Guide to Sustainable Construction in the North Sea Region and its Surroundings

Interreg North Sea Region

lifestyle

Sustainable Technologies
for Your Local Environment

Foreword

Different types of guides and guidelines for Sustainable Construction are emerging on a daily basis around the world. At the same time, new policies and information documents are being issued both on the European level but also on local levels, having an influence on the construction sector by trying to involve them in taking responsibility for the environmental impacts of the houses they build.

As a deliverable of the Interreg III project LifeSTYLE, Sustainable Technologies for Your Local Environment, a guide was created to Sustainable Construction in the North Sea Region and its Surroundings. The guide is created by analysing already built examples which portray different issues for Sustainable Building. Instead of making a list of things one should follow, we have decided to use the term *Learn by example* following the proverb:

If we hear, we forget; if we see, we remember; if we do, we understand.

Unknown author

Best building practices today are mostly isolated cases, unique by their character. They are driven by different circumstances and by different motives. If a proper follow-up was done on the project's performances and results, then it is relatively easy to draw up conclusions and learn from them. Both good and bad cases should be analysed in order to learn the best out of them. Naturally, successful cases have a high potential for mainstreaming, which is what is needed in order to reach the targets set for the construction sector to lower the emissions and improve the energy efficiency of the building stock.

Having all that in mind, an assessment of current best building practices in the North Sea region and its surroundings was a necessary beginning for creating this guide.

Evaluation of building projects and building developments in terms of sustainability is an evolving process. With many people from many disciplines working with many variables, a quantifiable picture of where we stand today can be evasive. However, certain approaches appear to consistently contribute to a new level of standards when it comes to reduction of resource use and improved quality of life.

The North Sea Region has its specifics in terms of city developments and types of construction, compared to the rest of Europe. Climate conditions are one reason for it, but a significant contribution has the level of development of states in the Region.

As much as we intended to do an exhaustive study and provide a good basis for benchmarking of best practices, we realize that some of the cases might have been omitted. It should also be mentioned that our search for best practices doesn't end by finishing this guide, it is a continuous process which will continue in the future.

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BEST PRACTICES IN THE NORTH SEA REGION TODAY (2006/2007)

North Sea Region is limited by its geographical boundaries but the climate conditions in its surroundings are similar. Thus, good examples from the surrounding regions have been included in this guide. They can be found in almost all countries that are partly included in the region: UK, Sweden, Germany, and The Netherlands.

Even though most focus nowadays is given to energy efficiency it is important to remember the sustainable tri-pod and include all aspects in planning for a development.

- **environmental - physical environment**
  - minimal ecological footprint, closing the loops
  - energy efficiency, renewable energy, 0 CO_2 emissions
  - resource efficiency,3R (reduce, reuse, recycle) materials
  - waste and water management
  - infrastructure
  - planning and landscaping
- **social**
  - diversity, safety and security
  - health and well being
  - flexibility, adaptability, attractivity
- **economic**
  - affordable, cost efficient over the whole life cycle

They should however not be looked and treated separately, and a couple of overlapping aspects stick out from the others:

- **socio - environmental:** close human contact with green open spaces
- **socio - economic:** available for all people
- **environmental – economic:** cost – effective and environmental-friendly building

All aspects of sustainability were considered when evaluating and presenting the projects. However, not all projects had a holistic approach.

The search for best practices in the Region has shown that they occur and can be divided according to the type of projects into:

a) Redevelopment of previously occupied city areas
   a. Bo01, Malmö, Sweden, - previously shipyard area
   b. Pilestredet Park, Oslo, Norway – previously hospital area
   c. Solar building exhibition, Hamburg-Heimfeld, Germany – former military site
   Outside the North Sea Region
   d. Hammarby Sjöstad, Stockholm, Sweden – previously industrial area
   e. Bedzed, Wallington, South London, UK – former brown-field area
   f. Vauban, Freiburg, Germany – former military area
   g. Greenwich Millennium Village, London, UK – former industrial site

b) Urban renewal projects, upgrading of existing building stock:
   a. Solar buildings Gårdsten, Göteborg, Sweden,
   b. Hedebygade, Copenhagen, Denmark
   c. Ekostaden Augustenborg, Malmö, Sweden

   Outside the North Sea Region

   d. Glastonbury House, Westminster, UK
   e. Flagship Home, Westminster, UK

c) New city areas:
   a. Braamwisch Ecological Settlement, Hamburg, Germany

   Outside the North Sea Region

   b. Viikki, Helsinki, Finland – eco-community project
   c. Kronsberg, Hannover, Germany
   d. Amersfoort, The Netherlands – 1MW PV building integration of PV cells

d) New buildings with special focus on energy performance of buildings:
   a. Passive houses in Lindås, Sweden
   b. Kvarteret Nornan, Landskrona, Sweden
   c. Brachvogelweg, Hamburg-Lurup, Germany

e) Other types of developments:
   a. William Gates Building, University of Cambridge, UK
   b. Zicer building, University of East Anglia, Norwich, UK
   c. Great Notley Country Park Discovery Centre, UK
   d. UK SmartLIFE business and training centre, Cambridge, UK

A number of mentioned projects cover more than one aspect of sustainability which gives them special value especially if they have succeeded in achieving their goals, and presented the results of applied solutions publicly.

It should be noted that at this time there are many new projects which have started but are not completed and results of their actions are therefore not available. When some interesting projects deserve to be mentioned for future reference it will be noted in the text. Since the intention is to continue the work beyond the time limits for this guide, those cases will be included later on with appropriate information and results.

It is important to draw attention to different programmes and criteria that were developed for guiding and following up the developments. This is most often the case with bigger developments which serve as a demonstration case for local communities with an intention to mainstream the good approaches and results.

REDEVELOPMENT OF PREVIOUSLY OCCUPIED CITY AREAS

With an increasing amount of people moving to the cities, city areas are becoming more and more valuable. Special attention is given to old industrial areas which once occupied peripheral city areas and are nowadays part of the inner city matrix. Other functions such as hospital grounds and military areas are also being redeveloped.
A number of redevelopment projects have been undertaken in specifically Bo01, Sweden, Pilestredet Park, Norway, and Solar building exhibition, Germany.

For former industrial sites, but also other types of sites where a potential pollution might have occurred, an important part of the redevelopment process is **environmental remediation** of the site. It is a costly activity and therefore in most cases special funding is searched for. When sites are bigger, often the authorities are involved in some way or another and funding is provided from different local or national programmes but also the EU. This was the case for Bo01 which as a former shipyard area had received approximately 25 mil Euro from the Local Investment Programme (LIP) and additional 1,9 mil Euro from the EU.

At Bo01, in Malmö, 100% of renewable energy is provided to the area. This is done by utilization of energy from sun, wind and water. Furthermore, to maintain a high level of thermal comfort for the residents of Bo01, the renewable systems have been linked with existing energy systems in Malmö. This provides storage as well as energy reserves for the district, allowing thermal comfort to be maintained.

In the case of Pilestredet Park, a former hospital area, focus was given on **recycling and reuse of demolition materials** in the area. An astonishing 98% (in weight) of demolition materials were reused and 75% of construction waste was reused. Still, **energy issues** were given high priority and high targets were set for energy consumption of buildings.

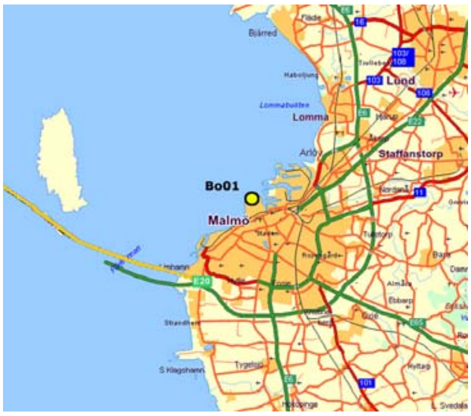
Note that at Pilestredet Park in Oslo there are no solar cells or solar collectors for producing energy. A study was performed on the feasibility for utilizing solar energy at the site and it has shown that the location is not suitable it, having low performance indicators due to too little sunny days.

In Solar building exhibition, in Hamburg, which was a previous military site, goals were set for building low-energy and passive houses with a primary energy use for heating and hot water below 40kWh/m^{2}a. The project doesn't lack other issues, such as the quality of the residential environment and the public space which played an important role in planning.

Outside the North Sea Region it is worth mentioning four projects: Hammarby Sjöstad in Stockholm, Sweden, Bedzed in South London, UK, Vauban in Freiburg, Germany, and Greenwich Millennium Village in London, UK. However similar in nature all of them are different and offer good resources and examples for how to work and, sometimes, how not to work for achieving sustainable construction.

On following pages you can read more about the projects and their specifics.

Bo01



Location of Bo01

Bo01

location: Malmö. Sweden

dates: 1996-2001 Exposition phase, development continues

type: New construction in brownfield / formerly industrial harbour

use: Residential, some commercial, come services

size: 25 hectares, 1000 units supported by renewable energy

people:

actors: City of Malmö; National Board of Housing, Building, and Planning; the Ministry of the Environment; the Swedish Government's LIP Programme; EU; various developers; E.ON Sverige AB, formerly known as Sydkraft (private energy supplier).

goals:
- To be a local, national, and international leading example in sustainable urban development
- 100% locally produced renewable energy from sun, wind, water. "Over the course of a year the electricity and heat produced within the area will at least equal that consumed by its residents".

energy use	KWh/m^2
heating & electric, goal	105
heating & electric, achieved average	120-150
heating & electric, best	87

systems	
district heating	x
combined heat & power	
solar panels	x
solar cells	x
biomass and refuse	x
wind power	x
natural ventilation	x
forced vent.w/heat recovery	x
non-renewable energy	
individual metering	x

Solar panels on top of a building at the waterside

construction
- wood construction
- concrete frame construction w/ infill environmentally certified material use

amenities
- proximity to public transport
- abundant public space
- waterfront access

special projects
- industrial land reclamation
- protection of marine ecology

site ecology
- green space factor
- European village
- wooden houses x 5
- resident participation
- solar thermal panels provide 15% heat
- 2MW wind turbine
- 120 m^2 PV panels
- Underground aquifers
- Biodiversity and quality of life
- Traffic
- Recycling

process and history
The city of Malmö was selected in 1996 by SVEBO, an organization formed by the National Board of Housing, Building, and Planning in Sweden, to host the fi rst European Housing Exposition. The opportunity to host the exposition coincided with the building of the Öresund link between the city and Copenhagen via bridge and tunnel, which would create an instantly expanded and opportunity-rich metropolitan region; at the same time a loss of traditional maritime-based business and economic base as well as an economic recession in Sweden was forcing Malmö to reconsider it's future in a pro-active manner.

