



ARCHITECTURAL STRATEGIES FOR PROMOTING WELL-BEING IN ENERGY RENOVATION OF POSTWAR SOCIAL HOUSING – PROGRESS REPORT

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The PhD project is based on the hypothesis that energy renovation can be seen as a lever for promoting well-being for the residents in social housing areas. There is, however, an identified barrier when it comes to addressing traditionally more qualitative values as part of interdisciplinary renovation projects.

Consequently, the PhD project focuses on identifying, articulating and assessing potentials for added value for the residents when performing energy renovation. The project applies a combined research design including a hermeneutic, an empirical and an action research approach.

The report presents and discusses a tentative draft for a framework for articulating potential synergies between well-being and energy concerns. Lastly, it brings up for discussion how to assess the identified themes as part of a holistic approach to assessment of value in building renovation.

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TABLE OF CONTENT

1. INTRODUCTION TO THE FIELD OF RESEARCH	3
<ul style="list-style-type: none"> • The need for energy renovation • The need for energy renovation of postwar social housing • The need for focusing on well-being as part of a holistic approach to energy renovation of social housing <ul style="list-style-type: none"> Hypothesis Research question • Summary 	
2. METHODOLOGY	6
<ul style="list-style-type: none"> • Objectives • Methods <ul style="list-style-type: none"> Studies of existing theory and "best practice" (hermeneutic approach) <ul style="list-style-type: none"> Literature study Case studies The user's perspective (empirical approach) <ul style="list-style-type: none"> Questionnaires Interviews The perspective of the practicing architect (action research approach) <ul style="list-style-type: none"> Research through design • Summary 	
3. RESULTS AND CONCLUSIONS SO FAR	12
<ul style="list-style-type: none"> • Well-being in dwellings and the experience of architecture • Well-being in the context of social housing • Energy renovation • How is well-being influenced when the dwellings "turn green"? • Articulating well-being in energy renovation in architectural terms • Establishing an architectonic framework for renovation • Exemplifying the tentative framework • Reflections on the tentative framework and perspectives for further development • Plan for remaining period • Summary 	
4. PLAN FOR REMAINING STUDY PERIOD	28
5. BIBLIOGRAPHY	29



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INTRODUCTION TO THE FIELD OF RESEARCH

1. THE NEED FOR ENERGY RENOVATION

Why perform energy renovation

The Government of Denmark aims for a 100 pct. coverage of the energy demand by renewable energy in 2050 (The Danish Government 2014: 4). To achieve this goal, a combination of comprehensive energy efficiency measures and a massive expansion of renewable energy is needed.

Buildings are responsible for 40-50% of the total European energy consumption. As such, the 2050 goals can only be reached by drastically reducing the energy use for construction and operation of buildings.

The construction of new buildings is very limited, when compared to the total building stock. During the economic boom, the construction of new buildings in Denmark amounted to 1 % of the overall building stock. Further, there has been a limited extent to the demolition of existing building. Consequently, the majority of existing buildings will still be in use in 2050 (The Danish Government 2014: 4f.). This clearly demonstrates that renovations represent an important focus area in the coming years.

Why perform energy renovation of postwar social housing

This thesis focuses on renovation of multi-family housing – in particular renovation of social housing from 1950-1970.

According to the Danish Government, there is an estimated number of 600.000 social housing units in Denmark. A considerable number of these were built before the national building regulations were tightened remarkably in 1979. As such, there is an identified potential for reducing the overall energy consumption in the building sector by addressing this particular typology (The Danish Government 2014: 56 f.). The need for energy optimisation coincides with a widespread need for updating the postwar social housing stock.

Clarification of the term “Energy renovation”

So, what do we mean by “energy renovation”? The topic has gained much attention in recent years due to the general focus on climate changes (Havelund 2011: 8) and covers diverse meanings. This will be the subject of later sections in this text, which include also an overview of typical actions included in energy renovation of social housing.

In the context of this thesis, we lean on the notion of energy renovation put forward in “Hvidbog om renovering” [white paper on building renovation] published by the Danish Association of Construction Clients and Danish Landowners Investment Foundation:

“Energy renovation” include renovations, which aim to improve the building’s energy standard by reducing the energy consumption/energy supply.”

(Free translation of Havelund 2011: 6).

As such, we use a broad understanding of the term, which is not tied to a specific solution or standard.

2. THE NEED FOR FOCUSING ON WELL-BEING AS PART OF A HOLISTIC APPROACH TO ENERGY RENOVATION OF SOCIAL HOUSING

Why consider wellbeing when performing energy renovation?

The Danish Building Institute (SBI) in 2010 put forward three scenarios for how renovations of the existing building mass can contribute to the overall goal of a carbon neutral society in 2050. The most far-reaching scenario would result in an energy reduction of 73% compared to the present situation (Kragh & Wittchen 2010: 26).

Such reductions are likely to influence the perception of the built environment dramatically (Acre & Wyckmans 2015) (Madsen et al. 2015) (Hvejsel et al. 2015). An example could be how an added mechanical ventilation system affects the height of a space, thus potentially affecting the perceived spatiality and access of daylight. Alternatively, how an added layer of exterior insulation may negatively affect the experienced coherence of a building to its neighbours from a culture-historical point of view.

The other way around energy renovation may represent an opportunity to rethink if the physical surroundings could be re-designed to better meet contemporary needs for dwelling. For instance by altering the thermal envelope in a way, which also provides improved access to private outdoor areas, or provides more intimate window niches by utilising the additional depth of the wall due to re-insulation. Subsequently, the PhD project is based on the following hypothesis:

HYPOTHESIS:

Energy renovation can be seen as a lever for promoting well-being for the residents through the physical environment, if we apply a more holistic approach to renovation.

According to Acre and Wyckmans “...the inattention to the potential of nontechnical dimensions such as spatial quality, by stakeholders involved in the energy renovation of dwellings, constitutes a lost opportunity to increase occupants’ receptiveness to energy renovation.” (Acre et al 2015).

Further, one could argue that inattention to the potential of spatial quality represents a lost opportunity to secure a long-term sustainable solution, in which we do not look at value as something static, but rather focus on how the building can stay valuable to society and its inhabitants over time.

Hence, the question of articulating the spatial consequences and potentials of technically motivated renovations is an urgent matter, if the energy saving are to be realised in a manner which provides added value to the end users rather than devaluing existing qualities. The challenge of transforming the building mass to be more energy efficient not only calls for separate technical development and innovation but for a holistic approach and the development of architectural strategies, through which to articulate the potential for synergies between *energy efficiency* and *improved well-being* for the people who inhabit the spaces.

Well-being in contemporary renovation practice

However, recent research has identified that there is limited attention to social and cultural values in in contemporary energy renovation practice. In 2015, Madsen and colleagues carried out a comparative study of eight evaluation methodologies with relevance for the Danish building renovation industry (Madsen et al. 2015). The researchers compared the metrics put forward in each of the methodologies and how these metrics were ranked. Based on the study, the authors highlighted an apparent emphasis on technical, quantifiable values and advocated a need to include qualitative socio-cultural values in future evaluations in order to secure a holistic approach (Madsen et al. 2015: p. 39). As part of this PhD study, a supplementing analysis has been carried out. The findings were presented in the paper “*Towards a Holistic Approach to Retrofitting: A Critical Review of State-of-the-art Evaluation Methodologies for Architectural Transformation*” at the World Sustainable Built conference in Hong Kong 2017. Based on a review of eight assessment methodologies relevant to the renovation industry, the paper identified a general challenge when it comes to addressing the implications of technical initiatives on the perceived spatial quality in the early phases of a renovation process (Jensen et al. 2017).

But how should this be approached? One suggestion is presented in the publication “Arkitektur Energi Renovering” [Architecture Energy Renovation]. In this publication, the authors propose a design guide for working holistically with aspects related to energy consumption, indoor climate and ‘improved spatiality’ (Marsh et al. 2013). The format ensures a hands-on guide for practicing consultants, which to the authors of this paper represents great strength as decision support in early phases of renovation projects. However, when highlighting the more “soft” themes, such as “improved spatiality”, the publication offers limited elaboration of the terms (Marsh et al. 2013).

Peters (2015) in her PhD thesis investigates architectural strategies for transformation of modern housing. She advocates that renovations should take into consideration the three following aspects: ‘improved daylight conditions’, ‘improved or new spatial experiences’ and ‘reconsideration of the connection to the outdoors’ (Peters 2015). She offers best practice examples of how to work with these themes alongside other sustainability goals, which provides a valuable palette of inspiration for future renovation of postwar social housing. The themes related to ‘improved or new spatial experiences’ are, however, still quite diffuse and therefore seem difficult to operationalise directly in interdisciplinary assessments alongside quantitative parameters.

At the time of writing this paper, new decision support and evaluation methodologies related to the field of renovation are being developed. E.g. within the framework of the on-going research projects REBUS and REVALUE (of which this PhD project forms part of the latter). The tools aim to incorporate as part of their scheme also qualitative values. This gives rise to discussions about how to do this. In order to sum up on the issue at hand, we lean on the words by Madsen and colleagues, who state that there is “...a big challenge in collecting and developing knowledge, which can qualify and describe the soft, qualitative values [in building renovation], in order to treat them on equal terms as quantitative data” (Madsen et al. 2015:39 - translation by the authors). In the present PhD project, the challenge is addressed through the following two research questions:

RESEARCH QUESTIONS:

- R1 Does energy renovation affect the wellbeing of the residents?**
- R2 If yes, how can we use this knowledge to identify, articulate and assess potentials for *improved well-being* when performing *energy renovation* of social housing?**

“...but this is not an energy renovation”

When discussing the research project with practitioners, I have sometimes encountered statements like *“this is not an energy renovation”* when referring to specific renovation cases.

This only serves to underpin the complexity of contemporary renovation projects. Renovation is seldom “just” about reducing the energy consumption of a building (Thomsen et al. 2012: 13).

