Göteborg, Sweden poses an illustrative example of a contemporary urban redevelopment project with high initial objectives to among other things mitigate environmental impact and ensure residential 'quality of life'. The paper explores the question of how goals for sustainability in the provision of housing, relating to design and concept development of dwellings, are interpreted and realized among primarily developers, but also architects in the case of Kvillebäcken. As housing provision in Sweden relies on a commercially driven market (Hedin et al., 2011), both for private and public development, it is of interest to explore perceptions and results of sustainable residential solutions from a market perspective in particular.

The paper begins with a general outline of issues of sustainability and challenges for a sustainable housing development. This is followed by the research design of the study and a section describing the case of Kvillebäcken. Empirical findings are then presented, where main thematic issues that emerged during data analysis are discussed. These revolve around household sizes and their demands, and spatial norms; and expected standards/comfort associated with the modern urban home. These aspects are argued to influence the absolute impact of residential standards and the

ideals perpetuated in contemporary housing development and in the creation of sustainable residential environments. It is suggested that without an anchored and systemic inquiry of residential norms and practices, eco-efficient measures on their own do not radically challenge the resource and energy intensity or social concerns of current housing development.

2. SUSTAINABLE HOUSING

2.1. Domestic demand

While the general impact of all household-related consumption, including major consumption clusters such as transport/mobility and food remains a significant issue for addressing the 'unsustainability' of modern life (Lorek and Spangenberg, 2001; Holden, 2004a); here, emphasis is put on the housing sector and physical residential environments. Defining a household also implies determining precisely where a domestic environment that a household inhabits ends, pinpointing the limit between the conventionally ascribed 'dwelling unit', and functions and spatial demands of households that fall outside of this unit. Of interest in this paper is to discuss normative concepts of spatial standards and resource use in a holistic perspective on home-related functions.

With a relatively young housing stock, about 60% built after 1960 (SCB, 2012), the Swedish post-war development was based on socialistic visions of the early 20th century, promoting good housing for all. Funded through grants, housing development was linked to national requirements for spatial standards as well as norms regarding central heating, kitchen equipment and bathroom facilities. Swedish post-war hosing has also been characterized by communal use; in for example local centers with services, district heating and shared facilities for washing and recreation (Boverket, 2008). As Swedish housing policy has changed considerably during the last decades, the current market-led development entails a significantly lower state involvement in the provision of housing (Hedin et al., 2011).

At present, particular focus is directed towards the reduction of energy and resource use in new residential development. Nonetheless, it is recognized that substantial efforts in addressing the demands and state of the existing housing stock need to be undertaken across Europe, including Sweden. Domestic energy use account for nearly a fourth of the total energy use in Sweden, and have thus been pointed out as a main area for action in order to reach the national goals for energy saving set for 2020 and 2050 (the Swedish Environmental Protection Agency, Naturvårdsverket, www.naturvardsverket.se). Besides reflecting the technical and thermal performance of Swedish residential buildings, the demand implied furthermore points towards the energy intensity of modern ways of dwelling.

Even as the aforementioned increase in energy-efficient construction and development of 'green' urban areas is supported by a growing marketing base for 'pro-environmental' lifestyles, the limitations of such housing and/or households to reduce absolute consumption, or contribute to an overall sustainable societal development has been stated (Holden, 2004b; Holden and Linnerud, 2010; Wangel, 2013). As citizens or residents are offered 'empowerment' in the role as rational consumers or clients, household-related consumption and the reduction or redirection of the same is framed in market terms (Jackson, 2005). It is argued however that beyond the notion of consumers making deliberate individual choices, households can also be locked-in by organizational or physical structures restricting room for action (Sanne, 2002).

It is acknowledged that rebound effects suggest limitations for measures of improved energy or material efficiency (Nässén and Holmberg, 2009; Sorrell, 2009; van den Bergh, 2011). In addition to potential spill-over effects to other sectors in society, the failure to bring more radical

synergetic transitions into the mainstream raises the question of how advantageous energy-efficiency measures in housing design and development are, when seen from a more holistic standpoint (Vale and Vale, 2010). Economic aspects of the 'Jevons' paradox' (Sorrell, 2009) would indicate that improved availability and efficiency of technology further reduces costs, which in turn entails that more people will have access to, and thus by extension maintain or drive the subsequent energy or resource demand up.

Previously driven primarily by building norms, today the market itself plays a bigger role in identifying and catering to various housing preferences, including for example requirements for living space. A recent study underlines the role of spatial standards, indicating that the relative leveling out of energy use in Norwegian households that occurred during the last 20 years is largely due to a slower increase in living space per capita (Hille et al., 2011). Although efficient technology and practices, along with a milder climate, were found to account for part of the total reduction, the most significant factor was that the rate of population growth surpassed the increase in total living space. Explanations given for such a shift include changing demographics and preferences, as well as increased costs. Such findings support the aforementioned supposition regarding the inadequacy of efficiency measures on their own to radically reduce demand, use and impact on a larger scale.

2.2. Social facets

Creating the attractive, 'livable' city based on ideas of diverse and functionally mixed urban environments has become a staple in contemporary urban planning and policy visions. The social and functional monocultures of the industrial housing boom in many European cities are thereby dismissed in favor of mixing housing of various types, sizes and forms of tenure, as well as residential and commercial functions (Dempsey et al., 2011).

A social diversity of households from different socio-economic segments of the population is believed to spur local social opportunities as well as counteract urban segregation (Barton, 2000). By bridging social and ecological sustainability, the importance of community, resident engagement, anchoring and support in the neighboring residential environment is often upheld (Dempsey et al., 2011; Vallance et al., 2011). Besides socio-economic development, mixing functions and allowing for a larger freedom of choice in settlement is also seen from the potential to reduce transportation needs, thereby further minimizing environmental impact (Barton, 2000). It is commonly proposed that socio-economic diversity within a residential environment further provides an inherent resilience in comparison to areas of a more limited internal variation. However, the success of deliberate planning and design for social mixing, and the intended outcome of increased social capital, remains a point of debate (Buys et al., 2007).

2.3. Changing circumstances for housing development

There are several demographic, normative and regulatory trends to be noted, influencing the conception and production of housing. In order to position the case presented in this paper, the focus is here on the Swedish context, although similar patterns can be observed across a European, or even global, scale.

The changing circumstances for housing must also be understood in the perspective of a relatively conservative housing sector. While other industrial sectors have seen a rapid adoption of new technologies, processes and services, the construction industry in general is found to have lower rates of (particularly technological) innovation (Reichstein et al., 2005; Bröchner, 2010). In addition, criticism raised concerning the success of emerging mainstream sustainable building

approaches to adequately address issues of growing housing consumption and demand (Jensen and Gram-Hanssen, 2008; Vale and Vale, 2010), further points to the challenge and necessity to collate a more holistic perspective of sustainable housing development.

2.3.1. Individual demand, household size and spatial norms

The general influence of a growing individualism, shifting demographics and the particular trend of an increasing number of small households can be noted across Europe (Clarke, 2004; Kabisch and Haase, 2011). This has implications for housing and absolute resource demand, both directly and indirectly (Liu et al., 2003). The number of Swedish single-person households continues to increase, and today accounts for about half of all households (SCB, 2012). Changing household configurations and the flux of urban inhabitants puts pressure on the provision of housing and thus also land (Haase et al., 2013), especially in metropolitan areas where land might be scarce or particularly costly to exploit.

Smaller rental apartments of 1 to 2 rooms plus a kitchen, along with larger apartments (4 or 5 rooms), are reported to be in acute shortage in Swedish metropolitan areas (Boverket, 2012). The shortage reflects the inadequacy of earlier housing policy to plan for the needs of households today, which includes an increasing number of elderly, students and young adults, as well as larger families. The nature of the housing shortage suggests that neither the existing stock nor contemporary housing development sufficiently meet the housing needs of the population as a whole, especially those less financially visible on the housing market, as suggested by Manum (2006) in a Norwegian situation. Housing affordability is a contested issue in the current commercial housing market. The amount Swedish households spend on housing relative to disposable income is high in a European comparison, yet should also be discussed in terms of the acquired quality and level of standard (Boverket, 2010).

Trends regarding living space per capita specifically relates to the increasing number of single-person households as one determinant of total material and spatial demand in housing (SCB, 2012; Haase et al., 2013). Swedish residents on average experienced an increase in spatial standard during the second half of the 20th century, both in terms of square meter per capita and the division and distribution of private space within the dwelling. Beyond living space per capita as usable floor area, the number of rooms in relation to the number of household members is here also used as a reference point. Whereas over 40% of Swedish households lived in overcrowded conditions[i] in the beginning of the 1960's, this number shifted to less than 10% in the late 70's (SCB, 2012). A norm from the 70's further recommends that every child should have its own bedroom, and by extension also counts singles living in studio apartments as crowded.

