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Barriers and challenges in nZEB Projects in Sweden and Norway

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Abstract

Nearly Zero Energy Buildings (nZEB) have been considered in current EU projects. There is little attention paid to the relationship between barriers in the decision making process and challenges in the retrofitting process of nZEB renovation. To address this gap, a comparative study of Norway and Sweden along with a review of European energy efficient projects is undertaken. Findings indicate common challenges of knowledge dissemination but differences related to ownership in Sweden and Norway. Results here have implications for Nearly Zero Energy Neighborhoods (ZenN) demonstration projects which are aspiring to meet ambitious calls from the EU since 2013.

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Keywords: energy efficiency, residential building, Zero Energy Building

1. Introduction

Buildings are a main source of energy use in Europe and the majority of building stock that exists today will exist in 2050. There are a limited number of near Zero Energy Building (nZEB) projects in Europe despite EU calls for 20% reduction of carbon emissions, 20% of increase renewable energy production and 20% improvement in energy efficiency by 2020 [1, 2]. New energy efficient approaches to retrofitting are developing in the building industry but adoption is slow. Nearly Zero Energy Neighborhood (ZenN) demonstrations as part of the European 7th framework program work on residential retrofit renovations in four European countries. Research based on a comparative study of Sweden and Norway is presented which is also part of the work in the ZenN program. Five technical and non-

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technical dimensions are identified from a review of energy efficient residential projects and programs in Europe. The review informs discussion of empirical work which explores how barriers in the decision making process and challenges in the retrofit process relate and impact each other in Sweden and Norway. Implications for ZenN demonstrations are developed which could be used as opportunities for intervention in ongoing work. The following describes this work.

2. Method

A literature review was undertaken to understand the current state of art in energy efficient projects which informed the comparative study of energy efficient nZEB residential projects in Norway and Sweden. The state of the art review focused on EU projects and programs from 2010 to 2013. The rationale for this time period is to reflect developments for nZEB since the recast of the European Energy Performance of Buildings Directive (EPBD) in 2010 which states all new buildings in Europe will have to be "nearly zero energy" by 2020.

The empirical work for the comparative study is based on reflective interviews from leading practitioners in the field of residential renovation projects, both with high and low energy efficiency ambitions. Two flexible interview guides were prepared to address specific questions related to decision making process and the retrofit process in practice. Questions were based on five identified dimensions (technical, financial, social, environment/health and organizational/legal) derived from the state of the art review. The same questions were asked in Sweden and Norway to enable comparable results.

In Norway, two representatives from finance and research bodies who had experience in the decision making process to renovate was considered by clients, residential end-users and building companies were interviewed. It was challenging to find interviewees who had completed renovation in residential buildings to consider the challenges of the retro-fitting process in Norway. Out of five firms interviewed (four architectural and one based in construction), two firms referred to energy efficient renovations in building offices and three firms spoke about energy efficient and high performing new builds rather than specific renovations. These new builds were for residential, publicly military building and an office building. While this was not ideal, there were lessons being learnt which reflect some of the complexities of renovation in residential buildings.

In Sweden, several on-going and completed residential retrofitting projects (rental houses) with very high energy efficiency ambitions as well as retrofitting projects with lower energy efficiency ambitions could be identified. Many of the retrofitting projects included several buildings, i.e. neighbourhood renovations, whilst others focused on one building. Ten interviews were conducted in Sweden with key persons involved in the identified retrofitting projects, representing both public and private housing companies as well as construction companies. Four interviews with key persons involved in retrofitting projects with low energy efficiency ambitions discussed their experiences of barriers in the decision-making process for more ambitious energy efficient targets. Six interviews carried out with key persons from retrofitting projects with high energy efficiency ambitions instead focused more on experiences of challenges in the retrofitting processes.

Analysis of empirical findings was done through a common framework based on the questions being asked under each dimension identified from the literature review. Key findings of the interviews were summarised and put into tables for comparative purposes between Norway and Sweden. Further considerations is given in understanding how these results relate to the current state of the art and how they could be used to facilitate ongoing demonstration projects of ZenN.

3. State of the art literature review

The aim of the review is to outline what work has been done in exemplar projects\ programs and the gaps that can be addressed within the work of ZenN. The review is based on reports of EU projects which focus on energy efficient residential buildings with an emphasis on retrofit (see Table 1). Five dimensions of "technical", "financial", "social", "environment and health" and "organizational and legal" emerge from these reports as impacting the development and implementation of nZEB.

