SUSTAINABLE BUILDING IN SCANDINAVIA: DIRECTIONS OF INNOVATIONS FOR SUPPORTING THE TRANSITION

Nina Koch-Ørvad[1] and Christian Thuesen

Department of Management Engineering, Technical University of Denmark – DTU, Building 424, 2800 Kgs. Lyngby, Denmark

Buildings are essential for securing a sustainable society, and the Scandinavian building sector is viewed upon globally as the one to lead the way. This paper investigates in which directions sustainable building in Scandinavia is likely to move and outlines a number of areas where sustainable innovations are necessary for supporting this movement. The focus on innovations as essential support for the sustainable transition of the building sector derives from the Multi-Level Perspective, which has been applied to this study as a framework for understanding sustainable transitions of socio-technical systems. The findings are based on twelve expert interviews with key persons from central companies, research institutions and associations in Denmark, Norway and Sweden. The experts identify five directions for sustainable building in Scandinavia and list a number of innovations that will support the movement of the sector in these directions. These paths to the future for sustainable building seem remarkable clear and manageable, and the paper discusses the risk of the experts being too optimistic in their assessment of the sustainable transition of the Scandinavian building sector.

Keywords: sustainability, innovation, transition management, Scandinavia

INTRODUCTION

The building sector plays a central role in the global transition towards a more sustainable society (International Energy Agency 2013; Chalmers 2014). Around the world, governments, researchers and companies are looking at the Scandinavian[2] countries as frontrunners within the field of sustainable building (World Green Building Council 2013; Strand *et al*., 2014). Being the frontrunner, the Scandinavian building sector holds an interesting position, as development of the sector will mark the directions in which sustainable building in a global perspective is likely to move. Furthermore, innovations for supporting the movement of the Scandinavian building sector also hold the potential to cross borders and thus initiate an acceleration of the sustainable transition of building sectors globally. This paper aims to outline the areas in which practitioners and researchers should focus their innovation activities to support the sustainable transition of the Scandinavian building sector.

The particular focus of this paper on innovations as essential for the sustainable transition derives from the Multi-Level Perspective (Geels 2004; Geels and Schot

[1] ninko@dtu.dk

[2] In this paper, Scandinavia refers to Denmark, Norway and Sweden

Koch-Ørvad, N and Thuesen, C (2016) Sustainable Building in Scandinavia: Directions of Innovations for Supporting the Transition. *In*: P W Chan and C J Neilson (Eds.) *Proceedings of the 32nd Annual ARCOM Conference,* 5-7 September 2016, Manchester, UK, Association of Researchers in Construction Management, Vol 2, 1111-1119.

2010; Schot and Geels 2008). The Multi-Level Perspective (MLP) provides a framework for understanding sustainable transitions of socio-technical systems (e.g. the building sector). MLP argues that transitions come about through innovation processes at three levels: socio-technical regimes, innovation niches and the overarching landscape (Geels 2004). This perspective, that sustainable transitions occur due to innovation processes, has scoped the study of this paper to focus on the innovations necessary for supporting the development of sustainable building in Scandinavia.

A considerable amount of literature has approached the topic of sustainable transition of the building sector (Rohracher 2001; O'Neill and Gibbs 2014; Zuo and Zhao 2014; Yong *et al*., 2011). A specific focus in the literature has been on drivers and barriers for sustainable building (Häkkinen and Belloni 2011; Bossink 2004) and innovation processes (Robinson *et al*., 2015; Berry *et al*., 2013; Shove 1998). However, current literature has only paid limited attention to the sustainable transition of the Scandinavian building sector. Specific aspects of sustainable building have been studied in the different countries, e.g., social sustainability in Sweden (Koch and Buser 2015), the role of house owners in Norway (Risholt and Berker 2013) and strategic spatial planning in Denmark (Quitzau *et al*., 2012). Based on twelve expert interviews with key persons from Denmark, Norway and Sweden, this paper contributes to the literature with a unifying, overall perspective on the transition process of the sustainable building sector in Scandinavia.