This is not least the case when referring to social housing. The starting point for initiating a renovation can be different from case to case, spanning objectives as diverse as social rehabilitation and constructional issues (Bjørn, 2015) (Bech-Danielsen 2012: 54). Due to the Danish subsidy schemes for physical renovation, administered by the Landsbyggefonden, financial support is only offered if physical damages or constructional errors can be documented. All renovation cases therefore start out with a surveyor’s report, stating what initiatives must be implemented to maintain the building from a technical and constructional perspective (Bech-Danielsen 2012: 54). “Energy consumption” is mentioned as part of the subsidy scheme. However, the foundation does not subsidy improvements, which go beyond the demands in national building regulations (Landsbyggefonden 2018a).

As such, energy optimisation may not be mentioned as the primary concern when initiating renovation of a social housing project. It is, however, always an integral part of the endeavor to future-proof the building stock - and will come to play an even more important role if we are to meet to 2050 goals. The complexity of concerns motivating renovation of social housing only serves to underline the importance of a holistic approach.

The PhD project focuses on physical initiatives. As stated by e.g. Bech-Danielsen (2012) it is important to note that the physical frame is important, but not determining, for the social life of the residential areas (Bech-Danielsen 2012: 53). As such, the physical transformation must always be combined with social efforts when working in social housing areas. This lies beyond the scope of PhD, which focuses on physical transformation, yet should always be an integral part of all efforts to rethink residential areas.

ReVALUE

The PhD project is conducted as part of the national research project REVALUE (value creation by energy renovation and transformation of the built environment – modelling and validating of utility and architectural value), funded by Innovation Fund Denmark. The REVALUE project is conducted as a collaboration between Aarhus University, Department of Engineering and el-

even partners from the building industry, which each represent different parts of the value chain.

The main partners involved in the individual PhD project are Aarhus University, Department of Engineering and AART architects. Based on this ‘setup’, the objective of the PhD can be viewed on two levels:

- “micro level”; the objectives of the PhD in its ‘own right’ (work-package 1 - task 1.4).
- “macro level” ; how the PhD project contributes to the Re-VALUE-project, by adding to the development of a holistic framework for building renovation (work package 1 - task 1.1. and 1.5).

A description of the objectives can be found on page 6.

The PhD candidate holds a background from architectural practice. This naturally influences the direction and course of the study. Further, the candidate receives supervision from both partners (university and industry partner) with the aim to secure an application oriented research project, which targets architectural practices and supports interdisciplinary collaborations.

3. SUMMARY

In the above, we have accounted for the context of the PhD study. The thesis inserts itself in the ongoing debate on how to respond to the climate challenges; Energy renovations hold an important potential to help reduce the energy consumption of the building industry and reach the goals for a CO2 neutral society.

The project focuses in particular on the challenges related to renovation of postwar social housing. “Future-proofing” these buildings in terms of energy efficiency involves radical changes to the existing built environment. The PhD project focuses on heightening awareness about this relation and using this awareness as a lever for identifying, articulating and assessing potentials for synergies between *energy efficiency* and *improved well-being*.



Fig.1 Through its focus on resident well-being, the PhD project is concerned with the “social” aspects of sustainability.

METHODOLOGY

RESEARCH DESIGN

The following section is devoted to an account of the methodology, methods and tactics applied in the project in order to answer the research questions. Specific (tentative) research objectives are described in Table 1.

Methodology / overall research design

The project is based on a *combined research design*, combining methods from diverse traditions and including qualitative and quantitative approaches (Groat & Wang 2013: 441).

The complex character of the research questions (and related objectives) makes it relevant to look at them from different angles to be able to give substantiated answers. The combined research design is chosen, based on an understanding that each research method brings with it particular strengths and weaknesses. By combining methods, the aim is to neutralise the weaknesses through 'triangulation' (Groat & Wang 2002: 361).

Methods / strategies

The combined research design is comprised by three "entries" to answering the research question (Fig.2):

1. A *hermeneutic* approach - focusing on deriving knowledge from the analysis of existing literature and contemporary renovation cases.
2. An *empirical* approach - focusing on deriving knowledge by asking the residents.
3. An *action research* approach - focusing on deriving knowledge by engaging in an architectural project team (as part of an interdisciplinary competition entry).

The original intention was to apply the methods in a sequence of distinct phases, where the hermeneutic approach could help build theory to be tested through the empirical and action research studies (Groat & Wang 2013: 443).

However, it was quickly evident that "the ship sails!" when you are not doing isolated research, but collaborate with others (the empirical approach) and work with real life projects (the action research approach). As such, it has been relevant to apply a 'mixed-methodology' research design, where the parts are conducted in roughly comparable sequences (Ibid 446) with the advantages and disadvantages that this triggers. The disadvantage could be that the approach is considered "*too unconventional for some purists*" (Groat & Wang 2013: 448), e.g. the research design poses a challenge to stay objective in the empirical studies, when simultaneously engaging more subjectively through action research. One overarching advantage is the potential to benefit from different perspectives on the research questions, thus neutralising weaknesses.

Table 1 Research objectives:

- O1** Establish if energy renovation effects the well-being of residents.
- O2** Gather existing knowledge from the fields of energy renovation and architecture in a theoretical model for articulating how energy renovation effects the well-being of residents.
- O3** Identify architectonic themes, through which to assess the influence of energy renovation alternatives on the well-being of residents in the early design phases and 'predict' the potential for synergies/added value.
- O4** Develop recommendations for how to evaluate the themes as part of the early design process.
- O5** Present examples of how the themes can be effected positively in energy renovation. Presented as images or drawings with description.

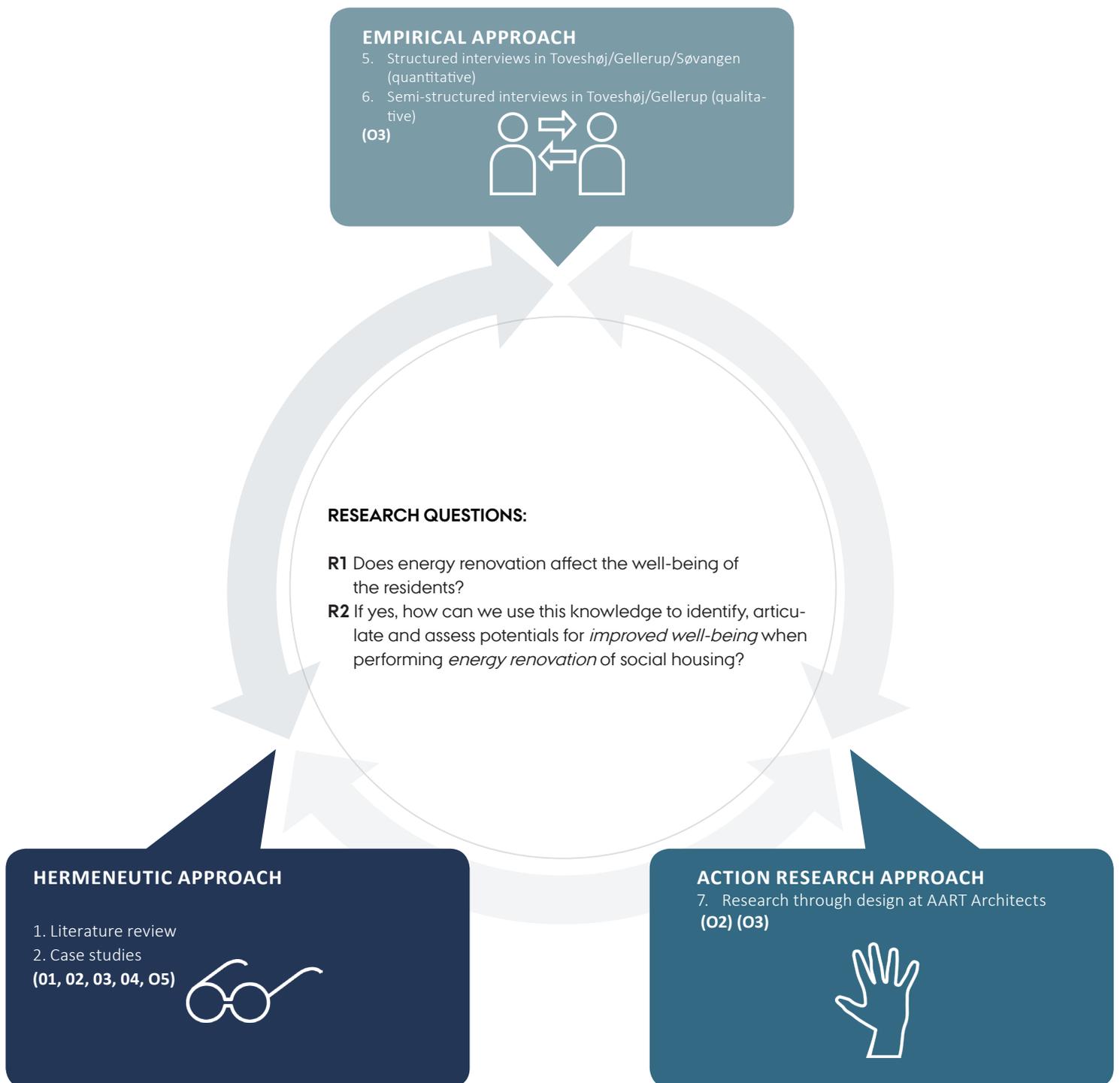


Fig.2 Graphical representation of the research design. Methods and tactics.

HERMENEUTIC STUDIES

LITERATURE REVIEW + CASE STUDIES

Literature review

The PhD project applies hermenautic interpretive studies both in establishing state-of-the art for the project and as an approach for identifying and juxtaposing existing knowledge relevant to the current challenge of energy renovation of social housing.

In establishing state-of-the art for the project, a review of eight existing assessment methodologies has been carried out. The aim was to compare which sustainability indicators each methodology attach importance to, by providing a meta-synthesis of the findings (Cronin & Ryan 2008: 39) (Onwuegbuzie & Frels 2016: 27).

