Has social sustainability left the building? The recent conceptualization of “sustainability” in Danish buildings

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Sustainable buildings have often been niche products, but in recent years a new approach has emerged in Denmark aimed at mainstreaming and normalizing this mode of construction and seeking to attract ordinary Danes through market conditions. The aim is to present an alternative conceptualization of sustainable buildings to the ecocommunities’ vision and to involve traditional building firms in their design and development. From a theoretical perspective, the mainstreaming of sustainable buildings can be seen either as an example of ecological modernization or technological transition. The new conceptualization has implied a narrower approach to sustainability and a lack of social sustainability measures. While earlier paradigms of sustainable buildings emphasized themes such as community building, self-provisioning, local empowerment, and shared facilities, such objectives are largely absent in the new types of sustainable buildings. We question to what extent it is possible to design sustainable settlements without social sustainability. By viewing sustainable buildings as technological configurations, we argue that the multactor approach, fragmentation of roles, and absent initiatives for social sustainability influence the buildings’ environmental performance and should be important for the next generation of these structures.

KEYWORDS: buildings, housing, interest groups, energy efficiency, architectural design, social environments

Introduction

Developing “sustainable buildings” has become a central goal for national and local policies as part of efforts to reduce energy consumption and to limit greenhouse-gas emissions. While numerous viable technical solutions already exist, the main challenge currently is to implement them in the built environment (Guy, 2006). Sustainable buildings have traditionally been “niche” products and have been introduced in protected contexts (Rip & Kemp, 1998); they have rarely matured for wider market dissemination. Previous development of sustainable buildings in Denmark has involved a changing range of concepts over time (Gram-Hanssen & Jensen, 2005; Jensen & Gram-Hanssen, 2007). The different configurations in terms of planning, “hardware” technologies, infrastructure, facilities, financing, and social ideals include the following:

• **Green buildings as energy-saving devices:** After the oil crisis of 1973, science-based efforts were made in Denmark to develop technologies to improve the energy performance of buildings and regulations were introduced for implementing these technologies.

• **Grassroots ecocommunities:** A number of alternative and green rural settlements emerged in Denmark in the 1980s and 1990s emphasizing community, self-sufficiency, alternative technologies and lifestyles, and spirituality.

• **Subsidized urban projects:** Commitment to the Brundtland Report created a public drive for green buildings in the 1980s and 1990s that was aimed at testing, approving, and institutionalizing green technologies on the basis of extensive public funding. Danish projects included sustainable renovation under the Urban Renewal Act, as well as sustainable building projects in the social housing sector.

A similar typology of sustainable buildings can be found in other countries, such as Germany and Austria (see, e.g., Rohracher & Ornetzeder, 2002). In recent years, however, there have been several attempts in Denmark to provide sustainable buildings for “ordinary Danes”—detached houses that appear traditional and where the sustainability enhancements are not very visible. These new building projects share a number of features in their visions, purposes, imagined users, design, and conceptualization of sustainability, and in many ways differ from earlier sustainable building “paradigms.” The new approach
has focused on applying low energy standards to "traditional buildings," primarily detached houses in suburban areas, and has devoted little attention to social sustainability. In other words, the buildings are typically established as traditional housing with limited shared responsibilities, facilities, and organization. The aim has been to involve the conventional building sector, encouraging and qualifying it to build sustainable buildings. This development can, in the light of sociotechnical transition theory (Rip & Kemp, 1998; Geels, 2002), be seen as an attempt to accelerate the progression of sustainable buildings from niche-based innovations to established regime-level alternatives. In this process, Danish local authorities (municipalities)—given the role that they have played in initiating and framing many of these development projects—have been very active. This process implies a number of changes and challenges in relation to previous approaches to encourage the construction of sustainable buildings.

This article explores challenges to the strategy of mainstreaming sustainable housing in Denmark, but the discussion is likely relevant as well for other contexts. We especially discuss the absence of the social dimension in relation to pursuing the goals of environmental sustainability, asking if it is possible to ignore social sustainability and still legitimately achieve environmentally sustainable buildings. And if not, why not, and how can the mainstreaming approach be improved by, for example, learning from other sustainable building concepts.

