

Transforming the existing building stock to high performed energy efficient and experienced architecture



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Summary

The project Sustainable Renovation examines the challenge of the current and future architectural renovation of Danish suburbs which were designed in the period from 1945 to 1973. The research project takes its starting point in the perspectives of energy optimization and the fact that the building process over the period changed from craftsmanship to industrialized production of housing. The aim is to present the context in which energy transformation has to be seen as an architectural question. The research field focuses on social housing blocks and expands the discussion of architecture from architectural heritage to energy efficiency and from architectural quality to sustainability. The first, second and third renovations are discussed from financial and sustainable view points. The role of housing related to the public energy supply system and the relation between the levels of renovation of the architectural heritage are examined as possible ideas for seeing the renovation field as an important synergy in society. The recommendation addresses balanced transformation.

Keywords: renovation, energy, industrialized building process, housing, suburbs, transformation, architectural heritage

1. Introduction

After the Second World War Denmark experienced a deficit in dwellings and both private and subsidized housing areas were built. During the period from 1945 to 1973, the building sector went from craftsmanship to industrial production and an enormous amount of standardized housing was constructed.

The building sector was characterized by “building by hand”, craftsmen at the site carried out the craftsmanship. But the new thoughts on industrializing the building process influenced the market and created new ways of solving needs and optimized the efficiency of the building process.

A building system was generated by the state [1]. The system was called montage building (prefabricated construction) and had its own measuring system in order to allow elements from different productions to fit together. The architectural typology was developed based on the thoughts of the French architect le Corbusier and modified to accommodate the Danish need for housing for everybody, the building projects were partly subsidized by the Danish state.

Two interesting building typologies which are examined here represent housing for everyday life. The architectural quality of types with different building characteristics and technologies are of different values. The majority of the building mass is not listed as architectural heritage although the period is the most significant building period in Danish history. Influences from the worldwide modern movement replaced craftsmanship by the industrial epoch. The ideals of a better future and the hope for an easier life through architecture and design created some of the most interesting and most qualified buildings for everybody in Denmark. The buildings are known as

functionalistic and montage buildings, and big suburban schemes were created around the city centres and called the welfare city.

With regards to the building process and techniques, the buildings are either built of masonry or from industrialized concrete elements. In a long-term perspective the building technique and the fast pace of planning and construction resulted in poor building technique; and many buildings have already been renovated once due to technical and aesthetic reasons.

2. How buildings of the welfare city meet actual needs

It is now 45 to 65 years since these buildings were built, and the demand for energy efficiency is an interesting question with regards to this segment; because the buildings perform badly and because there are so many of them. The two materials demand different solutions with regards to building physics, and the way these buildings are conceived and built, require very different designs for architectural renovation.

2.1 The period and building code after the oil crisis

Due to the oil crisis Danish building codes have been changes several times, which means that the basic understanding of energy use in buildings has had different foci.

Just after 1973, the Danish legislation demanded better insulation and very small windows – and up till the mid 90s different solutions for daylight and comfort in our building stock were examined. This led to a more experienced and open building code: a building code which took into consideration energy use from the sun. But it is only after the year 2000 that we have really begun to talk about energy use and about minimizing fossil energy used for operating buildings. We are now also striving for new standards for the building code in 2006, we were given new tools (BE06, now reformulated to BE10) for figuring out how to take both externally and internally produced energy into consideration when we calculate the whole performance of our buildings. In recent years, many research efforts have been made in order to optimize the energy performance of windows – and we are more balanced in the way we deal with old and nice detailed windows, e.g. adding removable windows in order to energy-optimize these.

2.2 Challenges of the welfare city

Ever since the suburb was born there has been a discussion about the quality of these building schemes – especially the social reputation of housing schemes has been criticised and discussed; and the social problems have been obvious. For a long time we have been discussing concrete as a poor material, believing that social problems were directly related to the building material while thinking very little about how we handled the management of these areas: differently managed strategies for the composition of populations will not be dealt with here. The discussion of materials in combination with problems related to building physics forced owners to begin the first renovation of buildings. The result was some post-modern, funny and colourful renewals which lead to criticism from established architects.

In 2008 the Danish Architects' Association accepted the challenge of discussing the image and performance of social areas in Denmark [2] in order to examine more closely the fact that several of these schemes were dysfunctional. In countries like France, Holland and Great Britain these schemes were called Ghettos – we are now used to this concept, even in Denmark, although our problems are not on the same scale as the problems in the other European countries.