This was supplemented by a narrative literative review of relevant studies that address the subject area of the PhD (Cronin et al., 2008: 38) (Onwuegbuzie & Frels 2016: 23f.).

The narrative literature review as a tactic has been applied also in the main body of the PhD. As far as possible, the literature reviews of the PhD study are based on what Groat & Wang refer to as explanatory theory, which documents a *"Plausible or scientifically acceptable general principle or body of principles offered to explain phenomena"* (Groat & Wang 2013: 111). Popular science publications are included, e.g. design guides, as the project is focusing on issues related to the practical dimensions of the profession.

In relation to Research Question 2: *How can we identify, articulate and assess potentials for improved well-being when performing energy renovation of social housing?* it is found relevant to include also references based on normative knowledge. According to Groat & Wang *"Normative theories inform much of what is done in architectural offices"* (Groat & Wang 2013: 116). Normative theory describes *"a belief, policy, or procedure proposed or followed as the basis of action; an ideal or hypothetical set of facts, principles, or circumstances"* (Ibid: 111). Within the field of architecture these two categories of knowledge/theory overlap because much knowledge is derived from practice (Ibid: 116). As such, it is found relevant to base the thesis on both categories.

Related publication:

- Jensen, SR, Kamari, A, Strange, A & Kirkegaard, PH 2017, Towards a holistic Approach to Retrofitting: A Critical Review of State-of-the-art Evaluation Methodologies for Architectural Transformation. i *World Sustainable Built Conference 2017 - Conference Proceedings*: 689-696. Status: published.

Case studies

Much knowledge in the field of architecture is embedded in actual built cases. In order to adress this otherwise "tacit" knowledge, the PhD study includes case studies to shed light on the potential for synergies between *energy efficiency* and *well-being*.

Two case studies have been initiated; One which compares two cases (Jensen et al. 2018), and second study, which extends the study to nine cases (Jensen et al. 2019). In both studies, a tectonic lense for analysis is applied based on the etymological studies by Eduard Sekler (Sekler 1964). This will be further elaborated in the following sections. The analysis is further based on color-coding, inspired by Martin Boesch' publication *Yellowred* (2017). The studies include European cases of renovation of social housing which have been completed within the last decade. They have all been published in architectural journals and/or received mentioning in the architectural milleu. This is used as an indicator that the works have been assessed to hold a certain level of architectural quality.

This section will be further developed, based on Yin (Yin 2013) og Flyvbjerg (Flyvbjerg 2006).

Related publications:

- Jensen, S.J., Hvejsel, M. F., Kirkegaard, P. H., Strange, A. 2018. *Renovation of social housing – a tectonic dialogue between past and present?* Under 2. round of review.
- Jensen, S. R., Postiglione, G., Leonforte, F. 2019. *Educational leaflet: Case study atlas*. In collaboration with Gennaro Postiglione. Status: in progress



EMPIRICAL STUDIES

INTERVIEWS + QUESTIONNAIRES

The PhD study includes questionnaires and interviews in Toveshøj, Gellerup and Søvangen in Aarhus, where extensive renovation is in progress. The study is conducted in collaboration with the Department of Public Health at Aarhus University, who is continuing a study performed in Trigeparken (as part of the project Be-Ready). More specifically, the study has been conducted in collaboration with PhD student Charlotte Gabel Hansen.

From the point of view of this PhD project, the purpose is to:

1. Establish a baseline for evaluating the renovation initiatives, to see if it has affected the residents perception of well-being relative to a number of factors (compare baseline and post occupancy evaluation).
2. Establish if there are patterns in the way, the residents perceive their built environment (in the existing building - baseline). If possible, to establish general preferences for different user groups.



Prior to conducting the study, sight visits were carried out in order to gather photo material and get a first impression of the physical characteristics of the place prior to renovation. The visits were carried out as "Serial visions", where we walked a predefined route, which was mapped through photographs along the way (Cullen 1961).

QUESTIONNAIRE

The questionnaire study has been organised as a structured interview, where the interviewer reads questions aloud from a questionnaire on a tablet. Following the interview, measuring devices were placed in the dwelling for 14 days (measuring particles, humidity, temperature, CO2). Analysis of the measurements is carried out by other involved parties. It is however, the intentions

to formulate a joint paper, where findings are compared.

Development of the questionnaire

The original intention was to make use of the Semantic Differential methodology to measure the annotative meaning of the built environment through a scaling of adjective pairs (Osgood, 1969). However, in order to align the type of questions with the ones in the questionnaire developed by Department of public health, the resulting questions are formulated as going from (A) "very satisfactory" to "very unsatisfactory" or (B) e.g. "very safe" to "very unsafe". The original questionnaire is based on SF12 (12-item short form health survey) and ECRHS (European Community Respiratory Health Survey). The author has participated in the data collection in the initial phase of the data collection - later handled by a group of student workers.

INTERVIEWS

Development of the interview guide

The author contributed with questions for an interview guide developed by anthropologist Mia Kruse to expand the focus from indoor climate to a broader understanding of well-being. The interview guide formed the point of departure for semi-structured interviews (Kvale & Brinkmann 2015), carried out by Mia Kruse. The author participated in two out of eight interviews in order to get an understanding of the approach and finetune the interview guide. The interviews were supplemented by images taken in all rooms in the apartments. Where the questionnaire study focuses on the breadth, the interviews are carried out to gain a more in-depth understanding of people's perception of their physical surroundings (Groat & Wang 2013: 280).

THE NEXT STEP

The next step is to analyse the data from the empirical studies in parallel to the analysis by Charlotte Gabel Hansen.

	Baseline 2017/2018			Renovation	POE
	Possible	Included	Visited again (= both summer and winter)		?
Gellerup B4 and B7, Toveshøj, A17	n=213	B4: n=12 B7: n=49 TH: n=17 Totalt n=78 => 37%	B4: n=4 (31%), B7: n=19 (43%) TH: n=6 (40%)	2018-19	?
Søvangen A2	n=418	n=104 => 25%	n=27 (26%)	?	?

Table 2 Status in relation to questionnaires.

Related documents:

Flyers (Danish, English, Arabic - translation by student worker Nesrin Awad), Information posters (Danish, Arabic), Questionnaire (Danish - on tablet), Interview guide for the interviewer (Danish), Secondary questionnaire (Danish - on tablet, to be filled out by interviewer)



Fig.3 Gellerup, Toveshøj & Søvangen.



ACTION RESEARCH

RESEARCH THROUGH DESIGN

5.1 Research-through design study

As part of the project a research-through-design study has been carried out in the studio of AART architects in Aarhus. The study took place from December 2016 to April 2017, where the author took active part in the design process in the competition phase of the renovation of a multi-family housing block in Gellerup, Aarhus. The study was based on the relatively open research question: *"how do practicing architects work to articulate, implement and assess values related to the well-being of residents in the design phase?"*

Groat and Wang explain action research in the following way: *"The emphasis is upon the specific design venue as a kind of microculture, complete with ways of doing, implicit understandings, technical terms, and so on, that all arise in the midst of creating a design"* (Groat and Wang 2002: 111).

In the project, this 'microclimate' has been made up by a team of architects working in the studio of AART architects in Aarhus.

The study leans on the definition by Christopher Frayling of research through design as *"materials research, development work or actions research, where a research diary tells, in a step-by-step way of the practical experiment in a studio and where the results are communicated in a research report"* (Frayling 1993:5).

In their publication *"An analysis and critique of Research through Design: towards a formalization of a research approach"* Zimmermann and colleagues (2010) points to the importance of documenting the design process (Zimmerman et al. 2010). This supports the quotation by Frayling in the above. In the present study, the steps of the process have been documented through a calendar of internal and external meetings and weekly/bi-weekly presentations within the interdisciplinary group of architects, engineers and contractors. Additional material counts the tender documents, final proposal and jury report.

Until now, the study has been used for exemplification of the developed architectonic themes. Further evaluation of the study will focus on identification of challenges and potentials in the process and in the framework for the competition for promoting well-being, e.g. the tender format.



Fig.5 Research approach focusing on the creative process in renovation cases.

Related publication:

- Jensen, S. R., Postiglione, G., Kirkegaard, P. H. & Strange, A. 2019. A tectonic approach to energy renovation of dwellings - the case of Gellerup. In: *Proceedings from the ICOSA 2019, 'Circular tectonics'*. Status: under review.

Fig.4 Using research through design as a method to gain insight into the dynamics of the interdisciplinary, creative process. Photo: AART architects.



RESULTS AND CONCLUSIONS SO FAR

WELLBEING AND THE EXPERIENCE OF ARCHITECTURE

In the following chapter, focus will be on unfolding the subject of "well-being" and address if and how it is influenced by alterations to our physical surroundings in general – and by energy saving initiative in particular (O1, O2). The findings are based on a literature review and with reference to the research through design study.

1. WELL-BEING IN DWELLINGS AND THE EXPERIENCE OF ARCHITECTURE

The concept of well-being

What do we mean by well-being in the context of this thesis?

In order to narrow down the understanding of the term, we look first at the synonym "comfort", which is often applied when characterising a given physical environment within the field of engineering.

According to Line Valdorff Madsen, "*The concept of comfort is often taken for granted*" (Madsen 2017). According to Madsen, "*comfort is most often inscribed as thermal comfort. As such, the meaning of the word comfort is implicit in energy research...*" (Madsen 2017: 3).

In the context of this thesis a broader understanding of the term comfort is pursued, which goes beyond physiological comfort. This in itself is not a novelty. E.g. Chappells & Shove state that "*comfort might be used to describe a feeling of contentment, a sense of cosiness, or a state of physical and mental well-being*" (Chappells & Shove 2004: 3).

We make use of the synonym "well-being" as a way to differentiate the work from the prevailing delimited understanding of comfort within the field of energy renovation.

If looking up the term in the Oxford English Dictionary we get the following definition of the noun:

"Well-being, n.:

With reference to a person or community: the state of being healthy, happy, or prosperous; physical, psychological, or moral welfare."