Methodology

This article is based on a recent study of new sustainable building development sites in Denmark. These developments do not necessarily define themselves as part of a collective approach, but clearly share an ambition to "normalize" sustainable buildings. The specific cases were selected to represent the characteristics of the new approach to sustainable buildings, but also to include properties with varied ownership (social housing versus privately owned accommodation) to provide a basis for comparison. We also prioritized projects where construction was completed, with residents in occupation for at least three months. The case studies are predicated on interviews with key actors, visits to the sites, and document studies. In total, 22 interviews were conducted across six cases. Informants included representatives from the institutions that took the initiative on the projects and included municipal officials, a producer of building insulation, and a social housing company, as well as other key informants such as designers, consultants and, in two instances, residents.

We conducted qualitative interviews, using a semistructured interview guide, but also allowed informants to introduce viewpoints about the concept and process, adding an explorative element to the procedure. We recorded and transcribed the interviews, and afterwards thematically analyzed them in accordance with the predefined themes of our interview guide: description of the project in terms of aims, sustainability focus, number and types of dwellings, and key actors; background for initiation; and experiences and themes raised by the informants. The analysis and conclusions from the case studies were subsequently presented to key actors on sustainable buildings at a closed workshop, as well as to individuals with general experience and expertise in the field of sustainable buildings, including researchers, architects, and regulators. The comments and discussions helped to correct, challenge, and qualify the conclusions.

To compare the studies of new sustainable buildings, we drew on existing research and documentation from several Danish ecovillages. This material included published studies and reports, websites of the respective communities, as well as our own investigations based on qualitative interviews and visits to the buildings. For example, we carried out studies as part of the collaborative projects “Sustainable Flow Management” (Moss et al. 2001) and Practical Evaluation Tools for Urban Sustainability (PETUS).

Theoretical Aspects

We apply two different theoretical perspectives to analyze development of the new mode of sustainable buildings in Denmark that aim to normalize the practice and make the homes accessible to "ordinary Danes" through customary provisioning channels.

First, ecological modernization theory (EMT) represents an optimistic view of the greening of the market based on a reinvention of existing institutions. From this standpoint, sustainability should not be seen as contravening the market, but rather as an opportunity for further market development. This view contrasts with the idea that sustainability can only be pursued in niches (a perspective sometimes referred to as "small is beautiful") that are outside market mechanisms. EMT suggests that sustainable development implies a modernization process in which sustainable practices are gradually integrated into institutions, businesses, and personal decision making instead of being delegated to the environmental management sector. This integration occurs through processes of measurement and visualization (Hajer,
the deployment of new economic instruments, novel modes of cooperation such as voluntary agreements (Boström, 2003; van Tatenhove & Leroy, 2003), and innovative roles for nation states, social movements, and market actors (van den Burg, 2006). The EMT perspective therefore highlights governance challenges for sustainable development. Accordingly, Spaargaren & Mol (2008) argue that increasing globalization weakens state-led environmental regulation and instead requires effective and legitimate forms of environmental authority at the local and nonstate level.

Second, we argue that sustainable buildings should be seen as sociotechnical artifacts where material structures are interwoven with uses of the building (Farmer & Guy, 2005; Guy, 2006; Lovell et al. 2009). We use transition theory to frame the understanding of sustainable buildings, as well as their relation to protected niches and possible transition pathways for the existing building sector (or regime). In this view, technology consists of material structures and physical artifacts in addition to natural resources, organizations, and social structures. Thus, technology can be seen as “configurations that work” (Rip & Kemp, 1998). The theory suggests that changes do not just occur in technology, but also in user practices, regulations, industrial networks, infrastructures, and symbolic meanings (Rip & Kemp, 1998; Geels, 2002). To work in practice, all elements have to be in place. When these elements are in balance they allow for some adjustments in the configuration, for instance in terms of facilitating smaller technological changes.

In contrast to a traditional view of technological development, Arie Rip & René Kemp (1998) argue that “emphasizing the artifact and the technologist runs the risk of underconceptualizing the social environment into which the novelty is introduced.” They suggest that instead of focusing mainly on the innovation itself more attention should be paid to its adoption or the rearrangement of individual behaviors, organizations, and society to adopt (and adapt to) the novelty.