The structure of this paper is as follows: The first section unfolds the theoretical framework for understanding sustainable transitions, the Multi-Level Perspective. The second section describes the empirical methodology of the study, and the third section presents the findings from the expert interviews. The fourth and fifth sections discuss the findings and conclude the paper.

THEORETICAL FRAMEWORK

The Multi-Level Perspective (Geels 2004; Schot and Geels 2008; Geels and Schot 2010) offers a framework for understanding and investigating the sustainable transition of a socio-technical system. The Multi-Level Perspective (MLP) understands transitions as arising from the interaction between developments at three levels; the socio-technical regime, the innovation niches and the overarching landscape (Geels 2014).

The socio-technical regime, e.g. the building sector (Gibbs and O'Neill 2015), is characterised by a number of established practices and associated rules that secure a dynamical stable condition of the regime. Hence, the innovations within the regime are incremental and occur along specific trajectories, e.g. technology, policy and user practices (Geels and Schot 2010). Radical innovations, on the contrary, typically occur outside or on the border of existing regimes in so called innovation niches (Geels 2004). Niches are small-scale experimental spaces for new technologies (Kemp *et al*., 1998) and act as incubation rooms that protect innovations against the regime's mainstream conditions and traditional practices (Geels 2004). Regimes and niches are set within the broader context of the socio-technical landscape that includes macro-political developments, e.g. globalisation, urbanisation and environmental issues (Geels and Schot 2010).

The Multi-Level Perspective argues that innovations play a particular large role in the transition of a socio-technical regime: "They are the seeds of transition" (Geels and

Schot 2010, p.24). Some innovation activities at the niche level can over time become aligned and stable enough to challenge the dominant regime. However, innovations will often remain in niches for a long time until changes at the landscape level (e.g. the climate change agenda) create pressure on the existing regime. This destabilisation can create windows of opportunity for niche innovations to be selected into the dominant regime (Geels 2004; Holm *et al.*, 2015).

Though conditions and activities at the regime and landscape levels are indeed influencing the transition process, this paper focuses only on the role of innovations. The paper investigates the innovations needed for supporting the sustainable transition of the building sector and outlines a number of areas in which practitioners and researcher should concentrate their innovation activities.

METHODOLOGY

Expert interviews is an efficient and concentrated method of gathering broad and widespread data, and is thus considered useful for exploring the sustainable building sector in Scandinavia. The notion of "expert" in research methodology refers to a person with a particular knowledge that the expert may not necessarily possess alone, but which is not accessible to anybody in the field of action under study. Experts usually have a privileged access to information about groups of persons or decision processes and have a high level of aggregated and specific knowledge that is otherwise difficult to access (Meuser and Nagel 2009).

The empirical exploration of the sustainable building sector in Scandinavia is based on twelve expert interviews. The experts are key persons from universities, non-governmental organisations, private companies, and governmental and administrative organisations in Denmark, Norway and Sweden. The criteria for selecting the experts are that they each hold relevant and supplemental knowledge of sustainable building, that they are positioned within areas of innovation and development, and that they in total are representative of the building sector in Scandinavia. The selected experts are presented in table 1.

The interviews were semi-structured based on open questions and a topic guide, as recommended by Meuser and Nagel (2009). The interviews took place in January-February 2016 and each interview lasted about one hour, and was recorded and transcribed. The extracts of the interview text were coded, thematised and further analysed. The majority of the interviews were conducted in the native language of the expert (i.e. Danish, Swedish or Norwegian) and a few in English. To include quotations in this paper, the author has translated parts of the transcribed interviews.

FINDINGS

According to the experts, sustainability is a substantial aspect of the Scandinavian building sector. However, the transition of the building sector is not complete; there is still a need for further development within a number of areas. This section outlines five directions, in which the Scandinavian building sector, according to the experts, is likely to move:

The focus will shift from energy to emissions
The concept of circular economy will be further introduced
The focus on the existing residential building stock will increase
The circumstances for collaboration will become more complex
The focus on social sustainability aspects will increase

Furthermore, the experts list a number of innovations needed for the building sector to move in the directions suggested.

