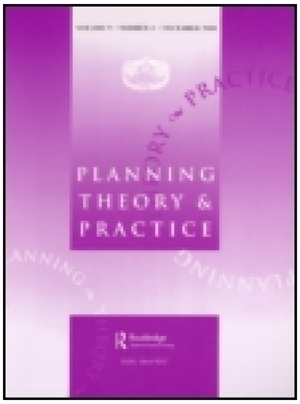

Planning Theory & Practice
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rptp20

Exploring the Challenges of Environmental Planning and Green Design: Cases from Europe and the USA Renovating to Passive Housing in the Swedish Million Programme Regulative, facilitative and strategic contributions of planning to achieving low carbon development West Village: Development of a New Ecological Neighborhood in Davis, California The Aldo Leopold Legacy Center: Expanding the Definition of “Community” in Carbon Management Low carbon developments as laboratories of innovative planning tools Integrated planning for ecological urban regeneration Behind the Green Curtain: Shifting Goals and Shifting Roles Creating Post-Carbon Communities: The Return of the Public Sector

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Available online: 22 Mar 2012

Planning Theory & Practice, Vol. 13, No. 1, 113–174, March 2012

Routledge
Taylor & Francis Group

INTERFACE

Exploring the Challenges of Environmental Planning and Green Design: Cases from Europe and the USA

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Introduction

This symposium deals head-on with pressing challenges of sustainable environmental and land-use planning, with real cases of experimenting with green planning and design taken well beyond the scale of green buildings. In an earlier auto- and oil-centric time we'd have said that these cases show us "where the rubber hits the road", but these cases try to show us exactly the opposite of that: how we might design neighborhoods and plan environmental footprints that make energy conservation and even carbon neutrality possible in radically new ways so that less and less rubber needs to hit any road.

We present four studies, European and American, along with four critical commentaries, to explore the complexity of sustainability and its relationship to the much debated topic of eco-communities. We have chosen these cases to range across scales and political settings—from single buildings to potentially millions of housing units— so that we might assess both shared elements and significant differences as well. In every case, though, the planners and designers involved have struggled to understand sustainability and green design as ecologically complex, fully social and political as well as technically thought out, thus innovative in all of these dimensions as well.

Our aim has been to approach these issues from an integrated perspective looking for cases that covered a whole spectrum of possibilities in relation to such communities, ranging from a small case of a single non-residential compound to whole neighborhoods that were the outcome of Scandinavian social democratic housing policies several decades ago.

Our aim is to address a series of questions, not so much answers, that will undoubtedly arise in different disciplines and policy realms in the next decades: What might the main features of eco-communities be in the immediate future? Should they be considered as ideal types of sustainability, developing new models of urban life? Or rather, should the mere notion of sustainability make us look at what we have already done and try to redress its deficiencies as much as possible? Is retrofitting or new construction the real path to urban sustainability and to approach the potentials of eco-communities? How important are the physical qualities of the built environment in relation to the social, political or economic dimensions of sustainability?

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1464-9357 Print/1470-000X On-line/12/010113-62 © 2012 Taylor & Francis
http://dx.doi.org/10.1080/14649357.2012.652007

We hope that the following pieces will contribute to these debates, now in an early stage, that we expect will become even more relevant in the context of continuing environmental and political-economic crisis.

Four Exemplary Case Studies

Although the concept of sustainability has its roots in the late-nineteenth-century "sustained yield" forestry practices of Germany, contemporary definitions of sustainable development relate more to an improvement in the long-term health of human and natural environments (Wheeler, 2000). Carbon dioxide mitigation, efficient use of energy, and renewable energy generation are all technical goals of contemporary eco-communities; the appropriate role of planning, interactions between the public and private sectors, and the appropriate balance of conservation and development continue their evolution.

In the first case study from the University of California at Davis, we see how the presence of a powerful sponsor, collaborative planning practices and creative public–private partnerships can result in high levels of environmental performance. When fully built-out, the West Village project will be the first net zero energy community in the USA, producing as much renewable energy on-site as is consumed by the commercial and residential buildings. Although the project displaces 53 hectares of prime farmland, it is one model for new town construction in the fast-growing sunbelt cities of the USA.

The second case study from Alingsås, Sweden challenges the need for new construction by showing how eco-neighborhoods can be created through the renovating of existing buildings and housing. From 1965 to 1974, the Swedish government responded to a housing shortage by constructing one million dwellings, typically as a "tower in a park" scheme. Many of these buildings now need renovation; in 2005, the local public housing authority in Alingsås started by retrofitting one building to a high level of energy efficiency. After learning numerous lessons from the first renovation, and collaborating with residents on subsequent projects, the remaining buildings have been able to meet a passive house standard, needing little to no inputs of energy to maintain interior comfort, even during long Nordic winters.

The third study describes additional lessons learned by examining the contribution of planning in the achievement of low-carbon development. The author compares two cases, the Hammarby Sjöstad project in Stockholm, Sweden and the car-free suburb of Vauban near Freiburg, Germany; both eco-communities have achieved significant reductions in annual carbon dioxide emissions when compared to standard practice. Though a comparison of only two projects, the role of planning in determining regulations, facilitating the projects, and providing strategic leadership is discussed. The paper concludes by recommending stricter building codes and better enforcement when residents are not engaged in the planning process; facilitation being more appropriate when residents are engaged energy citizens.

The fourth and final study, reviewing the design, construction, and operation of the Aldo Leopold Legacy Center in Baraboo, Wisconsin, returns the definition of sustainability to the sustained yield practices of foresters in the nineteenth century. While not a housing project, the design and construction of a structure that honors the "land ethic" expands the notion of community to include biotic systems, and documents how carbon management policies might expand to include woodlands and native prairies.

Reference

Wheeler, S. (2000) Planning for Metropolitan Sustainability, *Journal of Planning Education and Research*, 20(2), pp. 133–145.

Renovating to Passive Housing in the Swedish Million Programme

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ABSTRACT *In Sweden, there is a wealth of existing housing stock from the 1965–1974 intensive construction period known as the Million Programme. Many of the apartment buildings are now in need of renovation and have the potential for transformation to more energy-efficient constructions. This article examines the renovation of Million Programme apartment blocks in Alingsås, Sweden. The case study of Brogården, an urban housing area in the small city of Alingsås, reveals the quantitative success in energy savings through renovation to passive houses, and the qualitative success of the pragmatic process as residents, contractors and academics attest to the benefits of renovating with a strong environmental vision and a humanistic approach. Involving actors in a highly communicative process, and across multiple phases of the project, has closed the gap between research and practice. Combining existing data on the energy savings and comfort levels in the apartments together with interviews conducted with stakeholders from the partnering process illustrates the renovated buildings as technically efficient, and that the planning and construction process yielded unexpected results in social and economic sustainability. The Brogården renovations provide a concrete example of sustainable housing and overcome the typical challenges of moving from theory and idea to planning and realization. This article aims to discover the challenges and benefits of realizing ambitious passive house renovation projects to create eco-neighbourhoods.*

Keywords: passive solar housing; the Swedish million program; Brogården; partnering; pragmatic process; eco-neighbourhood; urban design

Introduction

Eco-neighbourhoods can be successfully created through renovating existing buildings and housing areas. In Sweden, passive house techniques can be effectively used for dramatic results in energy savings. The process of renovating to passive housing requires partnering between stakeholders, and a pragmatic process where participants learn as they work, continually developing their technique to achieve the highest quality. The case of Brogården, Sweden provides an excellent example of renovating to the passive house standard to create an energy-efficient and socially sustainable neighbourhood.

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Figure 1. Apartments before. Successful courtyard typology; problems with thermal bridges from inset balconies. *Source:* Carley Friesen.

Brogården is an urban housing area located in Alingsås, Sweden, a city of around 26,511 inhabitants (Alingsås Kommun). Brogården was built between 1970–1972 as part of Sweden's intensive construction period, known as the Million Programme. In 2005 Alingsåshem, the public housing company owning the area, made the decision to renovate the sixteen buildings comprising the Brogården neighbourhood. For years there had been problems with the brick facades crumbling due to freeze-thaw cycles and acid rain, and complaints about drafts and low indoor temperatures (Figure 1). They made the decision to renovate the houses to the passive house standard, which suited the needs of the Brogården apartments perfectly; simple to construct when a façade renovation was needed anyway, and providing good indoor comfort for residents.

The solution was augmented with the inclusion of consultants interested in the social and environmental sustainability of the area. Alingsåshem decided that increased accessibility and diversity would provide social and economic stability in the area, and that the lower energy costs could stabilize rent levels in the years to come. Combining these interests, the project unexpectedly grew from a simple passive house conversion to an extensive renovation of the buildings.

The Brogården renovations exemplify how an integrated planning approach and a pragmatic process have a ripple effect, creating direct and indirect benefits for social, economic and environmental sustainability. Quantitative evaluation of the performance of the renovated buildings shows the high quality of passive house construction which was

Figure 2. Apartments after. Maintained courtyard typology and look of facade while using new materials and fixing balconies. *Source:* Carley Friesen.

achieved by the pragmatic process (Figure 2). Interviews[1] from stakeholders were then compiled to give form to the process and show the far-reaching benefits of partnering.

Several questions formulate the analysis of both project data and interview anecdotes: How is passive house renovation an answer to energy concerns, as well as social and economic sustainability? How did the Brogården project benefit from a pragmatic process and partnering agreement, and how did the surprises during the process benefit the result? What are the challenges to passive house renovations becoming a recognized contribution to the eco-neighbourhoods trend?

History

During the period from 1965 to 1974 the Swedish government decided to respond to a nationwide housing shortage by constructing one million dwellings. This became known as the Million Programme (Hall & Viden, 2005, p. 303). There are a variety of styles and typologies within the Million Programme housing areas (p. 304). However, they are often associated with freestanding apartment blocks set in large green areas. The buildings were usually prefabricated and the rational, repeated designs were intended to provide an efficient construction process.

Almost since its inception, some aspects of the Million Programme have been a point of debate in Sweden, such as the uniformity of the design and construction, and segregation due to separated traffic planning and building typology.

Figure 3. Demonstration apartment. The demonstration apartment is used for resident meetings and to educate about the passive house construction. *Source:* Carley Friesen.

In Brogården there are five arrangements of three- to four-storey apartment buildings around square courtyards. The area has been successful in terms of a pleasant and safe community atmosphere. The repeated designs however, have resulted in a lack of diversity in the area. Problems due to material degradation have led to poor indoor comfort and inadequate energy efficiency.

Technical Dimension

In August 2005 Alingsåshem decided to renovate all 300 apartments in Brogården. The general manager of Alingsåshem, Ing-Marie Odegren, responded seriously to a non-committal phrase in their charter that states "work actively in energy efficiency" and used it as a convincing starting point in the decision for a low-energy renovation (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011). The thermal bridges caused by the balconies being on the same concrete slab as the interior floors, combined with drafts due to the crumbling brick facades, had resulted in complaints of poor indoor comfort. Passive house techniques provided the desired solutions (Janson, 2010). A passive solar construction has a highly insulated, airtight building envelope, and uses an air-to-air heat exchanger for heating and ventilation. The original idea was to wrap the house in an air barrier, install extra insulation on the walls, build in the balconies, replace the windows, and put on a new façade material (Eek, H. Passive House Expert and New Resident, The Passive House Centre. Personal Communication, 14 March 2011). An additional goal of the renovations was to increase physical accessibility, especially for seniors and people with reduced mobility, by

Figure 4. Stakeholder meeting. Residents, Alingsåshem, Tenants Society and the general contractor meet regularly to discuss the renovations. *Source:* Carley Friesen.

updating the washrooms for wheelchair access. These two aspects of the renovation would be relatively quick, and residents could stay in their apartments. The scope of the renovation, however, grew unexpectedly as several other factors came into play.

Alingsåshem engaged residents in a tenant survey, the results of which indicated the need for additional apartment types. There was also a need to equip some of the buildings with elevators since none of the original layouts have elevator access. Combined with a consultant evaluation to upgrade to wheelchair accessibility, many details of the interior layout had to change.

Alingsåshem decided that one building would be renovated first to have a more detailed view of the wall construction and to determine exactly what condition the buildings were in. They could then measure the quality of the passive house renovation. After starting the demonstration house, the general contractor found the inside of the walls, floors, and kitchens to be in worse condition than previously thought and the scope of the project again expanded.

Today, each building undergoes a major renovation where the residents are evacuated and the structural concrete frame is the only part of the building that is salvaged. The exterior walls are rebuilt with a steel frame, 480 mm of insulation and ceramic tile cladding (Figures 7 and 9). The old balconies are built in, and new balconies are placed on plinths separate from the façade. This requires a re-build of the roof, to properly protect extended walls. Insulation is added to the concrete slab foundation, and in the attic (Janson, 2010). A central ventilation unit is added in a room on the top floor. Energy saving appliances are installed in all apartments.

Figure 5. Renovation of a neighbourhood. Residents live on site during renovations, but there is a good atmosphere on the work site. *Source:* Carley Friesen.

> The project in itself is very revolutionary. It is the first time you go to the Million Programme and make a renovation, and take the renovation so far. (Eek, H. Passive House Expert and New Resident, The Passive House Centre. Personal Communication, 14 March 2011)

The major targets for energy savings were calculated and set early on. Consultants evaluated the buildings before and after renovation and compared their performance to calculated results.[2,3] The renovations have reduced the average total apartment energy consumption from 215 kWh/m^2 to 86 kWh/m^2 (Skanska, 2009) (Figure 8). This proves renovation to passive housing extremely effective from a technical standpoint, and economically effective, especially if façade renovations are needed anyway.

The level of renovation raises some questions, as it generates a large amount of waste and restricts design opportunities to the original concrete frame. The waste materials, however, are carefully sorted and about 85% of the material is diverted from landfills. The limitations of the concrete frame posed difficulties as the ceiling was lowered to accommodate air ducts. This makes a noticeable difference spatially and may make the apartments unattractive. The saving of the concrete frame, however, is environmentally significant as it is estimated that 5% of Sweden's total energy comes from the production of concrete (Jorlöv, B., General Contractor, Skanska. Personal Communication, 21 April 2011).

> Some people would say, "This is a compromise I wouldn't accept. It is the reason to build new." The Million Program was built up on rational building,

Figure 6. Public spaces. The community atmosphere is maintained throughout the renovations. *Source:* Carley Friesen.

> the same apartment, the same stairs, very rational to build. We did some things that made these houses irrational. (Westholm, H., Architect, Efem Architect Office AB. Personal Communication, 13 April 2011)

Possibilities to heighten the overall sustainability of the building such as insulation types and material choices were not exploited, perhaps due to the unexpected complexity of the renovation. In the courtyards there is a similar problem, as infrastructure such as bike racks, benches and play areas have been updated, but the ecological possibilities of the landscape such as day water systems, gardening opportunities, and healthy habitats have not been sufficiently explored. This shows the difficulty in providing well-rounded solutions to all of the issues in sustainable urban development. The Brogården project provides a base for passive house renovation techniques and positive social processes that in the future can be developed to provide more comprehensive efficiency renovations.

Governance Dimension (Political, Economic, and Community Relations)

Although the energy calculations prove the technical efficiency of the renovation, quality of life both during and after construction must be a main concern in the design of an eco-neighbourhood. The interviews revealed that the technical knowledge gains from the Brogården renovation were not as great as the learning outside of the actual construction process (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011).

Building envelope before	U-Value [W/m²K]	U-Value [W/m²K]	Building envelope after
Ground floor	0.38	0.2	Ground floor (12 -20 cm insulation)
Exterior walls (wood construction, 13 cm insulation, 120 mm brick cladding)	0.3	0.09	Exterior walls (steel construction, 44 cm insulation,ceramic tile cladding)
Windows	2.0	0.85	Windows
Roof (18 cm mineral wool and cellulose)	0.22	0.10	Roof (30 cm loose wool and 10 cm mineral wool board insulation)

Figure 7. Building specifications. *Source:* Figures and Details from Ulla Janson and Alingsåshem.

Maintaining the existing public life for the community is crucial in a renovation project (Figures 5 and 6). A strong community is connected through shared experiences and depends on the spaces that facilitate community activities (Sassi, 2006, p. 53). One measure the housing company took was to ensure that residents have the opportunity to live beside the same neighbour after renovation (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011). Another important aspect to community well-being is maintaining the sense of place and identity (Sassi, 2006, p. 129). A new building could be built for the same cost as the renovation but would have a different form, and more stories per building (Jorlöv, B., General Contractor, Skanska. Personal Communication, 21 April 2011). This would completely alter Brogården's intimate courtyard typology that has been effective in instilling a community atmosphere.

If the Brogården apartments are desirable throughout a resident's life, they will be valued for many years to come and longevity is a key factor to sustainability (Sassi, 2006, p. 53). After renovation there are two, three, and four-room apartments and around 60% of the apartments are accessible with an elevator (Skanska, 2009). This provides the opportunity for residents to live in a suitable apartment if their living situation or physical ability changes.

	Existing building	First renovation (demonstration)	Second renovation	Calculated
Heating	115	27	19	24.3
Hot water	41	25	18	
Domestic electricity	39	27	28	
Common electricity	20	13	21	
Total energy use	215	92	86	

Figure 8. Energy use [kWh/m2, 220 indoor temperature]. *Source:* Figures and Details from Ulla Janson, Alingsåshem (2007, 2010a), and The Passive House Centre[2].