Transition theory is based on a hierarchy of three levels: macro-level landscapes, meso-level regimes, and micro-level niches. First, “landscape” as a metaphor represents solid and stable structures in terms of cities, buildings, and technical infrastructure, as well as social structures such as legislation and norms. Second, “regimes” are the practices embedded in institutions and infrastructures such as production-process technologies, product characteristics, skills and procedures, in addition to the way problems are defined and managed (Rip & Kemp, 1998). The configuration of the technology within a regime gives it a large degree of irreversibility, and at the same time makes it difficult for new alternatives to scale up from niches. Some theorists have included other actors in the regime, such as users, policy makers, financial institutions, and scientists, labeling this element of the model as a “socio-technical regime” (Geels, 2002). Finally, “niches” are isolated and protected environments where technologies are able to develop and then possibly transfer to the regime. Rip & Kemp (1998) emphasize the role of niches in technological innovation, but other scholars have suggested that technological change might also be a top-down process, spreading from the macro-level (or the landscape) to the regime (see, e.g., Geels, 2002; Shove, 2003).

From the perspective of EMT, the sustainability agenda formulated by the eco-communities is likely to be understood as favoring demodernization, de-industrialization and counterproductivity (Mol & Spaargaren, 2000), and therefore not contributing to growth-based notion of sustainable development. While the new wave of sustainable buildings adheres to an EMT-oriented approach, anti-modernization and “back to basics” ideologies still have a notable role in the Danish context of sustainable buildings and it is difficult to grasp their development only through EMT (Jensen & Gram-Hanssen, 2007). By comparison, transition theory stresses innovative niche development, based on shared visions and protection from the market, as the main driver of technological change. The theory therefore offers a possible explanation and more elaborated understanding of barriers and potentials for sustainable technologies and practices to evolve, as well as an alternative to the gradual modernization process stressed by EMT.

Status and Background for the New Sustainable Buildings

Table 1 presents descriptions of the six case studies. A comparison of these cases to the earlier generation of Danish sustainable buildings points up several interrelated issues.

Normalization and Market Orientation

The new wave of sustainable buildings is strongly oriented toward the market, signaling that there is no conflict between economic growth and sustainability. The slogans include “from the extraordinary to the ordinary” (Lærkehaven), “building houses for normal people” (Fremtidens parcelhuse), and “building traditional family houses as passive houses” (Comfort Houses). These catchphrases are meant to convey a market approach that includes design aimed at integrating sustainability into modern, spacious, attractive buildings; collaborating with
“traditional” actors in the building industry; and, overall, making sustainable buildings economically accessible and attractive. As an example, the project program of “Fremtidens Parcelhuse” (Future Single-Family Houses) in Køge characteristically states:

[T]he Agenda 21 committee in the Municipality of Køge and the Green House believe there is a great need to develop modern Danish single-family houses that are energy-efficient and environmentally friendly. Work to develop energy-efficient and environmentally friendly single-family housing has been carried out at the grassroots level for many years, while the more professional companies have focused on buildings on a larger scale. Interest in living in a healthy environment, as well as living energy efficiently and environmentally soundly, has meanwhile grown markedly in recent years, and for this reason there is an increasing need for an effort in relation to the ongoing professional development of industrialized building in the field of single-family housing. The building must offer healthy, energy-efficient, and environmentally friendly housing which is attractive to ordinary Danes architecturally as well as financially (The Green House, 2005).

Similarly, the municipality of Stenløse Syd “preferred to collaborate with the market and thereby reach 90% of the population rather than collaborate with a small segment of environmentally conscious citizens” (planner, Stenløse). At the same time, the municipality had seen that voluntary agreements were not effective; professional builders were very slow to implement sustainable technologies and the users lacked the knowledge to demand these products. The municipality therefore saw itself as “the missing link” between the building sector and users of sustainable buildings and as landowners they could demand certain sustainability goals. In general, the strategy and ideology of the projects are, on one hand, a reaction to the previous understanding of sustainable buildings as something different and extraordinary and, on the other hand, a reaction to the rather inactive policy and slow development of sustainable buildings that had previously existed in Denmark.

Along with the market orientation, the new wave of sustainable buildings, in contrast to previous types, includes explicit sustainability goals, primarily on energy performance. For instance, by using the German passive house standard the energy performance

2 The German passive house standard is a building concept to ensure low energy consumption for heating (15 kWh/m²) and a comfortable indoor climate. The concept is not protected, but a certification scheme, the Passive House Planning Package (PHPP), has been developed to guarantee that only buildings fulfilling these criteria get the certificate.
of the building design must pass the “Passive House Planning Package” (PHPP) under supervision of a certified evaluator. This procedure might include several calculations during the design process with subsequent redesign to match the criteria. In a similar way, the introduction of two different “low energy classes” for buildings in the Danish building regulations and the development of a tool (Be06) to calculate the energy performance of the building made it possible for municipalities to define explicit goals for building performance and to check satisfactory achievement of these standards throughout the design process.3