The percentage of residents living in what is considered a high standard of space[ii] has increased significantly during the same time period. While less than a tenth of the population lived in a considered high spatial standard in the mid 60's, today around 40% of Swedes have rooms to spare (SCB, 2012). Although statistical averages of living space per capita must be understood precisely in the context of the high share of single-person households, along with contingencies of specific individuals occupying a much larger floor area, issues surrounding housing standards and household consumption are important to explore further.

2.3.2. Housing standards and residential comfort

Along with the trend of decreasing household size, resource and energy demands are increasingly individualized (Carlsson-Kanyama and Lindén, 2002). Expectations for housing standards remain

normative, both in a social sense and in policy. Norms for the functions expected within each dwelling unit give a subsequent need for facilities such as a bathroom and kitchen regardless of household size. Regulations such as accessibility also set spatial demands for individual dwelling units. Social norms and shifting perceptions both in regards to household configuration (Clarke, 2004), and the construction of the 'ideal' home influence housing demand and consumption (Gram-Hanssen and Bech-Danielsen, 2004; Leonard et al., 2004; Aune, 2007). The trend of open floor plans in new Swedish housing design further emphasizes prevalent societal norms and ideals of home life (Willén, 2012).

A main influence on the energy and resource intensity of housing should further be connected to notions of residential comfort and material standard within a normative social or structural context (Wilhite et al., 1996; Shove, 2003; Shove et al., 2008). The implications of household size can be debated in light of such norms, as explored by Klocker et al. (2012), indicating that it is an interplay of these factors that determine overall impact on household energy and resource use. As socio-technical transitions and the efficient manufacturing of household products has effected the rate and scale of household consumption, the housing sector has adopted a market offering dwellings, products and services that simplify home life for residents. Facilities or household technologies that were previously shared have through such a development instead been made available to the individual home.

3. RESEARCH DESIGN AND METHOD

The material presented here is part of a larger research project on sustainable housing, with a focus on the radical reduction of energy and resource use. While additional aspects are addressed in complementing research, the focus here is on the exploration of a market point of view, and how it translates into what is built. The empirical material is comprised of findings from qualitative interviews (seven in total) carried out with representatives from the marketing or development departments at the seven companies developing housing in the case area of Kvillebäcken in Göteborg. The interviewees were according to the companies those within the organization working with design and concept development of the dwellings offered. In addition, insights from a workshop with in total eight architects from the five respective architecture firms involved in the project are also presented.

Parallel studies have been carried out in the same area and provide a deeper understanding of the case. One focuses on the overall sectorial discourse on sustainability and sustainable innovation, based on data attained in conjunction with the interviews outlined here *[reference removed for peer-review]*. Another focuses on the role of client partnership models to stimulate innovation, which includes another 13 interviews with project leaders and managers of innovation and development. Interviews with two civil servants from the Municipal Planning Office in charge of the development, as well as observations at a meeting held by the Municipal Development Company for feedback of experience within the project, should further be mentioned.

In addition to the above-described empirical material, various readily available documents were reviewed on a more general level. These include the *Program for sustainable development in Kvillebäcken* (Kvillebäckskonsortiet, 2011), the master plan documents established by the Planning Office and proposed or realized floor plans from the respective companies.

For each of the seven semi-structured interviews (see table 1), a time slot of about an hour was allocated. Six of the interviews were held in English (due to the research team configuration),

one in Swedish. This has been taken into consideration when comparing the responses, as all interviewees were native Swedish speakers.

Table 1. *Type of company interviewed, and the type of dwellings built in Kvillebäcken*

	Type of company	Type of dwellings built
C1	National private construction, forestry & property group	Tenant-owned & Rental
C2	Municipal public housing company	Rental
C3	National cooperative housing organization	Tenant-owned
C4	International private construction & property dev. group	Tenant-owned
C5	International private construction & property dev. group	Tenant-owned
C6	National private real estate company	Tenant-owned & Rental
C7	Local private real estate company	Tenant-owned & Rental

The transcribed interviews were first coded roughly using pre-defined markers relating to the overall structure of the interviews, and subsequently through an inductive process, observing various topics or subthemes within the sections relevant to the topic presented in this paper. In line with grounded theory (Glaser and Strauss, 1967; Alvesson and Sköldberg, 2009), main themes that emerged during data analysis were noted and further analyzed.

The architect workshop was conducted during two hours and structured in two parts. In the first part, the participants were divided into smaller groups of two or three to discuss a series of questions regarding the perception of sustainable housing development; significant components or aspects of sustainability identified; as well as norms and alternative housing concepts. The second part took the form as an open focus group more specifically addressing the role of the architectural profession in a sustainable housing development. Although the focus of the workshop, as it was conveyed to the participants, was not limited to the case of Kvillebäcken, the discussions quite naturally revolved around anecdotes from the particular project.

4. THE CASE OF KVILLEBÄCKEN

The case used in this study is limited to a Swedish context, although parallels can be made to similar urban projects around Europe. Kvillebäcken is a redeveloped commercial brownfield site in a former industrial area of Göteborg, marketed as a model for sustainable urban development. The area is branded as a 'green district', and will upon completion provide around 2000 new rental and tenant-owned apartments. A consortium comprised of the Municipal Development Company Älvstranden Utveckling and the seven companies building in the area leads the development of Kvillebäcken, together with the Municipal Planning Office. The project is split into three phases and the first residents moved in during spring 2013.

A mutual agreement, in the form of the 'Kvillebäcken treaty', outlines the commitment to a sustainable development of the area. Further, a *Program for sustainable development in Kvillebäcken* (Kvillebäckskonsortiet, 2011) was created to concretize these aspects in the development process. Direct environmental targets and directives for the construction process were defined (including for example the requirement of max 60 kWh/m^2 delivered energy for all

buildings), and the project follows the silver level of the Swedish Green Building labeling system, with gold for energy.

Objectives of a social and economic nature, for example an outspoken goal for security and diversity, are defined as social interaction, qualitative public spaces that can be appropriated by the inhabitants, and a mix of forms of tenure and apartment sizes. Originally around 25% of the apartments in the area were planned to be rental units. This has since increased to about 30%, as two companies decided to redirect some of the apartments initially designated as tenant-owned to become rentals instead.

The creation of an 'urban atmosphere' that connects to the existing urban structure, and that offers an attractive and vibrant mixed-use environment is sought for. Accessibility to and within the area is highlighted. The master plan focuses on pedestrian traffic and car-dependency is addressed with a lower parking norm than in similar new urban areas, permitting higher exploitation. 'Environmentally friendly' forms of transportation such as biking or public transportation are upheld, as well as ambitions to create a car pool in the area. Relating to the individual household, consumer impact is emphasized by means of technology aiming to minimize consumption, individual billing of energy and water, and information provided to residents. When it comes to the apartments, little is explicitly mentioned in the program regarding the internal layout or design.

5. A MARKET PERSPECTIVE ON HOUSING DEVELOPMENT

Insights from the interviews with representatives from the seven companies and the architect workshop are presented and illustrated by selected quotes. Findings are structured into two main themes that emerged during data analysis. Furthermore, implications of these aspects on housing development are discussed.

5.1. Household demand, size and spatial norms

In line with a market assessment of viable household trends, the Kvillebäcken case underlines a shift towards smaller households. This is in part evident in that 2-rooms (1 bedroom) and a kitchen is the most predominant type of apartments being built in the area, followed by 3-rooms (2 bedrooms) and kitchen. Findings from the interviews and observations of the built area further point to a 'streamlining' of apartment types in Kvillebäcken. The limited market scope pursued, especially by the companies developing for sale (those building solely or mostly tenant-owned apartments) means limitations also in what is built:

> "We see that in our first buildings, we have rather many large apartments, compared to our competitors /…/the smaller apartments have been more popular in Kvillebäcken, so now when we are planning for the next phase, we also will build more smaller apartments."
>
> (Marketing manager, C4)

> "…we look at the companies building before us. /…/ And they sold not so many of 4-rooms, but they sold a lot of these smaller /…/ So we put our architects on that work and change it."
>
> (Project development manager, C1)

The participants at the architect workshop also attest to a shift during the process towards more similar types of apartments. The original ambitions of diversity (corresponding to the official planning documents and consortia agreement outlining quite vaguely to provide a basis for a mixed

population and household configurations within the area), in part ascribed to mixing apartment sizes, appears to be dismissed as the reality of the housing market and the lack of households willing or able to pay the mortgage and living cost of the larger apartments is assessed. Keeping costs down on all ends, to reach an affordable level for small or single-person households, is a challenge.

