SUSTAINABLE BUILDINGS IN INTERACTION

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Summary

The first attempts to build sustainable buildings in Denmark were typically located on the countryside. The basic idea was to create buildings that were independent of the technical infrastructure. District heating has, however, been the dominating solution to heating in buildings in Denmark, and the focus on sustainable building have gradually turned from special houses on the countryside to normally looking houses in the urban fabric, integrated in the technical infrastructure. Some new built urban areas in Denmark will, however, not have to be supplied with district heating – these developments are going to consist of passive houses. The first sustainable buildings were built by their users, and the user – building interaction still play a decisive role for the performance of the present sustainable buildings. The users have to understand how the building functions.

Urban design is essential for the possibilities of a sustainable building design: orientation and access to infrastructure are important factor. And the building design is decisive in making the city truly compact: dense in activities. In future, the interaction between the technical infrastructure, the buildings and their users will become even more complex, and the local authorities could play an essential role in finding solutions that reflect the specific local context.

Keywords: Urban design, technical infrastructure, users, local authorities, innovation

1 The image of sustainable building

Back in the 1970ies, sustainable building was for the few. People with ecology in mind moved from the cities to the countryside, experimenting with new materials, new shapes, solar heating, composting toilets – some building single houses, others forming eco-villages, like the Torup Ecological Rural Community in Denmark, inspired by the famous 'Blueprint for Survival' [1]. Many of the 30 dwellings are constructed by the residents themselves, and a vide range of different 'green' technologies are used. The rural setting give better possibilities for local self-supply. For instance, the classic conflict between solar heating and district heating is not present in this area, because district heating is not present. In an area with district heating based on combined heat and power production,

solar heating would have been irrational, since the CHP has a surplus of heat in the summer [2]. When talking of sustainable building, people often have the image of the strange houses, built of clay and straw-bales, in strange shapes, in mind. They imagine having to take cold showers when the sun doesn't shine, and spending much of their life shovelling the material from the compost toilets.

2 Many demonstration project with little documentation

The 1980ies and 1990ies have produces a number of demonstration projects, claiming to find integrated solutions on the problems of sustainability. The Danish projects have been characterised by being: Small scale; Bottom-up initiative; Transparent, simple technology with great symbolic value; Single sector – not integrated – efforts (for example use of grey water); Lack of documentation and evaluation of results and lack of systematic recording of experiences and collection of knowledge [3].

A few large-scale demonstration projects were carried out, for instance the 'sustainable' urban renewal of the Hollaendergade/Fredensgade Block in Kolding, consisting of 129 dwellings. The most spectacular part of this project is a giant glass pyramid cleaning the waste-water from the block using different biological elements. The main question is, however, why it is essential to clean the waste-water in this way, using much more energy than traditional waste-water treatment, given the fact that the traditional plant had much capacity left [4]. Another problem with many of the demonstration projects was that the experiences with demonstrated technologies were not used in other projects [5]. One possible reason for this is the economy in demonstration projects – in order to get the demonstration project funded, extra costs related to the 'sustainable technologies' needs to appear in the budget for the demonstration project.

3 The invisible sustainability in main stream building

A number of energy- and resource saving technologies have been adapted to main-stream building. The water-saving toilets, regarded as a special 'green' technology in the late 1980ies, are now common standard in all new buildings. Energy-saving light-bulbs are not rare; they are often used in main-stream buildings. In the design of sustainable buildings near the center of Copenhagen, the buildings are supplied with district heating, the waste-water uses the normal sewage system, and the storm-water is used in a general canal and lake system. The interaction with the public transport system is essential for the development, keeping the use of private cars as low as possible [6]. In a project concerning innovative single, owner occupied housing, the point of departure was to make sustainable single houses appear as normal buildings, although they are built with sustainability in mind [7]. In these cases, the users of the houses do not have to develop special practices in order to make the house function.

The interaction between users and the building has been a problem in other sustainable building projects. When the users have difficulties in understanding the technology, malfunctions occur. In one, otherwise promising, project, the residents blocked the innovative ventilation system, which lead to an increased use of energy for heating [8].

4 From de-central solutions to central – and back

Half of the dwellings in Denmark were built in the period from the late 1950ies to the mid 1970ies. Most of these were equipped with central heating based on oil as fuel – the residents being happy not to have to deal with coal anymore. The picture changed rapidly as a result of the two energy crisis in 1973/74 and 1979/80. Heat-planning became a central issue and district heating the dominant solution. The planning was unusually strong, considering Denmark being a basically capitalist society – some people even talked about 'Heat-planning-Stalinism'. In a large part of the country, people were forced to convert from their individual oil-based stoves to district heating, primarily based on CHP using coal as primary source of energy [9]. More than 60 % of the dwellings are supplied with district heating today – and 14 % are supplied with natural gas, another central system [10].

The large investments in the central solutions have made the Danish building sector relatively slow in developing buildings that are independent of external energy supply for heating. Passive houses have been developing in Germany and Austria, while very few have been built in Denmark.

Some municipalities have been very active in promoting sustainable building. They have in different ways tried to regulate the building programs for new areas, with more or less success. One of the successful ways has been buying the land and creating an easement. In Denmark, almost anything can be regulated though easements. In the 'Stenloese Syd' development, the Municipality of Egedal, in the first phase, 250 houses are built, followed by 500 buildings in the second phase. The buildings have to use less than 28-47 kWh/m^2/year according to the easement. Hence, the houses are not real passive houses, but far better than the national building code. The municipality does, however, recommend real passive houses built, in that case, the buildings do not have to be connected to the district heating [11].