New Actor Roles and Types of Collaboration

Another characteristic of the projects is that a number of actors have assumed new roles, especially the municipalities that have increasingly been leading the development process. Traditionally, local governments in Denmark have acted in a relatively passive role as regulatory authorities, issuing building permits and developing plans. In the new projects, these entities have been more active in defining sustainability criteria, buying land, setting up the collaborative framework, and so forth and often strongly influenced by Agenda 21 strategies and green nongovernmental organizations (NGOs). Private building firms are involved to a much larger extent, not only as contractors, but also as designers and developers. For example, Islover, a private insulation producer, took the initiative to build Comfort Houses that consist of ten individual homes based on the German passive house concept and set up a collaborative framework organized around “integrative design.” The project entailed considerable knowledge sharing among the design teams of the different houses. In several cases, integrated design was used as a form of collaboration between architects and engineers and as a way to integrate environmental measures and standards to achieve an attractive home design.

Experience from the New Wave of Sustainable Buildings

The new wave of sustainable building projects in Denmark has achieved several goals. These initiatives have shown that it is possible to build attractive buildings according to well-defined environmental standards, to involve traditional building firms, and to sell sustainable houses to “ordinary” Danes. Planners suggest that residents can be characterized as “average citizens” in socioeconomic terms and this is supported by a survey from Stenløse Syd that showed no income difference between the new occupants and residents of the municipality as a whole. Also, the new inhabitants did not appear to opt for residences on the basis of the sustainability performance of their new homes. In Køge, a residential survey demonstrated that environmental qualities ranked third in a list of reasons for moving to the area. In other new sustainable housing developments many residents were not aware that they lived in a “sustainable building.” The projects also demonstrated that local governments can play a large and active role in facilitating the provision of sustainable buildings and this effort has inspired other municipalities in the country to take similar steps. These initiatives are the first to implement the German passive house standard in Denmark and therefore have contributed to a learning process among the actors in the building industry who have apparently implemented some of their experience in their product lines. Several of the buildings have received awards for their architecture or collaborative frameworks, as well as a great deal of public and professional attention more generally.

Despite these achievements, our research shows a number of problematic issues related to the “new wave of sustainable buildings.” We can divide these issues into two parts.

First, concern exists about the new role of municipal governments in initiating and framing these projects. This unease came to the surface in Stenløse and Køge due to a desire to formulate sustainability goals for the buildings in the area, to encourage “traditional” building firms to construct houses that matched the criteria, and to build the buildings in accordance with market conditions (i.e., with no subsidies), and to market the buildings to “ordinary” Danes. One of the problems encountered entailed the assessment of how ambitious sustainability goals could be defined if one still wanted market actors to take interest in the project. If the goals were too ambitious there might have been insufficient uptake by investors to be able to construct the buildings and by owners to purchase them. Therefore, municipal planners need to have a good sense of the market, the attractiveness of the project, and the extra costs to implement the sustainability measures to be able to proceed. This process deviated from earlier efforts to develop sustainable settlements that involved highly engaged owners (grassroots ecocommunities) and/or ample public subsidies (subsidized urban projects) that gave such developments “niche” status and protection from market conditions.

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3 The two voluntary low energy classes (low energy class 1 and low energy class 2) were introduced in the Danish Building Regulations in 2006. Designing with energy class 1 will result in 50% lower energy loss for heating compared to a house built in accordance with traditional building regulations and energy class 2 will result in a reduction of 25% compared to a traditional house. The heating loss is calculated using the Be06 tool.
Another challenge was that the municipalities spent considerable time and resources transferring knowledge to construction companies about, for instance, how to design and build low energy buildings and how to translate design standards into actual performance outcomes. Also, the role of the municipal government relative to the building owners could be fraught with ambiguity. If something went wrong in relation to the low energy concept, owners expected that the municipality would help to resolve the problem since the local government imposed the measures for the buildings in the first place. However, the municipalities have no formal obligations to these buildings and responsibility for correction resides with the construction companies.

Similar views emerged in interviews with residents about obligations for maintaining sustainability performance over time. For instance, some residents asked why the municipality did not react when other residents built a garage with pressure-treated wood prohibited by the sustainability guidelines. This ambiguous status of the municipality has the potential to create disappointment among homeowners in the area and possibly discourage them from maintaining their own commitments to the project’s overarching principles.