The interviews generally point towards the decreasing overall size of apartments in terms of floor area as an economic necessity. This is reported as occurring both in Kvillebäcken and within the industry at large. The situation is summarized as:

> "The cost is increasing, and to make it available, or affordable for people, you have to downsize."
>
> (Regional manager, C5)

Another interviewee explains:

> "I think it's rather related to the market. When people don't have so much money to spend on housing, we have to build smaller apartments."
>
> (Marketing manager, C4)

While size might be decreasing, it is underlined that the housing developers seek to keep the number of rooms the same within a smaller footprint. Especially the bedroom is pointed out as a room with a potential to save space. A majority of the interviewees also point towards a general trend of open space floor plans, combining living room and kitchen. Besides allowing the use of "each m^2 for more purposes than before" (Communication and marketing manager, C2), it adds to a perceived spaciousness. The question of functionality in relation to m^2 area is however reflected, as one interviewee adds that this type of layout is not as popular among all resident groups, for example in the case of elderly or immigrant families.

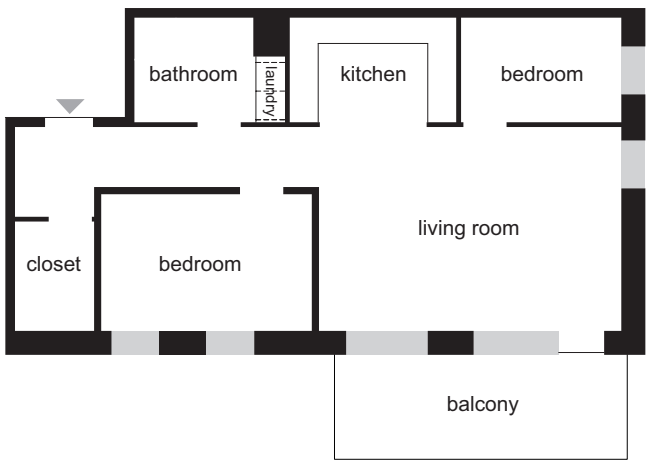


Figure 1. *Layout of a 3-room apartment, 78 m^2, built by one of the private build-for-sale companies*

Difficulties still persist as the individual demand for the more costly facilities are present regardless of household size. Some of the companies indicate that they are trying to find ways to address this dilemma. Terms such as 'compact', 'surface efficient', 'functional' and 'smart' are used:

> "We try to think smart, to use the space in a very good way, so it is not so expensive."
>
> (Project and local market manager, C3)

Especially looking at the 'functional cores' of the apartments, and improvements in terms of standardized solutions or optimized building processes are also of interest. Attempts to reduce floor area in these spaces are however oftentimes perceived as incompatible with for example regulation on accessibility:

> "The bathroom, we try to minimize, but it is always pretty big, because of the laws and regulations. /…/ it can't be smaller than it is today…"
>
> (Project development manager, C1)

Dwellings that accommodate the preferences, spatial and functional requirements of selected target groups remain a main interest in a case like Kvillebäcken, making concepts challenging the individualized demand less common. Endeavors of radical optimization or reconfiguration of individual resource use are also dependent on salient societal norms. It is stated that opposition can be found not only in regulation, but also in questions pursued by the Swedish Tenants' Association, which has worked hard for the functional standards that are commonplace today, along with the general perpetuated notion of quality in residential development.

5.2. Housing standards, material and residential comfort

A perceived level of normative household-related consumption associated with modern lifestyles can be found in the findings from the interviews as well as the architect workshop. The direct implications on housing are reflected in the material standards or appliances offered in new dwellings. This development appears to be the result of housing providers/developers adhering to their residents' preferences through market surveys as well as scanning of and aligning with general market tendencies. A majority of the companies offer appliances such as a dishwasher, and sometimes also a microwave, in addition to the regular all-inclusive kitchen arrangement. The common trend today is depicted as one of 'wear and tear', where the wear is usually a lot shorter than the life cycle of the material, appliances or apartment as a whole. One of the architects expresses criticism towards such short-term perspectives and perceives it as though you are encouraged to "throw your old kitchen out and buy a new one" on a regular basis. When it comes to rental apartments, one interviewee emphasizes that allowing the tenants to decide too much regarding the kitchen can be problematic. Current fashion in kitchen interiors might become obsolete in five years, leaving the property manager with an outdated apartment they can't afford to renovate again so soon.

The interviews reveal that laundry appliances (usually a washing machine and tumble dryer set in the bathroom) are also provided in each apartment, also in the municipal rental apartments. Shared laundry facilities are becoming less common – a feature that used to be a staple in Swedish multi-family housing (and still remains the norm in most of the older stock). When looking at other

common facilities than the laundry room, the interviews do not convey any particular trend. A few of the interviewees conclude that they are not building any formal shared spaces in Kvillebäcken besides the overall aim within the consortium to have a proportionally large amount of green space to be used for leisure and socializing.

Improved energy or material efficiency, as well as customers' perceptions of the comforts and conveniences of home are given as two of the main reasons for the continuous changes in quality and standards offered in new housing. One interviewee admits:

> "We put as many things in the apartment as possible, so it's easy for the people /…/ people appreciate it actually, that you can do it [laundry] whenever you want."
>
> (Development manager, C6)

There is a common image conveyed in home improvement shows, through food and interior design magazines, real estate promotions or advertising from housing developers that operate mainly on a speculative market. As one interviewee explains it, the results of a target group survey they did for the Kvillebäcken project show that:

> "…It's very important with kitchen and bathroom. Environmental stuff is good, but people aren't willing to pay for it. Really, it's rather obvious stuff. It's pretty much what you see on TV and what's modern. People want a good life."
>
> (Chief Executive Manager, C7)

One of the architects at the workshop questions whether this 'ideal' home or lifestyle becomes something that is intended primarily to be showcased, rather than the unpretentious place for restoration you would think the home might signify in an age of stress-related disorders.

The architects also convey their experience that there are few opportunities to challenge what is built today. They perceive that much is still traditionally designed for a 'nuclear family' view of society that no longer is a given. Alternatives, such as co-housing, 'every-other-week-dwellings' for divorced families, or voluntary simplicity (e.g. the tiny house movement), that support other household configurations or interpretations of residential standards and comfort, as well as issues of affordability, are so far limited and have little overall effect on mainstream building.

5.3. Implications

The long-term implications for sustainable development of the aspects of housing development illustrated in the case of Kvillebäcken are not yet possible to evaluate, as the area is not yet completed. The intentions of the project as a whole, and the residential developments pursued among the companies involved, however serve as a basis for discussion.

The two emergent themes presented in the results section are in themselves limited to certain aspects of housing development, indicating the gap in holistic perspectives on [sustainable] housing. Several of the architects who participated in the workshop experienced that in projects like Kvillebäcken, the easily measurable environmental aspects are often favored (such as energy performance). More 'immeasurable' qualities, as the architects expressed it, and solutions for a sustainable residential environment are overlooked. The architectural design reveals little of residential form that aims at reducing environmental impact. That the dwelling units in themselves

enable or stimulate larger changes in how we view the sustainable home and household-related consumption is not apparent.

The social goals for Kvillebäcken were to be concretized in a dense urban form, courtyards with ample meeting places and a mix of apartments in regards to forms of tenure and size. The move towards smaller, homogenous apartments can however be argued to create limited opportunities to for example move within the area as household situations change. This is similar for rental and tenant-owned apartments, and unanimous among private as well as municipal companies. Thereby an important aspect for social anchoring in the longer term is undermined. If Kvillebäcken is indicative of a slight trend shift, financial rather than environmental concerns appear motivational for reducing overall floor area. It also remains to see what, if any, notable effect this development will have on the continued expansion of per capita living space in general.

It would seem that a trend towards individualized use of resources (as opposed to sharing functions and spaces on a larger scale) and single households (as opposed to various forms of multi-person configurations sharing facilities within the dwelling), connected to a normative demand for living space, has significant implications on the goal of reducing residential energy and resource consumption as well as the provision of socio-economic diversity. In line with a normative understanding of 'good housing standards', settling with or seeking a significantly lower spatial standard – that is, fewer rooms per resident, while sharing larger apartments – or material comfort – sharing common facilities, which would contribute to decrease the environmental impact of housing, is not seen as a mainstream option. Cases of older housing in Sweden, pre-dating the establishment of stricter building codes, illustrate solutions for sharing facilities. However, few today would imagine sharing a shower in the basement, and viable attractive alternatives are yet to be proposed.