(The Oxford English Dictionaries 2018, "wellbeing").

Applying the above quotation to the specific context of this thesis, we are thus concerned with the "physical, psychological, or moral welfare" of the occupant of a dwelling in a social housing community. Acknowledging the limitations of physical initiatives, we focus on promoting physical and psychological well-being, and leaving morality for others to address.

Well-being in the context of the dwelling

In the following, the term "well-being" will be examined relative to the physical surroundings of the dwelling.

Before moving on to discussing the relation between well-being and energy saving initiatives, it is relevant to reflect for a moment on well-being in the context of the home and the presumption that our well-being is influenced by our physical surroundings.

In 1970 psychiatrist Ingrid Gehl examined how the physical living environment [bo-miljø] influences us. She stated that the living environment, cause a number of experiences, certain behavioral patterns and feelings (Gehl 2016: 13).

Gehl pointed attention to a number of "bo-behov" [needs in relation to living] that need to be met in order to accommodate human well-being. These include *physiological needs*, needs related to *human safety* as well as *psychological needs* (ibid 2016:) 18. As such, she provides us with an understanding of well-being in the context of the home, which goes beyond the physiological concerns related to e.g. 'thermal comfort'.

In the book "Hjemlighed" [homeliness] from 2006 pedagogic anthropologist Ida Winther unfolds perceptions of the home from a cultural-phenomenological perspective. She is concerned with what makes people "feel at home". As such, she too is concerned with the more emotional aspects of dwelling (Winther 2006). (As part of the PhD thesis the subject of 'dwelling' will be further unfolded).

Both the work by Ingrid Gehl and Ida Winther demonstrates that the living environment can be divided into a physical and social environment which mutually influence each other (Gehl 2016: 12). As stated in the introduction, the physical environment cannot be viewed in isolation when transforming social housing areas, and must always be accompanied by social efforts. Bearing this in mind, this thesis focuses in particular on the physical environment and the derived social processes.

The purpose of this section has been to clarify the understanding of well-being promoted in the context of this thesis. The aim is to expand the understanding of comfort as a matter of complying to physiological needs, to address also matters related to more psychological aspects of dwellings.

Based on the mentioned references we propose an understanding of the term well-being, as the satisfaction of the following needs:

Physiological needs

- Sleep, rest
- Food, drink
- Hygiene and defecation
- Sex
- Air, light
- Safety*

**Psychological needs**

- Contact:
- Privacy
- Varied experiences
- Purposefulness
- Play
- Structure and orientation within the environment
- Sense of ownership and identification with the community and environment
- Aesthetics and beauty
- Sense of security*



Leaning on Gehl, the 'dwelling needs' [bo-behov] are influenced by the physical environment through its:

- Dimensions
- Shape
- Furnishing: *the objects in the space.*
- Placement/layout: *location of the environment relative to other functions.*
- The impact of the environment on the senses: *sight, hearing, touch, smell, taste.*

(Gehl, 2016: 21).

Such influences are naturally present in different scales - in the interior as well as exterior spaces (Sattrup 2018).

The thesis will include a more thorough discussion of the term well-being. The above preliminary examination, however, serves to extend the prevailing understanding of comfort in energy research as "thermal comfort" (Madsen 2017: 3). As such, it can be seen as a first step on the road to promoting a more holistic understanding of the implications of energy saving measures on a resident's well-being in and around their dwelling. As part of the PhD project, the subject of well-being in the context of the home will be the subject of further studies, in order to strengthen the argument

It is relevant to note that (at least some of) the physiological needs

may be easier to measure than the psychological ones. E.g it is possible to say that the decibel level should be lower than a given value, whereas it is more difficult to provide numerical norms for the need for contact with others.

2. WELL-BEING IN THE CONTEXT OF SOCIAL HOUSING

In the previous section we have addressed well-being in the context of the dwelling and, based on literary references, we have suggested that the physical living environment may influence the well-being of the residents both physiologically and psychologically. In the same breath, it is important to acknowledge the limitations of the physical environment, as the physical frame is only one of a number of factors which influence our total well-being.

After addressing well-being in relation to dwellings on a general level, it is relevant to zoom in on the particular context of social housing.

In order to gain an understanding of the typology, the following section includes a brief clarification of the term and an account of the development of the postwar social housing stock followed by reflections on present challenges relative to the proposed understanding of well-being.

What is a social housing dwelling?

The social housing sector is concerned with providing quality dwellings at an affordable rent. Social housing is, at large, constructed and run by social housing organisations, which are run on a non-profit basis. According to the Landsbyggefond "…the term *"social housing"* is a collective designation for three different types of housing; *social family dwellings, social dwellings for the elderly and social dwellings for young persons*" (Landsbyggefonden 2018b). In the context of this thesis, we focus in particular on postwar social housing. As such, the subsequent paragraph serves to give an overview of the development of social housing from this period.

The development of the postwar social housing stock - a brief overview

After World War II, the Danish society faced an urgent lack of housing. The urbanisation and industrialisation had led to problematic conditions in the city centres. The living conditions in the dense and overpopulated city centres where poor and daylight and fresh air was in short supply. During the war, the building of housing had come to a stop. In order to overcome the problematic

* (in the context of this thesis, we place needs related to safety under physiological and psychological needs respectively).

WELL-BEING IN THE CONTEXT OF POSTWAR SOCIAL HOUSING

housing situation, a scheme was set up to allow for government loans for housing. By using this scheme, it was possible to apply for funding for up to 97 % of the expenses. This served to significantly boost the construction of social housing dwellings (In the course of 20 years from 1960-1979 approximately 200.000 social housing dwellings were built), of which most were built in the periphery of the cities (Bech-Danielsen et al, 2011: 13). (Bech-Danielsen, 2012: 51f) (Bech-Danielsen & Stender 2017: 7).

The building of social housing dwellings was successful in many ways. New industrialised production techniques were introduced based on standardization, allowing for mass production, which secured affordable rents. Many of the dwellings of the time had a high level of quality – even if compared to contemporary standards. Qualities such as spacious rooms, well-organised kitchens, living rooms with good daylight conditions and large balconies towards south can be mentioned (Bech-Danielsen, 2012: 52). However, already shortly after completion, challenges started to arise. It is important to note that there are of course several well-functioning settlements. Here, however, we address challenges to the typology on a general level.

In order to be able to address potential synergies between energy saving initiatives and well-being in contemporary renovation, it is relevant to understand the development of the typology and contextualise present challenges. This is an extensive subject in its own right. As such, the following brief account does not do it justice. It does, however, hopefully serve to underline the importance of pursuing synergies between energy efficiency and increased well-being in order to promote both.

Challenges in relation to the postwar social housing stock

Bech-Danielsen (2012) describe the challenges in terms of construction, social, experiential and challenges and changed norms. The *constructional challenges* consisted of e.g. damages in the concrete as well as leaking roofs.

The most *social challenges* arose in the 80's when, for different reasons, the areas had become the home for a large number of socially marginalised people (Bech-Danielsen 2012: 52f.)

Bech-Danielsen refer to *experiential challenges* in relation to the repetitive character of the prefabricated dwellings modules. Post modernist architects criticised the rational building form and the scale of the settlements. Another critic of the postwar way of building was Christian Norberg-Schulz, who pointed out that the universal character of the buildings lead to a 'loss of place; the

standardisation did not leave place for adaptation to local cultures and ways of building, which according to Norberg-Schulz is crucial for the development of a personal identity (Bech-Danielsen 2012: 53) (Norberg-Schulz 1995).

According to Bech-Danielsen, a part of the mentioned critique of the lacking experiential qualities can be explained through changed *societal norms*. In the wake of the youth revolution, the "low dense" movement arose, focusing on community houses and meeting places. Later, it was the increased individuality rather than solidarity that took center stage. Where the prefabricated postwar housing had targeted an average person with 'equility' as a core ideal (everyone should have access to the same), focus gradually shifted toward a focus on diversity and the individual towards the end of the century. In this light, the expression of the postwar buildings was problematic.

As part of the PhD project this very brief account will be elaborated based on literary references and with focus on the case of Gellerup, Toveshøj and Søvangen in Aarhus in particular.

The present situation

According to Bech-Danielsen and Stender (2017), most postwar social housing areas have undergone renovation at least once since their construction to overcome these challenges. Nevertheless, the challenges are more or less the same today, even if integration and ethnic minorities have gained a larger focus (Bech-Danielsen & Stender 2017: 14).

Over the years both physical, social and organisational initiatives have been implemented to attract more socio-economically advantaged residents and create a balanced demography. This has contributed to a positive development in some areas, whereas others still have a high concentration of socially marginalised residents. The quality of the areas as places to live has been heightened, but there is still a tendency that the dwellings figure low on the local housing market (Bech-Danielsen & Stender 2017: 17 & 21).

The present overview has focused on challenges, and as such, must be seen as a generalisation. There are postwar social housing areas, which have been spared the severe challenges here mentioned. Even if the challenges in some areas cannot be ascribed to the physical surroundings alone, it is relevant to continuously discuss how to support a positive development through transformation of the built environment.

In the context of this thesis, the postwar social housing stock appears as an obvious starting point when discussing the necessity of promoting well-being when performing energy renovation. In the context of social housing it appears as a matter of course to put the residents in the centre.

It is also evident that initiatives must go beyond well-being in a physiological understanding of the term (e.g. addressing issues related to moist and accessibility) and include a psychological understanding of the term (evident e.g. in an increased use of the term "tryghedsrenovering" - for instance in Bispehaven, Aarhus).

As mentioned also in the introduction, energy may not be the prime concern when renovating social housing areas. Nevertheless, energy optimisation include extensive alteration of the existing construction, and may, as such, be an occasion for promoting other values at a fair cost.

If looking at the issue from a different angle, the current focus on transforming social housing areas should be implemented with an eye for potentials to optimise the energy use of the building if we are to meet the 2050 goals for CO₂ neutrality. In other words, it is highly relevant to pursue synergies between *energy saving* and *well-being*.