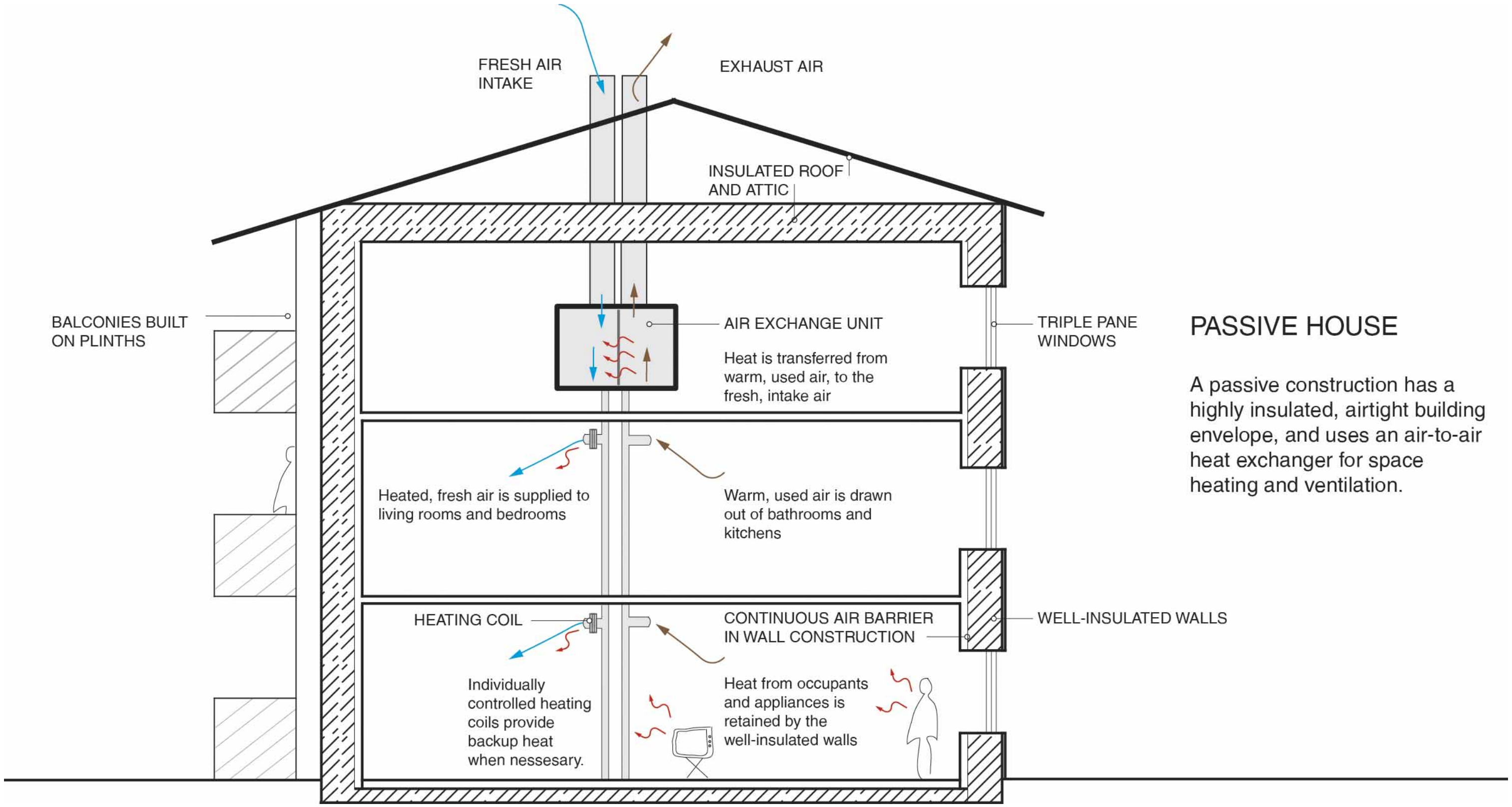

Figure 9. Passive house construction methods in Brogården. *Source*: The Passive House Centre[2] and Alingsåshem (2007).

Because the construction will be ongoing until 2013, Alingsåshem and the general contractor[4] carry out the renovations in a series, usually one building around a courtyard at a time, to cause the least possible disturbance to the residents. The general contractor designates the courtyards as construction-free zones, temporary offices and storage are accommodated in the buildings under renovation and delivery areas are set up at the back (Skanska, 2009).

Alingsåshem, together with the Tenants Society established a local newsletter[5] that has become important for all of the stakeholders. For the general contractor and Alingsåshem, it is a successful forum to share detailed updates on the renovation process. For the Tenants Society it is a way to advertise formal meetings, social community events and to answer resident questions and concerns. For residents, the newsletter provides renovation and passive house education in a simple and tangible form.

One apartment in the demonstration building has been set aside as a community space (Figure 3). Alingsåshem and the Tenants Society use the apartment to show how the renovated apartments look, for resident consultations, and for participative meetings in a familiar and welcoming context. At the participative meetings with the residents and general contractor, it is obvious that the residents are well informed, have pointed questions, and take advantage of their involvement (Figure 4). The general contractor has a sense of responsibility for explaining the procedures of the renovation to the residents.

Alingsåshem negotiated a rent increase of around £25/m^2 per year with the residents. The increase in rent per m^2, together with the increase in rentable area due to the balconies being built-in ensures Alingsåshem that the investment pays off in 10 to 20 years (Skanska, 2009). The interviews have revealed that most existing tenants are happy with the renovations (Corriere, C., Tenants Society Representative and Long-term Resident, The Tenants Society. Personal Communication, 26 April 2011). The long-term renters see the benefits of having their apartment refurbished by the housing company and appreciate the value-added measures, for example, choosing their own interior design materials and colours, and the opportunity to glass-in their balcony. The Brogården apartments required upgrading to provide suitable living for existing tenants and future tenants. The goal was to fix inadequate housing stock for the existing residents, and provide great variety in the neighbourhood without changing the social or economic profile of the area. Some tenants, usually from single households or elderly, have expressed concern about the rent increase, and chose to move. The question of some residents leaving is a political question, as the amount paid out by the government for elderly housing allowance has remained the same for many years, not following regular, incremental increases (Corriere, C., Tenants Society Representative and Long-term Resident, The Tenants Society. Personal Communication, 26 April 2011). Alingsåshem has stated that the current rent levels will not be changed for the next five years (Janson, 2010, p. 251).

The stability of rent levels through the event of rising energy costs will show the economic benefits of passive renovation. This is also important in terms of social sustainability. A rise in energy prices disproportionately affects the poor, who often live in less efficient buildings with higher energy demands (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011). Alingsåshem estimates that the passive buildings will be the only profitable properties in fifteen years if energy prices rise as predicted (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011).

> It is costly but there are several things that make it cheaper in the long term. Ing-Marie Odegren had the politicians see the whole thing, and how this will

> help Alingsås Municipality. (Westholm, H., Architect, Efem Architect Office AB. Personal Communication, 13 April 2011)

Process of Implementation

Due to integrated involvement, the project grew from a desire for a simple passive house renovation to a multifaceted overhaul of the buildings. Alingsåshem saw the benefits of including consultants and considering long-term resident needs to provide a comprehensive renovation.

The subsequent renovations translated the lessons from the demonstration project directly into modifications of the process and design. The outcome was energy savings better than the calculated targets. The same level of air tightness was achieved (0.2 L/s/m^2 at $\pm$50 Pa (Janson, 2010, p. 253)) as that expected for newly constructed passive buildings (Jorlöv, B., General Contractor, Skanska. Personal Communication, 21 April 2011).

> We made energy calculations from the beginning. When the consultants measured the first house, the results were better than our calculations. That is astonishing. You use normal materials. The only difference is you take more care of the building physics, and all of the workers know about that. The process in itself is a sort of development. (Eek, H. Passive House Expert and New Resident, The Passive House Centre. Personal Communication, 14 March 2011)

The Brogården project has arrived at these concrete results due to a pragmatic process which involved many local participants, and included a partnering agreement. The partnering agreement involved stakeholders in the early stages of the project. The experiences from the demonstration building were recorded in a database and could be translated directly to the subsequent renovations as part of a pragmatic process. The community atmosphere in Brogården enabled a high degree of communication between participants.

Pragmatic Process

Planners and architects often discuss pragmatic methods of development in their theory behind design solutions. However, with barriers such as high-paced development, short-term economic focus, and a lack of political will, the method is too often lost during the practice of building.

In Brogården there was not a conscious decision by the stakeholders to base the project in a pragmatic process. Looking back on the series of decisions, however, one can clearly see that Alingsåshem arrived at the process through recognizing the importance of "learning-by-doing", rather than exclusively adhering to predetermined plans and solutions. Alingsåshem connected previous experiences to the new situation through inviting sub-contractors to contribute to the design and involving many stakeholders to increase the insights into what is required to achieve sustainability (Farmer & Guy, 2010). Aside from stakeholders, Alingsåshem had a variety of consultants participate in the demonstration project. Involving passive house experts, a PhD architecture student[3] and accessibility planners increased the scope of the renovation (Figure 10). The relevance of the buildings improved both as an example of the possibilities for passive house architecture, and of renovations for greater physical accessibility.

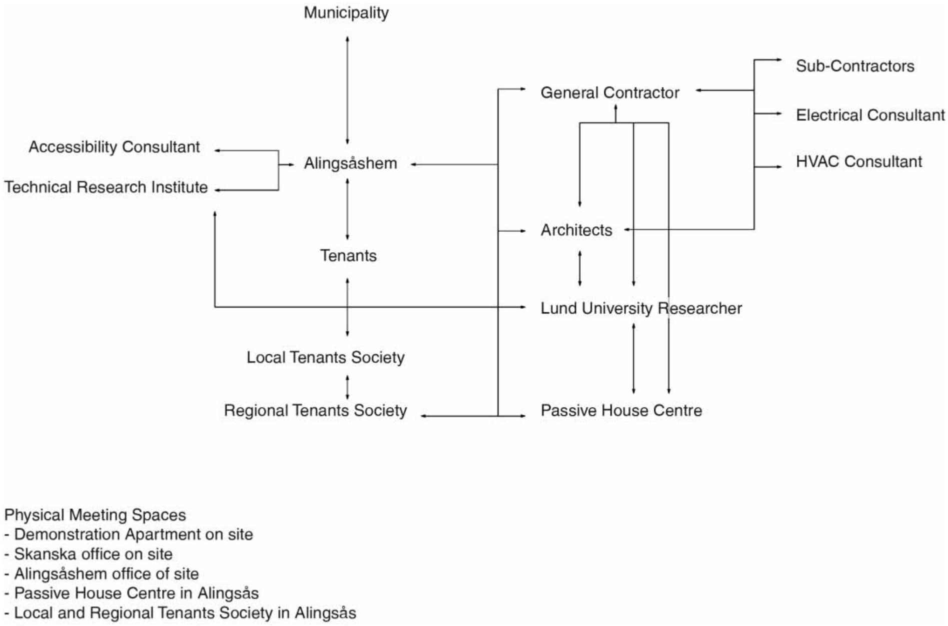

Figure 10. Participants in Brogården project. *Source*: Interviews[1] by Carley Friesen.

> There are so many buildings in the area so during the process you could do adjustments and that was good. Researchers were involved and were very helpful. I could sketch and the researcher would do the energy calculations and come back with the results of how the change would impact the efficiency. (Westholm, H., Architect, Efem Architect Office AB. Personal Communication, 13 April 2011)

> The project is learning-by-doing. It is an actual part of production. They are developing a method for all of the Million Programme areas housing stock. (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011)

Renovation is a challenge because knowledge about the building's construction and the precise condition of hidden materials can be difficult to obtain. During and after the demonstration project construction plans had to be adapted. For example, during the demonstration project, individual ventilation units were installed in each bathroom. Now they install a central ventilation unit in each building, which is augmented by a heating coil placed in the supply air duct in each apartment. Alingsåshem has estimated they will save approximately £5,766 each year in maintenance costs, and they are able to offer tenants a larger bathroom, since it will no longer contain an individual ventilation unit (Janson, 2010, p. 277).

The residents in Brogården were not initially involved in the decision to renovate to passive houses. It was after this decision that Alingsåshem together with the Tenants Society held meetings to discuss the passive house renovation with residents and carried out a survey to ask for their concerns and suggestions for other aspects of the renovation (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011). The residents are subject to post-evaluation (Corriere, C., Tenants Society

Representative and Long-term Resident, The Tenants Society. Personal Communication, 26 April 2011) and the contractors use their feedback to refine the work. For example, the placement of electrical outlets in the apartments was unsatisfactory, especially in the kitchens. A small group of residents photographed and sent in their suggestions. They received detailed comments about why the outlets were placed where, and which ones could be changed to meet the suggestions. The outlet locations have been changed in subsequent renovations.

> It was the wrong way in the beginning. The residents were not involved from the start, and voiced their concern. Alingsåshem took their reaction very seriously and changed; they began a dialogue with them about the problems. To make something better you first have to understand what is bad. (Corriere, C., Tenants Society Representative and Long-term Resident, The Tenants Society. Personal Communication, 26 April 2011)

The experience-based approach, where learning throughout the process reframes design problems, ensures a high quality in the design and construction of the building, which is difficult to achieve in a typical closed and linear operation. During the interviews, all of the stakeholders attested to the benefits of having trans-disciplinary contact, and the ability to utilize the skills and knowledge of the other stakeholders to aid their own portion of the process. It is critical, however, that the housing company has a strong strategy for the pragmatic process from the beginning, expecting adaptations. Although Alingsåshem arrived at a flexible process and learned early on from their oversights, residents and consultants in Brogården were sometimes engaged too late, forcing changes during the construction instead of the design phase (Janson, 2010, pp. 234, 279) causing time delays and adding to costs.

Partnering Agreement

The term "partnering" describes an agreement, often coupled with a legal contract, which implies a high level of communication and quality performance objectives (Smyth & Rawlings, 2004, p. 6). In a conventional construction project, the clients usually hire for a fixed amount of time, based on the best price or tender. In Brogården, the general contractor has entered an agreement with Alingsåshem based on the services they can provide throughout the course of the renovations. The general contractor then hired other contractors into a similar, long-term agreement based on their offer of services (Jorlöv, B., General Contractor, Skanska. Personal Communication, 21 April 2011).

Economically, the practice of partnering pays off through the benefits the communicative process delivers both to the contractors and the clients. The time spent on a well-designed building, together with the attention to detail required for passive house construction, results in lower maintenance costs (Pitts, 2004, p. 101). The focus is taken away from speed, and put on accuracy, creating a positive and safe work environment for the contractors. The project contractors have been hired from Alingsås or within 30 km of the site (Skanska), lending to local knowledge of the area and environment, as well as encouraging choices to support local businesses and material sources.

Environmentally, partnering allows a comprehensive approach to sustainability considerations. With all parties engaged, the agreement enables a deeper evaluation of the whole life cycle of construction materials and systems (Smyth & Rawlings, 2004, p. 6).

In Brogården, partners were encouraged to contribute their expertise towards the planning of the renovation and to set goals for achieving the air tightness required for an efficient passive house construction, including ensuring that all of the processes, from electrical to plumbing, did not disturb the plastic air barrier. It was important for each discipline to maintain a dialogue with the others, so that they were all aware of the modifications and that changes did not sacrifice the energy-saving solutions (Janson, 2010, p. 340).

As the project progressed, the contractors had the opportunity to suggest improvements in the process which they saw necessary. When these suggestions were implemented in future phases of construction, not only did the procedure become more efficient, but the carpenters felt more committed, as it was their own innovation helping to guide the project (Janson, 2010, p. 341).

For example, the experience of the demonstration project revealed that there was a need to simplify the construction of the exterior walls which contained four thicknesses of insulation and was difficult to install. The design also included a material used for the window installation which was time consuming to order, and heavy and itchy for those working with it. A meeting was held involving Alingsåshem and their partners; the general contractor, the designer, the salesperson of the exterior wall building system, and a carpenter. They came up with a new design that used only two thicknesses of insulation and a new material for the window installation. Economically, they estimated a time saving of 100 working hours per building, and a material savings worth approximately £9,690 per building. The savings in transport of these materials can also be deducted from both economic and environmental costs. Most importantly, they improved the work and health of the carpenters (Janson, 2010, p. 278).

> The workers are very satisfied with their work environment. As a resident, it is so nice to go there when they are working. They are very friendly to each other and don't have conflict or competition between each other. They really appreciate that, and really enjoy this job site. (Eek, H. Passive House Expert and New Resident, The Passive House Centre. Personal Communication, 14 March 2011)

Community Atmosphere

The interviews reveal that the partnerships and general networking between the stakeholders was a foundation of the project. With a connection to various opinions, the politicians were able to understand the benefits of the Brogården renovations from multiple standpoints.

The interviews revealed that an ordinary town was able to carry out a revolutionary and nationally acclaimed project precisely because of the strengths that come with being a small community. The stakeholder connectivity is in part due to neighbourly relationships fostered by the relatively small city (which, interestingly, is known for having many local cafes, around 26 in total). There are many crossovers in stakeholders, such as Eek, the passive house expert becoming a resident of Brogården, or Corriere, the administrator for the Tenants Society as an existing resident. These crossovers provide unique perspectives on the situation. The local government was closely tied into the project, and calculations from Alingsåshem convinced them of the benefits. Local offices and a main meeting space in the demonstration apartment provided physical space for in-person meetings and discussions.

Passive House Challenges

Passive house construction is becoming more widespread in Sweden, from two known projects in 2005 to over 1000 houses and apartments in 2010 (Passivhuscentrum cited in Janson, 2010, p. 337). Despite efficacy in lowering energy use, and the suitability of passive house techniques, there continue to be challenges in generating a wider acceptance of passive house construction and renovation.

Because passive house construction requires a high quality level of design and construction, time and in turn economic investment are higher in the beginning than in conventional construction projects. It is difficult for both housing companies and individuals to look beyond this initial investment to the long-term benefits of energy savings and the effects of comfortable indoor environments on quality of life and workplace efficiency.