From energy to emissions

The experts all emphasise that the environmental focus in the Scandinavian building sector is currently shifting from energy to emissions of greenhouse gasses: "We are approaching a break-even point where the regulations regarding energy use in buildings cannot become more demanding. The focus forward will be more on materials and CO2 emissions than on operation and consumption" (Norwegian architect). The experts predict that the forthcoming regulations will contain requirements for limited emissions related to building components and materials.

Table 1: Overview of background and knowledge areas of the experts interviewed

Type of company/organisation	Position of expert	Knowledge area
Norway		
Technical University Dep. of Architectural Design, History and Technology	Professor Architect	Research within sustainable architectural design and technology
Association for Clients, Contractors and Craftsmen	Director Engineer	Political agendas within the field of environment and energy in the Norwegian building sector
Architectural firm (350 employees)	Technology and Sustainability Manager Architect	Sustainable design in practice across Scandinavia
Consulting Engineering firm (850 employees)	Senior consultant Engineer	Sustainable building in practice, participation in several research projects
Denmark		
Association for Contractors	Director Architect, MPA	Political agendas of the Danish building sector. Administration of several inter-organisational development projects
Association for Construction Clients	Head of Projects Architect	Sustainability activities of Danish construction clients, author of several white papers on sustainable building
University Dep. of Development and Planning	Assistant Professor Engineer	Research in sustainable transition of socio-technical systems including the building sector
Architectural firm (75 employees)	Senior partner and director Architect	Innovation activities within sustainable design
Region administration Dep. of Climate and Resources	Chief consultant Facilities Management	Sustainable operation of buildings
R&D agency	Special consultant Engineer	R&D within ideation and launch of innovative sustainable building solutions
Sweden		
Technical University Div. of Building Technology	Professor Engineer	Research within life cycle assessment of construction materials and sustainability assessment tools for buildings
Technical University Centre for Management of the Built Environment	CEO	Research and industrial state-of-the-art within construction management

To support the shift of focus from energy to emissions, new technologies for documenting the properties of the building materials and components are needed. The development of Environmental Product Declarations (EPDs) is already in progress in all three Scandinavian countries, but also new applications in Building Information Modelling (BIM) are necessary to secure sufficient knowledge of the buildings: “We

need documentation of what is actually in the buildings when refurbishment is needed in 50-60 years" (Danish association representative).

The circular economy concept

In the past 5 years, certification systems such as LEED, BREEAM and DGNB have been used as "a very good way of operationalising sustainability" (Norwegian architect). Certification systems offer the practitioners a simple solution to the very complex task of designing measurable sustainable buildings. As the focus of the building sector shifts from energy to emissions, the attention on optimised use of resources, including a significant focus on waste, recycling and upcycling, increases. The circular economy concept, where costs of the products, their energy and resource consumption and their greenhouse gas emissions are assessed in a cradle-to-cradle perspective, connects these new aspects of sustainable building. Circular economy is a much-discussed topic, and the experts expect the concept to develop substantially in the next few years to become a leading paradigm for managing sustainable building: "We have not completely understood the concept of circular economy yet, but there is a potential to develop a much needed holistic view on economy and sustainability" (Danish association representative).

Documentation innovations are needed to support the movement towards a circular economy approach: "BIM can become the key to circular economy" (Danish architect). The movement requires not only new technologies for measuring, collecting and visualising information on embedded energy and emissions, but also new holistic models of calculation. These models should take into account the entire life cycle of a building and its components from raw material, through use to re- and upcycling. Furthermore, the circular economy approach requires new ways of designing, e.g. to secure the option of disassembling individual parts and components that need maintenance or replacements. This concept of designing for disassembling opens up a large field of potential innovations within both technology and design processes.

Existing residential building stock

Despite the shift of focus from energy to emissions and resources, the amount of energy consumed in buildings still has to be substantially reduced. In Denmark, the ambition is to reduce the energy consumption of buildings with 75% from 2006 to 2020 (Energistyrelsen 2014). Energy refurbishment of residential buildings is key in this process, as 51% of the energy consumption in buildings in Denmark originates from single-family houses (Wittche *et al*., 2014). The same circumstances are present in Sweden and Norway: "The existing residences are the greatest challenge" (Norwegian association representative).