3. SUMMARY

The purpose of this section has been to clarify the understanding of well-being in the context of this PhD thesis. The aim is to expand the understanding of comfort as a matter of complying to physiological needs and address also matters related to more emotional, psychological aspects of dwellings.

As part of this section, we have established that the physical environment in and around the dwelling influences the well-being of residents through its dimensions, shape, furnishing, layout and the ways it stimulates the senses.

In the context of postwar social housing, it is especially relevant to consider how to support a positive development through transformation for the built environment.

As such, it provides an obvious case for addressing simultaneously energy saving and potentials for promoting well-being for existing and coming residents - in order to secure that we get the most value for money during the renovation process, and in order to secure a more long-term sustainable solution.



Fig.6 Housing block in Gellerup, Aarhus.

ENERGY RENOVATION

1. ENERGY RENOVATION

What do we mean by energy renovation - vol. 2

In the introduction, a definition of energy renovation in the context of this thesis was put forward: *"Energy renovation" include renovations, which aim to improve the building's energy standard by reducing the energy consumption/energy supply.*" (Free translation of Havelund 2011: 6). This implies a broad understanding of the term, which is not tied to a specific goal. It is, however, relevant to note that extensive renovation is needed in order to reach the 2050 goal.

In Denmark, all renovation cases must comply to the national building regulations. Depending on the extent of the renovation, the BR18 (the Danish Building Regulations 2018) puts forward different minimum requirements. When focusing on conversions and replacements of buildings parts, the energy demands can be met by either following minimum requirements for the effected building parts (U-value and tightness) or by meeting the energy frameworks of renovation class 1 or 2 (Table 3) (Ministry of Transport, Building and Housing 2018).

However, the term 'energy renovation' may also be used to cover more extensive efforts, which go beyond the building regulations. As such, the final PhD thesis will include an overview of definitions of volunteer approaches to energy renovation, including the BR low energy class, DGNB, Deep renovation and NetZeb renovation.

Typologies of physical energy renovation strategies

On the opposite page, icons depict different strategies for energy reductions and - optimisations (Fig.7). With reference to Stewart Brand (1994) these are categorised in terms of strategies which focus on the *skin, installations or layout* (Brand 1994). The overview is not exhaustive. However, it serves to illustrate that there are multiple strategies for alteration of the existing construction, which can each be realised in different ways. This provides a space of possibilities – a space to work within and a space to challenge.

The overview is based on literary references (see main references below the icons). The overview will be further substantiated in relation to renovation of postwar social housing based on ongoing case studies in collaboration with POLIMI.

“Energy renovation” include renovations, which aim to improve the building's energy standard by reducing the energy consumption/energy supply.”

(Free translation of Havelund 2011: 6).

Table 3 Renovation classes (Ministry of Transport, Building and Housing 2018: 59) (Ministry of Transport, Building and Housing 2018b)

Renovation class 1	When the total energy supply demand for heating, ventilation, cooling and domestic hot water per sq. metre heated floor area does not exceed 70.0 kWh/sq. metre per year plus 2.200 kWh per year divided by the heated floor area
Renovation class 2	When the total energy supply demand for heating, ventilation, cooling and domestic hot water per sq. metre heated floor area does not exceed 52.5 kWh/sq. metre per year plus 1,650 kWh per year divided by the heated floor area.

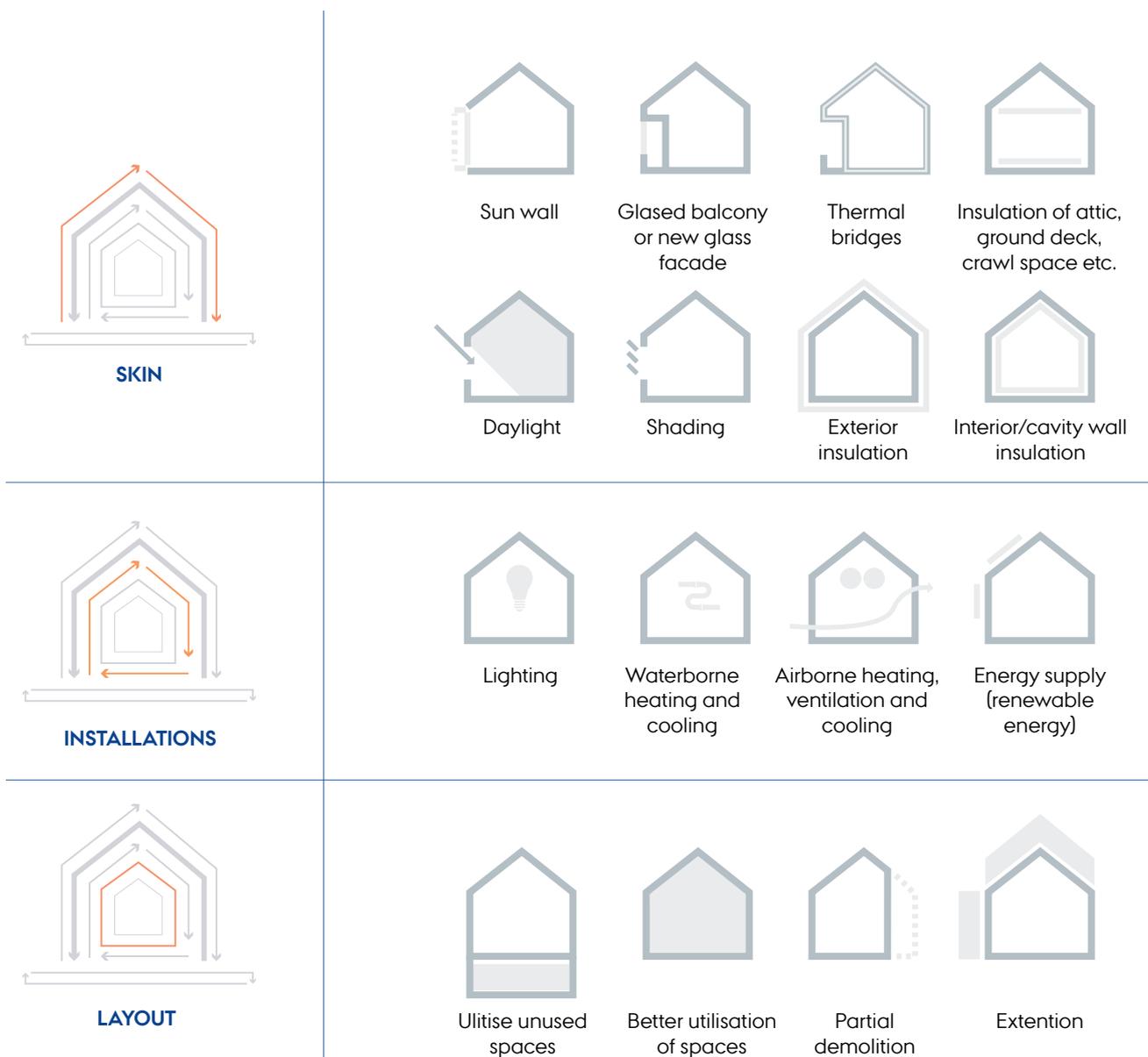


Fig.7 Typologies of physical energy renovation strategies relevant to postwar social housing. Main references: Tommerup 2010; Marsh 2013; Smidt-Jensen & Nørgaard 2011; Brand 1994. To be further substantiated through case studies.

ENERGY RENOVATION AND THE WELL-BEING OF RESIDENTS

HOW IS WELL-BEING INFLUENCED WHEN THE DWELLINGS “TURN GREEN”?

Does energy renovation affect the well-being of the residents?

In order to answer Research Question 1: *Does energy renovation affect the well-being of the residents?* It is relevant to establish if there is a correlation between what we refer to as *well-being* in the context of this project and *energy saving* strategies. To do so, we look into existing literature on the subject and compare this to the empirical findings from Søvangen and Gellerup. Since the latter is not yet available, this text relies on the findings from reviewing existing literature:

Only limited research has focused on this relation between energy motivated changes to the building and the well-being of the residents in a broad sense. Existing research has indicated that there is a potential to improve the perceived indoor climate (Vogelius 2017). This is also the topic of the ongoing research project BeReady (Realdania 2018). In the paper *“Renovation of social housing – a tectonic dialogue between past and present?”* (under second round of review), the PhD candidate has addressed how saving measures in two cases “Park Hill” in Sheffield, UK, and “Rosenhøj” in Aarhus, have implemented in a way that deliberately signals a step change (through restoration and reinterpretation in the former and through complete renewal in the latter). As such, it influences the *need for identification* and the *need for aesthetics*.

There is a general consensus in the field that energy renovation can affect the perception of the built environment dramatically (e.g. Madsen et al. 2015; Hvejsel et al. 2015; Acre & Wyckmans 2015; Jensen 2009: 9). Exterior re-insulation is an easily read example, as it influences the immediate appearance of the building.

In the previous section we have established that the physical environment may influence the well-being of residents through its dimensions, shape, furnishing, layout and the ways it stimulates the senses.

Some of the strategies listed in Fig.7 on the previous page may be more easily concealed. This is e.g. the case for cavity wall insulation and some installations. However, most of the strategies inevitably affect the dimensions, shape, furnishings, layout or how

we experience the building through sensory stimuli. Based on the included references, it is thus possible to gain backing for a deductive argument stating that energy renovation does indeed affect the perception of the built environment, and herethrough the physiological and psychological well-being of the residents.

It is the aim to substantiate this argument through the empirical findings from Søvangen, Gellerup and Toveshøj (if these findings turn out to support the argument!).

Based on results so far, it is possible to answer the research question affirmatively on an overall level. The results from the empirical studies are expected to further inform the argument.