Offering services and facilities in addition to the private dwelling gives the possibility of attracting residents wishing to expand their living space by gaining access to certain functions in the vicinity. Shared facilities could thereby alleviate the need for private and individualized spaces or equipment/appliances and to some extent challenge unsustainable consumption patterns (Mont, 2004). The overall implications of such solutions are however equivocal, as potential rebound effects of residents 'doubling up' rather than giving up personal space or consumption in favor of the shared must be considered. Possible social benefits are perhaps more relevant to discuss further. As an example of an effort in this direction, counteracting a general trend of diminishing shared facilities shown also in the case of Kvillebäcken, one developer is building an 'orangery' in the courtyard of one residential block. An earlier evaluation has noted that grow houses or community gardens in connection to multi-residential units can foster social sustainability (Örneblad, 1997).

The architects participating in the workshop are fairly unanimous in their belief that social aspects should be given more attention. In reality they, in line with what is implied in the interviews, feel that economy governs most decisions. An interviewee from the smaller family-owned property developer (building both rental and tenant-owned apartments) stresses the different prerequisites in being able to consider these 'softer' values:

> "/…/ most [developers] just want the cheapest of the cheapest to keep costs down, we think it's better to take the cost now, and then in a longer perspective it's probably a better holistic solution. But we can do that, as a long-term property owner. There aren't many like us, most are 'quarter capitalists' and are registered on the stock market…"
>
> (Chief Executive Manager, C7)

In Kvillebäcken, the architects emphasize that although the ambitions for the area were there at an early stage, the particular architects participating in the workshop only took over where the general design left of, limiting their influence. The architects feel like there is a misconception that long-term quality and overall well-considered residential environments is expensive. As a result, these aspects are often the first to be cut when a clear vision is lacking.

There is a need for housing and/or development companies competent and daring enough to be visionary and challenge contemporary normative housing design. The ambitions are there, yet establishing processes for how to actually achieve such a development remains an essential task within the sector. A deepened collaboration between different actors, such as architects and developers, could perhaps foster more innovative solutions yet provide no definite guarantee.

The conceptualization of the modern home and the implications of contemporary ideals and market perspectives in housing development remains a crucial topic, in order to understand how to adapt and drive solutions that more adequately consider a holistic perspective, including social aspects of sustainability. This entails examining not only how a sustainable housing development is envisioned and manifested in the built environment, but also why and what is to be developed, and for whom. Yet, a driver for housing development on par with the 'social spirit' and quality of housing stock of earlier decades is lacking.

6. CONCLUSION

As the production of environmentally responsible and energy-efficient residential buildings continues to expand, this paper investigates whether the same effort is made to facilitate a more holistic approach to the development of 'sustainable homes'. The case of Kvillebäcken as a 'front line' area illustrates how the market interprets and realizes sustainable residential solutions.

The streamlining of apartment types and sizes in Kvillebäcken would suggest individual property developers are ultimately driven by market assessments, regardless of initial ambitions of diversity. Furthermore, it remains to be seen if the development of this kind of residential area adds to an overall urban social development, in for example meeting present and future demands for affordable apartments for financially weak groups or dwellings for larger families with children. The mainstream market could be said to determine the current level of development expected, with an emphasis on technical solutions and efficiency, rather than social issues – an area in which the competence is still low and inconsistent among companies in the housing sector. Furthermore, no easily distinguishable difference between public or private actors is observed in this aspects – despite the assumed social ambitions of the former.

The reviewed material suggests intent in contemporary planning and construction to enable a lifestyle change among residents. While challenging some parameters of the energy and resource intense modern home, the Kvillebäcken case does not offer more radical solutions or strategies addressing current ways of dwelling. As notions of residential comfort further implies an increased number of resource and energy demanding appliances and facilities, developers are working on how to meet residential norms with efficiency measures. It is here suggested that without an anchored and systemic inquiry of the norms and practices surrounding the dwellings created, such measures on their own do not radically challenge the housing-related environmental and societal impact of the sector.

There is a need for further research bringing together the aspects of individual demand, spatial norms and expected standards put forward in this paper, as well as implications on both visions for

future housing development and policy. Continued studies on other segments of the housing market and in what way these can influence development would be valuable. The radical paradigmatic changes needed are not addressed explicitly in this study, but a basis for further discussions on the role of architectural knowledge in informing a market perspective is provided. Incorporating an integrative approach, merging architectural knowledge on residential quality (Nylander, 2011), housing design and objectives to radically reduce the resource and energy intensity of new (and existing) residential environments is key to bring sustainable housing development forward. Positive examples and alternative developments will need to be further explored and brought up to the table to spur a larger debate. Holistic approaches are needed; where sustainable development demands a systemic understanding, beyond individual household practices, market interpretations or simply efficient buildings.

REFERENCES

Boverket. (2008). *A history of the Swedish system of non-profit municipal housing.* (Karlskrona: Boverket).

Boverket. (2010). *Boendekostnader och boendeutgifter – Sverige och Europa*. (Karlskrona: Boverket).

Boverket. (2012). *Bostadsmarknaden 2012-2013 – med slutsatser från bostadsmarknadensenkäten 2012*. (Karlskrona: Boverket).

Alvesson, M. & Sköldberg, K. (2009) *Reflexive methodology: New vistas for qualitative research*. (London: Sage).

Aune, M. (2007). Energy comes home. *Energy Policy, 35*, 5457-5465.

Barton, H. (2000). *Sustainable communities: the potential for eco-neighbourhoods.* (London: Earthscan).

Bröchner, J. (2010). Innovation in construction. (In F. Gallouj & F. Djellal (Eds.), *The handbook of innovation and services: A multi-disciplinary perspective* (pp. 743-767). Cheltenham: Edward Elgar Publishing).

Buys, L., Godber, A., Summerville, J., & Barnett, K. (2007). Building community: collaborative individualism and the challenge for building social capital. *Australasian Journal of Regional Studies, 13*(3), 287-298.

Campbell, S. (1996). Green cities, growing cities, just cities? Urban planning and the contradictions of sustainable development. *Journal of the American Planning Association, 62*(3), 296-312.

Carlsson-Kanyama, A., & Lindén, A.-L. (2002). Hushållens energianvändning. Värderingar, beteenden, livsstilar och teknik – en litteraturöversikt. Report 176, University of Stockholm.

Clarke, J. (2004). Living alone in Britain. *Geography Review, 17*(5), 2-5.

Coolen, H. (2006). The meaning of dwellings: An ecological perspective. *Housing, Theory and Society, 23*(4), 185-201.

Dempsey, N., Bramley, G., Power, S., & Brown, C. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable Development, 19*(5), 289-300.

Gatersleben, B., White, E., Abrahamse, W., Jackson, T., & Uzzell, D. (2010). Values and sustainable lifestyles. *Architectural Science Review, 53*(1), 37-50.

Ghanbarpour, M. R., & Hipel, K. W. (2009). Sustainable development conflict over freeway construction. *Environment, Development and Sustainability, 11*(2), 241-253.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. (Chicago: Aldine Publishing Company).

Godschalk, D. R. (2004). Land Use Planning Challenges: Coping with Conflicts in Visions of Sustainable Development and Livable Communities. *Journal of the American Planning Association, 70*(1), 5-13.

Gram-Hanssen, K., & Bech-Danielsen, C. (2004). House, home and identity from a consumption perspective. *Housing, Theory and Society, 21*(1), 17-26.

Haase, D., Kabisch, N., & Haase, A. (2013). Endless Urban Growth? On the Mismatch of Population, Household and Urban Land Area Growth and Its Effects on the Urban Debate. *PLoS ONE, 8*(6), 1-8.

Hedin, K., Clark, E., Lundholm, E., & Malmberg, G. (2011). Neoliberalization of Housing in Sweden: Gentrification, Filtering, and Social Polarization. Annals of the Association of American Geographers, 102(2), 443-463.

Hille, J., Simonsen, M., & Aall, C. (2011). Trender og drivere for energibruk i norske husholdninger. Report for NVE, Vestlandsforsking.

Holden, E. (2004a) Ecological footprints and sustainable urban form. *Journal of Housing and the Built Environment, 19*(1), 91-109.

Holden, E. (2004b) Towards sustainable consumption: do green households have smaller ecological footprints? *International Journal of Sustainable Development, 7*(1), 44-58.

Holden, E., & Linnerud, K. (2010). Environmental attitudes and household consumption: an ambiguous relationship. *International Journal of Sustainable Development, 13*(3), 217-231.

Hoyer, K. G., & Holden, E. (2001). Housing as Basis for Sustainable Consumption. *International Journal of Sustainable Development, 4*(1), 48-48.

Jackson, T. (2005). Live Better by Consuming Less?: Is There a "Double Dividend" in Sustainable Consumption? *Journal of Industrial Ecology, 9*(1-2), 19-36.

Jensen, J. O., & Gram-Hanssen, K. (2008). Ecological modernization of sustainable buildings: a Danish perspective. *Building Research & Information, 36*(2), 146-158.