European Village at Bo01

Solar panels on the top of a building

The Turning torso

process and history, continued

Coupling the hosting of this exposition with the creation of a new university, all within a redevelopment area adjacent to the city centre, became part of Malmö's plan to capitalize on the interest, energy, and capital beginning to flow into the region due to the Öresund link's realization.

While Sweden has a history of eco-village experimentation, the idea behind this housing exposition was to bring these principles directly into an urban context; creating a viable market for ecological housing in a city then became the primary challenge, and it was decided early on that potential residents should have no limits placed on their urban lifestyle and that ecological goals would be attained in other ways. "Eco-villages had been characterized by a gang of enthusiasts making sacrifices to save the world. This time no privations would be needed in order to help reduce environmental impact. Being able to do so would be both enjoyable and comfortable."(Persson, p.14)

To create the high environmental and social standards around which Bo01 would be created, a Quality Programme was developed over the course of 5 months. This consensus document between the expo organisation, the cit, and the developers, set minimum levels of quality and environmental standards. This Quality Programme was included in the contract when developers purchased lots from the city. The Quality Programme involved the recommendations of experts from many fields, which were then tailored to realistic economic and time-frame conditions.

description of special project features

The organization of the project fell under the following eight focus areas, based on the Quality Programme which had the aim to create the high environmental and social standards around which Bo01 would be created:

- **planning**: creation of a dense and 'living' district. Less quantitative goals for human sustainability and quality of life were pursued along with the detailed criteria.
- **soil decontamination**: the process and procedures for creating housing on formerly industrial land brought about many differences of opinion in both evaluation and remediation; overall, the questions raised and the consensus achieved brought about a greater understanding of the issues and a body of experience to be drawn upon in the future.
- **energy**: creating a "system solution for 100% local renewable energy" has been a unique approach to creating a sustainable city district and has been a successful strategy. While many similar communities focus on reduction in energy use through building construction techniques, Bo01's concept presents an iconic and easy to understand approach of zero energy balance. To maintain a high level of thermal comfort for the residents of Bo01, the renewable systems have been linked with existing energy systems in Malmö. This provides storage as well as energy reserves for the district, allowing thermal comfort to be maintained.

  A nearby 2MW wind turbine provides much of the electricity for Bo01, the rest coming from solar panels (120m^2). 1400m^2 of solar collectors on 10 of the buildings provide 15% of the heating, but a more important source is a heat pump connected to aquifers 90m (297ft) underground. The water in the limestone bedrock is used to provide heat in winter and cooling in summer. Out of 1400m^2 of solar collectors 200m^2 are vacuum collectors (evacuated-tube collectors) while the rest are flat-plane collectors. Bo01 is connected to the energy systems in the city for district heating, district coolong and electricity grid - so surpluses can be used elsewhere in the city, or more can be drawn in if necessary.

- **waste management**: intentions to create a ‘cradle to cradle’ approach to waste for the whole neighbourhood resulted in many recycling and reuse techniques, including neighbourhood source separation, two different organic waste separation systems, and biogas extraction.
- **traffic**: traffic solutions were based on creating as many alternatives as possible for the residents and visitors of this neighbourhood. Bus stops were integrated into the schemes to make them easily accessible, car parking provided was just 0.7 parking spaces per household, and most of the area is open to pedestrians only.
- **bio-diversity in the dense city**: storm-water retention and use of storm-water in water features, as well as habitat-rich green and open space, were integral to the shaping of this development. Tools for increasing biodiversity are used like green space factor and green points list.

  Bo01, in partnership with the city of Malmö, developed a system of ‘green points’. Developers had to choose 10 green points from a list of 35 that they would integrate into their landscape plan. Subject to approval, developers could also create their own ‘green points’. This approach was created so that “the residential courtyards would contribute towards strengthening biodiversity and developing Bo01 into a ‘habitat-rich’ city district.” (Persson, p.51) Planning approval for projects was contingent upon demonstration of these green points. Examples of green points that benefit biodiversity; A bird nesting box for each apartment, bat boxes, part of courtyard left to grow in natural succession, courtyard containing at least 50 Swedish wild fl owers.

  The Green Space Factor, an urban planning principle developed by the City of Berlin, was a requirement for all Bo01 building projects. This works similarly to a fl oor area ratio requirement; a green space factor is required but it is up to the developer how to achieve it. At Bo01, a green space factor of .5 was required. For example if the lot was 50% built up or contained sealed surfaces, receiving a 0.0 rating for that portion, and 50% of the lot contained planting beds on natural soil, receiving a 1.0 rating for that portion, then Bo01’s green space factor of .5 was achieved. There are other ways of attaining this factor of .5, however; green roofs receive a .8 rating, climbing plants covering a specified amount of the building surface can receive a .2 rating, bodies of water on the ground receive a 1.0 rating, etc. “The more heavily the developer chooses to exploit his plot, the greater will be the demands for compensation through various arrangements within the buildings and the plot.” (Persson, p.52)
- **building and living**: variety in building appearances, construction types, and provisions for student and senior housing contribute to a varied population and interesting experience. The adjacency of so many different solutions located in one development provides an opportunity for research into which methods work best when trying to create an energy
- **Information and IT solutions**: consistent with its development as an exhibition project, Bo01 has acted as both site and catalyst for the dissemination of knowledge and ideas. Bo01 and the specific projects within it continue to be evaluated and discussed both locally and internationally. The internet has played a large part in this, including the web-based MiljöTV, an environmental communication tool that serves residents as well as the public at large. Within the project, IT solutions for reading meters and controlling ventilation and energy have been tried and are showing promise as a means to be aware of energy use; also, broadband internet throughout the development can provide residents with a means to work from home, reducing transportation needs.

funding

For the environmental initiatives of Bo 01, the amount of 250MSEK (~25 mil Euro) was set aside by the Local Investment Programme (LIP). Also 1,9 mil Euro was provided by the EU.

results

Best results for energy consumption were measured at the LB house, which consumes 87kWh/m^2 annually - compared with about 200kWh/m^2 for some other buildings in Bo01.

The aim was to transfer the experiences and systems for sustainable city development from Bo01 to the other parts of the Western Harbour. In 2007 the first multi family house using passive house technology is being built in the Western Harbour area, at an area close to Bo01.

contacts: **City of Malmö, general information:** tor.fossum@malmo.se

sources:

- Västra Hamnen, The Bo01-area, A city for people and the environment, A broschure published by the City of Malmö, available at: http://www.ekostaden.com/pdf/vhfolder_malmostad_0308_eng.pdf
- Sustainable City of Tomorrow Edited by Bengt Persson, Formas, printed by Edita, Västerås, 2005
- http://www.ekostaden.com/
- http://www.malmo.se/sustainablecity

Pilestredet Park

Houses, Site B

location: Oslo, Norway

dates:
1883 – 2000 Rikshospitalet University Hospital
1991 - Competition for the area.
1997, 1998 - Masterplan was adopted
December 1999-June 2000:Properties purchased
August 2001: Construction of site H
January 2005:Completion of site H
March 2005: 521 flats sold, 407 flats completed, 124 flats in production, 94 flats planned,
June 2007: All 625 flats completed

type: Transformation of the Former Hospital Site into an Eco-friendly Residential Area in the Inner City

use: Mainly residential area, offices, business activity and educational institutions

size: 70000m2

people: Approx 1380 apartments. Presented results are from Site H with 155 dwellings

actors: Statsbygg (The Directorate of Public Construction and Property in Norway), Pilestredet Park Boligutbyggning ANS (PPB) (developer and SunRise Contractor), GASA architects, Lund & Slaatto architects, Skanska Norway AS (total contractor, project management and environmental coordination and implementation during construction phase)

goals: Develop methods and solutions that contribute to higher quality urban dwellings and more environment-friendly construction, maintenance and refurbishment

energy use	KWh/m^2
heating&electricity, goal *(corresponds to half of the national average and 25% below revised building codes)*	100
heating&electricity,achieved	80-150

construction
- reused material
- steel columns and beams carry hollow, prefabricated floor slabs, perimeter walls with wooden framework filled with 20cm mineral wool, and covered with gypsum boards
- building cladding – 5cm of expanded polystyrene + plaster façade

amenities
- close to city centre
- proximity to public transport
- easy access to green spaces
- indoor and outdoor bicycle parking

systems	
district heating	x
combined heat & power	
solar panels	
solar cells	
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	x
non-renewable energy	
individual metering	x
building energy management system *(allowing temperature zoning of flats)*	x
light control systems	x

site ecology
- Planting covers 30% of roofs and ground
- 25% (weight) reuse of materials in outdoor areas
- composting of wet organic waste

special features of the project
- multi-thematic environmental programme
- integrated design process and systematic implementation of the programme
- integrated design of heating, ventilation and lighting systems
- environment-friendly materials and construction
- reuse of materials
- quiet, clean, dry and safe construction site
- high quality outdoor areas
- green roofs
- focus on pedestrian, bicycle and public transport

Pilestredet Park

Site plan


Central park


Balkonies, Site B


Walkway, Site B

process and history

Pilestredet Park is the name of the area in Oslo where the Rikshospitalet University Hospital was situated from 1883 until it moved to new premises in May 2000. In October 2000 Statsbygg assumed responsibility for the site, which consists of 70.000 m².

Pilestredet Park marks a transition from small-scale pilot studies to large-scale urban implementation of principles of sustainable building in Norway. The multi-thematic environmental programme which was developed for the project covers all main ecological issues and sets up quantified aims. It concerns

- energy saving (100kWh/m^2 coresponding to 50% lower than the national average and 35kWh/m^2 below the lowest category in new Norwegian building codes)
- water savings (150 litters per person per day),
- reuse of materials (90% of demolition materials, 70% of construction waste and 25% in new constructions, should be reused),
- waste reduction (waste separation systems in all apartments, composting of wet organic waste),
- avoidance of harmful substances (data collected and products screened which contributed to better indoor climate),
- improvement of local climate, high quality outdoor areas on ground and roofs, reduced run-off water
- good indoor air quality,
- reduction of noise, dust spreading and vibrations from construction work (the aim was to get increased public acceptance of construction processes in high density, urban areas
- focus on pedestrian, bicycle and public transport (vehicular traffic is limited, 2,5 bicycle parking places/apartment installed)

The Programme was developed for the planning, construction, and maintenance phases. After the initial work with the programme, it was modified and the aims were adjusted to achievable targets. Quantifiable goals were set for energy and water consumptions and the rest was presented in the form of design instructions.

Presented results are from the first project phase – Site H. It consists of 155 apartments and a gross floor area including parking of 17000m^2.