To what degree the energy saving initiatives affects the perceived wellbeing of residents (and if it is in a negative or positive way), naturally depends on how the strategies are implemented, which in turn depends on the level of knowledge amongst the stakeholders. This leads back to the stated *“challenge in collecting and developing knowledge, which can qualify and describe the soft, qualitative values [in building renovation], in order to treat them on equal terms as quantitative data”* (Madsen et al. 2015:39 - translation by the authors). In the project this is addressed through Research Question 2: *if we can identify, articulate and assess potentials for improved quality of living when performing energy renovation of social housing?*

ARTICULATING WELL-BEING IN ENERGY RENOVATION IN ARCHITECTURAL TERMS

The research objectives O2 to O5 are concerned with equipping architects with a vocabulary for addressing *well-being* and *energy concerns* on equal terms as part of their creative process and as part of interdisciplinary collaborations. As such, it is found relevant to look to architectural theory in order to conceptualise the question of well-being in energy renovation.

In the following we present reflections on the task of energy renovation relative to renovation theory and circular economy. Hereafter, we present reflections on the task of energy renovation relative to tectonic architectural theory. The findings of this rereading help us articulate well-being in energy renovation from an architectural point of view.

Energy renovation as a contextual matter - part I - towards a circular understanding

In "Strategi for cirkulær økonomi" [Strategy for a circular economy], recently published by the Danish Government, the following definition is put forward: "In a circular economy, materials and products are recirculated, their value fully exploited and the waste is minimised. Buildings and products are designed to be reused, repaired and recycled rather than thrown away" (Government 2018:6 - translation by the author).

When performing (energy) renovation of buildings, we work to reuse, repair and recycle the building to prolong its lifespan. Renovation is, generally speaking, a more resource saving alternative to new construction (Rasmussen & Birgisdóttir 2015) due to less "embodied energy, waste and material use" (Peters 2015:20). This is visualised in Fig.8 based on the Circular Economy System Diagram developed by Ellen MacArthur Foundation. The smaller the circle, the better. By renovating a building rather than demolishing it, we stay within the inner circles - closest to the original use and user.

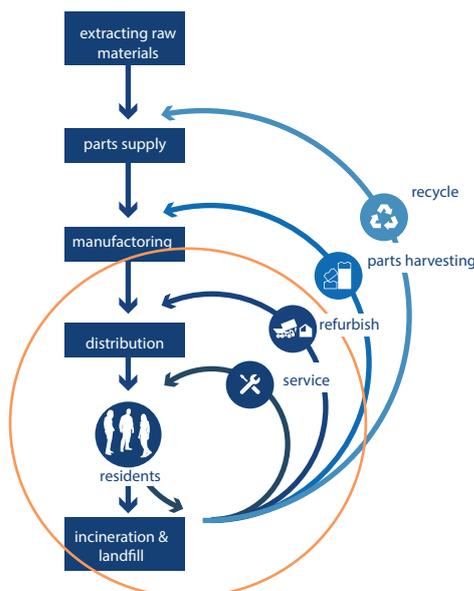


Fig.8 When we perform energy renovation of a building, we work to prolong the life span of the building. In a lifecycle perspective, this is a highly sustainable solution, however, only if the building is adapted to contemporary needs for dwelling. (Based on Ellen Mac Arthur Foundation 2015).

Such benefits in terms of saving resources are, however, only relevant if we are able to adapt the building to "contemporary demands for livable cities and housing for people" (Vestergaard 2017:2). Inge Vestergaard's definition of circularity in relation to renovation of social housing resonates with the following quotation by Fred Scott: "the purpose [of altering a building] is to work the existent and the ideal together through the process of intervention, to keep the existent occupied and significant" (Scott 2008:xviii). This is in line with the aim of this thesis, which aims to put the well-being of the residents center-stage in discussions on energy renovation.

Back in 1994, Stewart Brand presented a visual representation of such continuous efforts to update a building. In the diagram "Shearing layers of change", he depicted the layers of a building - the site, structure, skin, services, space plan and stuff - and how these layers are continuously changed (at different rates) throughout the life span of the building to adapt to changes (Brand 1994). We find that this is still a useful way to illustrate the circular and interdependent nature of all alterations; including energy motivated ones. Most of the reviewed literature concentrates on the potential for energy savings through alterations to the building envelope and installations - or what Brand refers to as the skin and the services (e.g. Tommerup 2010, Jensen 2009). Others include initiatives related to more efficient utilisation of the space plan (e.g. Marsh 2013) (Fig.9).



Fig.9 The build environment is made up of interconnected layers, which change at different rates. Energy saving initiatives to the skin, installations and layout can be seen as part of this ongoing process of alteration aiming to prolong the life of the building (based on Brand 1994).

In the understanding of circularity put forward in this paper, the alteration to the skin, services and space plan should be seen as part of a larger system, where we continuously *'work the existent and the ideal together through the process of intervention'* to prolong the lifespan of the building (Scott 2008). In this light, energy renovation cannot be viewed as something final or static, but as one of many interventions, which the building will undergo during its lifespan to ensure the continued significance to its users. This prescribes a throughout understanding of how the alterations build on existing conditions and allow for future needs for alteration.

(modified extract from the paper: Jensen, S. R., Postiglione, G., Kirkegaard, P. H. & Strange, A. 2019. A tectonic approach to energy renovation of dwellings - the case of Gellerup. In: *Proceedings from from the ICSEA 2019, 'Circular tectonics'*. Status: under review).

Energy renovation as a contextual matter - part II - towards a circular tectonic understanding

In the previous section, we have established that energy renovation must be seen as one of many alterations, which the building will undergo through its lifetime not only for repairs, but also to adapt to the societal and technological development. In this section, we seek to combine this understanding with a tectonic approach in order to articulate the interrelation between energy saving and improved quality of living.

Throughout the history of architecture, the notion of tectonics has been applied as a critical means to discuss the task, role and responsibility of the architect in bringing together technique and aesthetics. In this thesis, we reintroduce tectonic theory as a starting point for addressing energy renovations and articulate a linkage between technically motivated alterations and the spatial experience of the building.

The term 'tectonic' derives from the Greek word 'tekton', which signifies a carpenter or builder. Up through history the term has developed to signify what Kenneth Frampton refers to as "poetics of construction" - a linkage between a given construction of a space and the way people experience that space (Frampton, 1995, p. 3). Particularly, the notion reappeared in German architectural theory around 1850 as a response to the eclectic formal development

of architecture and its relation to a possible meaningful exploitation of emerging industrial technology (Semper, 2004 [1861], Bötticher, 1852). Several influential architectural theorists have addressed the subject with varying focus, including Karl Bötticher (19th century), Gottfried Semper (19th century) and Eduard Sekler (20th century), to name but a few. The application of tectonics as a lens through which to discuss a meaningful development of architecture rooted in primordial aspects of dwelling on the one hand and exploiting technological inventions on the other, has appeared again in the wake of postmodernism in the writings of particularly Kenneth Frampton. In current research, this interest in tectonics seems to increase, lately being associated also with the question of ecology (Frampton 1990, Frampton, 1995, Madsen and Beim, 2014).

In this text, we lean on the etymological studies of tectonics by Eduard Sekler. The reason for doing so is that Sekler's studies represent a relatively clear theoretical basis for talking about the interrelation between technique and the perception of a space. In the essay *"Structure, Construction, Tectonics"*, he defines tectonics as *"the noble gesture which makes visible a play of forces, of load and support in column and entablature, calling forth our own empathetic participation in the experience"* (Sekler 1964:93). In the text, he establishes a link between what he refers to as the 'structural concept', and how the structural concept affects the experiencing subject through spatial 'gestures' once it is realised through concrete 'construction' (Sekler 1964). Building on the work of Hvejsel et al. (2015), we propose to apply Sekler's terms to the field of energy renovation of social housing as a means to articulate also the experiential dimension of alterations to the construction. Whenever we alter a construction with the goal to increase energy efficiency, we inevitably influence the perception of the given space. If, and to what extent, this can be used positively to pursue synergies between energy efficiency and improved quality of living, depends on the level of awareness and knowledge of the involved stakeholders.

In the context of energy renovation, we suggest that Sekler's notion of 'structural concept' can be "replaced" by 'energy efficiency strategy'. We suggest that his notion of 'construction' can be used to articulate the way in which the energy efficiency strategy is

realised through specific 'alterations of the existing construction'. Lastly, leaning on the work of Hvejsel et al. (2015), we suggest that his notion of 'gesture' can be understood as the way in which the alterations contribute to 'improved well-being' through the spatial gestures, they provide.

Fig.10 serves to sum up the task of energy renovation as viewed through the lenses of circular tectonics: We built on an understanding of circular tectonics as a way to articulate that we renovate buildings to prolong their service lives. All alterations, including energy motivated ones, influence the way we perceive a building. If we are aware of this interrelation when we chose a specific strategy for altering the existing construction, it represents a potential for creating synergies between energy efficiency and improved well-being, which can help secure a long-term sustainable solution.

(modified extract from the paper: Jensen, S. R., Postiglione, G., Kirkegaard, P. H. & Strange, A. 2019. A tectonic approach to energy renovation of dwellings - the case of Gellerup. In: *Proceedings from from the ICSEA 2019, 'Circular tectonics'*. Status: under review).