The second set of potential problems concerned the absence of a social dimension in the sustainability concept being applied to high-performance homes in Denmark. This deficiency included the involvement of users in the design and planning phases, as well as supporting users in the operation phase. We elaborate on these issues in the following sections.

Narrowing the Sustainability Concept

The sustainability concepts that have been applied to the new wave of sustainable buildings have been rather narrow compared to how such ideas have in the past been used in Denmark through the engagement of grassroots’ ecocommunities during the 1980s and urban projects during the 1990s. Where these approaches previously paid notable attention to social sustainability, as well as adopted a holistic environmental approach, the new sustainable buildings have mainly addressed energy performance in individual buildings and have only devoted passing attention to material-sourcing requirements (for instance by not using polyvinyl chloride or pressure-treated wood) and rainwater percolation. In addition, no effort has been made to address waste sorting, local waste management, or, more generally, local self-provisioning. Neither has structural sustainability, including the separation of functions—home, work, leisure, public and private services—been addressed. Moreover, little consideration has been given to transportation, localization, shared facilities, or local technical infrastructure in terms of energy supply and water management.

In sum, the structures of the new sustainable buildings and settlements are to a large extent based on well-known planning types, primarily the suburban detached house, where social sustainability has not generally been a concern. Initiatives to foster social sustainability, such as combining land-use functions, mixing tenure types, establishing communal meeting places, facilitating place making, encouraging local ownership, and creating opportunities for collective management of facilities, have generally been overlooked (Polese & Stren, 2000; Carmona et al. 2010). Also, prospective residents have only occasionally been involved in the design of the buildings and the formulation of sustainability measures.

Facilitating Users

Helping users to manage the novel technologies in the new wave of sustainable buildings is another issue that has not been satisfactorily addressed, although experience from low energy buildings and passive houses reveals a number of challenges (Rohracher & Ornetzeder, 2002). In their operations phase, the effective utilization of low energy houses depends on specific sets of user practices. The buildings have very dense systems for providing mechanical ventilation, heat supply from heat pumps, heat regeneration (from the warm ventilation air), and passive solar heating. Furthermore, they sometimes rely on active solar energy from solar cells or solar collectors. Appropriate use of this type of house requires residents to adopt new habits and practices to keep energy use low and indoor climate optimal.

Some of these challenges relate to shading the house. For instance, during the daytime sunlight should be limited as the house will otherwise become very warm. Other potential problems relate to understanding how to operate the ventilation and heating system—the doors should not be kept open too long because it takes a longer time to heat the house once the temperature has dropped as compared to "traditional" heating devices. Also, doors and windows should not be opened to ventilate the house as the mechanical ventilation (which includes the heat-regeneration system) manages this aspect of home comfort. Adjusting to the new technology may well present obstacles for residents who have purchased their houses for reasons unrelated to energy performance. These challenges likely influence energy consumption.

A survey of actual energy consumption in nine houses in the Koge project revealed that actual use was on average 31% higher than calculated by BE06 during the preconstruction phase, mainly due to higher than anticipated heat utilization. Average heat
use among the nine houses was 55 kilowatt-hours per square meter (kWh/m²) per year (about half the amount of a “traditional” single-family house). However, the buildings consume 13% more energy compared to Danish low energy class 2, primarily due to higher energy use for heating (Kristensen & Jensen, 2011).

The high energy consumption seems to derive from a combination of residents’ comfort practices and a lack of information on maintenance, management, indoor climate, and heating and ventilation systems (Kristensen & Jensen, 2011). Generally, the transfer of knowledge from designers to users has been confined to guidance manuals for residents, but in practice this means of dissemination has had limited effect, or even no effect in several cases. Between 35% and 71% of the respondents in Køge disclosed that they had not received this information, although providing it is mandatory according to the Swan label (Kristensen & Jensen, 2011). This finding suggests uncertainty about the transfer of knowledge to users and how they are being integrated into the projects.

Moreover, some residents questioned how the environmental requirements for the neighborhood are managed in the operations phase. They are aware that one sustainability objective entails constructing houses without pressure-treated wood, but when they see their neighbors building garages with such materials they ask how the sustainability targets are enforced, and by whom? This kind of variance raises doubts regarding who should be responsible for ensuring that developments live up to their sustainability objectives and what organizational models and sanctions might prevent deviations.