The main challenge for upgrading the existing residential building stock is related to economic incitements: "There is no political will to regulate on private property. We need a carrot, an economic incitement" (Norwegian association representative). This challenge gives rise to a need of both "innovations that can lower the prices of products" (Swedish researcher), but also business model innovations that provide "one-stop-shopping" (Norwegian engineer) for the house owners. System providers will have great business opportunities for offering innovative total solutions for refurbishment targeted towards house owners. Furthermore, suppliers and manufacturers also have potential business development opportunities, as the challenge of upgrading the existing houses calls for innovative low-priced, sustainable products.

Complex circumstances for collaboration

The circumstances for collaboration and management of building projects will most likely change within few years, as more and more new actors enter the building sector: “The understanding of what the building sector comprises will change. Google might be part of the sector as data owner” (Swedish researcher). Furthermore, the increasing demand for a holistic view on economy and sustainability also requires new ways of collaborating to ensure that all sustainable components are interconnected and aligned.

New ways of collaboration are essential for supporting the sustainable transition of the building sector: "I believe that the technological development is coming along, but the traditional ways for collaboration and construction management are unsuitable" (Swedish CEO). With the increasing political focus on developing renewable energy in Scandinavia, great opportunities for the building sector arise. Several innovations are needed in the overlap between the building and the energy sector, e.g. technology for storage of renewable energy in buildings. Furthermore, the challenge of refurbishing residential buildings calls for new organisational constellations, where energy-related companies merge with building companies to provide holistic energy solutions to building owners. "We need a dialogue between the sectors that produce and consume energy. In the future, the energy companies can rent areas from the owners of buildings that produce energy" (Norwegian engineer).

Social sustainability aspects

The fifth direction, in which the experts suggest the building sector to move, is towards a much larger focus on social sustainability than today: “We shouldn’t just focus on the technical solutions, but also on the use, the functionality, the operation” (Swedish researcher). Aspects of social sustainability that relates to the use of the buildings, e.g. indoor climate, health and safety and the perceived functionality of the building, are very important for the sustainable transition of the building sector. Not only because the productivity of e.g. employees and students is significantly affected by the indoor climate of their office or school, but also because the actual energy and water consumption of a building often turns out to be considerable larger than what has been calculated by the designing consultants.

The increasing focus on the functionality of buildings produces several needs for innovations. These include both new technological systems, e.g. within indoor climate, integrated PV or customised user tech, and “new ways of combining the different technical solutions” (Norwegian engineer). Considerable amounts of energy and emissions can be saved, if the different systems in a building are much more integrated and adjusted to the actual use of the building. “The technical systems must be able to be turned on and off quickly and easy when needed. It will almost be revolutionary! Think about how much energy that will be saved, and we already have the technology for it” (Norwegian architect). Furthermore, innovative user-adjusted systems are needed for securing a stable and healthy indoor climate; an increasing focus that also give rise to innovations within healthy materials, ventilation, daylight etc.

DISCUSSION

In summary, the twelve expert interviews outline five directions of sustainability in which the Scandinavian building sector is likely to move, and a list of innovations needed for this movement. Though the experts represent three different countries and have different positions as practitioners, researchers or association representatives,

their tale of the future in sustainable building is remarkable clear and uniform. During the interviews, all experts touched on the five directions, and several of the innovations mentioned in this paper were repeated by experts across disciplines and countries. That the experts agree so strongly on the paths to sustainable building indicates that the future for sustainable building is in fact very visible, perhaps even obvious.