In 2011, our government officially named 29 of these schemes Ghettos, this raised a large discussion in the areas and in our media about the negative connotations of this term of abuse.

This focus by society on ghettos place a great responsibility on owners and architects with regards to renovating the schemes and creating designs with a possibility for change not only for the buildings themselves but also for the surroundings, for the space and for the expression of the space between buildings.

As Danish architects we are basically taught about the influence of the architectural design on our behaviour and possibilities for social interaction (from SBI and Jan Gehl). We know that the

architectural design of renovations has to be based on research in both planning and architecture – but we are also aware of the complexity of the technical strategies necessary for creating an indoor climate which is better and healthier than what we have been used to. With regard to building physics we are working on technical solutions which are both energy saving but which also create the best known indoor climate, such as, e.g. the passive house standard. This article focuses on buildings even though we keep in mind the lay-out and the whole scheme when we discuss social problems. This subject requires another discussion, which is definitely of great importance, but which has to be carried out at another time and place. We are, however, aware of this aspect.

2.3 The architectural heritage of the welfare city

In Denmark there is a huge focus on the welfare city. A great number of initiatives have been made in recent years and a recent report: `Looking for the preservation values of the welfare city [3] has described the building culture of the period and the situation as we see it now: the building mass is worn down and outdated. The suburb will soon meet the demands for sustainability, energy-efficient renovation and higher density.

So how can we preserve and renew while respecting the interesting period? how do we change these areas, which represent a great resource for society, into adorable living areas?

This is a challenge for architects which concerns cultural, social, political, economical and sustainable interests.

2.4 Two building types from the period were analysed

As we see from the above there are many driving forces behind the current renovation: a social motivation: the reputation, a technical motivation: better technical building processes and insulation, an environmental and energy-related motivation: improved energy efficiency. These motivations are directly related to the economic factor, which relates to the owners and, in the end, the tenants; and when we design architecture we should not forget the holistic approach which seems to play an extremely important role.

Six examples were studied in order to identify different ways to renovate. The cases are characteristic of the period, and the renovations are related to the identified points of view described in the above.

2.4.1 Masonry – craftsmanship – Danish building tradition



Photo: author

Møllevangen, Viggo Stuckenbergsvej
built in 1948, architect Hans Møller
building owner BO82, Aarhus
renovated “step by step”

This area [4] was built as the first blocks in Aarhus outside the new Ring Road, which means that the area represents some of the first schemes from the boom period and forms the beginning of the suburb. The material is red masonry. There are lots of noise problems inside the houses because the horizontal divisions between flats are made of wooden structures and are not sound-proof. Nevertheless, the flats have very good living spaces and the balconies are much used. The buildings have not been renovated in a extreme way. Recently renovated with new windows with very slim profiles, this just makes the original design more delicate and more energy efficient.



Saralystparken built in 1949-51
renovated lightly 5 years ago

This scheme has been renovated recently, mostly because of problems related to building-physics. Joints between bricks have been restored and the balconies have been torn down because of the bad condition they were in and due to problems with thermal bridges. Some of the spaces between houses have been altered to allow for new systems for refuse collection. This type of renovation is very quiet and does not spoil the heritage more than what can be restored when new solutions are found for connecting the balcony to the façade without creating significant thermal bridges.



Søvangen built in 1953-59
Building owner Brabrand Boligforening
Architect: Knud Blach Petersen
renovated in the 80s.

An icon of the functionalistic period was this scheme in Brabrand [5] built in yellow masonry just before the montage period started: the landscaping is very beautiful, sloping towards a lake, and all the flats have a view of the lake - an argument for the combined bay window and terrace.

The renovation was done early and properly because of damage from water from the roofs over the bay. Architecturally the renovation is misunderstood with a heavy roof, the façade was completely destroyed. We hope that a new and second renovation will be able to restore this.

2.4.2 Concrete - montage



Rydevænget, Herredsvang
Building owner Vesterbo
badly renovated around the 80ties

This renovation was done early and the intention was to transform the area from a dull concrete area to a much livelier scheme in the post-modern era. The characteristics of the buildings were completely erased, and the architecture was at the time extremely expressive. Today, we can laugh at the “Mexican biscuit boxes”, as a prominent Danish architect called the renovation.



Gyldenrisparken built in 1964
Architects, renovation:
Witraz, Vandkunsten 2005-10

The renovation was carried out on the same building type as mentioned beneath and with very qualified architectural design. The buildings are now experienced as very inviting, and the former bad concrete design has been changed into a light and interesting detailed architecture. It is still a concrete façade with many references to the former expression, but with a new building envelope, which is well proportioned and made of a better quality of concrete: fiber concrete. Let us hope, with regards to lifetime, that this new material patinates well. The renovation does not meet an ambitious energy standard – which seems a pity.