The division of roles among different actors (e.g., developer, designer, contractor, owner, operator, and user) in the new sustainable buildings departs from the organization of other sustainable building concepts (see Table 2). In the context of ecovillages, or sustainability projects in social housing, there is greater concurrence across roles. For example, in Danish ecovillages, prospective residents have typically framed the concept of the village, acting as their own developers (and to some extent as designers and constructors) and simultaneously as owners, operators, and users. In social housing, the organization often takes the initiative, defines the goals, and operates the buildings. The housing company itself decides the objectives for the buildings, operates them, and is able to collect experience for future projects. The principle differences between the various types of sustainable buildings are illustrated in Table 2.

In owner-occupied detached houses, there is generally no facilitation, no formal “expert” to ask, and no operator to check if the building is being used appropriately and whether the technological system is calibrated correctly. In comparison, social housing departments in Denmark have technical and administrative personnel who are often in close contact with the residents to inform and help them to maximize individual operational systems and the buildings as a whole. For example, the social housing association Ringgaard, the owner and operator of the sustainable buildings in Lystrup, is engaged in a continuous dialogue with its tenants and tries to instruct them about the use of the buildings and the monitoring of energy performance. This engagement includes facilitation of knowledge transfer between residents, for instance from a woman who has lived half her life in Morocco (and knows how to use the blinds to avoid overheating the building during the day) to occupants who are less aware of the need to provide shading.

This type of information and learning is possible because management is part of the social housing institution, along with other shared facilities such as administration, maintenance, common houses, and playgrounds. Such facilitation is not available in the detached homes where the owner acts as his own facility manager. In this respect, when examining the connection between social and environmental sustainability it is useful to compare the new wave of sustainable buildings with some features from the ecovillages, especially as a contrasting example.

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**Table 2 Different roles in sustainable building concepts.**

| Sustainable Building Organization | Developer | Builder | Operator | User |
|----------------------------------|-----------|---------|----------|------|
| Ecovillages                      | Residents | Residents | Residents | Residents |
| Social housing                   | Social housing companies | Social housing companies | Social housing companies | Tenants |
| Detached housing                 | Municipalities | Building companies | Owner | Owner |

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4 This includes energy for heating and electricity. To qualify for Danish low energy class 2 a house measuring 100 square meters would use a maximum of 66 kWh/m² per year.

5 The Swan Label is a common Scandinavian ecolabel.
Configuration of Ecovillages: Social and Environmental Sustainability

Most Danish ecovillages emerged in the 1980s and 1990s. Among the most well known are Dyssekle (Hundested), Hjortshøj (Arhus), Munksøgård (Roskilde), and Friland ( Djursland). Most ecovillages are members of the National Assembly for Eco-Communities (Landsforeningen for Økosamfund, or LØS). About 30 ecocommunities and a number of associated organizations and enterprises are part of LØS and they vary from smaller settlements situated around former farms (5–20 dwelling units), to larger ecovillages (10–400 dwellings), to communities formed around spiritual centers (10–40 units) (LØS, 2003). In general, the communities seek to achieve a high degree of self-sufficiency regarding energy and water management, food provisioning, and so forth and emphasize the creation of local jobs and facilities as ways to create community (Gram-Hanssen & Jensen, 2005). The goal of self-sufficiency creates a strong relationship between environmental and social issues and this feature represents an important element in the overall ecovillage configuration.

Organization and Participation

A large number of facilities and functions are primarily managed by the residents and this creates numerous opportunities for practical tasks. For example, in Munksøgård several activity groups provide practical and social services, including waste collection and management, visitor care, café operation, greenhouse gas-reduction visioning, social arrangements, green accounting, general information, information technology, pet care, landscaping, playground maintenance, environmentally sensitive farming, garden management, road repair and clearing, wastewater collection, toilet operation, and heating (Munksøgård Bestyrelse, 2010). In addition, a number of private associations and initiatives work on various issues, for instance promoting the production and consumption of organic meat. The high degree of communal self-sufficiency also includes many work obligations for the residents and working groups are organized around the “green economy” and the provision of mutual assistance. Considerable built-in flexibility creates useful opportunities to engage in the community, to establish local ownership among residents, and to create social networks.

Physical Design

In terms of the built environment, Danish ecovillages are often based on “organic” design with large variation in their architectural styles that include winding streets, meeting places, shared facilities, and varied vegetation. Many of these communi-

ties are in a process of continuous development. For example, in Hjortshøj at the time of this research construction of new housing was underway, as well as smaller projects including a new shared community house for meetings, dinners, hobbies, and common discussion (see Figure 1). Such circumstances mean that the village is “messier” than other areas, but residents regard this characteristic as a sign of life and communal evolution. In contrast, in the nearby Lystrup area, where three groups of sustainable buildings have been established, the variation is more limited and there is no neighborhood plan or functional integration (see Figure 2).