> Alingsåshem's forward-looking vision is possible because it is owned by the municipality of Alingsås. They can confirm savings in elderly care to the politicians in the immediate future, which is significant to the small community where cost for elderly care is 26% higher than the national average (Statistics Sweden, 2011). They can also demonstrate stable rent levels due to low energy use, and a contribution to variety in housing stock for the community. Private housing companies do not usually have the same long-term financial planning, connection to in-direct benefits, or community mindedness … In pilot projects there is often a huge wall between the project and the real thing. There is one project, no repetition, and they limit the possibility for learning. What is actually interesting is when it is used as a stepping stone. To Alingsåshem, this is not an experiment; it is development. The project is part of an internal development that is long-term. (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011)

Media often focuses on eco-neighbourhoods with innovative new technology, and newly built areas. Focusing on a renovation project, which looks very similar to the existing and whose key components (heavy insulation, and a ventilation system) are rarely seen, is not the type of visually exciting story which many media desire. Focus on the high-tech in eco-neighbourhood has generated scepticism around technologies which are owned, and the selling of "eco-ideas". Passive house technology, in fact, is not a technology but a technique. Housing owners may be sceptical of who is benefiting from their use of passive house techniques, and not realize that it is a free and unprotected method (Kyrkander, A., Energy Consultant, The Passive House Centre. Personal Communication, 31 March 2011). Experts at the passive house organization[2] that supported Alingsåshem have been working actively to shift the mindset from energy generation to energy conservation. The focus of the energy crisis is shifted from the energy source to an exploration of the potential of energy savings through good design and sound construction methods.

Concerning new construction, the European Union has a mandate that by 2020 all new houses in the Member States must be built to passive house standards, or as nearly zero-energy buildings (Council of the EU, 2010). In Sweden, solar orientation and thermal mass make little difference to the efficacy of a passive solar house (Eek, H. Passive House Expert and New Resident, The Passive House Centre. Personal Communication, 14 March 2011), so there are many possibilities for passive house renovations as well.

It is crucial that passive house renovations such as the Brogården example continue. It is estimated that there are 400,000 apartments in Sweden with the same construction as the Brogården Million Homes programme area, which can be similarly renovated (Skanska, 2009).

> We are bound to reduce our energy. We cannot do it only in new houses; we must retrofit. The Million Programme areas are able to be renovated in this way; this is a good possibility. (Jorlöv, B., General Contractor, Skanska. Personal Communication, 21 April 2011)

Conclusion

Passive house renovations are an appropriate method for adapting Sweden's Million Program areas into energy-efficient neighbourhoods. A pragmatic process combining a strong environmental vision and a humanistic approach to quality of life negates the conventional gaps between planning and realizing ambitious projects by involving public and private sector stakeholders, experts and residents.

Professionals, media, and politicians must focus on the multiple facets of sustainable eco-neighbourhoods. There are common goals for most communities, including a desire for inclusive, safe and healthy places, calm, attractive and natural areas, a balance of public, private and social life (Barton cited in Sassi, 2006, p. 53). Although these factors may be more difficult to evaluate than technical aspects, and thus are often neglected both by media and authorities, their inclusion in the design of neighbourhoods will lead to indirect and often unexpected benefits in economic and social sustainability, in turn contributing to environmental efficiency in the long term.

For passive house techniques and renovation projects to become an accepted contribution to the eco-neighbourhoods trend, practitioners must shift focus and include the variety of solutions found in a humble and humanistic implementation of efficiency strategies, one step at a time.

Notes

1. To gain a better understanding of the Brogården project the author conducted a series of five interviews, along with study trips to the renovated buildings and construction site. The interviews can be found on the works cited page.
2. Passivhuscentrum (the Passive House Centre) is a non-profit organization operating in Alingsås, Sweden, to deliver resources, advice and education on passive house construction. They can be found at http://passivhuscentrum.se/en
3. Lund University, Faculty of Energy and Building Design has been involved with the advice and evaluation of the project. Ulla Janson conducted a full research project into the Brogården projects and three other passive house projects in Sweden. The full results of this detailed study can be found at http://www.ebd.lth.se/publikationer/
4. The general contractor is Skanska Sweden. Their tender was chosen on competition and based on the acceptance for a partnering offer for all the building projects for Alingsåshem (Janson).
5. The newsletter, *Brogårdsbladet*, is available in Swedish on the Alingsåshem website at http://www.alingsashem.se/index.php?page = brogardsbladet

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Regulative, facilitative and strategic contributions of planning to achieving low carbon development

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ABSTRACT *The triple threats of climate change, resource depletion and energy security have led to a need to re-think the way in which we build and regenerate our cities. Increasingly low carbon infrastructure, buildings and lifestyles are being encouraged in urban areas. This trend has resulted in the emergence of a number of low carbon demonstration projects in cities across the world.*

The planning process is one of many tools in the armory for delivering low carbon development. It has a clear role in the delivery of low carbon demonstration projects and may also be used to encourage wider deployment of low carbon systems in cities. It has several roles – strategic, regulatory and facilitation (identified by planning theory) – all of which can be used to assist in the delivery of low carbon development.

Strategic planning can be used to coordinate resource and development strategies as well as encourage the alterations to urban form needed to support the deployment of low carbon technologies. The planning process itself can be manipulated to reduce the cost of low carbon development; used to facilitate discussion between key players involved in delivering low carbon development; and build support for low carbon infrastructure in communities. In its regulatory role planning can be used to enforce the adoption of low carbon infrastructure in communities.

The role of planning in delivering low carbon development will be investigated in this paper using a two case studies from Europe. The weakness of planning as a tool for delivering low carbon development and the factors which can provide greater leverage are also explored using case study examples. Finally the future role for the planning system in delivering low carbon development is discussed.

Keywords: low carbon development; planning; Freiburg; Stockholm; Hammarby; Vauban

Introduction

The triple threats of climate change, resource depletion and energy security have led to a need to re-think the way in which we build and regenerate our cities. Increasingly, low carbon infrastructure, buildings and lifestyles, the constituents of a low carbon energy system are being encouraged in urban areas. This trend has resulted in the emergence of a

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number of low carbon neighbourhoods in cities across the world. Some of the most cited examples can be found in Europe.

This paper discusses, critically analyses and compares different planning approaches to the delivery of low carbon development in Hammarby Sjöstad (Stockholm, Sweden) and Vauban (Freiburg, Germany). The critique is based on a detailed analysis of both neighbourhoods conducted as part of the Zero Carbon Homes project (the findings of which are presented in Williams, 2011). Both neighbourhoods have achieved considerable carbon reductions when compared with the average carbon footprint of citizens living in the cities in which they are situated.

Planning is one tool in the armoury for delivering low carbon development. As the local context (physical form, resource availability, culture, social capital, institutions, political and economic systems) greatly influences the implementation of different low carbon energy systems, the planning process has a clear function in delivery. Through strategic, regulatory, and facilitative roles, the planning process can deliver low carbon neighbourhoods (Bulkeley & Kern, 2006; Campbell, 2006; Crawford & French, 2008; Day *et al.*, 2009; Williams, 2010).

The community (residents, businesses, etc.) can take an active or passive approach to the delivery of low carbon energy systems. It can take an active role in supporting, designing, financing and operating low carbon energy systems, or play a passive role. In the former case the community becomes a co-provider, which ensures community support and engagement in the transition to a low carbon system (Devine-Wright & Devine-Wright, 2004; Sauter & Watson, 2007). In the latter case producers (utilities, municipalities, developers, etc.) deliver low carbon systems, whilst the community tend to act purely as consumers (Sauter & Watson, 2007). This approach has the benefit that it can often be applied over a relatively short time frame, although behavioural change and associated carbon reductions may be limited.

In each case planning plays a different role, in this paper exemplified by two low carbon neighbourhoods: Vauban and Hammarby Sjöstad. In both instances the regulatory, strategic and facilitative functions of planning have been used to deliver low carbon neighbourhoods. Both cases focus on the facilitative role of planning in building capacity amongst key stakeholders to deliver low carbon neighbourhoods. However, the stakeholder focus has differed between the community and those producing the built environment.

The Freiburg approach heavily involved the community (local businesses and residents) in the process of planning Vauban. This helped to raise energy awareness, engage public interest and involvement in the project. It built local social capital, which created the support and social structure needed to encourage pro-environmental behaviour, carbon reduction and the development of collective approaches towards energy generation and conservation (Williams, 2011). The Freiburg approach did produce a low carbon neighbourhood. However, the argument put here is that such an approach works well in localities where the public is already engaged, proactive and supportive of environmental objectives, but of course in many communities this is not the case.

Often the community does not have adequate interest or expertise to be involved in the development of low carbon neighbourhoods. In this context the application of passive low carbon energy systems through a top-down planning approach can be more fruitful (Williams, 2011). Here the planning process can be used to engage producers (the construction industry, municipalities and utilities) to create low carbon technical systems and neighbourhoods (Williams, 2011).

The process builds capacity to deliver low carbon neighbourhoods amongst producers (rather than the community). It enables more strategic approaches to the delivery of low carbon energy systems and wider deployment of low carbon technologies and lifestyles.

Such an approach is exemplified by the "Stockholm process" adopted in Hammarby Sjöstad. The problem with this approach is it does not address the attitudes or lifestyles of those living in low carbon neighbourhoods and thus will ultimately only partially address the issue of energy consumption.

Comparing the Low Carbon Neighbourhoods

Hammarby Sjöstad and Vauban are very different (Table 1). Hammarby is situated in a capital city rather than a regional town. It is four times the size of Vauban and significantly denser. It is located in an inner urban area (a popular water-front location) whereas Vauban is in a suburban district. Residents living in Hammarby tend to be affluent, whilst Vauban provides accommodation for diverse groups. The residents of Vauban are motivated by a green agenda,[1] whilst Hammarby residents are not.

In both neighbourhoods the aim was to lower carbon emissions from residents. In Freiburg the average citizen's carbon footprint is 8.5 tonnes per capita per annum compared with 0.5 tonnes per capita per annum for those living in Vauban. In Hammarby Sjöstad the average resident's carbon footprint is 2.5–3 tonnes per capita per annum compared with 4 tonnes per capita per annum for those living in Stockholm. The instant difference in carbon footprints between Stockholm and Freiburg relates to the carbon intensity of the main

Table 1. Comparing the case studies (key facts).

	Vauban	Hammarby Sjöstad
Population in neighbourhood	5,000 residents[a]	20,000 residents (9,000 units)[a]
Population urban area	217,000[b] (Freiburg)	1,000,000 (Stockholm)[a]
First phase completion	2007	2004
Income	High, medium, low	High
Country	Freiburg, Germany	Stockholm, Sweden
Location	Suburban (former industrial site)	Urban waterfront (former industrial site) – prime development site
Land use mix	Mixed	Mixed
Density	Medium	High (50 units/hectare)[a]
District energy systems	Local biomass fuelled combined heat and power (CHP) plant	See Hammarby closed-loop model
Energy-efficient buildings	65 kWh/m^2/year[a] or below (passive house [PH] and Energy-plus standard)	60 kWh/m^2/year[b]
Energy sources	Photovoltaic and solar collectors, biofuel, biogas	Solar, waste water treatment, biofuel, biogas, waste incineration, groundwater heating/cooling
Transport	Trams, buses, cycle lanes and parking, car pool, reduced parking spaces, car free development	Trams, buses, cycle lanes and parking, car pool (powered by biofuel, gas)
Carbon production in neighbourhood (tonnes per capita per annum)	0.5[c]	2.5–3.0[d]
Carbon production in city (tonnes per capita per annum)	8.5[b]	4[e]
Energy system	Active	Passive
Residents	Energy citizens	Passive consumers

[a] Antonoff (2007)
[b] ICLEI (2009)
[c] ACT Planning and Land Authority (2010)
[d] Brick (2008)
[e] City of Stockholm (2009).
CHP, combined heat and power; PH, passive house.
Source: Author.

energy supply. The carbon intensity of the energy supply in Freiburg (0.28) is double that of Stockholm (0.14) because Sweden's energy supply (heat and power) is largely sourced from nuclear, renewable energy and waste rather than fossil fuels as is the case in Germany.

Both neighbourhoods have achieved carbon reductions through:

- higher energy standards in building,
- efficient energy systems,
- generation of low carbon energy,
- schemes to promote alternatives to fossil-fuelled cars (public transport, low carbon vehicles, car pools, cycle lanes, etc).

Vauban and Hammarby took two different approaches towards visioning, designing, financing and operating the energy systems. In Vauban the approach included the community in all four processes, thus Vauban residents are active energy citizens. Developments within the neighbourhood adopted several different approaches to the delivery of carbon reductions. In some developments community heating was adopted, whilst others were connected to the district heating system powered by biofuel (2000 units). Some 59 households generated all their energy from solar radiation. Others opted to be car-free.

In contrast Hammarby residents were entirely excluded from the visioning, design, financing and management of their energy system by the project team. Thus they are passive consumers. This situation is reinforced by a lack of metering in homes. All households in Hammarby are connected to a closed-loop energy system. This is conceptually based on an eco-cycle model, where waste products from urban processes are used as a source of energy. A low carbon electricity supply from the national grid and low carbon technologies embedded in buildings complement the closed-loop system in Hammarby Sjöstad. Hence it is a passive, low carbon energy system.

The closed-loop system was initially developed by Stockholm Energi, Stockholm Water Company and the Stockholm Waste Management Administration. It utilises several low carbon energy sources including solid waste, biofuel, biogas and waste heat (Figure 1). Biofuel is used by Stockholm's combined heat and power (CHP) plant, thermal power station and by municipal vehicles. Organic waste produced by households fertilises the biofuel crops outside Stockholm. Household waste water is processed to produce biogas, which powers vehicles and provides gas for cooking in Hammarby Sjöstad. The heat produced from the process of purifying domestic waste water is used by the thermal power station.

Two very different planning processes were used to produce these contrasting neighbourhoods.

Vauban

The planning system has played a role in the incorporation of low carbon energy systems in Vauban. At the time Vauban was being developed, the planning system's role in delivery was largely regulatory and facilitative. However, post-Vauban the role of the planning in producing low carbon development has also become strategic, encouraging the diffusion of low carbon systems throughout Freiburg.

The Regulatory Role of Planning

The planning system adopted a regulatory role in the case of Vauban by enforcing localised energy standards for buildings (Figure 2). All units achieved the low-energy standard as a minimum (65 kWh/m^2/year). However, some exceeded this standard. For example, the passive and energy-plus houses achieved a space heating standard of

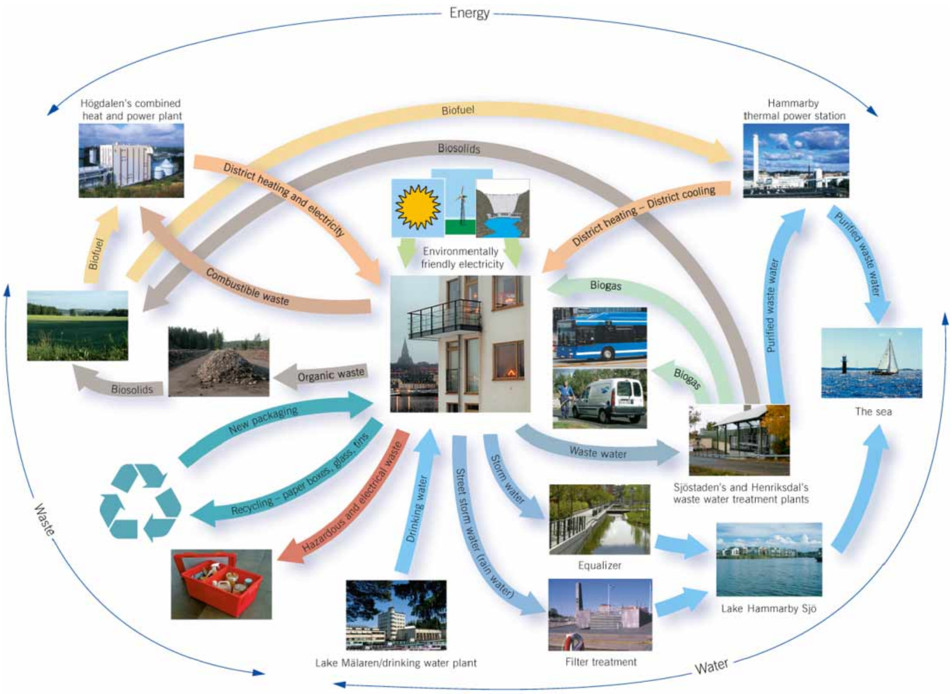

Figure 1. The Hammarby Model. *Source:* Hammarby (2010).

15 kWh/m^2/annum, whilst the latter also generated energy from solar radiation. Setting standards for new development on the site reduced energy consumption and associated carbon emissions, as demonstrated by the carbon footprint of an average Vauban resident.

Market demand for housing in Freiburg and municipal control of the site delivered higher energy-efficiency standards for building in Vauban (Williams, 2011). Municipal

Figure 2. Energy standards in Vauban. *Source:* Innovation Academy (2009).

ownership of the site provided the city council with the leverage it needed to demand higher energy standards in buildings (Daseking, interview, 2009; Donn, 2011). Market demand for housing in Freiburg in conjunction with limited land availability meant that competition amongst developers for the Vauban site was fierce (Daseking, interview, 2009). Thus, even with higher energy standards (and the inflated build costs associated with the use of low carbon systems) there was considerable interest amongst developers in Vauban.

The Vauban experiment showed that building to higher energy standards in new buildings was economically and technically feasible. As a result these standards are now being adopted by the latest zoning plan for Freiburg[2] (Figure 3) and in fact have informed conditions placed on development in other German cities (e.g. Frankfurt, Hannover, Hamburg, Munich and Ulm) and are now influencing federal building codes.

The Vauban experiment demonstrates that innovation in development can be encouraged locally using planning conditions. These are more flexible than mandatory federal or national building code. Thus, where the context suits innovation, planning controls can be used as a stimulus to encourage it, whilst where the context does not suit innovation, using more flexible planning controls can be useful to ensure sites do not become redundant (Williams, 2011).

The Facilitative Role of Planning

The planning process also acted in a facilitative role in Vauban. It helped to build the community's capacity to understand, support and be involved in the delivery of a low carbon neighbourhood. The planning process adopted in Vauban engaged the community in visioning and design consultation exercises (Sperling, 2002). It encouraged community support for more innovative development models and new technological systems (Ries, interview, 2011; Sperling, 2002).