Kabisch, N., & Haase, D. (2011). Diversifying European agglomerations: evidence of urban population trends for the 21st century. *Population, Space and Place*, 17(3), 236-253.

Klocker, N., Gibson, C., & Borger, E. (2012). Living together but apart: Material geographies of everyday sustainability in extended family households. *Environment and Planning A, 44*(9), 2240-2259.

Kvillebäckskonsortiet. (2011) Program för Hållbar utveckling i Kvillebäcken. Retrieved 21 November, 2013, from www.kvillebacken.se.

Leonard, L., Perkins, H., & Thorns, D. (2004). Presenting and creating home: the influence of popular and building trade print media in the construction of home. *Housing, Theory & Society, 21*(3), 97-110.

Liu, J., Daily, G. C., Ehrlich, P. R., & Luck, G. W. (2003). Effects of household dynamics on resource consumption and biodiversity. *Nature, 421*(6922), 530-533.

Lorek, S., & Spangenberg, J. H. (2001). Indicators for Environmentally Sustainable Household Consumption. *International Journal of Sustainable Development, 4*(1), 101-101.

Mallett, S. (2004). Understanding home: a critical review of the literature. *The Sociological Review, 52*(1), 62-89.

Manum, B. (2006) Apartment Layouts and Domestic Life; The Interior Space and its Usability: A Study of Norwegian Apartments Built in the Period 1930-2005. Dissertation, The Olso School of Architecture and Design.

Mont, O. (2004). Institutionalisation of sustainable consumption patterns based on shared use. *Ecological Economics, 50*(1–2), 135-153.

Nylander, O. (2011) *Bostadens omätbara värden.* (Stockholm: Svensk Byggtjänst).

Nässén, J., & Holmberg, J. (2009). Quantifying the rebound effects of energy efficiency improvements and energy conserving behaviour in Sweden. *Energy Efficiency, 2*(3), 221-231.

Reichstein, T., Salter, A. J., & Gann, D. M. (2005). Last among equals: a comparison of innovation in construction, services and manufacturing in the UK. *Construction Management and Economics, 23*(6), 631-644.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155-169.

Sanne, C. (2002). Willing consumers—or locked-in? Policies for a sustainable consumption. *Ecological Economics, 42*(1–2), 273-287.

SCB, Statistics Sweden. (2012) Yearbook of Housing and Building Statistics 2012. (Örebro: SCB-Tryck)

Schweber, L., & Leiringer, R. (2012). Beyond the technical: a snapshot of energy and buildings research. *Building Research & Information, 40*(4), 481-492.

Shove, E. (2003). Converging Conventions of Comfort, Cleanliness and Convenience. *Journal of Consumer Policy, 26*(4), 395-418.

Shove, E., Chappells, H., Lutzenhiser, L., & Hackett, B. (2008). Comfort in a lower carbon society. *Building Research & Information, 36*(4), 307-311.

Sorrell, S. (2009). Jevons' Paradox revisited: The evidence for backfire from improved energy efficiency. *Energy Policy, 37*(4), 1456-1469.

Thuvander, L., Gluch, P., Gustafsson, M., & Baumann, H. (2011, October). *Twelve years of environmental work in the Swedish construction industry*. (Paper presented at the International Sustainable Building Conference SB11, Helsinki).

Vale, B., & Vale, R. (2010). Domestic energy use, lifestyles and POE: past lessons for current problems. *Building Research & Information, 38*(5), 578-588.

Vallance, S., Perkins, H. C., & Dixon, J. E. (2011). What is social sustainability? A clarification of concepts. *Geoforum, 42*(3), 342-348.

van den Bergh, J. C. J. M. (2011). Energy Conservation More Effective With Rebound Policy. *Environmental and Resource Economics, 48*(1), 43-58.

Wahlström, Å., Jagemar, L., Filipsson, P., & Heincke, C. (2011). Marknadsöversikt av uppförda lågenergibyggnader. Lågan report 2011:01. (Göteborg: C.E. Management).

Wangel, J. (2013). Hur hållbara är Hammarby sjöstad och Norra Djurgårdstaden? (In H. Teleman, C. Caldenby, E. Ullstad & F. von Platen (Eds.), *Hållbarhetens villkor* (pp. 86-103). Malmö: Arena).

Wilhite, H., Nakagami, H., Masuda, T., Yamaga, Y., & Haneda, H. (1996). A cross-cultural analysis of household energy use behaviour in Japan and Norway. *Energy Policy, 24*(9), 795-803.

Willén, M. (2012). *Berättelser om den öppna planlösningens arkitektur: En studie av bostäder, boende och livsstil i det tidiga 2000-talets*. (Lund: Sekel)

Worldwatch Institute. (2010) *State of the World 2010: Transforming Cultures: From Consumerism to Sustainability*. (New York: Worldwatch Institute)

Örneblad, E. (1997) *Solhuset i Järnbrott : grönrum och kreativa sociala processer på väg mot en bärkraftig arkitektur.* (Göteborg: Chalmers tekniska högskola)

[1] According to the Swedish norm 2 for overcrowding: more than two residents per room, kitchen and living room excluded. (A normal standard of space in the Swedish context applies in the following conditions: 1 resident: 1–2 rooms, 2 residents 2–3 rooms, 3 residents: 3–4 rooms, 4 residents: 3–5 rooms, 5 residents: 4–6 rooms, 6 residents: 4–7 rooms, 7 residents: at least 5 rooms, 8 residents: at least 5 rooms.)

[2] A dwelling is considered to be of high standard of space if there is more than one room per resident, kitchen and living room excluded

PAPER III

Bannova, O., & Hagbert, P. (2014). Experiments in mapping human factors for sustainable design and living. In R. García Mira & A. Dumitru (Eds.), *Urban Sustainability: Innovative Spaces, Vulnerabilities and Opportunities* (pp. 117-130). A Coruña: Institute of Psychosocial Studies and Research.

EXPERIMENTS IN MAPPING HUMAN FACTORS FOR SUSTAINABLE DESIGN AND LIVING

Olga Bannova
University of Houston, Texas, USA
Pernilla Hagbert
Department of Architecture, Chalmers University of Technology, USA

Abstract

This paper explores architectural design considerations regarding challenges of sustainable living, drawing parallels to extreme environments, in relation to user-centered design research conducted by researchers at Chalmers University of Technology, University of Houston and NASA. It further discusses application in the context of a Sustainable Living Lab, to be built as student housing on the Chalmers campus. Extreme environments are here defined as places that pose significant complications and risks for people to maintain their usual everyday activities with a certain level of physical and psychological comfort. The research addresses the need for integrated solutions, and the conscious development of sustainable strategies based in an understanding of human factors and residential practices. The paper presents a theoretical and methodological background for a proposed experimental 'design/build/live' approach and results from initial studies with students on user perceptions and ideation. Findings indicate that an optimization of spatial or material use can be found for example in a reassessment of activities perceived as private or shared, as well as the spatial compatibility of different functions, informing the design of facilities and building systems, as well as social organization and demands for supporting systems. Perceptions on changing practices towards shared use, and the value of co-creation processes for enabling sustainable living practices are emphasized.

Keywords: human factors, sustainable, housing, extreme environments, user-centered

Design challenges in extreme conditions

As defined by NASA Astrobiology Institute: 'Extreme' is a relative word. An extreme environment can be characterized by conditions that are far outside the boundaries in which we humans dwell comfortably in the following categories: pH (measure of acidity), pressure, temperature, salinity, radiation, desiccation (measure of dryness), and oxygen level (NAI, 2012).

An extreme environment is oftentimes defined by its climate or weather conditions and therefore delimited by its geographical location (Harrison, Clearwater, & McKay, 1990). The definition can however also be broader than that when including a wider scope of aspects of human life or lifestyle. It is here explored in relation to increasing situations of crises around the globe, as new posed extremes can be found

in for example the deteriorating stock of natural resources, easily accessible fossil energy sources and the capacity to uphold further social development in the form of a growing economy (Murphy & Hall, 2011; Schneider, Kallis, & Martinez-Alier, 2010; Freeman, 2000). By discussing the context of the extreme, and lessons transferred to the 'everyday' in a situation of global crises, the border between the two becomes blurred.

Conditions become extreme when the environment poses special limitations and/or hardships for people to survive and maintain relative physical and psychological comfort (Bannova, Smith, & Landschulz, 2005; Nuttall, 2005). The major limitations are usually in regards to all or some of the following:

- Resources;
- Availability of services;
- Availability and accessibility of space;
- Mobility and transportation.