Social Mix

Despite their alternative approach, Danish ecovillages have had few problems attracting new residents and the population today includes individuals seeking environmental sustainability and people interested in socially relevant features. For instance, according to the residents of Munksøgård, the community has become very popular among people looking for social qualities (work groups, shared responsibilities, and social arrangements) and social mix (different types of home ownership, various ages).

In contrast, the quest for self-sufficiency in terms of facility maintenance, building operations, and other practical tasks means that the communities are careful about acceptance of residents. The self-reliance approach therefore includes a risk of exclusion for people who are not regarded as able to operate within the frames of “self-sufficiency.” However, contrary examples also exist. For instance, in Hjortshøj the community has fought to acquire an institution for mentally disabled residents and this is now being built. The objective is that the new residents will be able to take on smaller jobs such as
cleaning, caretaking, and general maintenance. Social diversity is to some extent ensured by including social housing in the development. Many Danish ecovillages, such as Hjortshøj, Dyssekilde, and Munksøgård, are divided into housing groups, with different types of homes, residents, ownership structures, and environmental features.

**Functional Mix**

Several ecovillages in Denmark have sought to create local workplaces and this effort has been, at least to some extent, successful. The workplaces are mainly provided by smaller enterprises related to community activities. In Hjortshøj, for instance, a self-employed gardener supplies organic vegetables to a local shop. In addition, a display building located in the middle of the development contains rooms for exhibits and educational courses and houses a local company and the international secretariat for INFORSE, an international network for renewable energy. In Dyssekilde, the community has developed a local income source by organizing tours for visitors. These activities are far from sufficient to employ all of the residents who want or need salaried jobs and therefore considerable car-based commuting takes place because most ecovillages are not located in proximate distance to public transport. However, the local enterprises are valued due to the contribution they make to enhance the social experience.

In summary, the understanding of sustainability being put into practice in the ecovillages entails a close relationship between the environmental and social dimensions. This feature, in combination with the various social qualities that are part of the overall design, adds a sense of community, an attribute difficult to find in the new wave of Danish sustainable buildings.

**Transformation Perspectives**

Transition theory emphasizes the need to reconfigure the social and organizational contexts as a precondition for technological change. Efforts to bring technologies such as sustainable buildings from niche-scale to regime-scale can be regarded as “‘real world experiments.” When working on systems change involving complex technologies, the best way to learn about them is to build them and test them in everyday life (Gross & Hoffmann-Riem, 2005). The new generation of sustainable buildings in Denmark that are based on market principles constitute such an activity. Our cases have shown that a precondition for these initiatives is that central actors, presently or formerly involved in niche activities (such as Local Agenda 21 initiatives and grassroots-oriented sustainable buildings), have paved the way for these experiments. Ironically, the actors in Køge and Stenlose who have this background are the ones fiercely promoting an EMT mindset in the “storyline” that has developed around these new sustainable buildings and emphasizing the shortcomings in how the ecocommunities approach sustainable buildings—they are regarded as too alternative, unappealing to ordinary Danes, and destined to remain “niche products.” Nevertheless, the cases illustrate the dynamic among niches, “real-life” sustainable building experiments, and regime and landscape changes in terms of new building codes and other types of public regulation.

From an EMT perspective, we might treat the new wave of sustainable buildings as examples of increasing experimentation and collaboration between public and private partners, generating new roles for actors, creating different uses of regulation, and so forth. On a practical level, the cases also show that these sustainable buildings face some energy-savings challenges related to their use and the absence of a structure to support and inform users about their technological aspects. As mentioned earlier, the
shortcomings stem from an overall need to include social sustainability in the building concept and to develop more ambitious targets with respect to environmental sustainability.

Danish ecovillages can be seen as experiments to explore the relationship between social and ecological sustainability. It can be argued that grassroots initiatives and niche developments generate ample opportunities for innovation that are valuable for market dissemination, but they also pose several barriers and challenges. As Seyfang & Smith (2007) argue: “Niches find themselves at the weak end of complex and extended power relations under globalising capitalism, and dominant individualist and consumerist lifestyles aspirations run counter to community collectivism.” Although grassroots innovations might include development of niche technologies and practices such as wind-energy production or car-sharing clubs, we contend that the lesson from the ecocommunities is that a direct transfer does not necessarily exist (neither is a transformation of individual technologies relevant). Rather, an understanding of sustainable buildings is best viewed as comprising a combination of self-sufficiency, ecological and economic sustainability, social activities, social mix, shared facilities, and functional diversity that in combination constitute a “configuration that works” (Rip & Kemp, 1998).