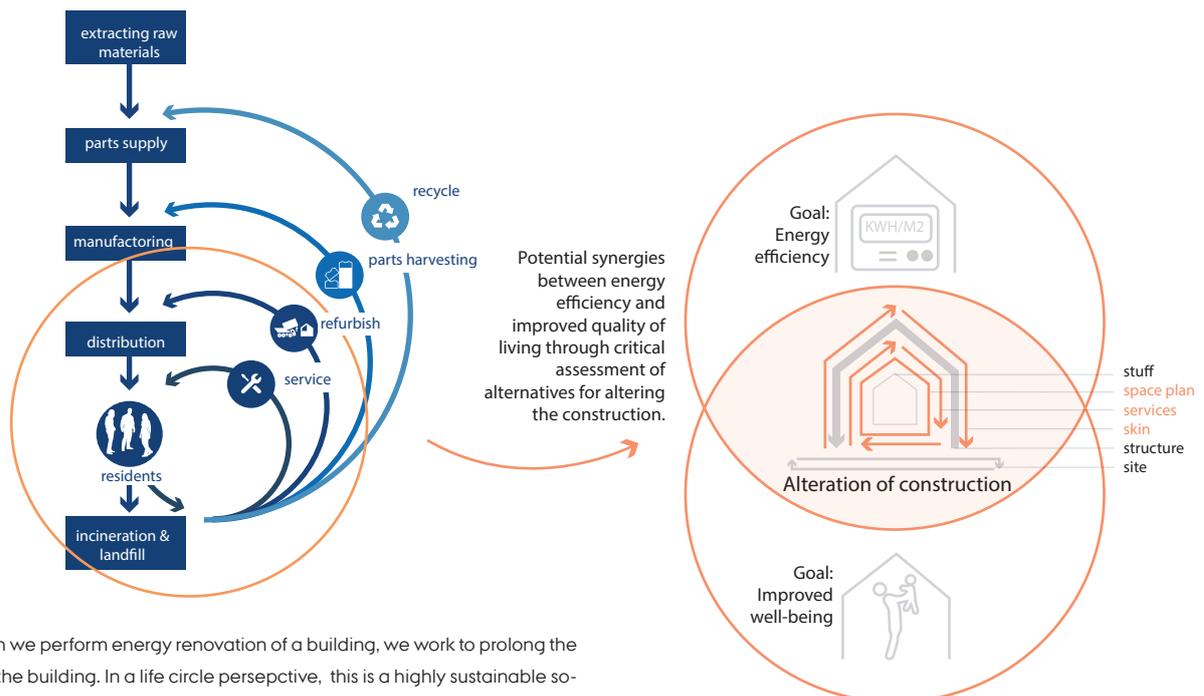


Fig.10 When we perform energy renovation of a building, we work to prolong the life span of the building. In a life circle perspective, this is a highly sustainable solution, however, only if the building is adapted to contemporary needs for dwelling.

Related publications:

- Jensen, S.J., Hvejsel, M. F., Kirkegaard, P. H., Strange, A. 2018. *Renovation of social housing – a tectonic dialogue between past and present?* Under 2. round of review.
- Jensen, S. R., Postiglione, G., Leonforte, F. 2019. *Educational leaflet: Case study atlas*. In collaboration with Gennaro Postiglione. Status: in progress

TOWARDS AN ARCHITECTONIC FRAMEWORK FOR ARTICULATION WELL-BEING IN ENERGY RENOVATION

ESTABLISHING AN ARCHITECTONIC FRAMEWORK

In the previous section, we have presented the findings of a re-reading of the task of energy renovation through the lenses of 'circular tectonics' (narrative literature review).

In this section, we investigate if it is possible to go a step further and identify a set of more explicit architectonic themes, through which to assess the potential for synergies between energy efficiency and improved well-being, depending on the specific strategy for alteration of the construction.

The tentative themes are presented in Table 4. Horizontally, energy saving strategies are listed on an overall level. Such, strategies are likely to affect people's perception of the associated spaces in different scales (Acre & Wyckmans 2014). We therefore suggest to establish themes vertically according

to where the alterations may be experienced from: from the *interior*, the *threshold between interior and exterior* or as part of the *urban morphology*.

The themes are developed during a research stay at the Department of Architecture and Urban Studies at the Politecnico di Milano.

Related publication:

- Jensen, S. R., Postiglione, G., Leonforte, F. 2019. *Educational leaflet: Case study atlas*. In collaboration with Gennaro Postiglione. Status: in progress

On the opposite side, examples of potential correlations between *energy saving* initiatives and *well-being* through alterations to the existing construction. Main references are listed below the examples. The examples cover both physiological and psycho-

Table 4 Architectonic framework for articulating potential synergies between energy efficiency and well-being.

		ENERGY EFFICIENCY		
ENERGY SAVING STRATEGY				
STRATEGY IN TERMS OF WELL-BEING		SKIN	INSTALLATIONS	LAYOUT
WELL-BEING	 INTERIOR	●	●	●
	 THRESHOLD	●		●
	 URBAN MORPHOLOGY	●	●	●

logical concerns and are based on references in the cross-field between architecture and engineering.

Please note the tentative character of the framework. The framework and themes are to be further developed and substantiated iteratively throughout the project through both the hermeneutic, empirical and action research findings.

The following section includes exemplification of the architectural themes through the case of a competition entry in Gellerup, Aarhus and reflections on the potentials and limitations of the tentative framework.

Views & privacy

- View from the interior to the exterior.
- Visual privacy from the exterior to the interior.
- Visual indoor climate (access of daylight, orientation of functions and openings relative to the path of the sun).

Indoor climate

- Acoustic, thermal and atmospheric indoor climate.

Spatial arrangements

- Internal division of space and spatial density (ceiling height and placement of physical elements in the space)
- Alternative utilisation of existing spaces and/or alteration of apartment sizes/layout.
- Adaptability for future changes in use.

Private/public transition

- Protected and sheltered entrance to the dwelling.
- Well-defined private, semi-private and public outdoor spaces, including balconies.

Permeability Changes in permeability, such as the size of windows and entrances.

Scale Alteration of the actual and perceived scale of the building(s).

Architectural main idea

- Restoration/preservation, reinterpretation or transformation (depending on the level of preservation value according to the national SAVE-system and/or the assessed value amongst stakeholders).
- Coherence in design choices.

Density & diversity

- Alterations to the built density of the area.
- Diversity in terms of formal language/materiality, functionalities and demography (offering a variety of dwelling types).

ACROSS SCALES:

Quality of construction

- Materiality (tactility, durability and patina)
- Attention to joints and details (craftsmanship, adaptability).
- Maintenance (cleaning/ durability/patina).

Accessibility

- Universal design and accessibility.

NB: the themes will be further developed and substantiated in the coming time.

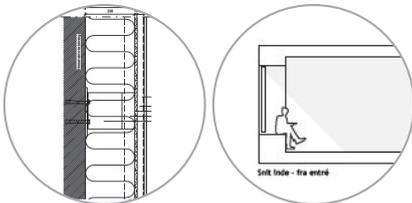
Main references: Acre et al. 2014, Madsen et al. 2015, Winther 2006, Bech-Danielsen, C. 2012, Bech-Danielsen & Mechlenborg 2017, Vestergaard 2017, Peters 2015, Scott 2008, Nygaard 2002, Gehl 2011, Kulturarvsstyrelsen 2011, Clausen 2000, Marsh et al. 2013, Pallasmaa 1996, Frasca-ri 1984, Smidt-Jensen & Nørgaard 2011, Tommerup 2010, Jensen & Beim 2003, Bertelsen et al 2001.

EXEMPLIFICATION OF THE FRAMEWORK

EXEMPLIFYING THE TENTATIVE FRAMEWORK

In the previous, we have suggested a framework of architectonic themes for energy renovation of social housing. In this section, a competition entry for renovation of a housing block in Gellerup, Denmark, is used to exemplify the themes. The exemplification is based on a research-through-design study carried out in the studio of AART architects in the winter 2016/17 (Frayling 1993, Groat & Wang 2013). The intention is not to highlight the entry as particularly successful or not, but rather to use the framework to show how the interdisciplinary team worked to propose synergies between energy saving and improved well-being.

The competition call included renovation of the building envelope, bathrooms and staircases, transformation of the ground and first floors into new so-called 'town-houses', and addition of new dwellings above a new road cutting 'through' the building. For the explanatory purpose of this section, we narrow our focus to alterations to the 'skin' of the building. In terms of energy, the target was to meet the Danish building regulation BR15 by securing that altered/replaced components comply with the standards (Ministry of Transport, Building and Housing 2018). The existing building was a prefabricated construction from 1968-72, built from concrete slabs and bearing walls. The loadbearing system made it relative-ly simple to disassemble the existing façade – allowing for a high degree of freedom in the renovation.



Interior: A focal point in the project was to provide new dwelling types, but also to heighten the well-being of the residents in the existing ones within a limited budget. As an example of the latter, new windows were proposed in the end walls (see existing uninterrupted end wall in Fig.11). The idea was to utilise the additional depth of the living room wall due to external re-insulation as a space for sitting and at the same time allowing for views towards the Brabrand lake and from the entrance corridor. Further, the solution was expected to add sense of security, as it would allow for supervision of a current 'blind spot' in the exterior. The project included

only limited refiguration of walls in the existing apartments, but throughout new utilisation of the ground floor dwellings and retail purposes. This gave rise to new energy related concerns, e.g. insulating the otherwise unheated spaces and relocating technical rooms, but was considered essential for improving the ground floor articulation. Considerations related to indoor climate in the existing dwellings focused mainly on maintaining the good daylight conditions when the façade was updated.



Threshold: Rethinking the transition between the private and public spaces on ground floor was a dominant focus – both in terms of functions and creating semi-private outdoor spaces. The proposal was to remove the existing entrance gallery and activate the relatively closed ground floor level by introducing new enlarged entrances, new 'town house'-dwellings and light retail with entrances to terrain. This was also part of a strategy to increase the sense of permeability and reduce the perceived scale of the residential block. A proposal for articulation of the transition zone included places for stays and preserving and adding plants. However, the limited budget of the project made this a subject of savings towards the submission deadline.



Urban morphology: The process included extensive discussions on the level of preservation vs. transformation of the original expression. The housing block is not a listed building, and its value of preservation is a much-discussed topic. The proposed solution had a hierarchical approach to alteration of the building envelope: preserving the "grid" (and restoring the original pixilation on the end walls with the addition of new windows) and signaling a

step change within the grid, in the base of the building and the new 'infill' above the road. This highly influenced the strategy of alteration, e.g. concerns related to thermal bridges in the concrete grid were de-emphasised in order to preserve the characteristic grid structure. The many subtasks in the project made it especially challenging to reach one coherent architectural main idea. This prescribed continuous iterations considering in parallel rather detailed solutions and their effect on the overall idea.