Three key groups were involved in planning Vauban: Project Group Vauban,[4] City Council Vauban Committee[5] and Forum Vauban.[6] Several other actors also had the opportunity to feed into the planning process (Figure 4). Workshops and exhibitions

valid for	required standard	
	from 2009	from 2011
Public buildings Municipal residential estates	Passive house	Passive house
Private residential buildings on municipal sites	Low energy house II	Passive house
Residential buildings on private sites with a new zoning plan	Low energy house I	Low energy house II
Residential buildings on private sites with an existing zoning plan	Standard from existing zoning plan and consultation of the client	

Figure 3. Energy requirements of new build development in Freiburg.[3] *Source:* Innovation Academy (2009).

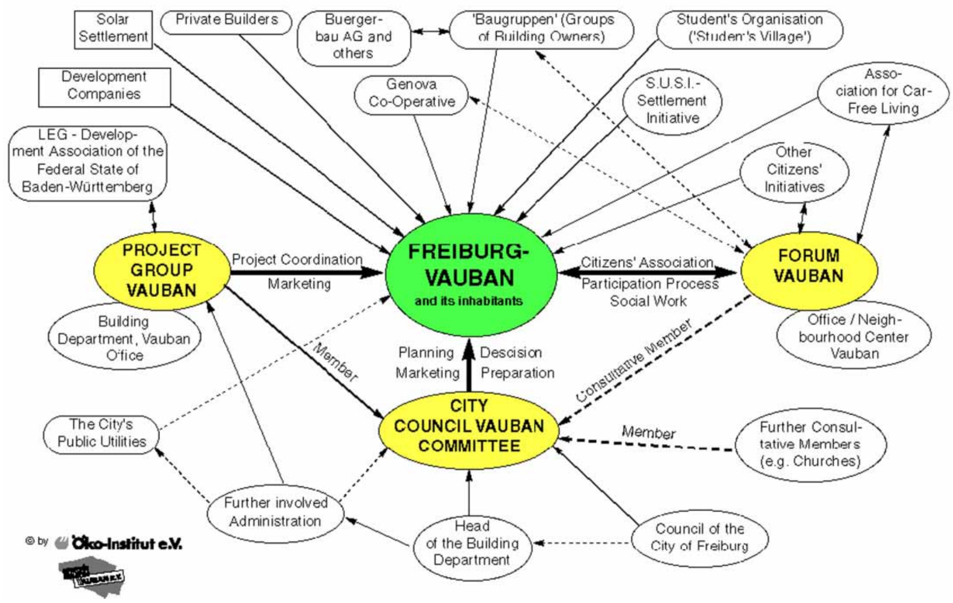

Figure 4. Actors involved in the participative planning of Vauban. *Source:* Brohmann *et al.* (2002).

organised by Forum Vauban engaged all key stakeholders in thinking about and discussing the development of Vauban. It brought together citizens, architects, engineers, financial experts, experienced managers of co-building projects and other partners. It acted as the hub for the exchange of ideas, concerns and expertise amongst these groups (Sperling, 2002).

This approach helped to raise public awareness of ecological and socially conscious design. It provided a forum to consider possible development options and negotiate potential solutions. It also helped to build social capital within the community (through engagement, discussion and negotiation), which enhanced the feasibility of collective approaches to the delivery of some services including energy. Ultimately it strengthened commitment to the ecological and social objectives of the plan amongst all key stakeholders (Sperling, 2002). It also translated into greater community support in the ongoing operation of low carbon systems in the neighbourhood and the creation of active energy citizens (Williams, 2011).

The range of stakeholders involved in the construction of several different housing projects on the site created diverse responses to the wider sustainability agenda. Some housing groups concentrated on environmental objectives and others on social objectives (Ries, interview, 2011). Some housing groups focused on maximising energy efficiency in their building and energy system (e.g. localised CHP biofuel systems), others sought to produce low carbon energy (e.g. energy-plus houses), others to share resources thus reducing energy consumption (e.g. through car-share schemes). These approaches produced models which could be used to deliver low carbon neighbourhoods. Allowing groups to choose their focus and solutions also ensures long-term support.

Public subsidies (for new low energy buildings, energy refurbishment and the generation of low carbon energy) and the local cultural context give this planning approach greater leverage (Williams, 2011). Bottom-up, low carbon initiatives in Vauban (and Freiburg) have been supported by an array of federal and local subsidy schemes. The energy refurbishment of existing stock and construction of low energy housing has been subsidised by low cost capital loans (e.g. KfW = Kreditanstalt für Wiederaufbau banking group loans). Capital grants have also been available for the installation of renewable energy technologies (e.g. 100,000 roofs solar programme which subsidised the photovoltaic (PV) arrays on the football stadium). The feed-in tariff (an operational subsidy) has encouraged the local community to invest in renewable energy projects. Local funds are also available from the regional energy company (Badenova) in Freiburg for local low carbon energy projects.

The cultural context has been integral to the success of this planning approach. The degree of community engagement in local decision-making processes and the provision of services in Freiburg as a whole is unusually high. This is exemplified by proliferation of community led, small-scale renewable energy generation projects (including local hydro-electric plants financed by housing associations; the solar collectors on Freiburg football stadium financed by the fans; the small wind farm constructed on the edge of Freiburg, wholly financed by the community) and energy refurbishments of existing stock financed by housing associations.

The proactive nature of Freiburg's community is further demonstrated by the emergence of *Baugemeinschaft* (30–40% of the housing stock in Vauban (Ries, interview, 2011)). These are groups of citizens planning to build their own accommodation. They are involved in forming, visioning, financing, designing and managing their own housing projects. This takes a great deal of commitment and demonstrates just how proactive the residents of Freiburg are prepared to be. Similar models do exist in a few other major cities (Munich and Berlin), but they were pioneered in Freiburg and Tübingen.

This high level of community engagement is (not surprisingly) also found in Vauban. In addition, residents strongly support the green agenda. During the European elections, the Green Party won 60% of the poll in Vauban (Paterson, 2009). Thus residents are clearly motivated by environmental concerns and prepared to prioritise environmental issues. Overall, residents in Vauban are very proactive and are keen to tackle their energy consumption and carbon footprint. Therefore, arguably it is not a huge leap for pro-environmental, proactive residents to become active energy citizens.

However, it is an enormous leap for the disengaged, passive and environmentally unaware individuals (probably constituting the majority of citizens living in many European cities) to become active energy citizens. Thus, it seems unlikely that this planning approach would bring about the same results in a different cultural context. Nevertheless, the Vauban case study does show that where the community has the potential to become active energy citizens, adopting this more self-deterministic, bottom-up approach to planning, in conjunction with public funding, could help to facilitate the transition.

The planning approach used in Vauban has now been adopted more widely by the municipality of Freiburg. Indeed, it has demonstrated significant benefits in terms of building support for both social and environmental agendas within the city. However, it is extremely resource intensive, particularly for the municipality. Involving such a large number of actors in the consultation process has also inevitably lengthened development time-lines and increased the cost of development. Thus, there are significant resource implications for planning authorities considering adopting the model as well as consequences for the speed of future development (Donn, 2011).

The Strategic Role of Planning

Since the completion of Vauban, the municipality has adopted a more strategic approach towards the integration of land use and energy planning (Daseking, interview, 2009; Donn, 2011). This approach should help to encourage the diffusion low carbon energy systems more widely throughout Freiburg. Carbon reduction targets inform the strategic plan, local policies and all planning decisions (Donn, 2011). The impacts of planning decisions on carbon emissions are now monitored and inform the strategic planning process.

Key stakeholders delivering low carbon systems are involved in the strategic planning process. For example, the regional energy company is involved in the creation of the strategic plan (Daseking, interview, 2009; Donn, 2011). It provides planners with the information needed to determine the best approach to delivering a low carbon energy supply to the locality or to specific developments. It also advises developers on the optimal energy systems for new developments which comply with local planning requirements. This approach means that planners in Freiburg do not have to be technical experts in energy planning. Their close working relationship with the energy company enables them to work with experts to identify the best technical options for reducing carbon emissions in existing and new development (Williams, 2011).

Strategically, the regional planning body for Baden Wurttemburg and the local planning body for Freiburg have been working in opposition in terms of delivering renewable energy (Donn, 2011). The latter has been supportive, whilst the former has actively prevented the development of renewable energy capacity. The regional planning body has prevented the development of wind farms in the region surrounding Freiburg, whilst the municipal planning authority has positively promoted all forms of renewable energy within the city boundaries.

Baden Wurttemburg politicians have supported the development of the region's nuclear capacity, whilst actively undermining renewable alternatives. This has limited the options for the development of renewable energy capacity to within the city-limits of Freiburg (only about 30 MW of installed energy) and resulted in the focus on biofuel and solar systems. It has also limited the potential for low carbon development. However, a recent political change in regional government, a shift towards a green agenda and the increasing unpopularity of nuclear energy in Germany look set to change this situation. This example demonstrates the importance of political support at an urban and regional level for low carbon systems.

Hammarby Sjöstad

The planning system has played a role in the incorporation of low carbon energy systems in Hammarby. The planning systems role in the delivery of the low carbon neighbourhood was regulatory, facilitative and strategic. The strategic role was of key importance, unlike the Vauban case study. Another difference was that the facilitative role focused on producers rather than consumers of the built environment. The regulatory role was very similar to that found in Vauban.

Regulatory Planning

The planning authority in Stockholm produced an environmental plan for the development of Hammarby. It outlined targets for emission reductions from buildings and the energy system. Overall, the target was to halve CO_2 emissions from the neighbourhood. This ambitious standard could be applied to the development for several reasons: municipal ownership of the site, market demand for housing in Stockholm and the availability of public funds (Stoll, interview, 2009).The municipality owned the site and thus could control the release of land for development. There was (and still is) considerable demand for new housing and a limited availability of sites within the metropolitan region of Stockholm. Thus, in part, demand for units in central Stockholm drove improvements in environmental standards. A significant injection of public funding in Hammarby also increased developer interest. The municipality and Swedish government invested a significant amount in the decontamination and preparation of the site for construction (Bylund, 2003). The municipality also invested in the creation of the bespoke closed-loop energy system, which reduced build costs for developers (Stoll, interview, 2009).

In reality, both buildings and the community energy system under-performed in respect to the CO_2 emission reduction targets. The environmental assessment tool developed by the City of Stockholm, Royal Institute of Technology, and Grontmij shows a 28–42% reduction in non-renewable energy use and a 29–37% reduction in CO_2 emissions resulting from the closed-loop system (Brick, 2008), when compared with the average for Stockholm.

The higher energy standards set for new buildings were not achieved. This was blamed in part on design. The residential units were larger than average and oversized in relation to functional requirements (Stoll, interview, 2009). This increased the amount of energy needed for space heating and cooling. The units also had oversized windows, which increased heat loss during the winter and contributed to over-heating in the summer (Stoll, interview, 2009). The technologies used for the building fabric were also a lower energy standard than required.

The system for monitoring and enforcing higher energy standards was lacking in Hammarby, relying on the accuracy of energy modelling; the expertise and skills of the builders in delivery, and integrity of those self-reporting build quality (Stoll, interview, 2009). No mandatory system of quality control post-construction exists in Sweden (Nässén *et al.*, 2008). This provides little incentive for developers to ensure construction has achieved the energy standards set. Post-construction monitoring and enforcement of energy standards by an impartial body is required.

A change in political control in Stockholm over the construction period (1998–2012) also affected the environmental standards imposed on the project. When the principal decision to develop Hammarby was taken in 1995, the City of Stockholm was governed by a red-green coalition who supported the ambitious environmental programme (Vestebro, 2002). When the blue coalition took over in 1998 it decided to convert the environmental programme from being binding to a status of recommendation. Thus, municipal control over the project slackened (Vestebro, 2002).

The blue coalition decided that municipally owned land should be sold to the private sector. Thus the municipality started to sell land on the Hammarby site to private housing and construction companies. They argued that land lease contracts could include clauses about environmental standards, but the reality was that selling the land made implementation of the environmental programme (and energy standards) much more difficult (Vestbro, 2002). This example illustrates the fallibility of using planning controls rather than statutory building regulations to ensure high energy standards are achieved in new development.

Poor energy performance was also explained by the energy consumption patterns of those living in the neighbourhood. Few of the units were fitted with metering systems (Stoll, interview, 2009). Thus energy awareness amongst residents remained low. This exemplifies the problem of adopting an entirely passive energy system. Engaging residents more in the process of financing, designing and operating the system might increase their energy awareness and reduce consumption.

Hammarby residents tended to be more affluent and thus could afford to spend more on energy (Exploateringskontoret, 2005). Improving the thermal efficiencies of housing units to an extent led to increased consumption of energy for appliances. Smart metering (interactive post-occupancy monitoring) could help to overcome this lack of energy literacy within the community, engage households in energy management and help to reduce CO_2 emissions.

The Facilitative Role of Planning

The model for city planning—the "Stockholm process"—was created through the development of Hammarby Sjöstad (Inghe-Hellström & Bjurstrom, 1997; Svane, 2005). In principle the "Stockholm process" is an iterative, dynamic and collaborative process which brings developers, municipality and those delivering the infrastructure to work alongside each other at the earliest possible stage in the development process (Stoll, interview, 2009). The planning authority in this model co-ordinates and encourages all the different interests in the plan, rather than enforces the vision. It also stimulates a learning process amongst producers (developers and utilities).

The city formed a development administration for Hammarby with its own project budget, a CEO and an environmental unit. The group had visioning, planning and facilitation functions (Stoll, interview, 2009). The development administration brought together the municipality, developers and utilities to work on a single vision for Hammarby and was able to apply for national and city funds for the development (Stoll, interview, 2009).

An overall vision for the project was developed by the group. The energy, water and waste partnership produced the vision for the integrated closed-loop system (Stoll, interview, 2009). The planners in the project group developed the master plan for the site alongside the infrastructural system (Stoll, interview, 2009). Twelve development districts were identified and handed over to a designer and builder. Competition (technical competitions) between developers was encouraged to try and achieve the best possible environmental design (Stoll, interview, 2009).

The municipality held open meetings with all the developers putting in proposals for the site (Stoll, interview, 2009). The developers had to present their projects every couple of months to their peer group (Stoll, interview, 2009). This enabled the transfer of information about innovative technologies, designs and approaches to construction between those working on the site (Stoll, interview, 2009). In theory, this helped to build capacity amongst developers to deliver buildings constructed to higher energy standards. Yet in reality, new developments did not achieve the energy standards set (for reasons explained earlier). The success of this approach hinges on post-construction monitoring and enforcement of standards.

Strategic Role of Planning

Urban form and land use are hugely influential in the successful delivery of low carbon systems (Williams, 2011). Urban densities, mixture of land use, population size and the availability of resources within the city-region all influence the technical viability of low carbon systems (as demonstrated in Freiburg). For example, dense mixed-use neighbourhoods support district energy and public transport systems. This has been recognised in Stockholm and informs the strategic plan for the city.

The municipality in Stockholm has coordinated historically spatial and infrastructural planning (Stoll, interview, 2009). Thus, the optimal solutions for the provision of energy, water, waste and transport infrastructure to new development sites have been considered during the planning process. There is nothing particularly remarkable in this; however, close collaboration between the municipally owned utilities (energy, water and waste)— and the urban planning department resulted in the development of the prototype integrated closed-loop energy system (Stoll, interview, 2009). The importance of this relationship should not be underestimated. It was crucial for the creation of the closed-loop system. Since energy provision is no longer in the control of the municipality (after Stockholm Energi was taken over by Fortum Energy in 2002), coordination has become more difficult (Stoll, interview, 2009).

The role of planning has changed in Stockholm since the initial development of Hammarby. It is now focused on coordinating and encouraging collaboration between key stakeholders (i.e. utilities, developers, community and municipality) in the development process. To an extent this more deregulated model (resulting from the privatisation of the utilities and reduction in planning powers) has undermined the more strategic approach to spatial and infrastructural planning adopted previously, producing more *ad hoc* results (as demonstrated by the Royal Seaport, Stockholm (Williams, 2011).

Reflections

These examples present two very different approaches to the implementation of low carbon neighbourhoods. The role of planning in each case is also different. The regulatory role of planning is important in both cases, although it is not the focus (Table 2). Hammarby demonstrates post-construction enforcement of standards and post-occupancy monitoring is needed if environmental standards set by the planning authority are to be achieved. Further, it suggests that environmental standards may be better enforced through statutory building code, as planning policy and process is often subject to political change which may undermine achievement of environmental standards. However, Vauban demonstrates that the flexible nature of planning conditions can be useful in encouraging innovation in contexts which are suitable, whilst not enforcing high environmental standards where development is already difficult.

Table 2. Comparing planning approaches.

	Vauban	Hammarby Sjöstad
Carbon production in neighbourhood (tonnes per capita per annum)	0.5	2.5–3.0
Regulatory role	Yes	Yes
Strategic role for planning	Not used for Vauban	Yes (focus)
Facilitative role	Yes (focus)	Yes
Facilitative focus	Consumers	Producers

Source: Author.

The facilitative role of planning is used in both case studies and is equally important, although more successful in delivering carbon reductions in Vauban. In Vauban the focus on the community helps to build support for new systems and adoption of new lifestyles. It seems to produce a greater reduction in CO_2 emissions. However, the success of this approach is context dependent. In the right cultural context a more bottom-up approach to planning, in conjunction with public funding, could help to facilitate the transition to low carbon systems. In Hammarby the facilitative process focuses on producers. In theory this helps to build capacity amongst producers to deliver low carbon development. However, in practice it doesn't seem to have been that successful. The success of this approach hinges on post-construction monitoring and enforcement of standards.