These challenges result in the experience of strong restrictions in the ability to execute everyday work tasks, impossibility to perform social interactions, and constraints in fulfilling necessary living needs. Perceived control and self-efficacy in situations where some or all of these conditions apply is hence impeded, further inducing psychological barriers for overcoming or adapting to these limitations, whether outspokenly defined as extreme or more abstract in nature, as in the case of climate change (Gifford, 2011). Investigating essential human needs and how those needs can be addressed in design and planning is a relevant challenge. Developing and applying sustainable design practices is essential to diminish and overcome difficulties imposed on people in extreme conditions; both in terms of physical, structural envelope solutions as well as user-derived strategies and social organization. The creation of holistically sustainable living environments is an imperative in the context of specific extreme situations such as space or the arctic (Petersen & Poppel, 1999). Much can be learned from previous projects in extreme environments or those posed in limited conditions, where closed resource and energy loops are considered, and where social organization and collaborative processes govern the design and facilitation of well-functioning, qualitative living environments.

In parallel, sustainable planning and design is an increasingly important factor for the development of living environments all around the world, as the environmental and social impact of the built environment is understood and problematized (Montserrat Pareja & Støa, 2004; Schweber & Leiringer, 2012; Sev, 2009). This has further become a critical element for the success of designing and planning for extreme environments, where construction and utilization processes developed may also be tested in terms of success rate and effectiveness. The pursuit of sustainable practices is spreading within the building industry, especially in a Scandinavian context (Jensen & Gram-Hanssen,

2008; Gluch, Gustafsson, Thuvander & Baumann, 2013). However, the *radical* mitigation of the environmental impact, distributive injustice and socio-economic segregation - to which the construction sector is a large contributor - is not yet achieved (Hagbert, Mangold, & Femenías, 2013).

As a broad concept, sustainable development is today an unavoidable mainstream connotation, with increasing implications on how we reside, conduct business and educate. Ranging from policy agreements or guidelines to pragmatic in-practice approaches, the global challenges we face in a time of rapid changes (whether climatic, financial or social) are addressed differently. The idea of sustainability can be applied practically to all aspects of human society, creating multiple facets of sustainability that include (Petersen & Poppel, 1999): 1) ecological and environmental behavior; 2) economics; 3) social habits; and 4) political actions and systems. All of these aspects of sustainability are regarded as interrelated and can benefit from each other, although criticisms and alternate suggestions regarding the ordering and hierarchy between them have been raised both within the design community and the discourse in large (Findeli, 2008; Kates, Parris, & Leiserowitz, 2005).

The overarching idea of achieving synergy effects between different facets of sustainability, as discussed by Robinson (2004), suggests an application in design and planning from the very beginning of the process, and throughout an extended period of time. Such an approach is addressed and applied in the research outlined in this paper. It is argued that an integrative comprehension in the design, build and living phases of housing not only put emphasis on user-centered and user-derived knowledge, but also the continuous re-negotiation of such processes, and subsequent need for improved design-user practices.

This paper investigates user-centered design research methodologies and practices for radically reducing energy and resource use, through a proposed ‘design/build/live’ approach in a ‘Sustainable Living Lab’ (SusLab) currently under development in the form of student housing at Chalmers University of Technology in Gothenburg, Sweden. The project involves researchers from multiple departments at Chalmers, but the specific research outlined here is the focus of the research team from the dept. of Architecture, consisting of professor Maria Nyström, assistant professor Paula Femenías, doctoral students Pernilla Hagbert and Olga Bannova (University of Houston), and visiting professor Larry Toups from NASA JSC (Johnson Space Center).

A brief overview of the project and the experimental design/build/live approach is first presented. This is followed by an account of international precedents dealing with similar experimental student settings and tasks. Methods and initial results from studies with students, to be integrated in the methodological and design development of the project, are further elaborated upon. The paper is concluded with outcomes and key points for future development.

Project background and approach

The work outlined here constitutes a part of the larger EU Interreg funded project SusLab NWE[1], studying sustainable living and innovations for the design of future residential environments. Through developing user-centered and participatory design research methodologies, along with technological advancement, the project explores how sustainable innovations are applied and perceived in everyday life and living environments. By gaining insights into the usability and acceptance of sustainable strategies, products and services regarding both spatial and material properties, the objective is to enable sustainable living practices.

The physical structure, called 'HSB Living Lab', is developed in collaboration with the largest Swedish co-operative housing association, HSB, and Johanneberg Science Park, and is being built in 2014 as student housing, located on Chalmers main campus[2].

The building will be three stories, with a ground space of around 400 m^2. It will accommodate about 25-30 students and guest researchers. The student units are designed to be flexible, with the possibility to change the layout during the course of the temporary ten-year building permit. The structure will include additional facilities like an exhibition area, a common laundry room and various meeting areas.

The overall SusLab project is structured into three phases:

1. Early insight studies with residents and users

2. Full-scale living lab studies, testing sustainable living innovations and strategies;

3. Final studies of sustainable living innovations and strategies as implemented in existing housing stock.

This paper discusses the first phase, with the intention of applying the insights in the research conducted in the Living Lab. During the course of the project development, the following objectives are expected to be fulfilled:

1. Completing a functional analysis of programming and schematic design relating to living environments;

2. Mapping personal and shared activities of users;

3. Analysing spaces in context of utilization timeframe and frequency;

4. Strategically positioning multi-functional spaces and utilities;

5. Creating conditions for sharing practices;

6. Providing means for visibility of successful sustainable practices within the community.

1 http://suslab.eu/

2 http://suslab.eu/partners/chalmers-th/hsb-living-lab/

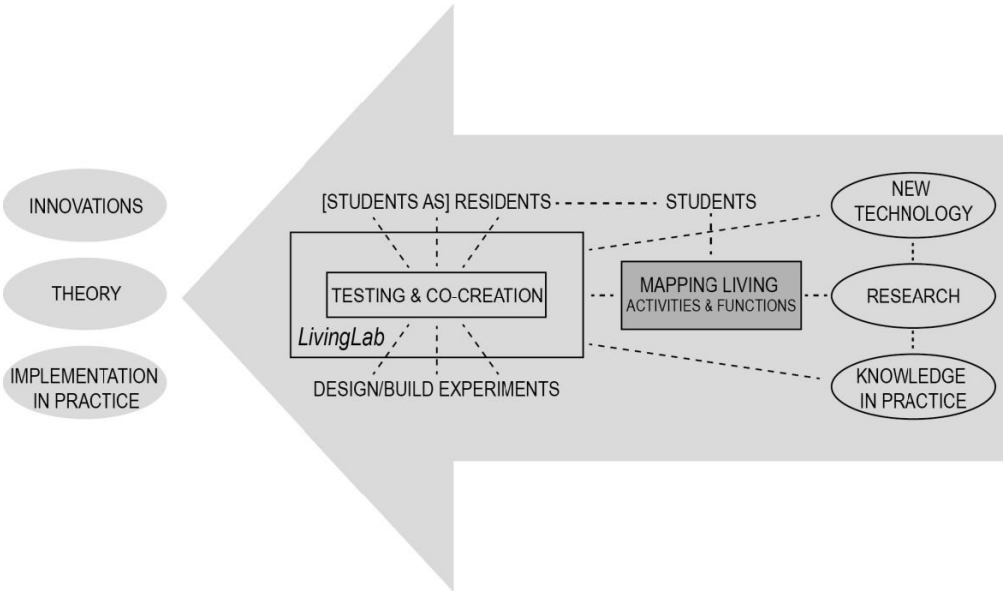


Figure 1. Diagram of proposed process, highlighting the focus point of this paper

The process is conceived to be advanced farther by incorporating an explorative design/build/live approach, where a group composed of students from different disciplinary backgrounds will be emerged in an experimental studio environment within designated units in the living lab building. The premise is that participating students, holding undergraduate degrees in architecture, planning, engineering or industrial design engineering, engage in explorations of various strategies for sustainable living, building upon a transdisciplinary research process and coherent knowledge creation (Després, Vachon, & Fortin, 2011). Moreover, it is here argued that hands-on learning and full-scale testing (Hornyánszky Dalholm, 1998) in 'real-life', process-oriented situations (Nicol & Pilling, 2000) is of relevance to complement the various learning styles associated with the design process (Demirbaş & Demirkan, 2003).

It is our opinion that sustainability should not be understood as something added, but rather an integral part of educational and professional practice. The complexity of the knowledge, skills and competencies needed to accomplish the tasks set in light of local and global challenges also demands more of design education than a conventional curriculum (González-Gaudiano, 2005; McMahon & Bhamra, 2012). Some of the skills and competencies identified as important for students to develop in order to engage in socially sustainable design are: participation, compromise, openness, engagement, reflection, critical questioning, understanding, comparison, accountability, communication, teamwork, and problem-solving (McMahon & Bhamra, 2012).These could be extended to cover multiple aspects of sustainability. The introduction of critical reflection through collaborative projects is vital. By creating a studio context where students act as designers, builders, as well as residents through constructing and inhabiting their own designs - an iterative process can be developed further as the students interact with problems in real-time as they arise.