Photo: Rie Øhlenschläger



Langkærparken - built in 1968-73
Architect: Børge Kjær
Renovation: Nova 5 Architects 2010 to “nearly Zero Energy” level

The renovation of one block which is called the climate block was planned to identify the 4 different levels of low energy standards. The perspective of the transformation effort in relation to this typology: we find about 136,000 dwellings of this building type in Denmark. The project, furthermore, had the intention of identifying the economic aspects of low-energy renovations and still demanding experienced architecture. A new project: developing the façade elements which can be customized to several architectural expressions cause the monotonous architecture will be expressed differently in the many lay-outs.

Photoes: author

2.5 First, second and third renovation

In the beginning of the 90s a wave of the first “montage” renovations of the schemes started. The reason was, first of all, technical problems: elements joined together were not airtight, this resulted in draught problems and water damage and often occurred in combination with the concrete having a very bad patina. These basic problems led to a renovation which also tried to solve the social reputation, sometimes using funny colours.

Now, in the 2000s, we see many renovations, some of them are very ambitious, but for others it seems as if society has not realised the energy question in its entirety. How come the energy question is not obvious to us? Is it too overwhelming to realize the total makeover of these schemes? We can conclude that the second renovation wave seems to have very limited energy ambitions, which will lead to a third renovation with extreme energy ambitions if we are going to meet the goals of the EU commissions in 2020.

If we continue in the direction we have seen so far, the third renovation will demand great

investments, it will create much waste and a great waste of manpower, the result will be costly for society and for the environment. The result will be very bad with regards to sustainability.

2.6 Sustainability seen from an economic viewpoint

When we renovate we need strategies which take the level of financial ability into consideration: first of all, the owner of the building may have an interest in doing as little as possible, but it is of great importance that what is done is not detrimental to quality.

A project in Denmark realised by Realea [6] demonstrates what can be done with different types of investments. The method is called economic sustainability: it demonstrates how 4 different one-family houses can be renovated at 4 different economic levels and the amount of energy savings which results from an investment is discussed, but it is also discussed how the architectural heritage can be protected. How can strategies be planned in phases in a way that does not spoil an investment? The project for single family houses show that with very little investment you can save up to 50% of the energy bill, and the saving and the investment is balanced. We now know that examining the investment in relation to the lifetime of the building can be of great importance for the choices we make and for the economic and sustainable investment.

In other words: can we afford the ideal renovation? Is the investment reasonable? The question is relative.

For the renovations it is of great importance with regards to sustainability that we take into consideration not only construction expenses. It is necessary to view the total economy seen from a financial perspective, but also from an environmental perspective. It has been calculated that expenses for construction equal 10% of the energy used during the whole lifetime, and that 90% of the expenses are used for operating the building. If we can cut down the operating expenses to a minimum we have succeeded.

2.7 The relation of buildings to the public energy supply

Before we decide to calculate the sustainable effect of the renovation of an ordinary house, we need to take into consideration the public energy grid. In Denmark all the major cities are heat supplied from district heating, and the heat is produced partly from fossil, partly from renewable energy. Many municipalities have defined new goals in order to bring their energy consumption down to a zero energy level in 2030. This, of course, means that many factors have to be taken in consideration, minimizing the building's energy consumption and the energy used for transportation are among the most important. The overall idea is both to save energy and completely to change the supply from fossil energy to renewable energy.

Recent research find this change to have an extreme effect on the way we calculate the energy consumption of our building schemes, and as this question is also a main aspect of this conference we are excited to hear more about this.

Because if the analyzed tendencies are believable we may not have to aim at zero-energy renovations in all cases – and this would be very significant with regards to our masonry buildings from before 1960.

3. Discussion

Based on the above text we have now defined several values which we have to take into consideration when we start to think about the next renovation.

Cultural values:

Discussions about the built heritage: are we destroying a whole period? or is our built environment meant to be used and transformed so that the changing demands can give our surroundings a new and better image? What are the cultural potentials? Some of these schemes are also called ghettos, maybe they need a change for the future?

Architectural values:

We are researching the different architectural strategies, we are evaluating the quality of the projects, and we should choose the most appropriate design for each case. But we also have to relate those to choosing energy efficient solutions: we cannot afford to renovate these schemes every 10 years. In Denmark we need a life span of 30 years which is the lifecycle of loans. Besides, much of the building stock is very poor experienced architecture!