Pilestredet Park

description of special project features

The energy saving installations and solutions included following construction:

- High insulated windows with total U value 1.4 W/m^2K (saving compared to new standards 3kWh/m^2)
- High insulated walls with 25cm insulation (steel columns and beams carry hollow, prefabricated floor slabs, perimeter walls with wooden framework filled with 20cm mineral wool, and covered with gypsum boards. Building cladding – 5cm of expanded polystyrene + plaster façade) (saving compared to new standards 1kWh/m^2)
- High insulated roof construction (35cm) with total U value 0,15 W/m^2K (saving compared to new standards 1kWh/m^2)
- Green roofs Roof terraces have ca 30% cover of plants (additional saving 1kWh/m^2)
- Reduced infiltration of air through walls – 0,15 h-1. (calculated savings 4kWh/m^2)
- Heat recovery ventilation system with a calculated effect of 80% (saving compared to new standards 11kWh/m^2)
- Installation of a new Building Energy Management System (BEMS) which allows temperature zoning in apartments and programmable time/temperature control (calculated energy saving 14kWh/m^2)
- Improved day lighting

results

Results from the first project, containing 155 flats, and having a gross area above ground of 12000m^2 show: 98% (weight) reuse of demolition materials (goal was 90% compared to Norwegian average 5%), 75% reuse of construction waste, more than 25% (weight) reuse of materials in new buildings and landscaping, visible reuse of old building components in outdoor areas, 50% reduction in energy consumption compared to national average, 25% reduction compared to recently revised building codes, system for delayed run-off of surface water, green roofs and roof terraces, clean site measures applied. Measures for reduced spreading of dust, noise and vibrations were applied (noise levels during construction were set to be 2dB below max set by municipality). Materials were screened to prevent harmful substances from entering the material cycles. Resulting indoor air quality was monitored. Architectural integration of measures is related to saving of energy and spreading of daylight. A twenty point checklist was made for systematic water protection during construction period.

Energy usage was measured in 8 apartments and the results showed that energy consumption reduced during the first year of occupancy, which was attributed to drying-out of constructions and the residents' initial trials of the climate control systems. The data shows that the goal of 100kWh/m^2 can be achieved without fundamental changes in occupant attitudes or daily routines. However the assessments show that individual habits of energy usage differ a lot between apartments.

costs

The stipulated costs were 1,27 mil Euros while the actual costs summed up to 1,56 mil Euro. The biggest changes were in the design stage costs where they went up from 161 thousand Euro to 333,4 thousand Euro.
The Pilestredet Park project has not recieved any support from the norwegian state or the City of Oslo. However, it was part of the EU-project SunRise project.

contacts: Marius Nygaard, siv.ark.MNAL, Arkitektkontoret GASA A/S, marius.nygaard@gasa.no

sources:

- Project information assembled thanks to Mr. Marius Nygaard, siv.ark.MNAL, Arkitektkontoret GASA A/S
- High ambition meets high realism (with highly acceptable results). Quantified aims and measured performance in Pilestredet Park, Oslo, by Marius Nygaard siv.ark.MNAL. Paper presented at Sustainable Building 05 in Tokyo
- Pilestredet Park: High Density Sustainable Urban Development, Technical report from the Sun Rise project
- EC Energie Programme Sunrise / NNE5-1999-18, Final Technical Report, Oslo Project, Pilestredet Park, Site H. Report prepared by Gasa Architects, September 2004
- http://www.pilestredetpark.com
- http://www.statsbygg.no/prosjekter/pilestredetpark/

Solar building exhibition

Location of Solar Building Exhibition

location:	Hamburg-Heimfeld, Germany
dates:	2002-2005
type:	new residential area on former military site
use:	residential
size:	1,5 hectares, 85 dwellings
people:	250 inhabitants
actors:	ZEBAU GmbH Hamburg City Council for town developement Hamburg Technical University of Hamburg-Harburg Low-Energy Institute, Detmold
goals:	KfW-40 (low-energy) standard and passive-house standard with a primary-energy use < 40 kWh/m²a Heating only with regenerative energy Additional use of solar energy

energy use	KWh/m^2
heating, goal	30
heating,achieved	30
heating,best	15

construction

KfW-40 (low-energy) standard
passive-house standard
elemination of thermal bridges
air-tight buildings

amenities

primary school, children's day-care centre, university, hospital, public transportation, city centre with cafes, shops, restaurants in walking distance

systems	
district heating	x
combined heat & power	
solar panels	x
solar cells	x
biomass and refuse	x
wind power	
natural ventilation	
forced vent.w/heat recovery	x
non-renewable energy	
individual metering	

special projects

district heating
solar heating
solar cells
partly barrier free for elderly people
public meeting areas

site ecology

rain water collection
waste separation

Housing at Solar building exhibition

process and history

For the solar building exhibition which took place in Hamburg in May 2005 a variety of energy-efficient buildings have been constructed on two city areas in the south part of Hamburg. The building site in Hamburg-Heimfeld near the centre of the district Harburg in the very south of Hamburg has a size of 1,5 hectares and was chosen as an example for the conversion of former industrial or military areas. This was in line with the program "growing city" of the Hamburg Senate which aims to keep the growth of Hamburg within the city borders by using these conversion sites for new residential and business areas. The main goals of the exhibition were on the one hand to demonstrate that energy-saving buildings meeting the KfW-40 (low-energy) or the passive-house standard can be build and sold for competitive market prices even in areas with rather moderate housing costs.

Solar building exhibition

Layout


Housing

process and history, continued

On the other hand the aim was to show the results and different techniques of modern methods of construction to a broad public so that the buildings can serve as multipliers. The different houses could be visited during the exhibition which also offered a broad variety of information concerning sustainable building through seminars and specific exhibitions.

The planning and organization started in 2002 as a part of the EU program ALTENER. The different buildings in Heimfeld have been constructed and sold by 8 investors. In 2004 the construction works in Heimfeld began and were mainly finished by the opening of the exhibition in May 2005.

description of special project features

The organization committee demanded to meet either the KfW-40 (low-energy) or passive-house standard. Therefore the maximum primary-energy use for heating and warm water was not to exceed 40 kWh/m²a. The use of solar energy, either with solar cells or solar panels, was also an important objective. The average insulation of the different buildings meets at least the low-energy standard. One building was constructed as a passive-house.

The heating of all the buildings is based on wooden-pellets. For one cluster of three building types a district heating system has been installed. In addition some buildings have been provided with solar panels and solar cells. Due to this use of regenerative energy sources the primary-energy use of each building could be kept low.

All of the buildings are supplied with forced ventilation systems of which almost all are equipped with heat recovery techniques.

A quality assurance program was set up to ensure that the energy targets would be met. It covered a control of the energy calculations by experts from the Technical University in Hamburg-Harburg during the planning stage and a quality control by the Low-Energy Institute during construction.

funding

The organization of the solar building exhibition was partly funded by the European Union within the ALTENER program. The public owned land was sold for regular market prices to or through the investors. The City of Hamburg provided the development of the public space.

For the buildings the investors applied for the regular federal or state subsidies. On the federal part the "Kreditanstalt für Wiederaufbau" and on the local side the "Wohnungsbaukreditanstalt" supported the construction of the energy efficient buildings by a loan with low interest rates. The City Council for town development in Hamburg provided additional subsidies for energy saving measures and the installation of thermal solar energy panels.

results

At the beginning of the exhibition in May 2005 almost all of the works on the building site had been completed, so that a variety of energy saving buildings and measures could be shown to the public. The quality control during the planning and later during the building phase had ensured that the promoted standards have been reached and that the energy targets have been met. At the beginning of the solar exhibition 80 % of the dwellings had already been sold.

contacts: **ZEBAU GmbH**, Große Elbstrasse 146, D-22767 Hamburg

sources: **Ausstellungskatalog zur Solar-Bauausstellung**, ZEBAU GmbH
Gedruckt von Gebr. Klingenberg und Rompel GmbH, Hamburg Mai 2005
www.solar-bauausstellung.de
Project information assembled by Prof. Dr.-Ing. habil. H.-J. Holle, Dr.-Ing. D.Scherz, Institute for Applied Building Technology, Technical University Hamburg-Harburg.

Hammarby Sjöstad

Location of Hammarby Sjöstad

GlashusEtt Information Centre

location: Stockholm, Sweden

dates: 1990 design beginning, 1992 beginning of construction; development ongoing, due to finish in 2016

type: New construction in brownfield / formerly industrial area

use: Residential, some commercial, services

size: 250 hectares

people: When finished 10000 dwellings for 25000 people and additional 5000 working in the area

actors: City of Stockholm, Stockholm Water Company, Fortum and the Stockholm Waste Management Administration (created the eco-cycle model -"The Hammarby Model"), different developers

goals: The overall environmental goal is that the impact placed on the environment by emissions from Hammarby Sjöstad shall be a massive 50 % lower than the corresponding level for newly constructed housing areas dating from the early 1990s. Other goals were:
Land usage: sanitary redevelopment, reuse and transformation of old brownfield sites into attractive residential areas with parks and green public spaces.
Energy: renewable fuels, biogas products and reuse of waste heat coupled with efficient energy consumption in buildings.
Water & sewage: as clean and efficient as possible - both input and output – with the aid of new technology for water saving and sewage treatment.
Waste: thoroughly sorted in practical systems, with material and energy recycling maximised wherever possible.
Transportation: fast, attractive public transport, combined with car pools and cycle paths, in order to reduce private car usage.
Building materials: healthy, dry and environmentally sound.

energy use	KWh/m^2
heating&electricity, initial goal (2000)	60
heating&electricity, updated goal (2005)	100 *(20 for el)*
heating&electricity,achieved	
heating & electric, best 2006 regulations for new building (BBR), goal	110

construction

- Sound, environment-friendly building materials

amenities

- proximity to public transport
- waterfront access
- preschools, schools, library
- healthcare
- commercial cervices
- recreation facilities (downhill skiing and cross country trails, kayaking, indoor recreation centres)

systems	
district heating	x
combined heat & power	
solar panels	x*
solar cells	x*
biomass and refuse	x
wind power	
natural ventilation	
forced vent.w/heat recovery	x*
non-renewable energy	x
individual metering	x*

site ecology

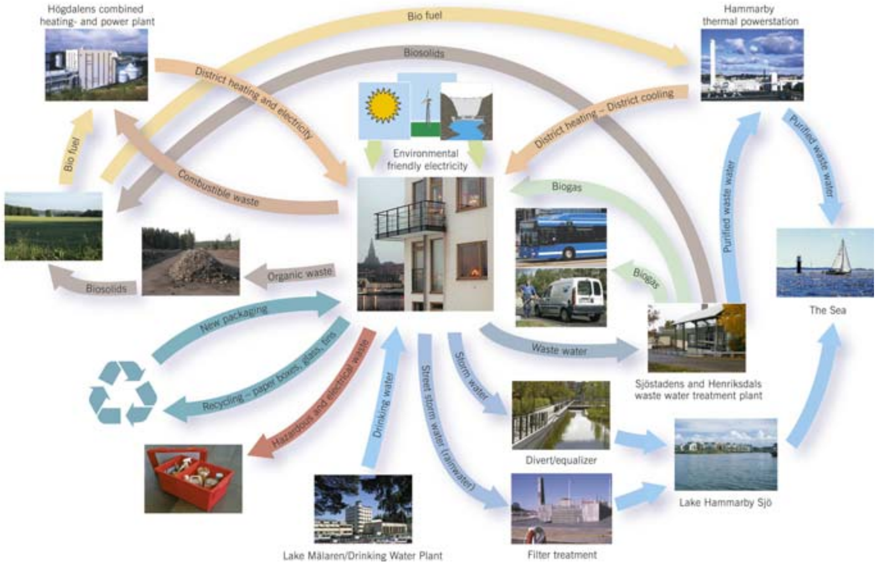
- industrial land reclamation
- 'ecoducts' for biodiversity
- soil decontamination
- preservation of the hill of oak trees
- noise reduction devices