Table 1 Outline of EU Projects and Programmes

Project/Program	Approach and outcomes
CONCERTO	Aim: Demonstrate energy-optimization of districts and communities cost effectiveness. Outcome: Existing buildings can cut CO2 emissions, at acceptable costs, by up to 50%.
CONCERTO Brøset	Aim: Integrated urban energy planning and transformation process Outcome: Innovation potential in terms of integrated energy design of an urban environment, buildings, infrastructure networks and supply systems, combined with high quality of life.
EeB/PPP	Aim: New methods and technologies to reduce the energy footprint and CO2 Outcome: Technology tools/approaches for energy efficiency new/retrofit projects which include historic buildings and materials for energy efficient building components.
E2ReBuild	Aim: Transform the retrofitting sector to innovative, high-tech, energy-efficient industry. Outcome: Limited cooperation possibilities in early planning stages, know-how losses from design to implementation, different interests and time expectations of involved actors.
NorthPass	Aim: Determine barriers and solution in implementation of low energy residential buildings Outcome: Barriers to low energy residential building could be addressed by LCC analysis and common specifications; knowledge needs updating; good project examples necessary
Renovate Europe	Aim: Benchmark the process to the ambitious building renovation roadmaps to 2050. Outcome: Economics reform needed in terms of sharing financial gains from energy efficient renovations between building owners and tenants as well as governments and private owners.
SCI-NETWORK	Aim: The SCI-NETWORK connects public authorities looking to procure innovative and sustainable solutions within their construction projects. Outcome: Separate budget costs results in little incentive for operation costs; networks and communication channels are necessary for engagement; a holistic view of the project is needed for shared savings and communication.
SERVE	Aim: Targeted more than 400 existing and new buildings for energy efficiency measures. Outcome: Production of renewable energy increased and holistic approaches required.
SuPerBuilding	Aim: Standardization processes and the usability of indicators in construction. Outcome: Lack of standard solutions, technology components and innovation in industry

3.1 Technical

Reports emphasize technologies and innovative solutions are key in addressing new approaches for energy efficient building. Tools have been developed to visualize performance for retrofitting processes [5, 14]. However, it is not necessary for all technology solutions to be new for retrofitting design to reduce building and energy costs [5]. There are a large number of solutions in development but a lack of standard solutions, technology components, innovation and knowledge dissemination for retrofitting nZEB is confusing [7, 13]. The challenge is how technical innovative solutions can become engaged and part of common practice within the building industry.

3.2 Financial

Initial investment cost to energy efficient renovation is small compared to operational costs by a ratio 1:5 which is not always communicated very well to the general public [10]. Life cycle cost analysis expands the reality of a combined cost of renovation and operation [7, 15, 16]. Life-cycle costing is criticized for being flexible in data input and cost optimal calculations, ignoring natural environments and complexities of financing for different stakeholders [13, 15]. Financial incentive schemes across Europe are considered necessary for success of energy efficient renovations but at the same time present challenges such as addressing increased equipment in projects and meeting conditional targets [13, 17]. Taking a building life-cycle perspective is important for financial decisions and should be supported by realistic incentive schemes.

3.3 Social

Identifying relevant networks and communication channels is necessary for engagement of residents [10]. Clients demand and willingness determines development [13] which is necessary in a building industry that is often reluctant to take on change and examples of poorly renovated energy efficient projects can confirm prejudices where there should be promotion of good examples [7, 17]. Architectural and cultural heritage values are necessary to consider for energy efficient renovation as refurbishment of can reduce CO2 emissions but is complicated by conservation restrictions [7, 18]. There are challenges in engagement of all stakeholders through information dissemination as well as maintaining architectural and cultural value in energy efficient renovation.

3.4 Environment and health

Environmental and health are primarily a challenge in use of an energy efficient renovated building. Technology tools can be used for developing predictions and indicators for energy performance of buildings [10, 13]. However, prediction tools often do not reflect the reality of residents living habits and therefore have a long-term environmental impact [19]. There are challenges in user behaviour related to indoor environment and inadequate use of an energy efficient building [7]. Residents may have aspirations to live in an environmental-friendly way but can also return to old habits ('rebound effect') [17]. Energy, social and economic performance life-cycle targets needs to be considered alongside the use of the building by the tenant or owner.

3.5 Organisational and legal

nZEB is characterized by a complex supply chain with various players and competing interests influenced by legislation. Governments are key in promoting energy efficient buildings by leading by example [5, 17]. EPBD introduced nZEB as a future requirement to be implemented from 2019 onwards for public buildings and from 2021 onwards for all new buildings [20]. Legislation is moving towards implementing targets for nZEB but there are ambiguities [7, 13, 17]. nZEB addresses only new buildings. There are no clear plans or requirements for nZEB renovations. Within the ZenN project, an nZEB definition is developed to be specific for nZEB renovation so that more than 50% reduction in yearly energy demand in the existing buildings is also included for the demonstrations involved in ZenN (For more information please refer to ZenN D2.1).