The strategic role of planning in the delivery of low carbon systems in Vauban was limited, but it was critical to the successful delivery of the closed-loop system in Hammarby. It demonstrates the benefits of strategic planning in designing integrated resource systems and co-ordinating low carbon infrastructure with development. Freiburg (post-Vauban) has developed a very strategic approach to the delivery of low carbon development. Carbon reduction targets are now integral to the strategic planning process. Key energy stakeholders are involved in the creation of the strategic plan. Certainly, this approach has developed rapidly in Freiburg recently. The clash between the strategic plans at a municipal and regional level which limited the development of renewable energy capacity in the city-region has further demonstrated the importance of a strategic planning approach.

The case studies illustrated that different planning approaches produce different types of low carbon systems. The more active system in which residents are engaged energy citizens can be encouraged through a more facilitative planning approach. In this instance regulatory controls and strategic planning can provide a wider context in which the low carbon neighbourhood can operate effectively, whilst the planning process is used to facilitate the involvement of the community in decision-making and eventually managing their own energy systems. For a system where residents become passive consumers, the planning approach is somewhat different. In this instance the strategic and regulatory roles of planning are more important in terms of delivery. Both approaches described here are equally valid depending on contexts and desired outcomes.

The case studies also revealed how planning as a tool for delivering low carbon development can be supported in a number of ways: the municipal ownership of land (Hammarby and Vauban) or utilities, transport and waste services (Hammarby); public funds (Hammarby); political support (Hammarby and Vauban); and cultural context (Vauban). Different planning roles are given leverage by different combinations of these factors. Regulatory and strategic roles are supported by public ownership of resources, public funding and political backing, whilst the facilitatory role is given leverage by public funding and cultural context.

Notes

1. Around 60–70% of Vauban residents vote green. This also translates into green actions, for example only 16% of inhabitants in Vauban own a car, whilst 35% of inhabitants in Freiburg and 65% in Germany own a car.
2. Latest zoning plan deposited in 2010.

3. Primary energy demand for passive house $\leq 120\,kWh/(m^2/year)^2$; low energy home 1 (LEH1) $\leq$ 40% maximum Energieeinsparungsverordnung (EnEV 2009) (Energy Conservation Ordinance) LEH2 $\leq$ 55% maximum EnEV 2009; standard from existing zoning plan $= 65\,kWh/m^2/year$.
4. The administrative coordination of the local authorities dealing with the Vauban project.
5. The main platform for information exchange, discussion and decision preparation.
6. The local citizens association and the legal body of the extended participation process for the district.

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West Village: Development of a New Ecological Neighborhood in Davis, California

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ABSTRACT *In this case study we present the example of West Village in Davis, California, a new ecological neighborhood for 4,200 students, faculty, and staff of the University of California, Davis. With its first phase opened in August 2011, the project includes housing, commercial space, recreational facilities, and a new community college center on 130 acres (53 hectares). We analyze this neighborhood's decade-long planning process and factors facilitating its development. West Village shows that district-scale net-zero electricity development is indeed possible in the USA, although it helps to have a strong institutional sponsor and progressive planning environment.*

Keywords: West Village; ecodistrict; ecological neighborhood; zero net energy; zero net electricity; sustainable development

Introduction

University of California Davis (UC Davis) West Village is a new community in the town of Davis, Californa, that since the start of construction in 2009 has become the USA's foremost example of ecological neighborhood development. Located adjacent to the University of California, Davis campus, near the city of Sacramento, West Village will eventually house 4,200 students, faculty, and staff. The project takes advantage of district-scale design for energy efficiency, drainage, transportation systems, and community vitality. Project developers intend the neighborhood to be net-zero electricity and to have very low motor vehicle usage, among many other green features.

The University of California, Davis is a public university with more than 32,000 students and more than 3,700 contiguous acres (1,497 hectares) in the Sacramento Valley of California. Faced in the early 2000s with limited and increasingly expensive housing in Davis, and the prospect of many students and employees being forced to live in surrounding towns and commute, Chancellor Larry N. Vanderhoef decided to construct a significant new housing community on the campus. By providing rental housing for students and affordable for-sale housing to aid in the recruitment and retention of faculty

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and staff, university leaders aimed to provide all connected with the university the opportunity to live locally and participate fully in the life of the campus.

About one mile from the academic center of the UC Davis campus, the initial 130-acre (53-hectare) phase of West Village will house approximately 1,980 students and when complete will include 343 for-sale homes for faculty and staff. Student apartments opened in August 2011, and a 20,000 square foot (1,850 m^2) classroom and administrative building for the Los Rios Community College opened in the neighborhood center in January 2012. Completed features within West Village include a village square with a central green, approximately 45,000 square feet (4,181 m^2) of retail/office/commercial space around the green, and a student community center building with recreation and study amenities for students. Due to the depressed housing market the for-sale homes will be constructed more slowly than expected, with units built in small phases as homes are pre-purchased.

Figure 1. West Village site plan. The east–west orientation of streets and buildings in West Village makes possible passive solar orientation of buildings. *Source:* Carmel Partners, UC Davis Office of Campus Planning and Community Resources.

Technical Dimensions

From the start, energy efficiency and passive solar design were primary goals of West Village. Following the nearby example of Village Homes, a well-known 1970s eco-development that emphasized energy efficiency (Corbett & Corbett, 2000), the designers created long east/west streets to maximize passive solar heating in winter and minimize unwanted heat gain in summer. This street orientation also maximizes opportunities for rooftop solar panels, which have since been incorporated into every West Village building to contribute to the net-zero-electricity goal, and it takes advantage of the cooling effect of southwest breezes from the Sacramento River Delta on summer evenings (Figure 1).

The initial apartment buildings and village square are designed as a zero-net-energy community, producing as much on-site renewable electricity as they use over the course of a year. The key is energy efficiency: building designs at West Village reduce their energy use by 50-60% beyond the requirements of California's already strict Title 24 energy codes. Photovoltaic panels on building rooftops and parking lot canopies as well as a planned waste-to-energy biodigester will meet remaining electricity needs. The biodigester, currently undergoing a feasibility study using a U.S. Department of Energy grant, would use raw food waste from the campus residence halls, manure from the campus dairy, and green waste as "feedstocks" to produce electricity. Future plans call for extending the zero-net-energy strategy to the for-sale homes and exploring additional sources of renewable energy.

From the start, university planners designed West Village for very low motor vehicle use, relying on its location close to campus and downtown and the already well-developed network of bikeways in Davis (the city prides itself on being the "bicycle capital of the USA"). Off-street bike paths and a grade-separated bicycle bridge across a freeway connect West Village to campus and downtown. The university will not issue monthly parking passes to residents unless special access accommodations are necessary. The campus-operated bus system, Unitrans, runs regular routes to the West Village square, and all residences in West Village will be within a five-minute walk of bus stops. Students support the bus system with annual fees and ride "free" by showing their registration card as they board. In the future other residents will also be able to board free under financial arrangements being worked out. The university hosts the Zipcar car-sharing service on campus, and it is likely that West Village will include shared vehicles through this company or a similar university car-share system. The university is currently exploring an electric car-sharing system that could significantly reduce the transportation-generated greenhouse gases of the community.

To recharge groundwater and reduce the potential for downstream flooding, West Village planners used several strategies to retain storm water onsite. The location is essentially flat, so designers were able to shape the topography to create drainage along perimeter greenbelts and interior "green streets" (with storm water draining to planted islands at the center of a boulevard). High points in each block allow surface drainage to a green belt or green street on either side; overflow moves to seasonal drainage ponds on the north edge of the project. The receiving ponds serve to retain all storm water on the site except in the most extreme flood conditions, and provide a shared open space amenity between the new West Village and existing neighborhoods in the city of Davis. Onsite drainage strategies produced a net financial saving to the project by eliminating the need for most underground piping of storm water.

Unfortunately, the State Department of Conservation categorizes all land on the Davis campus as prime farmland, and as "greenfield" development West Village displaces this valuable resource. At the beginning of the planning process the university recognized that the loss of prime agricultural land can never truly be “mitigated”, but it took action to compensate for the loss by securing and preserving farmland in another strategic location in the region. The campus’s real-estate staff arranged to purchase options to agricultural land at a freeway interchange five miles west of the campus, between Davis and the growing city of Dixon to the southwest. Securing the options opened the door for collaboration among two cities (Davis and Dixon), two counties (Yolo and Solano), and the State of California to purchase the property, deed the development rights to a local land trust, preserve the land in perpetuity as a functioning agricultural buffer between the two cities, and sell the property back into agricultural production. Subsequent to this action several adjacent landowners have moved to place their land in similar trust.

Plans called for West Village to fulfill the social goal of having members of the campus community live close to the university and participate more fully in the life of the university and town. The village square is home to all the highest activity uses in West Village and serves as a common social space and amenity for the West Village community and nearby Davis neighborhoods. The university catalyzed development of the village square early in the project by agreeing to lease back a significant portion of the first floor space around the village square, limiting the developer’s risk and allowing the university to draw on its existing retail, commercial and office needs to populate the first floor around the square.

Following a limited-equity model, sales prices of for-sale housing at West Village will be below the private market and appreciation will be capped on an annual basis to keep the units affordable for future generations of faculty and staff. Given the depressed economy, buyer interest in these units is uncertain as faculty and staff can now find relatively inexpensive units in other parts of Davis without provisions that restrict appreciation. However, in a stagnant or declining market, limited equity provisions may have advantages for buyers. Owners within a similar, much smaller housing project piloted by the university 15 years ago now see their homes appreciating at the capped rate annually while prices of homes in the private market are falling. Approximately 60% of West Village’s for-sale homes will also include second units to expand options for unique family needs or to provide rental income, further assisting with affordability.

Process of Implementation

Although the need for additional housing had long been apparent to university administrators, in 1999 the citizens of Davis approved a ballot measure (“Measure J”) requiring voter approval before development of agricultural or open-space property at the urban edge. In light of this constraint on the prospects for additional private sector housing, the university decided to use its long range development plan (LRDP) process to test ideas for a substantial housing community on campus. The university engaged a planning consultant team to help produce this plan and conduct the public process. The consultant team included MIG, from Berkeley, California, a firm well known for actively engaging the public in planning, and McDonough Associates, led by Bill McDonough’s well-articulated vision for “ecologically effective” planning. This team spent much of the 2000–2001 academic year analyzing the university’s growth needs and associated land-use requirements for facilities, infrastructure, open spaces, housing, and parking.

Early in the planning process, McDonough gave a free community lecture in a local theatre titled, “What does good growth look like?” In a community where “growth” had such a negative connotation that it was termed “the G word”, McDonough painted a picture of how urban growth could yield positive results for social and environmental systems. This "good growth" framework shared by McDonough had a strong influence on the university's conceptual approach to what later became UC Davis West Village.

The public portion of the process began in the spring of 2001. Though the city did not have approval authority over the campus plan, university leadership felt that an engaged public planning process was essential to gaining local understanding, if not support. With MIG's help, the university began the process with a land-use game crafted to allow all attendees at public workshops to create their own long-range development plan for the university. Seven out of eight teams arrayed new housing growth on campus land as close as possible to the academic core of the campus, rather than placing new student and employee housing much further away in cities other than Davis.

Much of the public process that followed the initial land-use game revolved around the size and extent of the planned community, which the university reduced in size twice in response to community concerns. Planning began with the concept that the neighborhood should include a village square as the social, commercial, and physical heart of the community, and that this center should be a shared amenity with other Davis neighborhoods. However, as the adjacent neighborhood groups sought greater insulation from the potential visual and traffic impacts of the development, planners had to move the village square to the center of the site, farther away from existing housing. This design change was unfortunate, as it meant that this central gathering space would not be as easily accessible to existing city residents. In response to neighborhood desires, backed by the Davis City Council, the university also eliminated direct street access from the surrounding city neighborhoods, leaving only bicycle and emergency vehicle connections.

Although residents in the two existing neighborhoods immediately north of the West Village site remained vocal in opposition, most participants within the public processes looked favorably on the idea that the university was planning to provide housing for its own growth. Throughout the remainder of the LRDP process the university developed two basic options, with multiple variations on each. The first included a new campus mixed-use neighborhood, while the second portrayed the same university population and facilities growth without a new residential neighborhood, creating the need for new students, faculty and staff to commute from surrounding communities. This strategy was an attempt to promote a community dialogue about the social and environmental pros and cons of providing local housing.

The University of California Regents approved the 2015 UC Davis Long Range Development Plan and its associated Environmental Impact Report in November of 2003 (Table 1). As frequently happens with large development projects in California, which has a strong state environmental review law, a neighborhood group then filed a lawsuit alleging inadequacies in the environmental analysis. The suit and subsequent appeal took about a year to resolve; both the lower court and appeals court sided with the university. This lawsuit delayed selection of a developer, and it could have delayed the project more seriously if the developer had already been chosen and then was unable to raise money because of the pending litigation.

Given constraints on university funding in a time of statewide budget cutbacks and the demands for investment in teaching and research facilities, constructing West Village was not possible without private investment. The university did, however, own the land, and invested approximately $17 million bringing utilities to the border of the site. It then sought a private sector development partner able to finance the construction. University planners received 19 developer submittals in 2004, and chose as the developer the West Village

Table 1. UC Davis West Village timeline

2000	Planning initiated through the university's LRDP process
2001	William McDonough provided "good growth" inspiration
	Workshops with Davis residents favor on-campus project
2003	UC Regents approved LRDP, Neighborhood Master Plan, and Environmental Impact Report
	Neighbors filed suit
2004	Lawsuit decided in favor of the university
2005	Developer selected and WVCP established as a joint venture of Carmel Partners and Urban Villages
2006	University developed West Village Implementation Plan to provide more detailed design guidance
2007	UC Davis Energy Efficiency Center completed first net-zero-energy study
2008	Ground lease negotiations completed between WVCP and UC Davis
2009	University awarded three state and federal grants for net-zero-energy planning and design
	Construction of community college center began
2010	Construction of residential buildings began
2011	Completion of initial phase, initial occupancy, and opening ceremony

LRDP, long range development plan; WVCP, West Village Community Partnership

Figure 2. Aerial view of West Village under construction. West Village consists of 1,015 student housing units in three- and four-story apartment buildings and 475 faculty/staff housing units in townhouses and single family homes, grouped around a village square with commercial, social, recreational, and community college facilities. *Source:* Carmel Partners.

Community Partnership, LLC, a partnership of Carmel Partners of San Francisco, California and Urban Villages of Denver, Colorado. These parties brought to the table extensive experience with New Urbanist-inspired infill development and expertise managing student housing elsewhere in California. The developer agreed to invest approximately $280 million in community infrastructure, residential buildings, urban amenities and open spaces to complete the first phase of the community. The university

Figure 3. West Village Square. West Village is oriented around a central square. Building roofs are covered with photovoltaic panels, and strategically placed shades prevent the sun from overheating buildings. *Source:* Photograph by Stephen M. Wheeler.

retains ownership of all land, established the design framework within which development occurs, and receives a fair market return for long-term leases with the developer.

In terms of ecological design, the University's planning team followed McDonough's lead in pursuing a vision of sustainability based on the three Es during its continued development of plans for West Village. Many of the features described earlier helped meet the environmental "E". Equity benefits primarily took the form of affordability for staff and faculty and greater convenience for all residents compared with living farther away. Inclusion of a community college providing relatively low-cost education to lower-income students and a potential entryway to a four-year university degree can also be considered an equity benefit. Economic considerations revolved around ensuring the university—a public institution after all—a fair market rent for its land, ensuring the developer a reasonable profit from its investment, and accessing several hundred million dollars worth of private investment and numerous jobs for the city and surrounding communities.

Planners then added a fourth E to their sustainability model to reflect the project's context—education. Constructing a new community on a university campus offers unique opportunities to promote ecological education and engage the teaching and research faculty in the conception, execution, and evaluation of the community. In particular, starting in 2006, planners involved the Graduate School of Management and UC Davis Energy Efficiency Center in developing an initial roadmap to net-zero energy. Faculty in the UC Davis-hosted California Lighting Technology and Western Cooling Efficiency Center have also contributed expertise to the project and served as judges at a technology

Figure 4. On-site drainage. Water from many public spaces at West Village drains first into swales planted with native vegetation, and then into a larger constructed wetland. *Source:* Photograph by Stephen M. Wheeler.

showcase where private sector companies were invited to share energy-efficiency products just arriving in the market. Faculty in the Department of Agricultural and Biological Engineering are included on grants assessing the viability of the waste-to-energy biodigester. The post-construction evaluation phase is likely to involve many additional faculty and students.

The LRDP and a subsequent West Village Neighborhood Plan approved by the university Regents did not include a strategy for energy-efficient buildings or zero-net energy. Shortly after the formation of the new UC Davis Energy Efficiency Center (EEC) in 2006, with the developer team already selected, the university planning office commissioned this organization to outline the technological and financial innovations necessary to achieve zero-net energy at UC Davis West Village. Andy Hargadon, a professor in the Graduate School of Management and founding director of the EEC, assembled an advisory committee of energy professionals, utility representatives, and bankers, as well as a team of graduate students to develop "packages" of energy-efficiency measures and investments that could help the project increasingly approach zero-net energy. Through this process it became clear that the most cost-effective strategy was to work at a neighborhood-wide level to achieve economies of scale.

Following the EEC report the developer teamed with Chevron Energy Solutions from San Francisco to further refine proposals for a zero-net-energy community. The agreed-upon vision called for energy-efficiency measures to reduce the need for energy to the point where all supply could be generated on-site using renewable sources. The original concept envisioned a stand-alone community energy system capable of functioning independent of the utility electrical grid, using a fuel cell and battery system for on-site storage of electricity. This model did not prove financially feasible, and the final proposal integrated renewable energy with the utility grid, using the grid as the "battery" that supplies power when production from on-site renewable sources is low, while the neighborhood's photovoltaics contribute power to the grid at times when production is greater than needed.