**some buildings, not all*

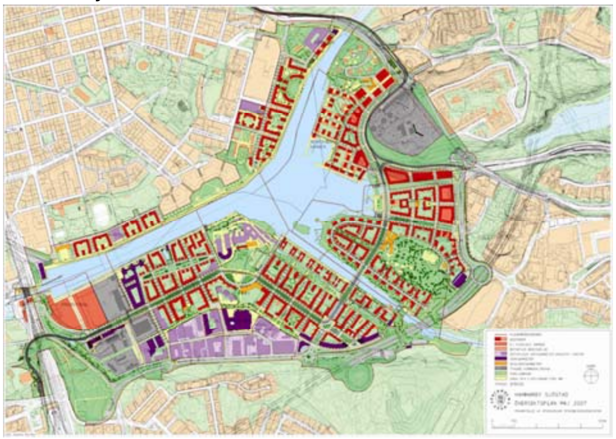
special features of the project

- GlasshusEtt, information centre
- Integrated planning
- Innovative eco-solutions
- Innovative technologies
- Strong environmental demands
- Waste water treatment plant
- Waste separation and central handling
- Grey and black water treatment
- Biogas production recovery nutrients for farmlands
- Green roofs

Hammarby Sjöstad



Hammarby model



Plan of Hammarby Sjöstad 200, from Stockholm City Development Administration web page

Sea bank

process and history

In 1917 the City of Stockholm bought the land south of Hammarby lake with the aim to develop an industrial area. In the major part of the Hammarby harbour area small and large-scale industries were mixed with office buildings and harbour activities. The industrial and harbour activities have led to high pollution of the area.

At the beginning of the 1990s, with a rise in housing need, plans started to be worked out for a new residential development. At the time most of the businesses of Hammarby were still prospering, but the City of Stockholm decided to turn this area into a new residential area. Several plans were made after the negotiations with the settled companies. The initial plans from the beginning of 1990s were changed in the 1996 and 1997, when new plans were developed as a support for the bid for the Olympic Games in 2004. An ambitious goal was set: 'twice (double) as good'. Even though Stockholm lost the bid, the environmental objectives were kept and further developed.

The idea was to create a new residential district, where people would live in comfortable housing with a good view of the lake, plenty of light, a beautiful natural area (green spaces, parks, and water), good transport connections and a location close to the Stockholm city centre.

description of special project features

In order to obtain the set goals an eco-cycle model 'Hammarby model' was developed for the area. It shows how sewage processing and energy provision interact, how refuse is handled and the added-values society gains from modern sewage and waste processing systems. The model was developed as a joint effort by Stockholm Water Company, Fortum and the Stockholm Waste Management Administration.

Special attention is paid to following aspects:

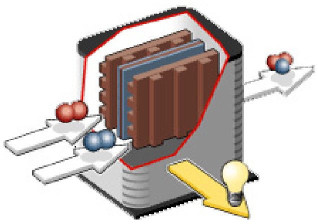
- Decontamination and clearance - The City of Stockholm's Environment and Health Administration has cleared and decontaminated the area to meet the requirements for not posing a health and environmental threat.
- Construction materials – all materials and products used should be sustainable, tried and tested, and eco-friendly.
- Storm water from streets – collected, purified and released into the Hammarby Sjö
- Solar panels – installed on some of the roofs, they meet half of the building's need for hot water

- Vegetation – preserved oak forest, vegetation ensures clean air, collects rainwater locally, and provides counterbalance to the dense urban landscape
- Vacuum system for solid waste and refuse sorting
- Green roofs – good local environment, rain water handling
- Ecoducts – ensuring biodiversity of local vegetation and animal species
- Communications – good public transport options, car pools, ferry traffic and foot and cycle paths
- Waste water treatment plant – it tests new technology, four different and new processes for purifying waste water. One of the products is biogas currently used as fuel in eco-friendly cars and busses

In Hammarby Sjöstad, an environmental information centre was built, GlashusEtt. It provides lectures on sustainable city planning and encourages inhabitants to live more sustainable. Interested citizens as well as visitors to the area can inquire about the features of the area.

The centre also serves as a testing ground for new technology with the aim to achieve good indoor climate with low energy consumption. Double-glazed facades, linked to an advanced control system cuts the energy consumption to 50% of that of an equivalent building with glass facades. The double-glazed facades reduce the need for artificial light and the energy requirement for heating, cooling and ventilation. Heating is primarily provided by a heat pump that takes energy from the pumping station's moist heat and the waste heat generated by the mains power installation.

A fuel cell – an advanced energy converter – has been installed for the first time ever in a commercial building in Sweden. The fuel cell runs on hydrogen gas.



The fuel cell (on picture to the right)

1. Hydrogen and oxygen are fed to the fuel cell.
2. Electrons are released in the fuel cell, generating electricity and heat.
3. The waste product is water.

A solar panel plant has been installed on the roof to supply the fuel cell with energy by breaking water down into hydrogen in an electrolyser. Surplus power produced during summer will boost the building's power supply.

A biogas boiler, to meet peaks in heating requirements, and a biogas stove in the kitchenette has been installed. The biogas is produced in the area's own sewage plant and is part of the eco-cycle solution.

results

Since different actors were involved in the project with different developers the results are various. The high energy targets that were set have in most cases not been reached. Some measurements are performed but the data is not available to the public. The environmental goals were revised two times so far. The first Environmental programme was issued in 2000, revised in 2002/2003 and in 2005. Some goals were specified in more detail, with higher demands, while others, as energy were changed to lower, more achievable goals.

Regarding water consumption, the goal was set to 100 l/person/day, and the average consumption during the period from July 2006 to July 2007 was 141,9 l/pers/day (Stockholm average consumption is 200 l/pers/day – according to the official site of Hammarby Sjöstad area - http://www.hammarbysjostad.se/).

Energy goals were initially set to 60 KWh/m^2 and updated in 2005 to the goal of 100 KWh/m^2. Good performances were reached at two multi family building blocks, holmen and Grynnan, which were constructed by NCC. Total building size is 212 flats and 1600 m^2 of non-residential area. On both buildings PV cells were installed in facades, balconies and windows with the total peak power 46 kW and PV production 32MWh. In total there are 212 PV modules installed on the south-west facing facades. The amount of produced energy is planned to correspond to the need of 70% of the energy needed for energy efficient refrigerator/freezer. The total budget for the project was app 35 mil Euro. The project was financed by NCC with a 30% subsidy for the innovative parts related to the environmental efforts, by the LIP programme. The project is carried out by NCC and the architect is White Architects. The PV supplier has not yet been selected, as this will be subject of an open tender.

funding

LIP (Local Investment Programme) Stockholm has supported the development of the Hammarby Sjöstad area by 300 mil SEK (33 mil Euro)

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sources:

- More on Hammarby Sjöstad on the Stockholm City Development Administration Office web page http://www.stockholm.se/Extern/Templates/InfoPage.aspx?id=45432
- More on the NCC project Holem and Grynnan can be found on: http://www.pvnord.org/buildings/ncc_hammarby_sjostad/Brief_Building_Report_HolmenGrynnan.pdf
- Cas Poldermans (Feb 2006). Sustainable Urban Development, The Case of Hammarby Sjöstad, Paper for Kulturgeografiska Institutionen, Advanced Course in Human Geography Fall Semester 2005, Supervised by Lennart Tonell

BedZED

Location of BedZED

Roof at BedZED

location: Wallington, South London UK
dates: planning begun 1999, completed 2002
type: new construction on former brown field site
use: residential, office/ workspace, open space

size: 3.5 acres, 1.42 hectares
people: 240 residents (100 units), 100 workers
actors: Peabody Trust, Bill Dunster Architects, BioRegional Group, Ove Arup and Partners, Gardiner and Theobold

goals:
- to create a 'net zero fossil energy development'
- 50% reduction in fossil fuel consumption by private car
- use
- locally sourced materials: 52% of constructions concrete,
- brick, and recycled steel from sources within 35 miles of site.

energy use	KWh/m^2
heating&electricity, goal	NA
heating&electricity,achieved	NA
heating&electricity,best	NA

construction
super-insulated heavy masonry
triple- paned fenestration and skylights
recycled steel
83% construction timber FSC certified or reclaimed

amenities
community garden
local food production
community center
athletic facility

systems	
district heating	x
combined heat & power	x
solar panels	x
solar cells	x
biomass and refuse	x
wind power	
natural ventilation	x
heat recovery	x
non-renewable energy	x
individual metering	

special projects
car-sharing club
wood-waste powered CHP plant
'living machine' waste treatment system

site ecology
stormwater retention
green roofs
permeable roads/ sidewalks

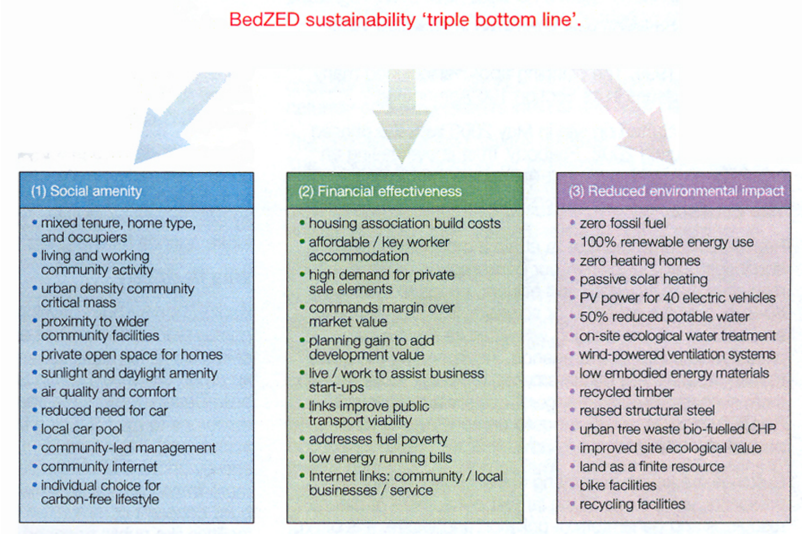
process and history
For this project, the building design, site planning, and larger systems designs were completely integrated such that the individual factors contributing to both the shaping and the outcomes of the development cannot be separated from one another. The site plan was carefully designed with the buildings such that density and lease able or sellable square footage was maximized; this is part of the underlying idea that the economic interests of developers are compatible with sustainable strategies of building as densely as possible, preventing further agricultural land or open space from being developed. The site was a brown field property close to existing commuter rail lines, and the architect stresses that all of the land that we need for housing as our populations grow can be had within already existing urban boundaries on derelict or overlooked sites. According to the architect's website, the development of BedZED in South London was a "3rd generation design developed over 5 years." BedZED was a prototype for all members of the team that led to its realization; the architect, the developers, and the consultants. Further improvements on this prototype are now being developed both together and independently among these groups based on the experiences learned here.