Technical values:

The buildings are definitely not suited to be preserved without any technical sustainable solutions: we have many technical innovations that need to be implemented, and we have a lot of monitoring to do to assure that we choose solutions with a long life time. Sometimes it will be all right not to optimize energy use because we have very sensible constructions made of wood inside the building body and a very sensible architectural heritage as well. As we know so far it is extremely risky to insulate the houses from the inside. In some cases it will be appropriate to cover the house with a totally new "overcoat". This structure can easily be airtight.

Sustainable value – embodied energy:

Many highly relevant initiatives must be combined in the efforts of renovating existing buildings, whether it is of cultural value or not. It seems that if we look at our existing building mass it contains a great deal of embodied energy. If we can rethink the existing values for the future we can save a great deal of energy for the production of new building structures and materials. If, in our efforts for renovation, we can reach a factor 10 as the passive house examples from Austria demonstrate we have made significant progress towards achieving a zero energy building mass.

Sustainable value – the habits and involvement of users

Fundamentally, it is important for the renovations that, through the process of planning and constructing, the users take responsibility for what has to be done. It is the tenants who have to live in these areas, they have to take care of the renovated areas, they have to get used to new ways of operating their houses, and, first and foremost, they have to adore and be proud of their renovated homes in order to make the areas last for the future.

Social values – are not described

Taking into considerations the multiple issues related to energy efficient renovations of the existing building stock one might wish that the aim was a factor 10.

In order to achieve a high performance society, the owners and the consultants should look at the energy aspects from a broader angle and investigate, in an interdisciplinary way, how a community can achieve energy savings: it is important to look at the transition from fossil energy to renewable energy. It is obvious that we should reduce our use of energy, and that, concerning the renewal of existing buildings, we should plan and rebuild from an overall perspective on energy saving which allows us to take into consideration a much broader perspective, such as the energy grid for the city.

In order to optimize the building process it seems reasonable to industrialize and customize the process e.g. to strip some buildings down to the raw construction and rebuild with complete industrial facade elements. For that process it would be better to install an airtight membrane.

The users should be involved, take responsibility and truly want the renovations because a successful total energy minimization should involve the users and change their habits of daily life in all the years to come.

The use of sustainable and long life materials parallel to achieving a more multifunctional living area and increasing living quality should attract new segments of users to the social housing areas.

The architecture and the attractive components should change the experienced architecture in a way which makes the users happy and proud of their energy renovation, and which also encourages them to participate socially in the local community, in that way we may perhaps avoid creating so called ghettos.

Building owners and public authorities should take their responsibility for decisions about renovations seriously, and they should ask for the most ambitious architects and consultants for designing renovations.

4. Conclusion and recommendations

As described in the above, we as society, have many problems we need to solve in the coming renovations of the welfare city. These renovations must not only consist of renovation the houses themselves, but should also be seen in a wider context as many factors are playing a role.

It is of great importance to see the complexity of the problem and furthermore to choose strategies which have a long perspective and which allow us to intervene at different times to fulfill the tasks. The society has a huge resource in the welfare city and the heritage has to be used in an innovative way. The result, over time, can be better and more flats, more human spaces between the buildings, more adorable housing schemes with great narratives and last, but not least, this should be carried out in an energy-efficient way. By choosing better and more sustainable materials, these investments may, over time, be the biggest resources for energy saving for society and, at the same time, they can create new possibilities for modernizing the building stock. This second renovation can be in direct correspondence with the ideas which gave birth to the ideas of the modern movement: to give more space and daylight to the people and a better life for everybody. And from an economical point of view it can be done with a new and appropriate instrument: the new industrialization.

Balanced efforts listed as recommendations:

The process should start by screening the cultural, social, technical, architectural and sustainable values of the buildings and the layout before designing the new architecture.

It is important for the success that users, owners and consultants are involved in the process from the very start.

Long time perspectives should be taken in consideration.

In order to act energy efficient and sustainable a plan for the project should be worked out related to intervention and investment over time in order to save without damaging, the project may have several phases in order to invest with common sense.

The relation between the specific site and the public energy supply should be analyzed to realise the best use of energy, related to the specific situation.

The most qualified and sustainable design should always be achieved.

Research projects attempts to emphasize that we should bring all forces together in a common understanding that the renovation should bring the energy performance to the best standard possible and in a balanced way which respects architectural heritage.

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