Based on the university's goal of maintaining affordability and the developer's drive for cost effectiveness, the shared objective was to accomplish zero-net energy with no increased cost to the future residents of UC Davis West Village. To help meet this goal the university submitted successful proposals for three grants to assist with the costs of planning and engineering the zero-net energy system at a community scale. These grants totaled $7.5 million from the California Energy Commission's Renewable-Based Energy Secure Communities program, the U.S. Department of Energy, and the California Public Utilities Commission. Two of the grants provide funding for the university to issue recommendations on simplifying or altering existing state energy policy to facilitate the production of similar communities in the future.

The developers broke ground on the Los Rios Community College center in West Village in 2009, and on the residential apartments in 2010. Construction proceeded rapidly, and in August 2011 the first students moved in (Figures 2-4). Planning continued for later phases of the project, in particular to work out net-zero-energy provisions for the for-sale housing, and to analyze options for the large-scale biodigester in conjunction with relocation of a dairy on campus. The university will need to reach new agreements with the developer for these phases.

Political, Economic, and Community Context

Development of West Village has taken place within a context of relatively progressive and environmentally oriented politics in the City of Davis and northern California generally, a strong economy and high housing prices followed by a prolonged economic slump, and a slow-growth local community environment. Each of these factors has had major influences on development of the project.

The environmentally oriented politics of the city, state, and region helped create a context in which planners could start with a relatively strong vision of an environmentally sensitive neighborhood and then improve it over time. The City of Davis, for example, has a history of promoting bicycle and pedestrian transportation, energy-efficient development, and compact urban form, and planners assumed from the start that such goals would underlie the project. The Village Homes neighborhood—after 35 years still the nation's leading example of ecological suburban development—is less than a mile away from the West Village site. Principles such as passive solar design and on-site drainage pioneered at this well-known model seemed only natural for West Village as well. At a regional scale, the Sacramento Area Council of Governments spearheaded a regional visioning exercise known as the Blueprint process in the early 2000s that called for compact development within or contiguous to existing towns and cities. This vision also supported the emerging West Village plan. At a state level the 2006 passage of AB 32, the California Global Warming Solutions Act, established a statewide planning initiative to reduce greenhouse gas emissions (State of California, 2011). This and related initiatives, such as the 2008 SB 375 legislation requiring regional plans for reduced motor vehicle-related emissions, created a context which likewise encouraged highly energy-efficient development.

Economic factors, especially the extraordinary rise in housing prices in the 1990s and early 2000s, provided much of the impetus for the West Village project in the first place.

University administrators perceived a strong need for affordable housing for faculty, staff, and students, and as noted above, wished that housing to be located close to campus to reduce commuting. The housing market slump beginning in the late 2000s then changed the project context, especially for the for-sale units, in ways that may affect future build-out.

Lastly, the slow-growth community context with the City of Davis stimulated initial project planning, since university planners thought it unlikely that private development would be able to provide sufficient housing supply. Community desires also altered design details of West Village, for example to move development farther away from existing neighborhoods and to eliminate street connections. At the same time, the strongly pro-environment views of Davis residents encouraged planners to make the project highly green in order to gain community support.

Surprises

Although many elements of West Village evolved over its 11-year planning period, probably the biggest surprise for project planners was the crash of the housing market beginning in 2008. Median home prices in nearby Sacramento County fell from $392,750 to $169,900 between August 2005 and April 2011, a 57% decline (Brooks, 2011). Although prices in Davis declined less, about 21% between 2007 and 2011 (Zillow, 2011), this phenomenon meant that the market for the West Village for-sale housing became uncertain, and undercut the rationale for limited-equity housing. The developer has responded by planning to construct homes only when pre-sold, which is likely to slow future build-out of the neighborhood. Luckily, West Village's initial phase of apartment housing rented up quickly in 2011, meaning that economic woes seem unlikely to hinder the rental portion of the project.

Another unexpected but welcome occurrence was the evolution towards net-zero-electricity status. Although the university and later the developer team set out in the early 2000s to incorporate best practices of town planning and environmental design, net-zero-energy considerations did not emerge until well after the original plan was approved in 2003. The growth of the Energy Efficiency Center and related technical expertise on campus, the success of the planning grant proposals, and rising statewide interest in mitigating greenhouse gas emissions all played a role in helping the project evolve in this direction. Specific energy systems also changed as the project evolved. For example, all the solar panels were originally going to be aggregated into large-scale community solar farms to take advantage of economies of scale. However, regulatory incentives did not favor such centralized systems, and the plan was altered to include a combination of rooftop and parking lot photovoltaic panels totaling 4 MW.

Analysis

One main factor that helped this project come to fruition, as with so many other innovative neighborhood developments in the past, was the presence of a powerful project sponsor. UC Davis is a very large institution, owns the land, provided a built-in market for the units, mobilized extensive staff time to plan the project, and, as a state agency, is exempt from the need for local planning approval. Although the university is not financing the development of the site itself, following the New Urbanist tradition, it established very clear development guidelines through the LRDP, Neighborhood Master Plan, and West Village Implementation Plan. The university also mobilized expertise to help develop the net-zero-energy plan, and was well-positioned to secure the state and federal planning grants that assisted in implementing this strategy.

Still, even a large institution such as UC Davis could not have pursued this development independently, and a second main factor behind the successful construction of this ecological district was the establishment of effective and creative partnerships. The West Village Community Partnership was perhaps the central player, but the success of the West Village Energy Initiative rested on additional partnerships with the UC Davis Energy Efficiency Center and the participants in their original zero-net-energy study, as well as the California Energy Commission, the California Public Utilities Commission, the US Department of Energy, and Pacific Gas & Electric. Also crucial to various aspects of the project were a number of formal and informal working relationships between UC Davis, the UC Office of the President, the Los Rios Community College District, city staff, elected officials, neighbors, and centers on campus, in addition to the Energy Efficiency Center such as the Institute for Transportation Studies, the Water Energy Efficiency Center, the California Lighting Technology Center, and the Western Cooling Efficiency Center. Effective coordination between this large constellation of players was crucial.

The public/private nature of the West Village project provided leverage in a number of ways. As a state agency the University was able to create entitlements for development, removing an enormous hurdle for the private developer. It also provided the land (at a fair market lease) and was able to obtain energy planning grants, which were only available to public entities. For its part, the developer was able to secure financing for the project, which the university would not have done, as the first call on its capital funds is for academic buildings and support facilities. The developer also took advantage of tax credits and incentives only available to the private sector for implementing the energy plan, and brought financial analysis and construction experience to the energy efficiency and renewable power investments. The project provides benefits to both public and private parties, positioning the developer as a sustainability leader in the marketplace, and enhancing the University's role as a sustainability leader within academia.

The decision to create a district-scale development afforded planners opportunities to pursue a systems approach to multiple aspects of the community, including social structure, transportation, open space, landscape, water use, and energy. This approach enabled cost-effective zero-net-energy strategies that would not have been possible had development proceeded within a building-by-building framework, and allowed planners to produce a truly comprehensive energy package. The diverse mix of elements within the project also enabled it to survive and move forward in difficult economic times. When demand for faculty and staff housing fell due to a weak housing market, the developer was able to take advantage of strong demand for student housing to proceed with the first phase. Having the community college in the mix also enabled construction to move forward, since that institution possessed a voter-approved bond for its facilities.

Ironically, green design rating systems were of limited help in the planning of West Village. The pilot program for the U.S. Green Building Council's LEED-ND rating system only opened in 2007, well after the project was underway, and the American Society of Landscape Architects and other groups did not release their Sustainable Sites rating system guidelines until 2009. University planners consulted the LEED-ND draft as an informative checklist for the potential scope of sustainability measures. However, actual certification would have been difficult as one of the LEED-ND prerequisites is to avoid agricultural land with prime soils. Project planners did deliver on a successful initiative to create an agricultural buffer in trust at a location near a freeway interchange about five miles away, thus offsetting the project's use of farmland, but this ad-hoc arrangement might not have qualified for an exemption under LEED-ND guidelines.

Conclusions

UC Davis West Village is well-positioned to become the USA's leading example of ecological neighborhood development. Its low-energy design, bicycle transportation emphasis, relatively high residential density, on-site drainage, community-oriented facilities, and affordable housing components embody many goals of sustainable development. The project shows that district-scale net-zero-energy development is indeed possible in the USA, although it helps to have a strong institutional sponsor and a progressive planning environment.

The project's actual performance on most dimensions will not be known for several years. Research is needed to document actual energy consumption and motor vehicle usage by inhabitants, energy performance of buildings and components, drainage and habitat function of West Village landscapes, and the extent to which residents and visitors are satisfied with the project design. UC Davis faculty and research scientists are already planning to conduct such research, and so a comprehensive evaluation should be possible in a few years' time.

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The Aldo Leopold Legacy Center: Expanding the Definition of "Community" in Carbon Management

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ABSTRACT *This paper describes the development of a carbon neutral building integrated with environmental and land-use management practices for the Aldo Leopold Foundation near Baraboo, Wisconsin. A collaborative effort between the foundation staff and the building design team resulted in an innovative net zero energy and carbon neutral facility for a not-for-profit organization*

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dedicated to advancing the understanding, stewardship and restoration of land health based on the principles of Aldo Leopold. In addition to describing the energy performance of the facility, the paper describes the methodology for calculating the carbon emissions balance for the building, organization, and managed forest.

Keywords: Aldo Leopold; biotic community; carbon neutral; net zero energy

Introduction

This paper presents a case study of the planning, design and construction of a net zero energy, carbon neutral building and landscape for the Aldo Leopold Foundation near Baraboo, Wisconsin. One of the unique features of this project was a collaborative decision by foundation staff and the design team to connect ecological forest management with the design, construction and operation of a new building. In addition, the programming of building energy demand and carbon emission goals between the foundation and design team resulted in a project with a higher level of performance than the majority of buildings in the USA, setting a precedent for future attempts to reduce carbon dioxide emissions from the built environment.

Aldo Leopold (1886–1948) spent his adult life researching and revealing the relationship between humans and nature. In the mid 1930s, he started the world's first academic department of Game Management (eventually Wildlife Ecology) at the University of Wisconsin. Around the same time, he purchased an abandoned farm along the Wisconsin River where he and his family renovated a chicken coop into a retreat called the Shack, now a National Historic Landmark in the USA.

At the Shack, the family observed nature and restored health to the land by planting acres of prairie and roughly 48,000 pine trees (referred to here as Leopold Pines). Leopold chronicled his observations in *A Sand County Almanac* (1949, p. 224), which he concluded with an essay entitled *The Land Ethic* that states: "A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise." Today we typically define sustainability in anthropomorphic terms, the most quoted example is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, opening lines of Chapter 2). Aldo Leopold gave a more encompassing ethical statement of sustainability relative to all life on earth.

After Leopold's death in 1948, his wife Estella and their five children continued to manage the Leopold Pines along the Wisconsin River. In 1982, the Leopold children formed the Aldo Leopold Foundation to further the idea of a land ethic. The Aldo Leopold Foundation assists in coordinated management of thousands of hectares of their own and partnering natural areas. Despite the complexity of land types, and differences in values among partners, clearly defined goals and measures of success have proven possible within this landscape. Usually taking the form of an adaptive management cycle, new data informs old, and efforts reach ever closer to meaningful ecological health and integrity.

By the mid 1990s, 60 years after planting the pines, the Leopold Pines needed thinning to maintain health. At the same time, the Foundation had outgrown its office space, a rented house in Baraboo, Wisconsin. The Foundation Board and staff decided to build a new facility as a demonstration of Leopold's land ethic. The foundation decided that a carbon neutral building, a new concept at the time of a structure that would not result in net carbon emissions to the atmosphere, would align with Leopold's land ethic. Carbon neutrality was therefore the primary requirement for the new Aldo Leopold Foundation headquarters.

A harvest in the Leopold Pines stand could both maintain the health of the stand and be available for the building structure. Health and longevity of the remaining Leopold Pines was paramount; the harvest focused on poorer quality trees. In addition to the pine stands, the foundation owned a stand of mixed hardwoods. In the absence of active management, this stand would eventually lose its oak component and capability with the management of surrounding plant communities and larger conservation directives. Harvested maple, cherry, aspen and some black oak reasserted oak dominance and the potential for oak regeneration in the understory. This harvest also yielded material for the new headquarters. The sustainable harvest of the 3.64-hectare Leopold pine forest and 8.09-hectare oak forest was certified under Forest Stewardship Council (FSC) guidelines. After the harvest was complete, the foundation hired a commissioning agent, an architect and a construction manager, all with experience in the design and construction of green and LEED certified buildings.

Initial Resource Programming and Environmental Goals Meeting

In December of 2004, the Foundation staff and Board of Directors met with the commissioning agent, the construction manager, architect and the architect's ecological consultant to determine environmental goals for the building design. As part of this process, the team considered LEED Certification from the U.S. Green Building Council (USGBC).

LEED, which is an acronym for Leadership in Energy and Environmental Design, provides a list of energy and environmental prerequisites and goals grouped into six areas: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality and innovation and design process. The total number of credits a project receives determines the certification level of the building, the highest level being platinum.

While carbon neutrality was the ultimate goal for the facility, the foundation board and design team also set LEED platinum as a design goal for the building. The LEED protocol did not provide guidance for achieving carbon neutrality or for being a net zero building. Therefore, the first task of the team was to define the meaning of these two concepts.

First, fossil fuels would not be used in building operations. Electricity and wood would be the only two energy sources permitted for use in the building. Wood was available from the managed forest stands; photovoltaic panels on site would generate electricity. To be carbon neutral, the building would need to be at least net zero in its energy use. Net zero was defined as generating as much renewable energy on site in a year as the energy consumed in the building during the year. Energy used by staff to commute to the building would also be included in carbon emissions accounting.

Carbon sequestered each year in the managed forests would be considered in carbon accounting for the foundation operations. Carbon emissions occurring during building construction fell outside the boundary of carbon analysis as information on embodied energy and carbon emissions for equipment and manufactured building products was not readily available. However, quantities of material going into the building would be documented to allow a partial evaluation of carbon emissions due to construction. This boundary for counting carbon flows was later expanded to include air travel by the staff for foundation business, waste disposal and energy consumed by foundation equipment (tractors, trucks, etc.) With a boundary for carbon emissions calculation and a working definition of a net zero building, energy utilization intensity (EUI) goals and renewable energy generation goals could be established.

The typical approach to high performance building design is to consider renewable energy systems after designing an energy-efficient building. The design team developed a different approach, one that is applicable to net zero buildings and net zero communities. An EUI goal for the building was set allowing an estimate of the projected annual energy use. EUI is defined as the annual building energy consumption per unit building floor area. Measured values of EUI can be used to compare performance of different buildings or, as in this case, to determine an EUI goal for the building. The projected annual energy use is estimated as the product of the proposed building floor area and the EUI goal. The size of solar photovoltaic array required to meet the projected energy demand with renewable energy can then be estimated.

At a schematic design meeting the ecological consultant presented measured EUI values for nine high performance buildings (presented here in Table 1 along with the EUI average for all office buildings in the USA). The EUI values for the high performance buildings ranged from 18% to 53% of the average EUI for office buildings in the USA. Two of the buildings discussed, the Schlitz Audubon Nature Center and Urban Ecology Center, were designed by Kubala Washatko, the architects chosen to design the Aldo Leopold Legacy Center. The foundation board and design team discussed all nine buildings, including their design and their heating, ventilating and air-conditioning (HVAC) systems, and decided on an EUI goal for the Aldo Leopold Legacy Center of 53.6 kWh/m^2 per year, roughly equal to the highest performing building reviewed at the meeting. The proposed building area was 929 m^2. The estimated annual energy use is the product of the EUI goal and building area, therefore the goal for renewable energy production was roughly 50,000 kWh per year.

Solar photovoltaic systems in Wisconsin typically produce between 1,200 and 1,300 kWh per year per rated kW$_{peak}$ DC of the photovoltaic array. A photovoltaic array rated at 40 kW$_{peak}$ DC was established as the solar photovoltaic array size required to provide 50,000 kWh per year and balance the projected energy demand. By the end of the schematic design meeting the Aldo Leopold Foundation Board and staff along with the design team had defined the boundaries of carbon emissions accounting, set a goal of a net zero building, set an EUI goal and estimated the size of the photovoltaic array required to meet the net zero building goal.

Net Zero Building Design

Every occupied space in the building is daylit and naturally ventilated (Figure 1). The building enclosure insulation levels are twice the local building code requirements. More

Table 1. Measured EUI values for nine high performance buildings in the USA

Building	Annual EUI
Woods Hole Research Center (http://www.whrc.org/)	51.7 kWh/m^2
Zion NP Visitor's Center (Torcellini *et al.*, 2004)	85.2 kWh/m^2
NREL Thermal Test Facility (Torcellini *et al.*, 2004)	89.9 kWh/m^2
Lewis Center Oberlin College (Torcellini *et al.*, 2004)	94.0 kWh/m^2
Schlitz Audubon Nature Center (source: utility bills)	94.2 kWh/m^2
Cambria Office Building (Torcellini *et al.*, 2004)	116.4 kWh/m^2
Big Horn Building Materials (Torcellini *et al.*, 2004)	124.9 kWh/m^2
Chesapeake Bay Foundation (Torcellini *et al.*, 2004)	126.8 kWh/m^2
Urban Ecology Center (source: utility bills)	156.6 kWh/m^2
U.S. office building (http://buildingsdatabook.eren.doe.gov/)	293.3 kWh/m^2

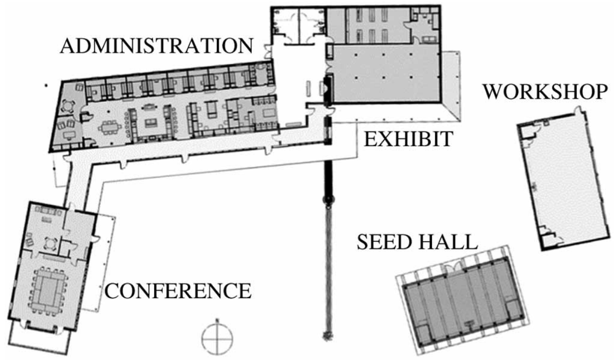

Figure 1. Aldo Leopold Legacy Center Facility Plan Scale 1:1000. *Source:* Michael Utzinger.

uniquely, thermal zoning is employed. Thermal zoning means building spaces are grouped according to common occupancy schedule and thermal comfort requirements. For example, the seed hall, used for classes and prairie plant seed sorting from spring through fall, was constructed as a separate building without a mechanical heating, ventilating and air-conditioning (HVAC) system.