The competition project formed part of a larger masterplan for Gellerup (Aarhus Municipality and Brabrand Housing Association 2010). The competition itself included sketching the utilisation of the neighboring plot. As such, it formed part of the larger strategy to densify the area. The masterplan outlined intentions to go from a mono-functional more or less disconnected area to a number of diverse multifunctional neighborhoods within Aarhus. Such considerations were not directly connected by the alteration of the building. Nevertheless, it is relevant to note that the building (due to its location at the 'entrance' to the area) was considered key in signaling a step change both within the area and towards the city. As such, the specific alterations to the skin of the buildings were considered essential for a new understanding of the area on neighborhood and city scales.

Across scales: 'Offered quality' was stated explicitly as an evaluation criterion in the tender documents. This supported that priority be given to materials of high quality in terms of tactility, low maintenance and natural patina. During the project, however, we had to continuously revisit this theme due to budget. As such, considerations on what existing components to preserve and repair - e.g. floors, handrails etc. - and what components to change - e.g. the trapezoidal profiled sheets on the end walls - became a matter of adding as much experiential value as possible whilst reducing the material resources and money spend. Accessibility was treated as an implicit part of the project. In relation to the alterations to the 'skin' the primary concern was to ensure equal and simple access for all in the new entrances on ground floor.

The complexity of the project in Gellerup was considerable, not least due to the number of stakeholders involved in the project and the sensitive character of the area. As such, this brief account does not do it justice. It does, however, serve to exemplify how

a project team has worked to create synergies between energy saving related to the 'skin' of the building and the aim to improve the well-being of the residents through critical assessment of alternatives for altering the existing construction.

Further evaluation of the study, will focus on further identification of challenges and potentials in the way the project was carried out and its framework, e.g. the tender format.

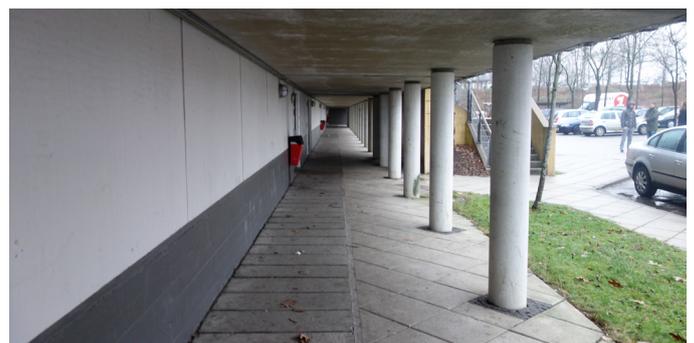


Fig.11 The residential block before renovation..

REFLECTIONS ON THE TENTATIVE FRAMEWORK AND PERSPECTIVES FOR FURTHER DEVELOPMENT

REFLECTIONS ON THE TENTATIVE FRAMEWORK

In the previous, the notion of 'circular tectonics' has been proposed as an outset for developing an architectonic framework for articulating potential synergies between *energy saving* and *well-being* in energy renovation of social housing. This section is devoted to a brief discussion of the underlying idea of establishing such themes and of using circular tectonics as a point of departure for doing so. Further, potentials for further development are discussed.

The relevance of establishing explicit architectonic themes?

In establishing a framework of architectonic themes, critical voices could claim that one risks reducing the complexity of the architectural field to a matter of checkboxes. E.g. Kirstine Brøgger Jensen states that "*...it is a widespread notion architectural quality cannot be put into formulas*" (Jensen 2015:102). This discussion in its own right deserves further elaboration (please refer also to Jensen et al. 2017). In the development of the tentative framework, we lean on the words of Erik Nygaard, who states that it is possible to define and treat themes related to architectural quality separately, in an analytical manner – keeping in mind that architecture cannot be reduced to one or a few of these themes and must always be assessed as a whole (Nygaard 2002). We are aware that establishing such themes may invite reductionism. The presented tentative framework does by no means capture the full complexity of the architectural field of renovation. The tentative themes are selected because there is a documented (or presumed) link between them and energy saving initiatives, depending on the chosen strategy for alteration of the existing construction. For now, they make up a sort of "call attention to"-list. Further research is needed to substantiate the themes and establish a meaningful operationalisation of the framework for decision support in interdisciplinary teams during the design process.

Circular tectonics and the task of architectural quality in energy renovation

In this paper, we have leaned on a circular tectonic understanding of the task of energy renovation of social housing. As mentioned, the themes in the framework are included, because there is a presumed correlation/a potential for synergies between them and energy saving initiatives, depending on the chosen strategy for alteration. The potential for synergies may be of a more 'direct' or 'indirect' character. By 'direct', we mean that there is a direct synergy between energy savings and well-being.

By 'indirect', we mean that we extend our focus to include alterations to the construction, which may not contribute directly to energy savings (and may even pose added construction costs). However, they are relevant to consider, because they are expected to improve the quality of living for the residents and may therefore contribute to prolonging the life of the building. This issue is exemplified in Fig.14, which displays three different approaches to realising the same energy saving strategy.

PERSPECTIVES FOR FURTHER DEVELOPMENTS

As mentioned in the previous section, further research is needed to establish a meaningful operationalisation of the framework as a process guideline, which can help inform the creative process (Research objective 4) (Fig.12).

This includes considerations about the format of (e.g. a guideline building on principles in "Arkitektur Energi Renovering"? (Marsh et al. 2013) and if, and to what degree, it is possible to establish metrics in relation to well-being, which can be evaluated on equal terms with some of the more 'hard' values as part of a digital tool (Fig.13). This latter subject is treated by the author in the paper "*Towards a Holistic approach to Low Energy-Building Design: Introducing Metrics for Evaluation of Spatial Quality*" (Jensen et al. 2017) and will be the subject of further investigation in the remaining period of the study.

PLAN FOR REMAINING PERIOD

A Gantt-chart for the remaining project period is included on the next spread. The project will run until June 2020.

SUMMARY

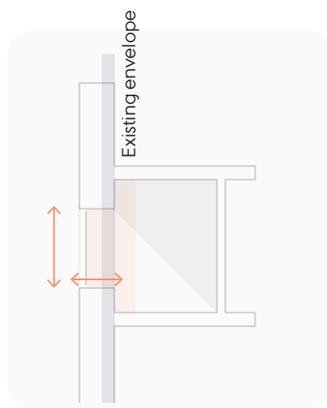
This PhD project deals with the task of updating our existing postwar social housing stock through energy renovation. Such renovations are likely to influence the experience of the built environment dramatically, which may in turn affect the residents' sense of well-being. It is however, identified as a challenge to articulate 'soft', qualitative values alongside 'hard', quantifiable ones in contemporary renovation practice.

In the PhD project, this challenge is addressed through the two following research questions:

- R1 Does energy renovation affect the wellbeing of the residents?
- R2 If yes, how can we use this knowledge to identify, articulate and assess potentials for *improved well-being* when performing *energy renovation* of social housing?

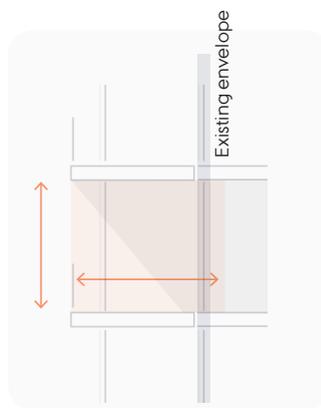


Fig.14 Each strategy for energy optimisation can be realised in different ways. Which approach brings more value, depends on multiple factors. Below three different approaches to altering the "skin" are visualised. It is relevant to note that in a more long-term sustainable perspective, it may be relevant to prioritise also alterations which are not directly related to energy efficiency, but can benefit the well-being of the residents.



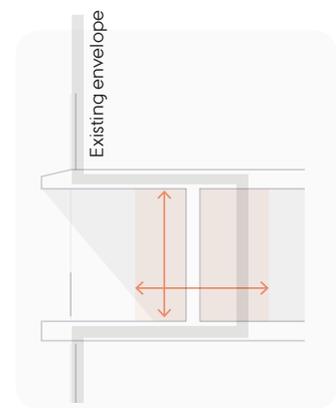
Rosenhøj, Aarhus

Exterior resinsulation of the existing envelope. New facade material and sitting niches.



Tour Bois-le-Prêtre, Paris

Removing existing facade and adding new self-bearing wintergarden (two independent layers of translucent panels, thermal curtains and glass).



Park Hill, Sheffield

Partially removing existing envelope and building new one in different position to create private and semi-private spaces.

This process report has included an introduction to the applied research design and methods. The thesis is based on a combined research design, combining hermeneutic, empirical and action research approaches. This report is based mainly on the tentative findings of the hermeneutic studies (literature studies) and action design study.

In the presented findings, we have addressed the concept of well-being in the context of dwelling and how well-being may be influenced by the physical environment in general and energy renovation in particular. These studies will be further elaborated in the remaining period.

In order to articulate potential synergies between energy saving initiatives and well-being, a tectonic framework has been proposed. The framework is intended as a process tool and will be further developed as such, with the aim to support a more equal trade-off between 'hard' and 'soft' values, when assessing alternative renovation scenarios.

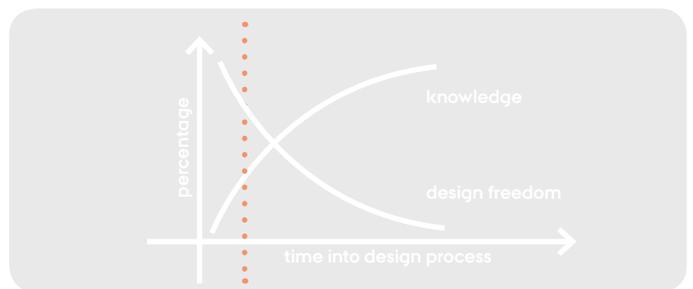


Fig.12 The perspective of the research: to develop the framework to support the creative process in the conceptual design phase (orange bar) (based on Ullman 2009: 19).



Fig.13 The remaining period will include a study of how to evaluate different themes related to well-being.

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