5 The role of the users in the design of sustainable building

Users played a decisive role in the early development of sustainable buildings. They were the innovators, having no problems in understanding the function of the building and the special installations in the building. Some users are still looking for especially sustainable buildings, having special demands. It is, however, no longer the optimal solution to let the users decide the actual solutions. What the users perceive as the most environmentally friendly solution might not be the best solution. The users and the professionals have to enter in a dialogue to clarify the real priorities of the users and letting the professionals propose solutions that reflect the values of the users. In the design of the Eco-Village Munkesoegaard, the future users and professionals entered in such a dialogue. The users would originally have chosen composting toilets, but after the dialogue processes with the professionals, it became clear, that it was a system with special low-flush toilets that meet the criteria of the uses. Much to the surprise of the future users, composting toilets had a very low score in meeting the criteria [12].

It is quite essential that the users understand the building and its functions, and the involvement of users in an early stage of the building design might prevent later malfunctions – sustainable building are not sustainable, if their users do not use them in the

right way. User manuals could be of great value [13]. But self-explanatory systems and very simple systems are preferable.

Some of the advanced designs are blocking for the users pet-solutions. A large number of the future users in 'Stenloese Syd' would like to have floor-heating in their houses, but floor-heating are not compatible with the general design of the buildings heating system. This makes the users prefer 'normal' houses and they have made an effort to extinguish the easement that makes it compulsory to build low-energy houses in the area.

6 Sustainable houses and the compact city

Basic urban planning is decisive for the sustainability of the houses. Key factors as the orientation of the houses, exposure to sun and wind, access to public transport and possibilities for integration of dwellings and workplaces are all decided in the early planning phase [14]. It is not enough just to follow the guidelines of the Green Paper on the Urban Environment [15], making the city compact. The compact city is a prerequisite for a good public transport system.

One could, however, question how the compactness is to be understood. In urban planning and the design of the sustainable buildings, it is not usual to consider the size of the dwellings. Some speak of 200 m^2 houses for normal families as sustainable houses. The performance of the building, measured per square meter might be quite good, but using this much space, energy and material for one single family can not be considered as sustainable. And is not the floor-space which use the public transport systems, it is the people. Hence, the density of activities should be considered as the measure for the compactness of the city, and a relevant indicator for sustainable building. Making a good, compact design of dwellings helps to solve the regional problem of creating a dense city, supporting good public transport [16].

The integration of dwellings and office facilities in the same buildings could be a way of making the buildings more sustainable by increasing the density of activities. One could imagine that a number of facilities are shared, making these facilities used in more hours of the day. Furthermore, the integration would allow the functions to be placed in an optimal way in relation to the corners of the world: dwellings could primarily be facing South-West and office space primarily North-East.

7 New roles of the buildings

In future, the buildings might not only be functioning passively in relation to the technical infrastructure. New sophisticated ways of interaction might be developed. The further development of photovoltaic can make some buildings net-producers of electric energy, altering between being receiver and producer of energy. Another quite essential function of buildings in future might be to be an integrated part of the retention system for storm-water, keeping in mind that climate changes will make rain fall far more intense than 20 years ago [17].

The change from supply driven logic of the technical infrastructure systems to more focus on balancing demand and supply and focus on demand side management, makes the interaction between the technical infrastructure, the buildings and their users more complex [18]. It is a major challenge for the urban management to make the entire system function,

with a wide range of different actors, and a number of small, unstable contributors. The designers of sustainable buildings face the challenge of building a house that is performing well in this complex system, in interaction with the technical infrastructure and the users, taking the specifics of the local contexts into account.

8 Public authorities as drivers of sustainable building

The national legislation plays a decisive role for the way buildings are being built. The national building code is a strong instrument. It tends, however, to be rather conservative – one has to be quite sure that the demands in the building code can be met in practice. Furthermore, it is a national code, and thus not able to reflect differences in local context – it tend to be the lowest common denominator. However, the latest version of the Danish Building code really challenges the Danish building sector by having quite strict demands for energy efficiency in buildings.

The role of the local authorities has been contested in Denmark. Several municipalities have tried to be frontrunners, trying in several ways to promote sustainable building in their municipality. In the Danish Planning Act, the possibilities of regulating energy efficiency, use of materials etc. in the district plans are presently limited. But changes might be on the way, and new ways of private-public collaboration could be a way of catalyzing sustainable building and sustainable urban development in general [19]. The local authorities have possibilities for catalyzing sustainable solutions that reflect the specific local context.

9 Conclusion

Sustainable buildings are not unique self-sufficient buildings placed on the countryside, far from the urban technical infrastructure. Sustainable buildings are integrated in the urban fabric, interacting with the technical infrastructure and the users. The buildings could become independent of the heating infrastructure in future, while the interaction with other infrastructure elements becomes increasingly complex. The different scales interact, a building design allowing a high density of activities is a part of the basis for the development of a sustainable transport system on the regional level. It is important that the solutions reflect the local context; it could be a role for the local authorities to catalyze such solutions.

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