So far, the impact of five dimensions in European projects have been discussed but have not been considered in terms of the relationship between the decisions making process for nZEB renovation and the impact in the retrofit process. The next section compares Norway and Sweden in order to 1) identify similar and different *barriers* at the decision-making level for nZEB renovation projects and 2) identifying similar and different *challenges* in current practice of retrofitting processes. The outcomes results are contextualised from key points from the state of the art review in terms of how barriers in the decision making process and challenges in the retrofit process inter-relate.

4. Results: Barriers in the decision making process and challenges in the renovation process

The following sections take the key points from the literature review which are emphasized by italics and discussed in terms of the finding outlined in Table 2.

4.1 Technical: Technologies and innovative solutions along with knowledge dissemination are key for low

Lack of knowledge and dissemination in terms of the technical dimensions is highlighted in the state of the art review emphasising the need to consider optimum ways of how lessons learnt can be implemented. The challenges of not having these lessons learnt is reflected in results from Sweden and Norway where uneven dissemination of knowledge is apparent as a barrier in the decision making process and a challenge in the retrofitting process. In Norway there is a mix of low and high energy ambitions which is a barrier for nZEB as *"contractors are very likely to pick the low hanging fruit. The problem is the projects won't be ambitious enough or ambitious as is needed" (Financial representative)*. In Sweden the high energy consumption as a baseline for nZEB is too ambitious and is viewed as difficult and unrealistic. The diverging approach for energy ambitions in terms of being mixed in Norway

and high in Sweden indicates a reluctance to take on high energy ambitions. This could be explained through what is happening in the retrofitting process where proven technical solutions do not always work or are suitable for nZEB renovation in both countries and therefore nZEB is risky.

Implication:

Technical solutions are necessary along with dissemination of knowledge but this must coincide with realistic energy efficient ambitions for projects. Committing to high ambitions with an unknown technical environment may result in projects seemingly failing by not reaching their ambitions. However, in reality projects may still be energy efficient, just not be as ambitious as they intended.

4.2 Financial: Lifecycle perspective of costs rather which incorporates financial incentives

Energy efficient goals are subordinated to economic considerations in both countries. There is a lack of financial incentives for nZEB renovation highlighted as a barrier for deciding to implement nZEB emphasised in the empirical studies in Norway and Sweden. The importance of incentives is reflected in challenges of the retrofitting process where in Norway they are used in choosing high performing solutions.

In the state of the art there is a view of thinking of the investment as part of the life-cycle of the building, however, this neglects diverse ownership structures. Norway and Sweden they are quite different in terms of ownership. In Norway, approximately 80% of the population are home owners leaving a very small rental sector [21]. These home owners have input to changes in their homes either on an individual level or through housing associations. In Sweden, there is a large rental market, in particular family-oriented apartment blocks, 63% are rental while 37% are owned [22]. There is no return on investment noted in Sweden and Norway which is a barrier in decision making. The reason for this in Norway was often indicated by interviewees due to the high labour costs, low electricity bills and small market interest. In Sweden, the life-cycle model for investment breaks down in a rental market. The owner of the building takes a loss an initial loss of revenue by having to move residents during a renovation which is an indirect cost of the renovation. Residents on the other hand may be forced to move as a result in an increase in rent (which is under social dimension).

Implication

The differences between countries in terms of current costs of energy and return as well as re-examining the rational of thinking in the long-terms of building life-cycle does highlight a need for different business models that accommodate both short and long term investments.

4.3 Social: Maintaining architectural and cultural integrity of buildings and engagement of stakeholders

Similar to issue in the state of the art review, cultural and historical values of building is a barrier in the decision making process for nZEB in both Sweden and Norway which was often referred to in terms of the technical limitations in the retrofitting process in these buildings. Engagement was also highlighted as a challenge in the retrofitting process in both countries but not so much in the barriers in the decision making process. Ownership again is apparent under this dimension. In Norway, the ‘do it yourself’ attitude was a barrier for deciding to take up nZEB as it requires a highly skilled professional. There is also a perceived risk of being an early adopter in nZEB based on the individual being the owner and this individualism is reflected in the challenges of retrofitting process as there is no one solution for the end user. In Sweden, there is a collective of inhabitants to consider under the rental umbrella and public housing which must be affordable. There is no wish or possibility to increase rents as a source of funding an energy efficient renovation which is a barrier in the decision making process and as already mentioned the challenge in the retrofit process is to avoid tenants moving as a direct result of increased rents.