description of special project features
The distinctive form of the buildings is a direct result of this planning for density, combined with optimal solar exposure as well as daylight, fresh air, and private open space access for all units. The architect says that "it is hard to see how higher density urban infrastructure can be achieved without stealing a neighbouring plots' sunlight, or building rooms that can only be mechanically vented and artificially lit". Additionally, the use of all exterior building surfaces is

BedZED

BedZED development

BedZED development



description of special project features

maximized. Solar cells are integrated into the vertical south-facing facades, and also form a large installation on the south-facing portion of the roofs. Large protruding wind cowls, responsible for driving the fresh air and heat recovery systems, are interspersed with sedum roof beds that contribute to the handling of rainwater on site. The north-facing portion of the roofs sloped to allow the sun's rays on the shortest days of the year to reach the next row of buildings, contain a series of private terraced rooftop gardens with deep beds that can be planted for food growing.

These gardens are separated by large skylights, triple-paned to provide high U-value, that allow daylight into the deeper portions of the units while separating the private terraces from one another and reinforcing privacy between units.

BedZED was developed by the Peabody Trust, a well- established social housing association committed to linking social housing aims with sustainable methods. A third of the housing was dedicated to low-income rental units, with shared ownership (rent-to-own) and outright ownership making up the other two thirds. Integration of work spaces into the project allow people to work closer to home, reducing the carbon emissions of transport while encouraging the development of a diverse neighbourhood and contributing daytime activity to the site. Demand for the units and the workspaces have been high, with all units sold and rented immediately and re-sale value greater than similar-sized properties in the same area by 15%. Residents attribute this popularity to the daylight and open space availability within the units.

results

The strategy for reducing energy consumption at BedZED includes:

1. reducing or eliminating space heating demand by providing a super-tight insulated shell and passive solar design
2. providing power, heat, and hot water from a small, locally placed CHP plant which runs on the wood waste from a nearby municipality.
3. solar installations provide hot water and power for electric vehicles
4. low-energy lighting and energy effi cient appliances are used.

Water saving fixtures combined with a local 'Living Machine' waste-water treatment system make up the strategy for water conservation.

Intentions aside, the wood-waste powered CHP unit, which is newer technology, has not been working properly and the community receives power from a traditional power network. Boilers were installed to respond to hot water needs of the residents. The waste treatment system is also out of service, due to problems securing an operator.

Even without the use of these systems, and with the goal of 'zero (fossil) energy' not being attained, BedZED has considerably reduced its carbon footprint. While energy consumption for space heating has not been monitored or recorded, "monitoring data on water and energy consumption demonstrated savings of over 30% on water use from water efficient appliances and fi ttings alone and approximately 90% on space heating" according to Jenny Organ at BioRegional. And according to an October 2002 bulletin from the architect's office, annual energy used for water heating is 43% less than that for similar typical UK residences, electricity consumption is 60% less, and water consumption is 56% less. One resident stated that "because the houses are well insulated and the wind-driven ventilation system so efficient, there is barely any need for heat."

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sources:
http://www.guardian.co.uk/renewable/Story/0,,1776166,00.html
http://www.sd-commission.org.uk/communitiessummit/show_case_study.php/00035.html
http://www.peabody.org.uk/pages/GetPage.aspx?id=179
http://www.zedfactory.com/bedzed/bedzed.html
http://www.arup.com/DOWNLOADBANK/download68.pdf
all photos: Bill Dunster Architects

Greenwich Millennium Village

Location of BedZED

Public space at Greenwich Millennium Village

location:	London Borough of Greenwich, London, UK
dates:	1997 regeneration project started, due for comletition 2012
type:	New development on a previously occupied area (gas works)
use:	Residential and mixed use development
size:	72 acres
people:	more than 13000 homes
actors:	Project Team: Promoter: English Partnerships, Masterplanner: Ralph Erskine. Phase 1 design co-ordinator: Hunt Thompson Associates. Project Manager: Trench Farrow & Partners. Specialist architects: Baker-Brown & McKay, Cole Thompson M&E engineer. Landscape and ecology: Battle McCarthy. Developer Consortium: Countryside Properties plc, Taylor Woodrow plc, Moat Housing Group and Ujima Housing Association.
goals:	Explore and implement sustainable innovations in planning, design, and construction of a mixed-income, mixed-use residnetial neighborhood on a brownfield sites.

energy use	KWh/m^2
heating&electricity, goal	NA
heating&electricity,achieved	NA
heating&electricity,best	NA

construction

Environmentaly sustainable materials

amenities

primary school, day nursery, health centre and convenience store
Greenwich Yacht Club

systems	
district heating	
combined heat & power	x
solar panels	
solar cells	
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	
non-renewable energy	
individual metering	

special projects

site ecology

process and history

Greenwich Peninsula was once the site of the largest gas works in Europe, and now is one of the largest development sites in London and one of the biggest regeneration projects in Europe. With a previous industrial history, accommodating manufacturing industries such as munitions, chemical, steel and soap and finally having gas works it was a challenge to start the regeneration. In 1997 regeneration of the Peninsula was started by English Partnerships, stimulated by the fact that the site has been chosen to house the New Millennium Experience. At the beginning, English Partnerships have launched a competition in order to find a development team which would create a residential and mixed-use neighbourhood and set the standard for future sustainable urban regeneration. The winning consortium comprises Countryside Properties and Taylor Woodrow in conjunction with Moat Housing Association. The first Millennium Village is an exemplar scheme in the creation of sustainable new communities. It is located on the eastern side of Greenwich Peninsula.

description of special project features

Site remediation

As a beginning the site was cleaned from the polyaromatic hydrocarbons and heavy metals up by the English Partners. Also attention was paid to preventing the pollution of the Thames, by installing a slurry wall adjustment to the river, which prevented shallow contaminated water from migrating into the river. In addition a capping layer was installed across the entire site in order to ensure that the future site users are separated from the remaining lower ground level contaminated materials.

Greenwich Millennium Village

Public space at Greenwich Millennium Village

Public space at Greenwich Millennium Village

The Ecology Park at Greenwich Millennium Village

description of special project features

Master Plan and design

The vision for the Village was to create a vibrant new community that works for people and where the pedestrian has priority over the car. A part of the Master plan is a series of Engineering and Landscape layers which include topography, climate, energy, geology, remediation, movement/security, landscape/ecology, waste, and surface water. The layers form a sustainable development framework and are integrated together by the design team to improve the sustainable design efficiency of the whole development. The levels of infrastructure include district heating, electrical distribution, foul water drainage, gas routes, and surface water.

Also, noise pollution, good indoor environment, human satisfaction, air quality, thermal control, acoustic control, daylight, and security were early taken into account into the design process.

Another innovation that was brought into the project concerns adaptability of the buildings. Greater levels of adaptability are achieved by using pre-engineered steel framed structures with standardised connections, grid layouts and arrangements that allow for later change; dry building techniques, services distributed so that they can be easily adjusted to the new needs; and cladding systems which can be dislocated to adjust to the new requirements.

Energy

Energy was considered as an important element of the development. The aim is to maintain steady organic flows of energy in and out of the neighbourhood. A new energy supply contract between Greenwich Millennium Village Ltd and Green Energy UK plc, means all the electricity in the communal areas, such as the stairs and hallways of the Village is now 'green'. All homes were equipped with water and energy efficient domestic appliances.

The heat and electricity needed for the Village is being generated on site through local, small scale, gas powered combined heat and power (CHP) plants.

Materials

The buildings are being built from materials that are environmentally sustainable. Recycled and locally produced materials are being used whenever possible. Proposed standard for Greenwich Millennium Village was to have walls areas satisfying 0.35 W/m^2K (building standard at the time 0.45 W/m^2K) while windows 1.8 W/m^2K (building standard at the time 2.8 W/m^2K).

funding

English Partnerships has invested over £200m in acquiring, reclaiming and developing the site.

results

If one goes to the official web-site of the Greenwich Millennium Village http://www.greenwich-village.co.uk/index_main.htm one can read only positive things, with the results being quite impressive. As with many other developments it depends how one defines and interprets the data. However, by simple search on the Internet one can also find articles that critically look at the development and present a different picture.

According to Kyung-Bae Kim, Greenwich Millennium Village Limited (GMVL), "…the team with the winning proposal, was expected to set and achieve specific sustainability goals that would be subject to review and approval by English Partnerships (EP), the government agency acting as land owner and project overseer of the GMVP, before the project could progress into any of its four phases. Most of the sustainability goals and targets in GMVL's proposal were either dramatically modified or completely omitted after winning the competition (e.g., 10% energy reduction target was not met, zero carbon dioxide emission target was revised to a 35% carbon dioxide reduction, 35% water use reduction was lowered to 15% reduction in the first year and ultimately 30% reduction in five years, waste reduction goals were left out of the legal agreement, standardized off-site construction was changed to brick and concrete on-site construction, integrated private/social housing goals were modified and diluted, community was not involved despite GMVL's claimed commitment to community participation)."

Katice Helinski wrote that: "…the winning architecture firm, Hunt Thompson and Associates, has resigned from the project "because the original ecological (or sustainable) standards were increasingly being run down by the developers, to such an extent that they could no longer sign-up to the project."

At the official web-site of the Greenwich Millennium Village results are presented as:

Targets and results to date

The technical innovation targets were set to be achieved during the first development phase of the project. They involve:

- **Primary energy – reduce by 80%.** By March 2007 achieved reduction is 65% through improved insulation standards and use of Combined Heat and Power
- **Embodied energy used for building construction – reduce by 50%.** By March 2007 reduction was 25% achieved by selecting materials using BRE Green Guide that require low amounts of energy for their production and make use of recycled product.
- **Water consumption – reduce by 30%.** By March 2007 reduction achieved was 25% by specifying water efficient taps, showers, toilets, and white goods.
- **Construction cost – reduce by 30%.** By March 2007 the real costs were reduced by 20% while maintaining high specification levels through value engineering, partnering with suppliers and standardisation.
- **Construction period – reduce by 25%.** By March 2007 20% of time saving in construction periods was achieved. Standardisation and early weather tightness is the main reason for the results.
- **Work towards achieving zero defects on practical completions.** By March 2007 significant improvement has been achieved through implemented staged quality reviews during the design and construction.
- **Construction waste – reduce by 50%.** By March 2007 target has been reached. Waste that is produced is segregated and when possible recycled, it is measured and continuously reported.