Precedents in experimental student design and living experiences

Although there is a long history of experimental architectural education for design, technology development and behavioral research, only two examples can in essence be considered as precedents for the here outlined approach. Indeed, Alexander Pike's Aukarktic House built with students from the University of Cambridge in 1971, the Rural Studio at Auburn University pursuing community-oriented work since its establishment in the 1990s, TUDelft's co-ordination of the SusHouse project in 1998-2000, the BBC Integer House project in 2001, and others offer hands-on learning experiences. Yet they do not fully address the latter stages in the here outlined approach, where it is proposed that students inhabit, evaluate and re-build the environments they have created, during a longer period of time. Because of this distinction, the TreStykker project and SICSA's hands-on 4th year studio project are regarded as two precedents that more fully reflect the objectives of the presented project.

The TreStykker project was initiated in the summer of 2005 when students from three Norwegian universities (The Oslo School of Architecture and Design, the Bergen School of Architecture and the Master Program in Architecture at the Norwegian University of Science and Technology in Trondheim) participated in a workshop to design, finance and build a small experimental student house (Thomsen & Tjora, 2006). The project's goal was to explore the spatial experience of living in a transformable environment, in an experimental student house where only interior space was convertible. The collaborative nature of the effort added educational value and is regarded as having contributed to its success. Series of student interviews were conducted during the project and the findings were based on: 1) looking at a house as a transforming place, examining the flexibility and changeability on a daily basis; 2) studying social life as collaboration, investigating relationships between social life and privacy; and 3) studying how building residents see the image of their habitat and the importance of that image. It is argued that such experiments can be seen as a way of understanding and adapting to constantly changing needs throughout an extended timeline, and thereby approaching sustainability of residential buildings from a user perspective: "…flexibility in housing should not necessarily be seen as moveable elements but may include a 'neutral' plan solution, where no specific use is pre-ascribed to rooms, for example with all rooms of equal size" (Thomsen & Tjora, 2006:20). Flexibility may be space or time related and structured depending on different time periods. For example, some may occur in a few minutes, while others involve major efforts and resources, but would be applied much more random (Thomsen & Tjora, 2006). Qualitative research methods used during the study included both individual and group semi-structured interviews and weekly diaries that provided personal data. This methodology proved to be effective in accumulating information on an individual level, providing foundation for the overview of students' housing requirements and needs. Group interviews on the other hand demonstrated that a participant's responses may be influenced by others, and may alter his or her response based on a popular opinion.

A second precedent is the hands-on Closed Environment Laboratory for 4th year architectural students, run at the University of Houston's Sasakawa International Center for Space Architecture (SICSA)[3] for several years until 2004. Every year, a one-year project included one semester of design and research, followed by a one-semester design/build stage when students had to learn how to implement their design ideas in real life conditions and test design solutions as they are being built. The testing environment represented a mock-up of a conventional space module like those currently used in the International Space Station (Figure 2). Challenges that students had to deal with during the course included: coordinating design solutions with limitations and restrictions of confined environment of the module; investigating how living and operating in such conditions would affect person's everyday schedule and hierarchy of activities; and how and when design elements may interfere with human factors. The design had to be done in accordance with specifics of extreme environment of space and satisfy all human factors requirements at the same time. That brought uniqueness to the project and encouraged students to take their roles as designers very seriously. Every year students had to review the previous year's proposals and design their projects based on that cumulative experience. They also had to test their design solutions and submit reviews on the whole studio experience and their involvement in it. Even though the evaluation process was not an ultimate goal of the project, the reviews demonstrated that hands-on studio education is a valuable experience for the students. The students appreciated an opportunity to learn and see in real life how their design solutions affected the overall architecture of the mock-up and human factors. It also proved to be an effective method to stimulate student design research and learn cost-effective techniques.

Figure 2. Closed environment laboratory. SICSA, 2004.

The discussed precedents have demonstrated the benefits of involving students in the design process at all stages of development. The project outlined here is a step forward from these experiences. It expands and extends learning prospects and is more inclusive in design aspects and involved disciplines. It is also argued that extending the experience of students to that of being longer-term residents of the developed structure would offer better research opportunities and provides a more solid foundation for future improvements and innovations. Building upon these two precedents, an essential

3 http://www.uh.edu/sicsa/

part of the presented design/build/live approach is also to more rigorously research and develop strategies enabling sustainable practices among participating students, as well as possible follow-up evaluations after they move out of the facility.

Proposed and applied methodology in initial empirical studies

The proposed methodology for the experimental design/build/live program outlined here is based on the assumption that students are the main drivers of this aspect of the project development, and will research, design, build, live, review and subsequently advance design solutions throughout the lifetime of the facility. Key elements of that include:

- Students' involvement at all levels of the project;
- Creation of multidisciplinary student teams;
- Support from faculty and construction and management companies.

Primary elements of the process are co-creation workshops and surveys in the form of activity diaries among student respondents. Preliminary empirical data on daily living activities was gathered in December 2012, with students at the Architectural Department of Chalmers University of Technology and the University of Houston's College of Architecture, and workshops were held in December 2012 and May 2013 at Chalmers only. An understanding of the functional breakdown of student housing from these initial findings can be discussed according to: 1) Grouping of activities and human functions (Table 1 and 2); 2) Levels of private or shared use of space and resources (Table 1); 3) Defined or perceived corresponding spatial, energy and resource requirements.

Table 1. Daily activity assessment based on students' perception of degree of sharing

	SLEEPING	*EATING*	*HOUSEKEEPING/ COOKING*	*STUDYING*	*HYGIENE*	*RECREATION*
COLLECTIVE (SHARING ACTIVITY AND RESOURCES)	NO	YES	YES	YES	NOT LIKELY	YES
INDIVIDUAL/ SHARING RESOURCES	MAYBE	MAYBE	MAYBE	YES	NOT LIKELY	MAYBE
PRIVATE/ NOT SHARING AT ALL	YES	NOT LIKELY	MAYBE	NOT LIKELY	YES	NOT LIKELY

Activity diaries collected at both Chalmers and the University of Houston (n=19) outlined temporal, material and potential social characteristics of various activities. They further demonstrated differential understanding and presumptions of collective

and private values. For example, even though students belonged to same age groups and had relatively similar disciplinary background, their demand for privacy diverged, most likely based on cultural and social specifics and housing situation. This was further underpinned at two workshops held with respondents at Chalmers only.

The first workshop revolved around the students self-reported activities and understanding of functions in their living environments. Through an inductive process, using simple means (Figure 3), the students produced and organized their understanding of living activities in a current and potential 'extreme' condition. The result, although to be understood in this precise context as a qualitative method and snapshot, point to some interesting aspects regarding living functions, hierarchy of activities (and space) and home-based practices students see as more or less negotiable. The participants mapped their understanding of student living as ranging from 'basic survival', 'supportive activities' and 'life quality', as well as on a more general scale of relating to spaces inside or outside the dwelling unit. In a context of optimization, the relationships between activities were challenged, and the suggested division between private and shared functions became more blurred as activities such as showering were discussed as conditional (it was argued that students could imagine sharing showers, at a farther distance from their sleeping area, if there was a wash basin provided in the most immediate vicinity).

Figure 3. Student functionality and activities assessment workshop.

The overall results from the data analysis of the workshops and surveys were developed in a form of a 'human tree' of living functions. Through a cross-analysis, overlapping spatial, energy and resource requirements are outlined with regards to both current functional understanding and in a scenario of optimization due to posed limitations. In addition, human factors conditions - physical, organisational or behav-

ioural prerequisites (Matthews, 2000) - for the amelioration and optimization of living functions from a residential quality perspective, as well as the radical reduction of energy and resource consumption were discussed.

Data were furthermore analyzed in order to establish a pattern of compatibility, with a focus on spatial composition, functional relationship and overall layout of the facility (Table 2). It is clear that the current understanding of habits such as relating to personal hygiene remain normative, but students' changing practices also point at some interesting developments regarding, namely, new educational modes (higher degree of group work, different work loads, media used for study, etc.) or new forms of recreation (changing role of TV, online streaming and portable devices enabling flexibility as well as potential issues of conflict). The implications of such assessments for programming, layout and execution are of interest for the development and research conducted in a proposed designated facility where the users –the students – are also the designers.

Table 2. Compatibility assessment.