Furthermore, the experts state that in addition to being clear, the five directions are reachable. The innovations needed, whether related to product innovations (e.g. technologies for emission documentation or low-priced products for housing refurbishment) or process innovations (e.g. new models for collaboration or user-behaviour oriented design), are not radical innovations. As the Norwegian architect stated in the last quote: "we already have the technology for it". The innovations needed to support the sustainable transition are all described by the experts as incremental innovations that should be able to be developed and brought to the market within a few years. The experts acknowledge, though, that there are barriers for innovation, e.g. the project oriented organisation of the building sector that hinders long-sighted, strategic innovation activities: "We work very project oriented and base our work on what is relevant for the individual client… What interests me in terms of innovation lies within a time horizon of 1-3 years max" (Danish architect). Nevertheless, the experts assess the sustainable transition of the Scandinavian building sector as fairly within reach.

This clear outline of the transition process brings hope to the communities working within sustainable building, be it researchers or practitioners. The assessment of the experts indicates that 'yes, we can' make the necessary movement towards sustainable building. We are not there yet, but the path is clear and the tools we need to get to the finish line seem manageable to develop. However, a contrasting thought cannot help to spring to my mind: Is the outline of the experts ambitious enough? Is there a risk for the building sector not to reach the national and global goals for sustainable transition? Are we unconsciously aiming too low, and thus missing the target? The consequences for this mismatch will be fatal, due to the significant role buildings play in the global transition towards sustainability, as stated in the introduction of this paper. Furthermore, as Scandinavia is viewed as frontrunners in the field of sustainable building, a deluded apprehension of the road ahead could end up with the blind leading the blind.

This foreboding of the experts' outline of the future for sustainable building being too unambitious to meet the actual global needs might turn out to be in vain; perhaps the directions are as clear as the experts state. However, the consequences of the low ambitions are too significant to ignore. I therefor request further research within the field of sustainable transition of the building sector in Scandinavia. I particularly propose a focus of studies on the potential mismatch between the global sustainability goals and the building sector's own ambitions and plans for activities. On the one hand, if such studies reveal that the global goals can in fact be reached by focusing on the directions and innovations outlined in this paper, the next step would be for practitioners and researchers to concentrate their R&D activities on these specific areas, producing the needed innovations and thus accelerating the movement towards sustainable building. On the other hand, if the studies show that further action is needed to reach the global goals, a new R&D agenda for sustainable building must be investigated and developed to secure that the Scandinavian building sector will lead the way in the right direction.

CONCLUSIONS

The aim of this paper is to investigate the sustainable transition process of the Scandinavian building sector with a particular focus on the directions the sustainable building sector in Scandinavia is moving, and the innovation processes needed to support this movement. Based on twelve expert interviews, five directions, in which the building sector is likely to move, are identified: (1) The focus will shift from energy to emissions; (2) the concept of circular economy will be further introduced; (3) the focus on the existing residential building stock will increase; (4) the circumstances for collaboration will become more complex; and (5) the focus on social sustainability aspects will increase. Furthermore, the experts list a number of innovations needed for the building sector to move in each of the five directions.

The findings indicate a very clear and manageable path for the sustainable transition of the Scandinavian building sector. However, a potential risk arises; that the outline of the experts is not ambitious enough for the building sector to reach the global goals for sustainability. As frontrunners, the Scandinavian building sector is expected to lead the way, and the risk of going in the wrong direction has too large consequences to be ignored. This paper proposes further research within the field of sustainable innovation processes to assist future actions for both practitioners and researcher and thus secure and support the sustainable transitions of the Scandinavian building sector.

REFERENCES

Berry, S, Davidson, K and Saman, W (2013) The impact of niche green developments in transforming the building sector: The case study of Lochiel Park. *Energy Policy*, **62**, 646-655.

Bossink, B a G (2004) Managing drivers of innovation in construction networks. *Journal of Construction Engineering and Management*, **130**(3), 337-345.

Chalmers, P (2014) *Climate Change: Implications for Buildings*. Cambridge: Cambridge Institute for Sustainability Leadership.

Energistyrelsen (2014) Strategi for Energirenovering Af Bygninger. Copenhagen: Danish Agency of Energy.

Geels, F W (2004) From sectoral systems of innovation to socio-technical systems : Insights about dynamics and change from sociology and institutional theory. *Research Policy*, **33**(6-7), 897-920.