There is no doubt that Danish municipalities can get inspiration from ecocommunities and other sustainable buildings (for instance by visits and information exchanges), but there is a need to find ways to institutionalize knowledge transfer and competence building. Local management of buildings should have a greater focus on social sustainability, in terms of social and functional diversity and shared facilities, in combination with design and place making that support these functions. Users live in the buildings as homes, not as technical artifacts. Domestication theory, as it pertains to technological adaptation, demonstrates that the way technologies are integrated into specific contexts such as “a home” often include different practices and meanings than those imagined by the architects and engineers who initially planned them (Lie & Sørensen, 1996). This situation calls for better understanding of users as residents and consumers at the same time, improvement in the interplay between designers and users, as well as efforts to include users in decision-making processes on design and technical solutions (Rohracher & Ornetzeder, 2002; Hoffman, 2007).

Strategies to improve competence regarding how to use the buildings could include knowledge transfer whereby existing expert users would act as mentors for new residents and teach them how to use the buildings and technologies in an optimal way. Concrete suggestions from actors in the sustainable buildings sector include systems for better building monitoring and ways for residents to gain information about their house—such as Internet based solutions—that could be implemented without changing the basic concept of mainstreamed sustainable buildings.

On a larger scale, municipalities could facilitate such learning processes by inviting and grouping settlements to enable mutual learning. For example, Roskilde municipality has developed the area of Trekroner which is a cluster where different types of ecocellations can establish themselves. Established developments such as Munksøgard are already located in the district and are able to share facilities with similar settlements and help with practical problems.

Although social sustainability is a concept with many diverse interpretations (Vallance et al. 2011), there are pragmatic ways to make it operational and accountable, for instance by following best-practice checklists and applying measures on social sustainability (for instance regarding social mix, meeting places, and shared facilities) (Polase & Stren, 2000; Carmona et al. 2010). Emerging standards on sustainable buildings and neighborhoods might be another way to incorporate social sustainability measures. Although recent research suggests that these evaluation systems do not take all features into account when evaluating sustainable communities (Mapes & Wolch, 2011) and have difficulties quantifying the softer benefits (Retzlaff, 2010), they might be a way to highlight qualities of social sustainability in such settlements.

Because the new wave of sustainable buildings, as well as the sustainability standards, are signs of adoption and diffusion of sustainable technologies and concepts (Rip & Kemp, 1998), we can ask whether we still need inputs, innovations, and concepts from bottom-up initiatives and niche developments. From this perspective, initiatives from within the sector (for instance developing a sustainability label for buildings), in combination with administrative and regulatory reforms, seem the most likely path for the continuous mainstreaming of sustainable buildings. Our research suggests that in light of the very limited inclusion of social sustainability measures in these sustainable buildings, we still could learn a lot from the niche products and bottom-up approaches on sustainable building. Not only could this make the new sustainable buildings more attractive, but larger inclusion of social structure

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6 Two prominent examples are Leadership in Energy and Environmental Design (LEED) in the United States and the Building Research Establishment Environmental Assessment Method (BREEAM) in the UK.
could also help improve the interaction between buildings and users to reduce energy consumption.

Conclusion

We can interpret recent efforts to mainstream sustainable buildings as generally consistent with EMT, particularly in terms of a robust market approach and a rejection of the antimodernist attitude that has been generally evident in sustainable buildings in Denmark and elsewhere. From a transition theory perspective, mainstreaming sustainable buildings is a strategy within the existing regime, a promising way to implement such innovations, but one that so far faces a number of shortcomings and challenges.

The observations from practice indicate that social sustainability initiatives—physical, spatial, organizational—have not been satisfactorily implemented and issues such as engagement with residents, information about building use, and creation of “ownership” regarding sustainability measures for the settlements are unresolved and unaddressed. We argue that this situation has negative consequences for the energy performance of these buildings and for the sustainability of larger settlements. We therefore suggest that the next generation of sustainable buildings should adopt a broader perspective in terms of environmental sustainability and include more robust initiatives on social sustainability, including the physical and organizational layout of settlements.

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