	SLEEPING	*DRESSING*	*EATING*	*COOKING*	*GROUP WORK*	*SOLITARY STUDY*	*HYGIENE (WATER)*	*RECREATION*	*RELAX*
SLEEPING		well	cond.[1]	poor	poor[2]	ok	poor[3]	cond.[2, 5]	well
DRESSING			poor	poor	poor[2]	ok	ok	ok	ok[4]
EATING				well	well[1]	ok[5]	poor	well[1, 6]	ok[1,5, 6]
COOKING					ok[1, 5]	ok[1, 5]	poor	well[6]	cond.[1,5, 6]
GROUP WORK						well[5]	poor	well	cond.[2, 5]
SOLITARY STUDY							poor	ok[5]	well
HYGEINE (WATER)								poor	poor/ cond.[6]
RECREATION									ok[2, 5]
'UNWIND'/ RELAX									

Notes: (1): requires easy cleaning/flexible
(2): issues of privacy/safety
(3): issues of humidity/air quality
(4): both secluded places, yet not necessarily day lit
(5): possible issues of noise
(6): as part of socializing/relaxation

Resulting from the complexity of the project, every discussion grew out of the initial scope of work and resulted in a spill-over of questions and concerns to be addressed further, but that need to be resolved prior to the initiation of design/build/live experiments. The table below categorizes and summarizes some of the issues that were discussed during the second workshop and that have to be included into the develop-

ment process based on a user-centered approach, mapping individual and joint activities and home functions (Table 3). Generally speaking, private activities may include: sleeping, washing (range), dressing and other basic activities, while sharing may include cooking, diverse hobbies, studying and other social–related actions.

Some of the issues have to be addressed and solved before the programming stage of the project begins. For example, legal agreements and budget arrangements have to be resolved before students will start signing on. Experiencing from the 'inside' and mapping such experiences based on spatial, social, economic and time requirements is essential for creating consistent sustainable practices (Yaneva, 2011).

Table 3. Design tasks.

ISSUES		*ISSUES*	
STUDENT INVOLVEMENT	who do we want to attract?	*STRUCTURE/BUILDING*	envelop elements testing: what, how, when
	only students or are friends also allowed?		including spaces for lounging for the whole building
	criteria for grouping people who will be living there		measure impact changing envelope elements on heating/ cooling
	co-gender groups or mixed		how much change/not change in surroundings
	mixed ages or different year students allowed?		what's changing with the environment? (eg. fire codes?)
ORGANIZATIONAL	type of rental contract (timing, aligning with students' needs)	*LAYOUT*	living room wasted space? if the kitchen shared – is there need for a living room?
	maintenance: who does what?		kitchen is the 'core' of home?
	insurance		neutral spaces are needed for meetings
	rules and regulations		multifunctional spaces: cooking/eating, library, something else?
	security		changeable interior walls and interior blocks
SOCIAL	living with friends: groups up to 24 / strangers: no more than 4	*LIFESTYLE*	what to share and how?
	accessible place to socialize		recycling or sharing
	creating positive and sustainable dominant living practices		challenge laziness

Conclusions and future investigations

Real conclusions and evaluations will only be made possible after the proposed design/build/live approach within the overall student housing structure will have been operational for a few consecutive years and data have been collected throughout its development and operation phases. It will also be important to conduct surveys amongst students participating in the project after they have graduated and moved out of the environment they co-created, to see if they were influenced by the experience, in terms of sustainable living or in professional practice.

Further investigations within the project are based on forming a design process where several human factors of student living are explored, both in regards to physical design parameters as well as social psychological indicators influencing sustainable practices and user perceptions in home environments. The next stages of research will revolve around four points: 1) Optimization based on human factors; 2) Informing the design of facilities and building systems; 3) Informing social organization and demands for supporting systems;4) Co-creation processes for enabling sustainable living practices.

Farther development also includes a potential expansion of the design/build/live approach, and student exchange involving students from Chalmers (Sweden), Houston (USA) as well as partners in Kisumu (Kenya), creating more opportunities to advance experimentation and research by design for sustainable living strategies. Research objectives at each location should be complimentary, creating a network of university-based laboratories (Snyder, 1984), that offer essential insights and understanding of social and cultural influences on selection of sustainable design approaches and their adjustments in relation to local specifics and availability of resources.

References

Bannova, O., Smith, I., & Landschulz, A. (2005). Autonomous Architecture: Summit Station in Greenland Design Proposal as a Test-Bed for Future Planetary Exploration. Paper presented at the International Conference on Environmental Systems. Rome: SAE International.

Demirbaş, O. O., & Demirkan, H. (2003). Focus on architectural design process through learning styles. *Design Studies, 24*(5), 437-456.

Després, C., Vachon, G., & Fortin, A. (2011). Implementing Transdisciplinarity: Architecture and Urban Planning at Work. In I. Doucet & N. Janssens (Eds.), *Transdisciplinary Knowledge Production in Architecture and Urbanism: Towards Hybrid Modes of InquiryUrban and Landscape Perspectives*. Dordrecht: Springer.

Findeli, A. (2008). Sustainable Design: A Critique of the Current Tripolar Model. *The Design Journal, 11*(3), 301-322.

Freeman, M. M. R. (2000). *Endangered peoples of the Arctic: struggles to survive and thrive*. Westport: Greenwood Press.

Gifford, R. (2011). The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist, 66*(4), 290-302.

Gluch, P., Gustafsson, M., Thuvander, L., & Baumann, H. (2013). Charting corporate greening: environmental management trends in Sweden. *Building Research & Information*, 1-12.

González-Gaudiano, E. (2005). Education for sustainable development: configuration and meaning. *Policy Futures in Education, 3*(3), 243-250.

Hagbert, P., Mangold, M., & Femenías, P. (2013). Paradoxes and Possibilities for a 'Green' Housing Sector: A Swedish Case. *Sustainability, 5*(5), 2018-2035.

Harrison, A. A., Clearwater, Y. A., McKay, C. P. (1990). *From Antarctica to Outer Space: Life in Isolation and Confinement.* Springer.

Hornyánszky Dalholm, E. (1998). *Att forma sitt rum: fullskalemodellering i participatoriska designprocesser [To design your space: full-scale modelling in participatory design].* (Dissertation for the degree of PhD), Lund University, Lund.

Jensen, J. O., & Gram-Hanssen, K. (2008). Ecological modernization of sustainable buildings: a Danish perspective. *Building Research & Information, 36*(2), 146-158.

Kates, R. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is Sustainable Development? *Environment, 47*(3), 8-21.

Matthews, G. (2000). *Human Performance: Cognitiion, Stress and Individual Differences*. Hove: Psychology Press.

McMahon, M., & Bhamra, T. (2012). 'Design beyond Borders': International collaborative projects as a mechanism to integrate social sustainability into student design practice. *Journal of Cleaner Production, 23*(1), 86-95.

Montserrat Pareja, E., & Støa, E. (2004). Dimensions of housing and urban sustainability. *Journal of Housing and the Built Environment, 19*(1), 1-5.

Murphy, D. J., & Hall, C. A. S. (2011) Energy return on investment, peak oil, and the end of economic growth. *Annals of the New York Academy of Sciences: Vol. 1219(1)* (pp. 52-72).

NAI. (n.d.). NAI: Ask an astrobiologist. Retrieved December 11, 2012, from NASA Astrobiology Institute: http://nai.nasa.gov/astrobio/feat_questions/extreme.cfm

Nicol, D., & Pilling, S. (2000). Architectural education and the profession: preparing for the future. In D. Nicol & S. Pilling (Eds.), *Changing architectural education: Towards a new professionalism* (pp. 1-21). London: Taylor & Francis

Nuttall, M. (2005). *Encyclopedia of the Arctic*. New York: Routledge.

Petersen, H., & Poppel, B. (1999). *Dependency, autonomy, sustainability in the Arctic*. Aldershot: Ashgate.

Robinson, J. (2004). Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics, 48*(4), 369-384.

Schneider, F., Kallis, G., & Martinez-Alier, J. (2010). Crisis or opportunity? Economic degrowth for social equity and ecological sustainability. Introduction to this special issue. *Journal of Cleaner Production, 18*(6), 511-518.

Schweber, L., & Leiringer, R. (2012). Beyond the technical: a snapshot of energy and buildings research. *Building Research & Information, 40*(4), 481-492.

Sev, A. (2009). How can the construction industry contribute to sustainable development? A conceptual framework. *Sustainable Development, 17*(3), 161-173.

Snyder, J. C. (1984). *Architectural research*. New York: Van Nostrand Reinhold.

Thomsen, J., & Tjora, A. (2006). Changeable space as temporary home: a qualitative exploration of life in an experimental student house. *Nordic Journal of Architectural Research, 19*(3), 13-22.

Yaneva, A. (2011). From Reflecting-in-Action Towards Mapping of the Real. In I. Doucet & N. Janssens (Eds.), *Transdisciplinary Knowledge Production in Architecture and Urbanism: Towards Hybrid Modes of Inquiry* (pp. 117-128). Dordrecht: Springer.