For the period between 2007 and 2014 a new set of targets are set and some of them are:

- CO2 emissions are not to exceed 20kgCO2/m2 when calculated in accordance with 2005 Standards.
- Embodied energy used to construct buildings to be less than -
  - For high rise apartments - 500KgCO2/m2 total building area including foundations and associated common parts (excluding podium car parking structures).
  - For low rise houses and apartments - 260 $KgCO_2/m^2$. No C rated materials from the BRE Green Guide to Housing to be used unless required for performance reasons.
- Water consumption in the home to be less than 40 cu m/bed space/year as calculated by the BRE EcoHomes methodology.
- Provide facilities in and around the home for residents to pre-sort 50% of domestic waste into recyclable components.
- Reduce average construction waste for apartment block construction (excluding ground work) to a maximum of $20m^3$ per dwelling.

contacts: gmv@cpplc.com

sources:

Greenwich Millennium Village, London, http://www.englishpartnerships.co.uk/gmv.htm
Greenwich Peninsula http://www.greenwichpeninsula.co.uk
Greenwich Millennium Village, London, case study from the Countryside Properties PLC, http://www.countryside-properties.com/news/case-studies/10378 date of retrieval 2007-05-29
Kyung-Bae Kim, Ph.D., (2005). Toward Sustainable Neighborhood Design: A Sustainability Evaluation Framework and a Case Study of the Greenwich Millennium Village Project, Journal of Architectural and Planning Research, volume 22, issue 3, pages 181-203
Katice L. Helinski, Greenwich Millennium Village: planned sustainability? http://ocw.mit.edu/NR/rdonlyres/Architecture/4-183Spring2004/B674D26D-5433-412C-880F-F1C20A3DEDCA/0/midhelinski.pdf
http://www.gmvonline.com/GMVCW/index.php?section=greenIss&M=0 Information retrieved 2007-05-30

URBAN RENEWAL PROJECTS, UPGRADING OF EXISTING BUILDING STOCK

On an annual basis, on average, in EU the new building rate is about 1-5%, depending on the country and region. This means that 95% or more are existing ones and most of our work in the future will focus on renovation and upgrading. Today, the rate of renovation is about 1%. According to Petersdorff, Boermans, and Harnisch in 2002 the residential sector is responsible for 77% of the total heating related CO_2 emissions and single family houses represent the largest contributing group, by 60% of the total.[1] **There is an enormous potential to save energy if existing buildings are refurbished.** According to The European Alliance of Companies for Energy Efficiency in Buildings there is a potential to save 70-80% of heating demand when different refurbishment measures are done on multi-family high-rise buildings.[2]

Furthermore, in many of the mass built areas in the 1960s and 70s, there are different social problems and the layout of apartments does not fulfil today's needs of the inhabitants.

In the North Sea Region there are a number of good examples where different refurbishment projects were carried out.

In Hedebygade, Copenhagen, eleven urban renovation ecology projects were carried out on a block originally dating from 1880s. Instead of demolishing the old block, many different technical solutions were tested, among these several innovative ones. Beside energy consumption, water and waste was also considered and an eco-accounting concept was developed for following up the results of the measures implemented. Experiences from Hedebygade serve as a guide to other renovation projects.

In Gårsten, Göteborg, multi-family housing from the beginning of 1970s was renovated having **participation of the inhabitants** as an important element for the success of the project. Energy efficiency was coupled to the reduction of costs for the tenants, while improving the quality of life. Solar energy was utilized to support the heating demand for the area. Individual metering with a **charging incentive** – pay as much for the energy as you spend, has additionally help reduce the energy consumption.

On the other hand, in Ekostaden, which is an area in Malmö built in the late 1940s the intention was to work with a wider spectrum covering social, environmental and economic sustainability spheres. High unemployment rate in the neighbourhood with a high turnover of tenants added to the problems the neighbourhood was facing. Thus, residents played a significant role in planning and implementation and the result of the project indicated that Augustenborg has become an attractive, multicultural neighbourhood.

There are a number of ongoing projects, like in Alingsås, in Sweden, where renovation of the "million programme" housing targets at significant improvement of energy performances of buildings. The goal is to lower the total energy demand from 204 kWh/m^2 to 95 kWh/m^2. Since the project is not finished yet and the results are not available the project is not included in this guide.

Outside the North Sea Region it is worth mentioning two additional projects both from UK: Glastonbury House in Westminster, UK and Flagship Home in Westminster, UK.
On following pages you can read more about the projects and their specifics.

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[1] Petersdorff, Boermans, and Harnisch (2006), Mitigation of CO2 Emissions from the EU-15 Building Stock. Beyond the EU Directive on the Energy Performance of Buildings, Environmental Science and Pollution Research journal, Volume 13, Number 5 / September, 2006,

[2] http://www.euroace.org/index.htm

Solar Buildings Gårdsten

Gårdsten, location

location:	Göteborg, Sweden
dates:	originally built 1969-1972, renovated 1998-2004 in 2 phases
type:	Sustainable renovation of existing 'million programme' prefabricated element and slab housing buildings
use:	residential
size:	255 apartments (18 720 m^2 of living area) in phase 1 and about the same in phase 2
people:	
actors:	City of Göteborg, Gårdstenbostäder, Christer Nordström Arkitektkontor AB, SKANSKA Sweden AB, Rune Lindh Byggadministration AB, IO design, CIT Energy Management AB, Andersson & Hultmark AB, LTB Byggkonsult AB, Partille Elkonsult AB, Taggen Miljö och Landskap AB, EU Projects 'SHINE' and 'Regen-Link'

goals:
- to revitalize a run-down development
- to closely cooperate with tenants to create a strong and vibrant community with an interest in maintaining the properties
- to focus on energy efficiency and reduce energy costs for tenants and owners while improving quality of life, and to integrate renewable energy and sustainable design into the renovation project wherever possible

energy use	KWh/m^2
heating&electricity, goal	270
heating&electricity,achieved	146
household energy,original	55
household energy,achieved	53

construction
- prefabricated concrete slabs and frames
- increased insulation where necessary
- replacement of interior glazing w/ low- e glazing
- minimizing thermal bridges

amenities
- community greenhouses
- community rooms
- composting machines

systems	
district heating	x
combined heat & power	
solar panels	x
solar cells	
biomass and refuse	
wind power	
natural ventilation	x
forced vent.w/heat recovery	x
non-renewable energy	x
individual metering	x

special projects
- tenant participation in meetings and work groups

site ecology
- new planting areas

process and history
The housing area of Gårdsten, in Göteborg Sweden was built in the early 1970's. It soon fell into decline due to the poor initial building construction and a lack of services to the area. Since 1996, Gårdsten is undergoing a process of social and physical regeneration.In 1997, a public corporation called Gårdstenbostäder was formed, to purchase the buildings and refurbish them.
Funding and the subsequent requirements from the EU's SHINE and Regen-Link projects, as well as Gårdstenbostäder's and resident's initiatives, defined the renovation project in terms of energy efficiency.
An architect with experience in solar systems, Christer Nordström Arkitektkontor AB, was hired and worked with both the building company and resident's groups to create solutions that would both increase efficiency and raise the quality of living within the development. The task was to perform a design with high standards regarding social ambitions, sustainability, energy conservation and economy.

Solar Buildings Gårdsten

Before renovation

After the renovation

description of special project features

Two types of buildings make up the 4 -building block units that characterize the district of Gårdsten; 6 story balcony access buildings with external staircases, and conventional 3-story slab buildings with internal staircases. Buildings are connected to the district heating system.

Situation before renovation

Before the renovation the area suffered from severe social problems due to more than 60% unemployment causing poverty, lack of self confidence and increasing crime rate in the area. A large representation of different languages and cultures in combination with few Swedish dwellers lead to separation between groups of tenants and difficulties to integrate with the society.

Buildings – technical problems

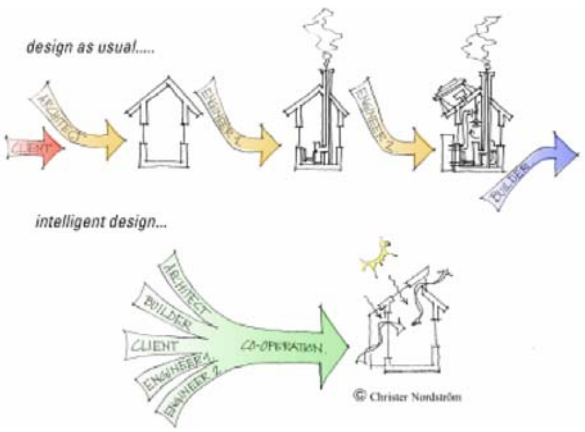
- Most of the roofs had problems with leaking of rain and snow which had to be repaired almost every year.
- Facades and structural elements of concrete had damages cased by corroding concrete reinforcements
- Plaster falling down
- Corrosion of metal details such as doors, door frames, balconies, etc.

Health problems occurred due to poor ventilation systems. Open space under buildings caused very windy outdoor environment and the overall outdoor environment was unfriendly for children.

Energy problems

- Overall high energy consumption (heating 270 kWh/m2)
- Poor insulation of roofs and external walls
- Cold bridges in intersections between façade elements – especially important on facades exposed to prevailing winds.
- Windows did not match the standard.
- Very inefficient and energy consuming preheating ventilation systems
- Inefficient lighting and electrical appliances
- Energy wasting behaviour

Besides mentioned issues, the area had environmental problems with waste and PCB which was detected in some joints and sealants between concrete elements. Aesthetically the area was not appealing and gave a bad atmosphere to the place.



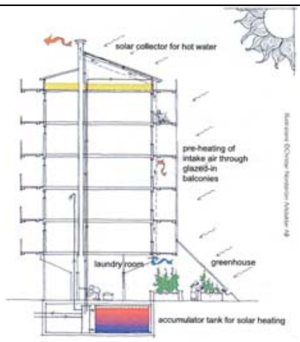
Figur 1 Design process

The success in the renovation is seen in the integrated design process shown on figure 1.

With the renovation being approached as an opportunity to save energy, the following solutions were applied:

1. In the balcony-access buildings, exhaust-air ventilation was introduced, and in the lower slab buildings, Heat Recovery Ventilation was provided.
2. Existing balconies were enclosed with operable glazed panels. This was done in conjunction with the repair of the balconies, which were in disrepair. This layer of glazing protects the original facades and reduces heat loss in the

cold months, while pre-heating the ventilation air when the sun is shining in the spring and fall months. Residents can move the glazing out of the way during the warmer months.