The facility is occupied five days per week during winter and six days per week the remainder of the year. Ground source heat pumps provide hot and chilled water for the air handling unit and radiant floor slabs. The radiant slabs provide thermal comfort. Air is not recirculated, mechanical ventilation provides only outdoor required air. The supply air is tempered by passage through earth tubes before entering the building. Air is exhausted directly from spaces, reducing total fan power. Utzinger and Bradley (2009) provide a detailed description of the HVAC system and the integration of simulation modeling with the design process.

The south facade of the Aldo Leopold Legacy Center is illustrated in Figure 2. The 39.4 kW_{peak} DC photovoltaic array covers most of the south-facing roof. The image is a

Figure 2. Aldo Leopold Legacy Center south facade. *Source:* Michael Utzinger.

Figure 3. Aldo Leopold Legacy Center office space looking west. *Source:* Michael Utzinger.

montage of two photographs shot at 7:53 a.m. solar time on May 25. Sun angles are near the summer solstice in the image. Shading of the south façade and most of the conference wing glazing is evident. When glazing is properly shaded during summer, natural ventilation can be employed as a ventilation strategy.

The interior office space of the building is illustrated in Figure 3. The heavy timber columns and beams as well as the peeled log rafters are pine harvested from the Leopold Pines. Wood for the interior and exterior wall surfaces, ceiling surfaces, trim, doors and built in furnishings was also harvested from forest stands managed by the foundation. In the image, the lights are off and the space is fully daylit. Windows along the south side of the open office and transom windows above the staff offices are operable, allowing cross-flow ventilation when the building is in natural ventilation mode.

The building was occupied in May of 2007. Documents for LEED Platinum certification were submitted in August of 2007. The building was certified at the Platinum level achieving 62 points, the most ever received for LEED certification up to that time. The single Innovation and Design point received for net-zero energy and carbon neutral emissions represented the first time the USGBC recognized a building for carbon neutral operation.

Building Energy Performance

The building uses two energy sources: electricity and wood. The $39.4\,kW_{peak}$ DC photovoltaic system installed on the building and the local power grid provide electricity to the building. Two meters were installed, one to measure electricity produced on site in excess of building demand and distributed to the grid and one to measure electricity from the grid consumed in the building.

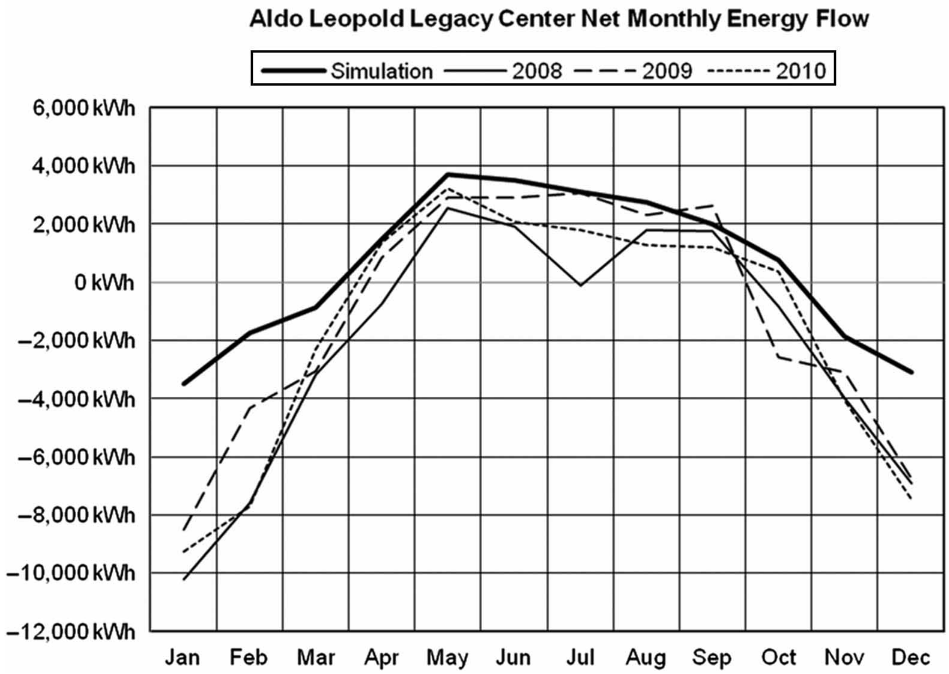

Figure 4. Simulated and measured net monthly electrical energy flow. *Source:* Michael Utzinger.

Defining electricity flowing from the building to the grid to be positive, and electricity flowing from the grid into the building to be negative, the net monthly flow of electricity is illustrated in Figure 4. The graph includes the simulation-modeled electrical energy flow and net measured electrical energy flow for the first three years of occupancy. During summer, when day length is longer, and solar radiation is higher, net electricity flow is from the building to the grid. During winter, when these conditions are reversed, the grid provides electricity to the building. The simulated annual net energy flow is 5.4 kWh/m^2 flowing to the grid, better than net zero.

For the years 2008 through 2010, the net energy flow was −22.3 kWh/m^2, −11.8 kWh/m^2 and −17.0 kWh/m^2 respectively, falling short of the net zero energy goal. There are a number of factors that led to the actual performance being less than the design projection. Measured plug loads were greater than estimated. Snow covering the PV array in winter reduced renewable energy production; annual snowfall totals during the past four winters have exceeded average values.

Wood was used to provide spot heating in the offices, lobby and seed hall and to bring temperatures in the meeting room up from 14°C to 20°C when the meeting room was used. Three half-cord wood storage bins were placed outside the building. After each heating season, the volume removed for combustion in stoves was measured. The first winter slightly more than 2 cords of wood were combusted to provide supplementary heat. An energy audit revealed a problem with the stove in the conference wing. The stove was replaced after the first winter and the new equipment has performed much better. Wood consumption in the past two winters has averaged half a cord of wood per year, equivalent to an EUI of 3.34 kWh/m^2 per year.

Carbon Balance

The design team developed a carbon dioxide emissions accounting structure based on the set of Greenhouse Gas Protocols developed by the World Resources Institute (Greenhalgh, *et al.*, 2007). These protocols call for establishing organizational and project boundaries for carbon dioxide emissions analysis as well as providing techniques for measuring and estimating carbon dioxide emissions, offsets and carbon sequestering. In the protocol, greenhouse gas emissions are divided into three categories:

- Scope 1: Direct—Combustion (stationary combustion devices, organization owned vehicles, etc.),
- Scope 2: Indirect—Electricity (grid purchased electricity, site generated electricity),
- Scope 3: Indirect—Organization Activities (employee commuting to work, building construction, employee business travel, manufacturing processes, etc.). Organizations may also manage land as a carbon sink (i.e. managed forestry).

The Greenhouse Gas Protocols require Scope 1 and Scope 2 carbon dioxide emissions be considered in all organizational carbon dioxide emissions accounting. Scope 3 accounting is optional, at the discretion of the organization.

The organizational boundary for carbon emissions analysis is the Aldo Leopold Foundation. The project boundary for carbon emissions analysis is the new Aldo Leopold Legacy Center, its site, all organizational activities originating on the site, and the managed forest stands that provided materials for the building. Not included are emissions from a house owned by the Foundation and all other forest and prairie lands owned by the foundation. Building construction was not included within the project accounting structure.

Carbon dioxide emissions within the project boundaries are presented in Table 2. Scope 1 carbon dioxide emissions include all combustion emissions with the project boundaries. For the Aldo Leopold Foundation, this includes emissions from the wood burning stoves

Table 2. Aldo Leopold Foundation carbon emissions accounting: First year.

	Total emissions	Emissions per GMA
Level 1 emissions: Combustion on site		
Wood-burning stoves − 0.54 t biomass	0.80 t CO_2	0.70 kg CO_2/m^2
Gas powered equipment—7,950 L	19.44 t CO_2	16.98 kg CO_2/m^2
Total level 1 emissions	20.24 t CO_2	17.68 kg CO_2/m^2
Level 2 emissions: Electricity		
Purchased—45,320 kWh	33.76 t CO_2	29.49 kg CO_2/m^2
Solar to Grid—25,183 kWh	−10.70 t CO_2	−9.34 kg CO_2/m^2
Purchased emissions credit: 33,400 kWh	−10.55 t CO_2	−9.22 kg CO_2/m^2
Total level 2 emissions	12.52 t CO_2	10.93 kg CO_2/m^2
Level 3 emissions: Organizational activities		
Employee commuting—2,044 L	5.00 t CO_2	4.37 kg CO_2/m^2
Business air travel—46,670 km	5.78 t CO_2	5.05 kg CO_2/m^2
Solid waste removal—2.36 t biomass	3.46 t CO_2	3.02 kg CO_2/m^2
Total level 3 emissions	14.24 t CO_2	12.44 kg CO_2/m^2
Total emissions levels 1, 2 & 3	46.99 t CO_2	41.05 kg CO_2/m^2
Annual carbon sequestration in the forest		
Pine forest—3.64 hectares	−24.04 t CO_2	−21.00 kg CO_2/m^2
Oak forest—8.09 hectares	−86.07 t CO_2	−75.18 kg CO_2/m^2
Total carbon sequestration in forest	−110.10 t CO_2	−96.18 kg CO_2/m^2
Net carbon balance	−63.11 t CO_2	−55.13 kg CO_2/m^2

Note: A negative net carbon balance indicates that the overall facility sequesters more carbon than is produced from all of the activities associated with the Foundation.

and emissions from gasoline consumed in organizational vehicles and equipment for land management activities. As mentioned above, approximately one half-cord of wood (540 kg) is consumed each winter generating 0.8 metric tonne of carbon dioxide emissions. In the first year of operation, the foundation purchased 7,950 L of gasoline for organizational activities. Gasoline combustion generates 19.44 metric tonnes of carbon dioxide emissions per year for the organization. The total Scope 1 annual carbon dioxide emissions are 20.24 metric tonnes (17.68 kg CO_2/m^2 per year) with 96% of the emissions from fossil fuels and 4% from biofuels.

Scope 2 carbon dioxide emissions are due to electricity consumption within the project boundary. The average annual electric purchase from the grid for the first three years of operation is 45,320 kWh generating 33.76 metric tonnes of carbon dioxide emissions. The simulation model used by the design team estimated a smaller annual electric grid purchase, 33,000 kWh per year.

A decision was made during design that the electric energy flow from the grid represented carbon emissions to be accounted for in the organizational carbon balance. The local electric co-op serving the building did not have a Green Power Purchase program. In addition, the electric utility neither generated nor purchased electricity from renewable energy. To offset carbon emissions due to electricity from the grid, the foundation did purchase an annual carbon dioxide emissions credit of −10.55 metric tonnes avoided carbon dioxide emissions per year based on 33,400 kWh of electricity generated by a Colorado-based wind farm. The solar photovoltaic system annually generates an average 25,183 kWh of excess electricity sold to the utility during the day, primarily during summer. However, that electricity does not offset carbon dioxide emissions in the grid at the same rate that they are produced. The team assumed that the offset was the same percentage as the wind farm credit, 0.57 kWh of grid electricity offset per kWh of solar electricity sold to the grid. Using electric power grid emissions factors reported by Deru and Torcellini (2007), the total offset of carbon emissions due to solar electricity sold to the grid was calculated to be −10.70 metric tonnes of carbon dioxide emissions per year.

Scope 3 carbon dioxide emissions are due to organizational activities. While not required for greenhouse gas emissions accounting, three organizational activities are monitored by the Aldo Leopold Foundation: employee commuting, air travel and solid waste removal. Commuting activities were determined by employee interviews and estimated at 2,044 L of gasoline per year, resulting in 5 metric tonnes of carbon dioxide emissions per year. Air travel in the first year of occupancy was estimated at 46,700 km. Assuming an efficiency of 25 passenger km of air travel/L of jet fuel, the emissions due to air travel are 5.78 metric tonnes (MacKay, 2008). Solid waste is assumed to be primarily biomass (paper and food scraps) with 2.36 metric tonnes removed per year (6.46 kg per day) resulting in 3.46 metric tonnes of carbon dioxide emissions annually. The total Scope 3 emissions are 14.34 metric tonnes of carbon dioxide (12.44 kg CO_2/m^2 per year) with 76% of the emissions from fossil fuels and 24% from biofuels.

The annual carbon dioxide emissions for the Aldo Leopold Foundation due to building occupancy and organizational activities is 46.99 metric tonnes (41.05 kg CO_2/m^2 per year). 46.3% of those emissions are due to building operations and employee commuting, the remainder is air travel and gasoline consumed in vehicles and equipment as part of land management activities.

Finally, the Leopold pines (3.64 hectares) and oak forest stand (8.09 hectares) are being monitored to determine whether growth rates (carbon sequestering) improved after the harvest. While direct measurements of growth rates have not yet been made, the annual sequestration rate has been estimated from published productivity data for temperate and boreal forests.

Harte (1988) gives average net primary productivity rates of 0.36 kg carbon per m^2 per year for boreal forests and 0.56 kg carbon per m^2 per year for temperate forests. One kg of carbon sequestered in a forest stand per year results in the removal of 3.67 kg of carbon dioxide from the atmosphere. Assuming the two forest stands managed for materials for the building have a net productivity equal to at least 50% of the published average productivity values, the Pine stand will remove 24.04 metric tonnes of carbon dioxide to sequester 6.56 metric tonnes of carbon in the biomass per year. The oak stand will remove 86.07 metric tonnes of carbon dioxide to sequester 22.66 metric tonnes of carbon in the biomass per year. Thus, the managed forests result in removal of 110.1 metric tonnes of carbon dioxide from the atmosphere per year, which more than offsets the 46.99 metric tonnes of carbon dioxide emissions emitted by the organization. While the building fell short of achieving net zero based on energy balance, better than carbon neutrality was achieved for the Foundation's activities.

Comparing required solar photovoltaic area and forest sequestration area against the building area is instructive. The building occupancy results in a net carbon dioxide emission of 21.76 metric tonnes at the average sequestration rate of 9.39 metric tonnes of carbon dioxide removed per hectare per year, 2.32 hectares would be required to balance the building's emissions. In other words, the building requires 20.25 m^2 of healthy forest per m^2 of building to achieve carbon neutral operation. In contrast, 0.26 m^2 of photovoltaic panel per m^2 of floor area are nearly enough for net zero operation. Therefore, balancing emissions with managed forests requires much larger areas of forest relative to the building size.

Conclusion

At one level, this case study of the Aldo Leopold Legacy Center provides us with an applied ecological field study. Ecology embraces the study of species populations, flows of materials and energy, interrelationships among species, spatial and temporal scales of life, stability, mutation and evolution. Accordingly, this paper presents flows of materials and energy of the Aldo Leopold Legacy Center as a function of a unitized spatial variable, building floor area. This information will provide future planning and design teams with the ability to estimate achievable EUI goals, and to determine strategies to produce renewable energy or to sequester carbon through land management. While the case presented is at the scale of a building, the approach would also be applicable to communities or for the establishment of building codes and policies.

As an interpretation of Aldo Leopold's land ethic, this project demonstrates that when planners and designers consider a facility as part of a larger ecological community, net carbon dioxide emissions from the building operation and organization activities can be offset by carbon sequestration in managed forest stands. While the building did not achieve its net zero energy goal, the net consumption of 17 kWh per m^2 per is only 5.8% of the average U.S. office building and 14.8% of the energy required if the building were merely code compliant. Taken together, these two results demonstrate the real possibility of having better than carbon neutral operation of the built environment, opening up new opportunities for design and policies to slow the advance of climate change.

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Low carbon developments as laboratories of innovative planning tools

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The debate around the role of urbanism to reach more sustainable cities constitutes a great opportunity to rethink many of the practices and tools that urban planning develops nowadays. Faced with pessimistic positions that claim the obsolescence of many urban design techniques, there are some determined proposals committed to creating new ways of connecting urban planning and civil society by changing these old devices and creating new ones. This hopeful vision of the role of urban planning demands examples where new management and design procedures can be verified. These examples could provide answers to urban development amidst changing economic circumstances and social initiatives of different natures.

Urban planners, sociologists and architects such as Peter Hall, François Ascher or Rem Koolhaas have pointed out the need for a change in urban planning policies and

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methodologies in order to adapt them to new development paradigms in urban areas. Likewise, these examples of low carbon neighborhoods constitute good laboratories to research new fields such as bottom-up management, integral design of closed-loop urban energy systems, energy savings monitoring systems, new partnering solutions between stakeholders, participative processes and renovation techniques, among others.

The four articles in this Interface symposium represent the urban planning concern with the development of new tools capable of building communities where social cohesion, environmental sustainability and participative management are a must.

It is possible to study different attitudes reflected in the cases that have been presented here. They can be summarized as a call to rethink urban planning as an integrative, interdisciplinary, adaptive and participative tool, which can constitute a useful instrument in achieving low carbon neighborhoods.

Firstly, some of these cases insist on the need to develop technical tools to enable energy-efficient design from a thermal point of view and an adequate monitoring of its energy performance after the building's start-up. In this sense, it is worth highlighting the article by Michael Utzinger and Steve Swenson about the Aldo Leopold Legacy Center, where the different design and resource management tools make it possible to go beyond administrative requirements, reaching extraordinary ratings and showing new research lines to improve energy balance through renewable resources and energy sources.