Implication:

Ownership is both an individual and a social/economic and engagement should accommodate how nZEB can address the individual and the wider social aspects of a residence.

Table 2 Barriers in the decision making process and challenges in the renovation process

	Barriers in the decision making process	**Sweden**	**Norway**
Technical	Uneven dissemination of knowledge amongst all stakeholders	X	X
	A mix of low and high energy ambitions		X
	High energy consumption as a baseline makes nZEB levels difficult	X	
Financial	Lack of financial incentives for existing building	X	X
	Energy efficiency goals are subordinated to economic considerations	X	X
	Majority agreement of housing associations for some renovations		X
Social	Balance nZEB aspirations with cultural and historic values	X	X
	Architectural and cultural values limit the choice of technical solutions	X	X
	Not possible for "do it yourself" approaches		X
	Residents reluctance to be an early adopter of technical solutions		X
	No wish or possibility to increase rents as a source of funding a more energy efficient renovation, especially in low-income areas.	X	
	Public housing often has an explicit social responsibility to provide residents with affordable housing	X	
Environment and Health	Not a barrier - overall high level of environmental considerations and criteria for material and waste are already considered	X	X
	There are changeable definitions of non-toxic materials and living energy efficiently vs living comfortable		X
Organization and legal	Contractual forms can be diverse which affects decision-making processes	X	X
	Lack of regulations		X
	Challenges in the retrofitting process	**Sweden**	**Norway**
Technical	Uneven dissemination of knowledge amongst all stakeholders	X	X
	Proven solutions do not always work and need to be altered/replaced	X	X
Financial	Fiscal incentives could go further for high performing solutions		X
	Cost needs to be considered in business models for long term investment alongside new financial or profitability models for nZEB	X	X
	Loss of revenue from rents in large-scale neighbourhood nZEB renovation as residents need to be evacuated	X	
Social	Communication with end users and with/between contractors is key	X	X
	Not just one solution for all end-users		X
	Increase in rents for the tenants and large share of old tenants moving – risk of disputes and social implications.	X	
	Architectural and cultural values limit the choice of technical solutions.	X	X
Organization and legal	Contractual forms can be diverse which affects decision-making processes		X
	Long-term-ownership necessity/prerequisite	X	
	Energy distribution and ventilation requirements are debated		X

4.4 Environmental and health: Challenge in use of energy efficient renovated building.

Similar to the review, the empirical work did not indicate environment and health as a barrier in the decision making process and a challenge retrofit process in Norway and Sweden. Several interviews referred to how the building regulations that are already in existence address this adequately. However, it was found in the review environment and health became an issue once a building is occupied with predicted energy performance reduced.

Implication:

Environment and health is not an issue before a renovation is complete but clearly is when a building is occupied. Understanding how a building is used at an early point may positively impact on environmental and health. ZenN addresses this issue in the design phase through spatial quality indicators under the determinants of residential use, building and block scales, and indoor and outdoor environments [23].

4.5 Organizational and legal: Construction environment has various players and context influenced by legislation.

In the empirical work, complexity of diverse stakeholders is considered a barrier in the decision making process in Sweden and Norway but only a challenge in the retrofit process in Norway. This indicates complexity of diverse stakeholders is less of an issue in Sweden than in Norway. Lack of regulations is only considered a barrier to the decision making process in Norway which seeminly has wider impacts on the retrofitting process where energy distribution and ventilation requirements are debated. In Sweden, a challenge in the retrofitting process was not having a long term ownership perspective which respondents saw as a necessary prerequisite. However, having such a prerequisite does not reflect the reality of the rental situation.

Implication:

Evaluation at different intervals of nZEB project is one way for perspectives of diverse stakeholders be combined and used for future decisions, which is being developed in ZenN through a dynamic capability framework. ZenN has also addressed ambiguous regulation for renovation by creating own standard as already referred to in section 3.

5. Conclusions

Barriers in the decision making process to take up nZEB relate to the challenges in the retrofit process as the latter often explains what is happening in the former. There is a lack of knowledge dissemination in nZEB renovations in Sweden and Norway within both processes that were examined. This indicates lessons are not being transferred from retrofitting projects to the decision making process. Findings also indicate ownership impacting renovations projects specifically in dimension of finance, social and organizational and legal. The implications found will be developed within future work with demonstrators of ZenN as indications for opportunities for intervention.

nZEB renovations are becoming more and more frequent which is encouraging [24]. This raises further questions on why some projects continue with nZEB renovation while others do not, how knowledge being transferred to other nZEB projects and how can energy goals become superior to economic considerations. Further research is needed and these questions will be considered in FP7 Near Zero Energy Neighbourhood demonstration projects where replicability of nZEB renovation is a priority.

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