Geels, F W (2014) Regime resistance against low-carbon transitions: Introducing politics and power into the multi-level perspective theory. *Culture and Society*, **31**(5), 21-40.

Geels, F W and Schot, J (2010) The dynamics of transitions: A socio-technical perspective. *In*: J Grin, J Rotmans and J Schot (Eds.) *Transitions to Sustainable Development : New Directions in the Study of Long Term Transformative Change*. London: Routledge, 11-101.

Gibbs, D and O'Neill, K (2015) Building a green economy? Sustainability transitions in the UK building sector. *Geoforum*, **59**, 133-141.

J Holm, Søndergård, B and Stauning, I (2015) *Sustainable Transition of Housing and Construction*. Frydenlund Publishers.

Häkkinen, T and Belloni, K (2011) Barriers and drivers for sustainable building. *Building Research and Information*, **39**(3), 239-255.

International Energy Agency (2013) *Transition to Sustainable Buildings: Strategies and opportunities to 2050*. OECD/IEA.

Kemp, R, Schot, J and Hoogma, R (1998) Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technology Analysis and Strategic Management*, **10**(2), 175-195.

Koch, C and Buser, M (2015) Sitting between two chairs: Introducing social sustainability in three large swedish contractor companies. *In*: A Raiden and E Aboagye-Nimo (Eds.) *Proceedings 31st Annual ARCOM Conference, 7-9 September 2015, Lincoln, UK*. Association of Researchers in Construction Management, 397-406.

Meuser, M and Nagel, U (2009) The expert interview and changes in knowledge production. *In*: A Bogner, B Littig and W Menz (Eds.) *Interviewing Experts*. London: Palgrave Macmillan, 17-42.

O'Neill, K J and Gibbs, D C (2014) Towards a sustainable economy? Socio-technical transitions in the green building sector. *Local Environment: The International Journal of Justice and Sustainability*, **19**(6), 572-590.

Quitzau, M B, Hoffmann, B and Elle, M (2012) Local niche planning and its strategic implications for implementation of energy-efficient technology. *Technological Forecasting and Social Change*, **79**(6), 1049-1058.

Risholt, B and Berker, T (2013) Success for energy efficient renovation of dwellings—Learning from private homeowners. *Energy Policy*, 61, 1022-1030.

Robinson, W, Chan, P and Lau, T, 2015 How do technological niches emerge? A Case analysis of servitization in construction. *In*: A Raiden and E Aboagye-Nimo (Eds.) *Proceedings 31st Annual ARCOM Conference, 7-9 September 2015, Lincoln, UK*. Association of Researchers in Construction Management, 1157-1166.

Rohracher, H (2001) Managing the technological transition to sustainable construction of buildings: A socio-technical perspective. *Technology Analysis and Strategic Management*, **13**(1), 137-150.

Schot, J and Geels, F W (2008) Strategic niche management and sustainable innovation journeys : Theory, findings, research agenda, and policy. *Technology Analysis and Strategic Management*, **20**(5), 537-554.

Shove, E (1998) Gaps, barriers and conceptual chasm: Theories of technology transfer and energy in buildings. *Energy Policy*, **26**(15), 1105-1112.

Strand, R, Freeman, R E and Hockerts, K (2014) Corporate social responsibility and sustainability in Scandinavia: An overview. *Journal of Business Ethics*, **127**(1),1-15.

Wittche, K B, Kragh, J and Aggerholm, S (2014) *Potentielle Varmebesparelse Ved Løbende Bygningsrenovering Frem Til 2050*. Statens Byggeforskningsinstitut: Aalborg Universitet.

World Green Building Council (2013) *World Green Building Trends: Business Benefits Driving New and Retrofit Market Opportunities In Over 60 Countries*. Bedford: McGraw-Hill Construction.

Yong, H A, Pearce, A R and Ku, K, (2011) Paradigm shift of green buildings in the construction industry. *International Journal of Sustainable Building Technology and Urban Development*, **2**(1), 52-62.

Zuo, J and Zhao, Z Y, (2014) Green building research-current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*, 30, 271-281.