3. Balcony-access buildings received solar panels, placed at an optimal solar aspect and integrated into the roof, to pre-heat water used within the 4 buildings that make up a block. This pre-heated solution is used to heat the water in large tanks in the basement level, which is then distributed to the 4 buildings that define a block. On the ground level of these buildings, a greenhouse was added along most of their length, similarly protecting the ground floor from the outdoor environment while providing indoor gardening and gathering space for the tenants. In the lower slab buildings, solar air collectors mounted vertically on the south facades provide warmed air that is circulated within the cavity created by the original building facades and the new insulated facades that were added on the north, east, and west sides. This reduces heat loss.
4. The inner pane of the existing double-paned windows was replaced with low-e glazing.
5. Roof insulation was added when the roofs were renovated.
6. Insulation was added in the gables of building roofs when the facades were re-built.
7. The base slabs were insulated when new drainage systems were installed.
8. Energy efficient washing and drying machines were connected to the solar hot water system.
9. Energy-labelled electrical appliances for the units were part of the renovation.
10. Efficient occupancy- sensor lighting was installed for common areas in the buildings.
11. A central control and supervisory system was installed to monitor energy and water use within the buildings. This system also involves individual meters for each unit, so residents can monitor their own use of energy and water. While a basic level of heat, 21C, is provided for in the rent of the units, residents can get a rebate for using less or must pay more for an increase in temperature. This also empowers residents to choose whether to spend their money on greater thermal comfort or to save it by living with a slightly lower indoor air temperature. This system also applies to water usage.

Community Involvement

Tenants were seen as a key to the project's success. This was difficult initially, as most of the residents did not believe that their opinions would influence the outcome. To create interest in the project, an information apartment was created where tenants could meet with project representatives and discuss issues both more informally and in more depth than at the larger community meetings. A 'graffiti' wall was set aside in the living room of the information apartment where residents could write comments under the categories of "We Want" and We DO NOT Want". This wall became an important reference for Gårdestenbostäder and the design team.

Focus: The Working Group for the New Ground Floor, Utility Rooms, and The Environment.

This working group "rejected the architect's first proposal and instead, in consultation with the architect, they formulated a further proposal for how the new ground floor should be designed." This led to the utility rooms being located on the ground floor with the other public rooms, with access and windows onto the new indoor greenhouses. This also led to a re-organization of the waste handling system, with composting that provides rich soil for the indoor greenhouse beds.

funding

The total cost of renovation was app 12 mil Euros. The additional cost for operating and energy saving measures amount to app 2 mil Euros of which less than 30% was covered by a contribution from the EU and the Swedish Energy Agency.

results

Performance:

After a large initial drop in consumption of water and energy which has lasted and is due to the increased energy efficiency of the construction and the integration of renewables, decreases in consumption continue every year. These decreases are attributed to a greater consciousness of the residents; the individual monitoring of each unit is allowing residents to reduce their household energy and water consumption, with the incentive of saving money on their utility bills.

The solar systems provide heating for hot water that translates to a reduction in the district heating needs of approximately 15 kWh/m2 per year of heated floor area.

contacts: Jan-Olof Dahlenbäck, jan-olof.dalenbackcit@chalmers.se; Christer Nordström, cna@cna.se; Gårdstenbostäder, gbg@gardstensbostader.goteborg.se

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Solar buildings at Gårdsten, a brochure downloadable from:
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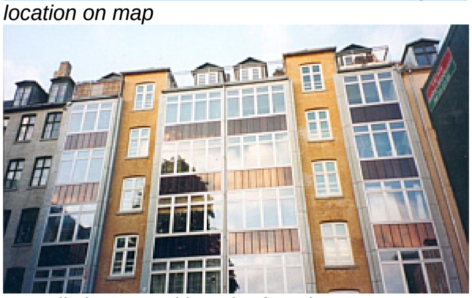
http://www.gardstensbostader.se/data/content/DOCUMENTS/2006511193945647SolarBuildings.pdf,
TREES case study by Jan-Olof Dahlenbäck and V. Pavlovas
Solar Housing Renoavtion in Gårdsten, Göteborg, Sweden, Entry for the World Habitat Awards, by Christer Nordström Arkitektkontor AB
Pictures provided by Christer Nordström

Hedebygade

location on map



Pv cells integrated into the facade

Inner-courtyard facade

location: Copenhagen, Denmark

dates: Original construction was in 1880s. Initial reconstruction begun 1972; Various ideas and plans for the Hedebygade block continued into the 1990's; Final plans produced 1996; construction completed 2004.

type: Urban ecological renovation (experimentation and demonstration) project

use: Residential

size: 9 buildings in an urban block, 150 apartments reduced to 115

people: 600 inhabitants before the renovation and 430 after

actors: Copenhagen Municipality, Ministry of Housing, SBS (Urban Renewal Company), several consulting architects, engineers, and residence.

goals:
- to establish a greater demonstration project in Copenhagen of ecological (environmentally sound) renovation
- to contribute to ecological solutions for renovation of old houses
- to demonstrate Danish capacity of ecological renovation
- to promote commercial utilisation of ecological solutions for urban renewal

energy use	KWh/m^2
warm water&heating, urban renewal environmental target	100
warm water&heating, goal for new construction	75
warm water&heating, achieved average	110
el. use kWh/person, urban renewal environmental target	2000
el. use kWh/person Copenhagen, average	1550
el. use kWh/person, achieved	1073-2039

construction
- existing load-bearing masonry

amenities
- shared community house
- waste-sorting facilities

systems	
district heating	x
combined heat & power	
solar panels	x
solar cells	x
biomass and refuse	
wind power	
natural ventilation	x
forced vent.w/heat recovery	x
non-renewable energy	x
individual metering	x

site ecology
- new planting areas
- rainwater collection
- plant selection to encourage native birds and insects

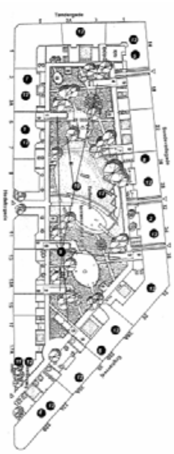
special features of the project
- tenant involvement
- individual metering
- heliostat-focussed daylight
- indoor planting beds used to clean air
- sun walls with solar cells and heat exchanger
- energy saving facades
- a prism with light-shaft effect
- focus on pedestrian, bicycle and public transport

process and history

Some of the first buildings built outside the original city limits of Copenhagen were built in the Vesterbro district for working class families, along with trade and industrial buildings. Within this district is the dense Hedebygade block, consisting of approximately 18 residential buildings grouped around a long and asymmetrical courtyard. The courtyard, typical to this type of housing, initially had housing within it as well; this had been cleared in 1972 as the City Council prepared to renovate portions of the Vesterbro district rather than demolish the entire district as earlier urban renewal projects had done in other neighbourhoods. Various action plans were considered and taken up in the ensuing years, until a proposal acceptable to both the residents of the buildings and the City Council resulted in a plan for renewal of the Hedebygade block in the spring of 1996.

Hedebygade

Inner courtyard



Site

PV cells integrated in the facade

PV cells integrated into the façade

process and history

This renewal plan coincided with an increased focus by the city in urban ecology, supported by public sentiment. This led to a grant of 5 Million Euros by the city government to assist with demonstration projects as part of the renewal of Hedebygade, which would showcase Danish innovation, technology, and knowledge within the field of ecological and sustainable building, construction, and planning.

description of special project features

As a part of the urban renewal of the Hedebygade block, 11 out of 12 different projects of urban ecology have been completed. This includes projects in 9 buildings, and 2 projects covering the whole block. Each project dealt with a different subject: prism, flora, 'green' kitchen, sun wall, flexible facades, integrated ecological renewal, sun in the urban renewal, waste sorting, shared courtyard and community house, house end project, and measurement of consumption. The municipal plan which was developed for the area stated that existing houses had to be preserved with regard to environment, architecture and social life. Many different technical solutions were tested, among these several innovative ones. The facade solutions were the most convincing: The sun walls with solar cells (photovoltaics) and heat exchanger, and the energy saving facades demonstrated in the subprojects 5, 6, 7 and 8. Subprojects 6, 8 and 11 are examples of the successful integration of photovoltaics into the facade. Some of the more successful projects were the following:

1. Project 5, the Sun Wall project. This project utilized passive solar techniques combined with solar air collectors on the roof, added insulation, low-e glazing, and heat recovery.
2. Project 6, the Flexible Facades project. PV's and low-e glazing added to the facades and balconies.
3. Project 8, Sun in the Urban Renewal. In this project, solar cells were integrated into the roof, ventilation with heat recovery was implemented, daylight to the apartments was increased, low-e glazing was used, and solar panels were integrated into the facades.
4. Project 10, Shared Courtyard and Community House. This project was responsible for arranging the waste-sorting stations, the rainwater collection ares, planting bed locations, and a community house with a kitchen and laundry facilities located centrally in the courtyard.

Solar cells make a visionary impression, although photovoltaic panels of that size and of that location provided only a small supplement to the total electricity consumption.

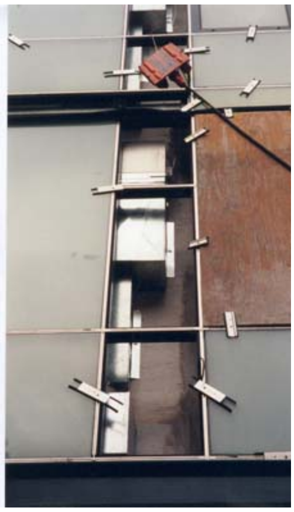
results

Following the concept of Eco-accounting (Environmentally accounting) improved by the Danish Builiding and Urban Research, five indicators for the extent of sustainability are used. These 'urban ecology indicators' are heat consumption, electricity consumption, water consumption, waste production and CO_2 emission. All indicators are based on annual accounting and related to the amount of residents'.

Hedebygade

An additional indicator makes up the heat account in relation to the area being heated.

While two of the buildings do achieve a lower energy consumption than the goal, it has been pointed out that this does not result in less carbon emissions. This is due to the fact that the district heating system emits less CO_2 than the electricity required to power the heat recovery ventilation and other systems that partially replaced the demand on the district heating.



Water consumption per person was reduced to 89-120 l/per, where the average for Copenhagen is 126l/per and the goal is to have 110l/per. Household waste was increased from 279hk/per year in 1996 to 300 kg/per year in 2003, where the average for Copenhagen for the mentined years rose from 231 kg to 241 kg.

Architecturally, the renovation project is a success.

Extra investment in urban ecological solutions will return the whole investment within a period of twenty years – a period that could be shortened considerably by increased energy prices.

To the participants the many projects that were gathered in one location revealed some basic principles for renovation of the older building stock. Furthermore it revealed how far it is possible to advance by using new aesthetic expressions.