Another interesting approach is that of integrating buildings' energy performance into a wider range of measures oriented towards closing the metabolic cycle of urban areas in order to minimize the consumption of natural resources (land, water, building materials, petrol, etc.). These include recovering them when possible, maximizing energy performance, restricting mobility (especially private transport), promoting public transport services and minimizing waste emissions (from gases like CO_2or NO_x to solid waste or sewage). Many of these questions entail a close dialogue between environmental policies and urban design.

Jo Williams's article makes a comparative study of Vauban (Freiburg, Germany) and Hammarby Sjostad (Stockholm, Sweden) neighborhoods, showing different proposals oriented towards achieving low carbon communities. In both cases, energy efficiency is conceived as a goal integrated in a broader spectrum of measures to accomplish carbon reductions. However, the success of this objective is subjected to the different attitudes of neighbors and authorities. In this way, Hammarby's proposal is a top-down model where, according to Williams, the planning system's role was "regulatory, facilitative and strategic" and was focused on a closed-loop energy system where residents had a passive consumer role as it was centered on producers' coordination. Nevertheless, "optimal solutions for the provision of energy, water, waste and transport infrastructure to new development sites have been considered during the planning process." On the other hand, Vauban's urban planning system gathers a tool-set of participative dynamics in a bottom-up process, conceived to facilitate proactive attitudes amongst inhabitants. In the first example, the neighbors' social lifestyle does not facilitate this kind of orientation. It is only when population involvement is clear and there is previous energy awareness, as in Vauban's case, that planning can play an important role in designing formulas for proactive communities.

New possibilities in planning processes related to the search for a progressive planning environment and alternative partnering solutions between stakeholders are analyzed by Stephen M. Wheeler and Robert B. Segar in West Village (Davis, California, USA). This partnering solution involves promoters, inhabitants, constructors, technical consultants and others under the leadership of the University of California. In the case of Hammarby, this partnership includes close collaboration between the municipally owned utilities (energy, water and waste) and the urban planning department. Both processes demand strong leadership able to organize the effective participation of stakeholders through discussion forums and representative bodies. In the West Village example, one of the most important tools of this planning system was a long range development plan, a process to test ideas for a substantial housing community on campus. The planning system was conceived flexibly enough to adapt to changing circumstances in the socioeconomic environment, most relevantly including alterations in the real estate market, constraints on funding, delays, incorporation of energy-efficient buildings and zero net energy strategies, regulatory changes and neighbors' demands.

Finally, the article written by Carley Friesen, Björn Malbert and Henrik Nolmark about the Brogården (Stockholm, Sweden) case study reveals a very important issue related to eco-urbanism proposals that are not focused on new developments but on the renovation of postwar residential districts. These areas were built to meet a massive housing demand and currently require a critical reevaluation to update their operating capacity. Holistic planning and a pragmatic process were designed in this case. Initial experiences were used to try different techniques and evaluate the quality of the passive house renovation. In addition, this process was highly participative as different solutions based on residents' opinion were tested on a prototype. The whole renovation process was highly concerned with questions such as those regarding residents' quality of life during renovation.

Even though some important environmental questions such as land consumption have not been raised in depth, many of these examples deal with this issue. Clearly, renovation in urban areas like Brogården is the best way to reduce land consumption, but different strategies that have been developed in other cases are very interesting. In this way, West Village's move to compensate for the loss of prime agricultural land in the new development by securing and preserving farmland in another strategic location in the region represents a partial solution to agricultural land reduction on the Davis campus. This means of compensating for environmental impact by transferring it to other land is also adopted by the Aldo Leopold Legacy Center, which takes into account managed forests in order to achieve zero net emissions.

In conclusion, these four articles provide a broad perspective about low carbon neighborhoods that simultaneously comprises a series of methodologies and innovative resources. These constitute a useful reflection about the adaption of urban planning to community requirements and demands. Moreover, they demonstrate the capacity of planners to deal with urban complexity and develop adaptive tools under changing circumstances.

Integrated planning for ecological urban regeneration

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Considering that the vast majority of housing stock existing in 2011 will be used to satisfy residential needs in the year 2020 and beyond, ecological urban regeneration appears

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clearly as the key issue in relation to global urban sustainability for the most part of this century. Thus, if the 1992 Rio Summit identified the urban environment as the main arena where the global environmental crisis should be fought, 20 years later we must emphasize that it is mainly to the real cities and territories around us now where we should address our attention.

On the other hand, the actual crisis of representative democracy, as well as the growing awareness attained during the last decades about the real complexity involved in the process of decision-making in general and especially in relation with the construction of the city, brings forward the idea of governance as another relevant issue to consider unavoidably when we consider the future of urban planning.

Both issues are somewhat present now in almost every reflection or proposal on progress about urban sustainability, but the debate remains open on both fronts: the usefulness of model ecological cities or eco-cities conceived *ex novo*, as opposed to *ad hoc* regeneration strategies on one hand, and the superior efficiency of a top-down approach led by experts in ecological planning, as opposed to a complex bottom-up approach driven by communities on the other. Naturally, everyday practice shows that there is not really such a clear opposition or gap between the extremes considered for the two issues, but it is important to set practical and theoretical priorities clearly, especially in a moment such as now, of scarcity of financial resources.

It might be useful to use this conceptual framework to analyze the projects of ecological urban planning presented in the four articles published in this issue, as it permits us to set a sort of hierarchy or ranking among them according to their relation to the two relevant issues considered. Naturally, this simple exercise is not intended as a statement about the intrinsic quality of the projects themselves, neither about the coherence between their aims and their results in terms of energy efficiency and low carbon emissions, but rather about their relevance and potential of replicability in global terms.

The proposed ranking would go as follows.

In first position, we would place one of the two low carbon neighbourhoods, Vauban, in Freiburg, Germany, reviewed by Jo Williams in her article, as it reunites several features of significance in global terms: it is developed on a brownfield site by a dense middle-sized city, it combines rehabilitation and change of use of existing buildings with construction of new ones on recycled public land, and it has been developed with a heavy involvement of the community and a decided bottom-up approach with innovative management and financial procedures. In fact, the case of Vauban is considered generally an unavoidable reference for eco-urbanism in the European context, and several other projects on similar grounds have been developed there rather successfully, for instance the French Quarter and the Loretto area in Tübingen, Germany, or the eco-neighbourhood Trinitat Nova in Barcelona, Spain.

The case study of Brogården in Alingsås, Sweden, as analyzed by Carly Friesen with Björn Malbert and Heinrik Nolmark, would share first position or a close second position in this informal ranking. Its main interest lies in dealing with the renovation of an existing development of social housing built within an intensive program of construction known as the Million Programme in the period 1960–1975. Considering that the bulk of existing social housing stock in the European urban peripheries belongs to this period, any experiment addressing energy saving through renovation to passive standards of this type of urban pattern is of crucial importance, furthermore, when it deals synergistically and with a community-driven approach, with a variety of problems, especially the upgrading of the usually shapeless open space between blocks. In contrast with Vauban, in this Swedish operation the residents were not involved from the beginning, although their participation was then fully incorporated. In this instance, we can also find other regeneration projects of similar approach and scale, among them the successful regeneration of La Mina neighbourhood in Barcelona, but none of them so ambitious in terms of energy savings.

The third and fourth positions of this ranking would be occupied respectively by another Swedish case, the low carbon development of Hammarby Sjöstad in Stockholm, also presented by Jo Williams, and West Village, in Davis, California, USA, analysed by Stephen M. Wheeler and Robert B. Segar. The first of these two cases is unquestionably relevant for its large scale (20,000 residents in 9,000 units) and its commitment to energy saving, as well as for the high quality of urban space attained, but the fact of being mainly a new building development on municipality owned greenfields and its rather top-down approach reduces its potential for replicability and exemplarity in relation to the two issues considered.

With respect to the California project, it is a highly interesting experiment in net zero building with a deliberately synergic approach and a wide scope, including crucial aspects such as sustainable mobility and mix of uses, but its relatively small scale and its specific character as a university neighbourhood debilitate its potential for replicability. In addition, the polemical occupation of prime agricultural land for the project, although interestingly off-set through the creation of an agricultural buffer nearby, is somewhat risky as a planning tool when considered from a general point of view.

The remaining project, and the last one in our ranking, is the Aldo Leopold Legacy Center, in Wisconsin, USA, presented in this issue by Michael Utzinger. Consisting of a very rigorous and coherent exercise in energy-saving and bioclimatic design, it is especially interesting for its attention to the life cycle and energy content of materials, components, and processes beyond the usual net-zero building concept, but its unique character and small scale place it off the general framework of comparison set here.

Apart from the ranking here presented in relation to urban regeneration and citizen participation, each one of the projects analyzed has specific aspects of relevance in the face of global urban sustainability, but maybe the most important conclusion is that, within this heterogeneity and diversity, many common features emerge from the whole in a converging vision: the need of an integrated and dynamic approach to urban planning based on the partnership between all the stakeholders involved; the necessity of widening the scope of the energy-saving solutions in order to identify synergies in other spheres beyond the technical one; and the importance of increasing the environmental awareness of the population, experts and decision-makers included, to facilitate and expand the potential of an urban planning that can be truly eco-logical.

Behind the Green Curtain: Shifting Goals and Shifting Roles

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When innovative projects are completed, it is easy to assume that each project represents the culmination of a smooth process with clear goals, cooperative partners, and enthusiastic

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community support. These four case studies help us peer behind the curtain of green design, and they provide us with insight and encouragement to embrace the ups and downs that real projects inevitably bring. These case studies reinforce some of the known challenges of green development. Green development projects are generally longer, due to the extended planning processes necessary for innovation at the systems level. The funding strategies for green development tend to be more complex and the financial viability of on-site, clean energy production is still largely dependent on public subsidies. But these case studies also convey the increasing sophistication in our aspirations and accounting. I have selected two issues to highlight in my commentary. The first issue is how our green development goals are shifting upward in their aspirations from zero-net energy to carbon neutrality. Secondly, despite our increasing technical sophistication, community members continue to play important roles in the advancement of green development projects. Three of these case studies illustrate different approaches to public engagement.

As our knowledge of development's impact on the environment increases, our ability to identify and calculate the impact of related environmental problems expands. This increased knowledge has shifted our notions of what can be accomplished through green design. Early green development projects highlighted consumption and prioritized on-site energy conservation. More recent green development projects have incorporated energy production as a key component of their design. The best of these developments have sought zero-net energy balances, thus equalizing energy consumption through on-site energy production. Some of the latest green development projects up the ante from aspirations of zero-net-energy to carbon neutrality. In the comparison of the Vauban neighborhood project in Freiburg, Germany with the Hammarby Sjostad neighborhood project in Stockholm, Sweden, the author concisely defines the four elements of low carbon development. Low carbon development seeks carbon reductions through higher building energy standards, efficient energy systems, the generation of low carbon energy, and strategies to decrease the reliance on single-occupancy vehicles. While the explicit goal of the West Village in Davis, California, was to be a zero-net-energy neighborhood, their inclusion of alternative transportation, clean, on-site low carbon energy, and off-site land preservation also address green development's third wave of carbon neutrality.

The Aldo Leopold Legacy Center, outside Baraboo Wisconsin, aspires to be both carbon neutral and zero-net-energy. While the Aldo Leopold Legacy Center has not achieved a net-zero energy status, it has expanded its carbon accounting to include the relevant behavior of its employees. Carbon neutrality requires that the center's forested property sequester sufficient carbon to compensate for the employees' car travel to the site and their work-related air travel. The careful documentation of the carbon calculations helps us understand the magnitude of forested area required to sequester carbon and the challenge of including human behavior in our performance assessments.

Public engagement was explicitly addressed in three of the four case studies. In the comparison of the Vauban neighborhood project in Freiburg, Germany with the Hammarby Sjostad neighborhood project in Stockholm, Sweden, the author contrasts the public engagement strategies used in the two communities. The author notes that the high degree of engagement in Freiburg motivated participants to understand how their behaviors contributed to the community's carbon footprint and was an important educational opportunity that may motivate change. Public engagement in the Stockholm development was much less. This author believes this decreased the community education component and reduced the public's support for the innovative project. However, the author notes that engagement processes must be tailored for different communities, and high involvement strategies demand considerable inputs. Interestingly, in the West Village case in Davis, California, its "greenness" helped decrease public opposition.

The Alingsas, Sweden, case described how a modest renovation targeted to improve energy efficiency and increase resident accessibility in an existing apartment complex evolved into an extensive renovation. While the authors rightly encourage the recognition of renovation and passive strategies in green development practice, this case is notable for its sensitivity to an existing community. The design team recognized the strength of the residents' relationships and their concern for the preservation of their community. The design team stressed regular communication with the residents throughout the process, including the creation of a newsletter. Residents were interviewed to determine how the units and buildings could be retrofitted to permit aging in place and better serve their evolving needs. A model unit was created so that residents could see the proposed changes in place and specify desired finish materials and colors for their units. Sustainability in this case meant the consideration of how to sustain and respect an existing social fabric in addition to making structural updates and increasing energy efficiency.

These case studies are valuable contributions to research and practice because they illustrate how green development accounting practices are evolving with our environmental concerns, and they help us to remember the importance of people in these processes.

Creating Post-Carbon Communities: The Return of the Public Sector

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The four articles presented in this issue of *Planning Theory & Practice* consider case studies centered on low or zero carbon emission development. These studies are important explorations of the transition to a net zero carbon emission society. The articles situate planning among efforts to redevelop society in a manner that interrupts human-driven climate change.

Planning will be critical in making this transition both because of its general role in guiding social investment and because of the specific nature of the effort requiring, as Jo Williams notes, a detailed knowledge of local context including "physical form, resource availability, culture, social capital, institutions, political and economic systems" (p. 127). As planners and developers step away from a reliance on fossil energy sources that overpower local differences, a more acute understanding of the particularities of place become critical to the post-carbon planning process.

A central issue presented by these case studies is the essential role of the public sector in driving real change toward achieving a low or zero carbon emission future. This in turn

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raises a second issue, namely the degree to which the private sector can present itself as the primary means toward achieving such a society.

Essential Role of the Public Sector

The majority of the case studies placed the public or non-profit sector in a dominant role, driving the planning process and setting the development agenda. In each of these scenarios the private sector was subordinated to the mandates and authority of the public sector. The public sector (and in the case of the Leopold Center, a non-profit organization) held ownership of the land and placed a premium on the development as a means to educate private sector contractors and the public toward low-carbon outcomes. To achieve this, each case eventually included public input as an important part of the process.

In Davis, California, Vaubaun in Germany, Alingsashem, Sweden, and the Leopold Center in Wisconsin, a broad range of residents, community members and organizations as well as contractors and consultants were invited to contribute their perspectives, influence the development process and learn from its outcomes. The exception to this framework was Hammarby Sjostad, Sweden. In Hammarby Sjostad planning played a less dominant role, taking the often traditional position of facilitator and convener of the process, subordinate to private sector control of the agenda's content. The site, originally under public ownership, was sold off to the private sector following a change in political leadership. In addition, public input was limited to developers, utilities and the municipality.

Results from the first four of these processes were impressive. The Leopold Center, although initially unable to attain its net-zero goals, consumes on a per-square-foot average only 5.8% of the energy required to drive a standard U.S. office building. In Vaubaun, citizen's average carbon emissions are 1/17th of those in the surrounding area. Efforts in Alingsashem, Sweden harnessed low-tech passive house strategies resulting in considerable energy savings and established a collaborative planning process that will be applied to the renovation of the one million residential units constructed during Sweden's Million Programme. Lastly, the University of California's West Village project developed an holistic approach to ecological development that, similar to that pioneered by Vaubaun, included active transportation, water quality, affordable housing and higher residential densities to augment renewable energy and low-energy use building designs.

Results from Hammarby Sjostad, Sweden were less impressive. The "Stockholm Process" approach created in developing this community limited input to "producers", i.e. the municipality, developers and utilities. Consumers were not included because apparently the producers assumed, as does Williams, that "it is an enormous leap for the disengaged, passive and environmentally unaware individuals (probably constituting the majority of citizens living in many European cities) to become active energy citizens" (p. 133).

Given this bias, no capacity was built toward creating such "energy citizens" in Hammarby Sjostad. This, combined with the voluntary and short-term profit focus of design and technology selection driven by the developers, ensured that "the higher energy standards set for the buildings weren't achieved" (p. 135). Per capita carbon emissions in Hammarby Sjostad remained at about 75% of the standard. In addition, participating producers did not show subsequent initiative in adopting low-carbon technologies or developing low-energy communities.

In order to avoid severe global climate change, significant carbon emissions reductions from human-driven development will be necessary. The above case studies underscore the suggestion that public sector planning will need to be at heart of achieving that goal. Furthermore, they suggest that the private sector will need to be a subordinate part in this process.

In each of the four successful efforts, the public (or in one case, non-profit) sector took a long-term, multi-level approach that eventually centered itself on a democratic, participatory process. These elements allowed local knowledge to be harnessed which increased on-site compatibility and efficiency. In addition, the emphasis on participation insured that the groundwork for active energy citizenship was established. In combination these factors opened the path toward impressive reductions in carbon emissions and a more holistic, long-term approach to ecological community design.

Questioning the Role of the Private Sector

These results when compared to the modest gains realized in Hammarby Sjostad where public planning, landownership and participation were subordinated to the private sector raises the question of the degree to which the private sector can present itself as the primary means toward achieving a zero-carbon emissions society. At the 1992 Earth Summit in Rio de Janeiro, the World Business Council for Sustainable Development declared that the private sector alone had the capital, speed, efficiency and flexibility to deliver an ecologically secure planet (Schmidheiny, 1992). Since then, this idea of the centrality of the private sector has dominated the discourse.

The results of these few case studies question this assumption. Their combination of public land ownership, public investment, democratic process, long-term objectives and follow-up evaluation suggest a framework outside standard market relations. While the private sector had a role in each effort, its subordination to the public and non-profit sector’s broader scope of priorities and participation offers an alternate approach to achieve a post-carbon world.

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