Visualisation of individual metering

One of the critical lessons to be taken from this project is the value of visualisation metering. This has been successful in other projects as well, such as Gårdsten in Goteborg, Sweden. When households are given the opportunity to visualise their consumption of electricity, hot water, and heating, their consumption levels drop. In many ways this is tied to economics, where a direct correlation between utility bills and resources consumed becomes visually apparent.

In the case of Hedebygade, where the residents have been a part of the dialogue concerning ecology throughout the project, this visualisation also encourages and supports an attitude throughout the community where lower resource consumption is a goal, and so it could be said that the motivation is not entirely economic.

The meters, placed in each fl at, allow household members to view the daily, monthly, or yearly consumption of water, heat, and electricity. These meters read from the radiators, hot water sources, and electricity sources for each flat. The meters are also connected to and inform a central computer that registers consumption by each unit but also generates quarterly accounts and Eco-accounts. These accounts are posted in the central hallway or stairways of the buildings and allow tenants to compare their consumption against other tenants.

costs

The total cost was 50 million euro. The Ministry of Housings granted a total of 40 million DKK (app. 5.3 million €) for the greening of the buildings. The funding came from the national campaign “Project Renovation”, where a number of different renovation processes and technologies were tested and developed.

contacts: Ole Michael Jensen, Danish Building Research Institute, omj@sbi.dk

sources:

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Ekostaden Augustenborg

Location of Ekostaden Augustenborg

location: Malmö, Sweden
dates: 1948-1952 initial building
Renovation 1998-2002 – first phase
type: Urban renewal and rehabilitation, social and economic sustainability
use: residential
size:
people: about 3000 residents
actors: The City of Malmö, MKB housing company, local community
goals:
- Improve living conditions
- Increase green areas
- Increase use of public transport
- Reduce car mobility
- Waste recycling

energy use	KWh/m^2
heating&electricity, goal	
heating&electricity,achieved	
heating&electricity,best	

construction

amenities

systems	
district heating	x
combined heat & power	
solar panels	x
solar cells	x
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	
non-renewable energy	
individual metering	x

special projects

Demonstration and pilot project
Integrated planning approach
Public participation
Rain water collection
Waste recycling

site ecology

process and history

Augustenborg was originally built between 1948 and 1952 to international acclaim, but has over the decades suffered from general neglect, economic decline and severe unemployment.
In the post-war period the area was a pioneer of the new Swedish housing policy. The new People's Home was to offer high quality accommodation combined with local schools, shops, employment, social facilities and a pleasant environment. However, over the years, Augustenborg suffered more than most areas of Sweden from problems associated with unemployment. The inhabitants have exchanged over the years and the new migration to Malmö in the '80s and '90s increased and brought a new cultural diversity to the neighbourhood.
The City of Malmö and the housing company MKB are since 1998 working together to integrate different ecological technologies into efforts to re-stimulate social and economic community development. The focus of the redevelopment is in the Ekostaden program.

This project deals with the local residential area as well as the school, industrial area and local businesses. The aim is to make the City District a more socially, economically, and ecologically sustainable neighbourhood.
The results so far indicate that Augustenborg has become an attractive, multicultural neighbourhood in which the turnover of tenancies has decreased by almost 20% and the environmental impact has decreased to a similar degree.
Some of Ekostaden's main objectives are:

- Enable residents to play a significant role in planning and implementation;
- Improvements in local traffic conditions;
- New local waste and resource management systems;
- New systems to locally deal with rainwater;
- Significant demonstrations of roof greening;

Ekostaden Augustenborg

process and history, continued

- Ecological renewal of community school grounds and park;
- World's first electric road train.

This urban renewal project is specific for its:

- Intensive participatory planning process;
- Innovative local mobility initiatives;
- Integration of social and ecological interests;
- Comprehensive approach to neighborhood redevelopment.

description of special project features

Resident Involvement and Employment

With the assistance of the European URBAN program, a variety of community cultural events have been organized. A number of new businesses have been established in the area. Street Train Sweden for example has formed to develop and market the concept of the electric street train. A local resident is pioneering new designs for rainwater systems that are being tested in Augustenborg. A new management company is being considered for the administration of the area's waste and water systems as well as open and green spaces. This company may employ local residents, perhaps in the form of a cooperative. Other jobs have been created on a short-term basis through various Ekostaden projects.

Energy efficiency and production

A number of initiatives have been undertaken throughout Augustenborg to increase resource efficiency by up to 20% compared to 1995 levels. Measures to increase energy efficiency have been undertaken throughout the neighbourhood, optimising heating and hot water systems and cutting electricity use.

MKB have launched a pilot project to find the most efficient and equitable system for individual charging for heat and hot water which are both currently included in the rent. Some residents have taken part in a programme to weigh in their CO_2 and then work together to find ways of decreasing their carbon footprint.

The inhabitants of Augustenborg have been questioning why they didn't have any renewable energy production in their area. That became the start of a new project between the city, Malmö University, E.ON and MKB which today has led to a 450 m^2 solar thermal plant and 100m^2 photovoltaics producing hot water for the district heating system and electricity. The football pitch has been fitted with underground piping to pump solar heat out of the ground all summer and the residual heat from the ground all winter, producing hot water for the district heating system. As a side effect, when the temperature drops below 5 degrees, an ice rink can be created, offering the kids from the school and neighbourhood a new and exciting experience.

Building renovation

Due to the energy crisis in the 1970s the buildings from the 1950s were covered with insulation and steel sheeting. This has caused serious problems to the internal environment with damp, bad ventilation and temperature control. Therefore, as a beginning, on five buildings, the outer covering of the walls has been removed and a new insulation layer has been covered with a skimmed painted render. The appearance of the houses is now more like the original and the energy efficiency has increased by about 10 percent compared with the 1998 status of the buildings or approximately 35% more efficient than the original status of the building. The goal is to renovate all the buildings.

A new school building has been erected using natural materials, a high level of natural lighting, ground source heat pump, solar thermal panels, composting toilets and a number of other finesses to create what pupils and teachers alike agree are the most pleasant classrooms in the school.

Local Transportation Initiatives

Augustenborg projects have prioritised safety and comfort for pedestrians and cyclists as well as public transport, and worked to decrease local traffic speeds and through traffic in general. While all of Augustenborg will have a 30 km/h speed limit, Garden Streets are also being developed that have a 15 km/h limit. These efforts and an encouragement of a local use of electric vehicles are also leading to reductions in noise and air pollution in Augustenborg. The first "Electric Carpool" in Sweden has been organized as a form of local car-sharing in Augustenborg. Electric cars can be picked up and returned to the parking lots of a local supermarket.

Electric Road Train

Promoted as the "world's first electric road train", Augustenborg's Green Line's zero emission electric street train service has been developed to decrease car dependence and improve the mobility options available to area residents, for example senior citizens and people with health problems and low incomes. Two of these prototype trains, each with space for 28 passengers and capable of going 30 km/h, are now in service, having been built by the new local company Street Train Sweden AB. The trains powered by renewable energy sources and riding on rubber wheels, offer new employment opportunities as well as an ecological transport alternative. The train was terminated because the economy in the project was not as good as hoped mostly because they had a separate ticketing system

Local Resource Systems

A significant initiative aims to recycle at least 90% of Augustenborg's waste, through a system that is intended not just to increase recycling but also to create new job opportunities The approximately 1700 households are all provided with small bins for separating their own wastes, which they then take to one of 13 neighbourhood Resource Houses where there are large containers for all types of recyclables. The Resource Houses also house large automatic composting machines, and themselves are built with green roofs.

A major incentive for the redevelopment of Augustenborg was serious annual flooding and related sewage system troubles. An objective in response to this is to locally collect and handle at least 70% of the rainwater. Therefore the green roofs were created as a solution to the problem, which retain about 50% of the rainwater that falls on to them. They have achieved 70% of water retained in the area and the flooding problems were solved.

Roof Greening

Scandinavia's largest green roof has been built in Augustenborg. The 9,500 m^2 Botanical Roof Garden is primarily being developed to locally minimise rainwater run-off and to serve as a demonstration and research project for such systems in Scandinavia. With local, national and European funding, the Botanical Roof Garden involves partnerships with several universities and private companies.

Community School and Park

Augustenborg school pupils have been involved in a number of local developments, for example with the planning of a new community/school garden, rainwater collection pond/ice rink, and ecological building projects. The new music garden and playground invites children to create their own sounds by interacting with a variety of wood and metal structures.

funding

Ekostaden is supported through a partnership between the MKB housing company - which as a newly formed company in 1948 developed the Augustenborg neighborhood - and local partners within Malmö City and Fosie District. The project is further financed by the Swedish government's Local Investments Programme for Ecological Conversion and Eco-Cycle Programme, as well as the European Union's LIFE and URBAN programs and a number of other sources both public and private. The total cost of Ekostaden Augustenborg and related projects is in excess of 100 million Swedish Kr (¨10.7 mil Euro).

results

The initial Ekostaden programme was expected to be completed in 2001, but it was envisioned as the beginning of a long-term community development process. By the end of 2000 many of the initiatives had already been successfully implemented, collectively building a strong foundation for activities in the coming years.

contacts: Trevor Graham, Ekostaden Augustenborg, mail: ekostaden@malmo.se

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Echoes of Tomorrow, a brochure about Ekostaden Augustenborg written by Trevor Graham, issued in Malmö, 2002.
Ekostaden website: www.ekostaden.com (pictures are taken from this site)
City of Malmö website: www.malmo.se

Glastonbury House

location on map (image from Wikipedia: http://en.wikipedia.org/wiki/Knightsbridge)

Façade

location: Westminster, Pimlico, London ,UK

dates:

type: Refurbishment

use: Residential

size: 20 storey tower block

people: 162 flats for older people

actors:
Client: Westminster City Council / CityWest Homes
Architect: Cole Thompson Anders
Cost Consultant: Franklin + Andrews
Intelligent Systems: i&i limited
M&E Engineer: WSP
Structural Engineer: WSP
Landscape Architect: Studio Engelback
Main Contractor: Wates Construction
Communications Management: enabling concepts
Research Management: i&i limited

goals:

- Decent homes improvements
- Installation of equipment to make use of non-renewable energy sources, including a wind turbine to generate residents' power supply, and rainwater harvesting to minimise water use
- Environmental improvements, including new communal gardens

energy use	KWh/m^2
total energy demand, goal	
total energy demand, achieved	

construction

amenities

systems	
district heating	
combined heat & power	x
solar panels	x
solar cells	x
biomass and refuse	
wind power	x
natural ventilation	
forced vent.w/heat recovery	
non-renewable energy	
individual metering	

special project features

- Environmentally sensitive building materials
- Waste sorting and collection system
- Water saving measures
- Rainwater harvesting

site ecology

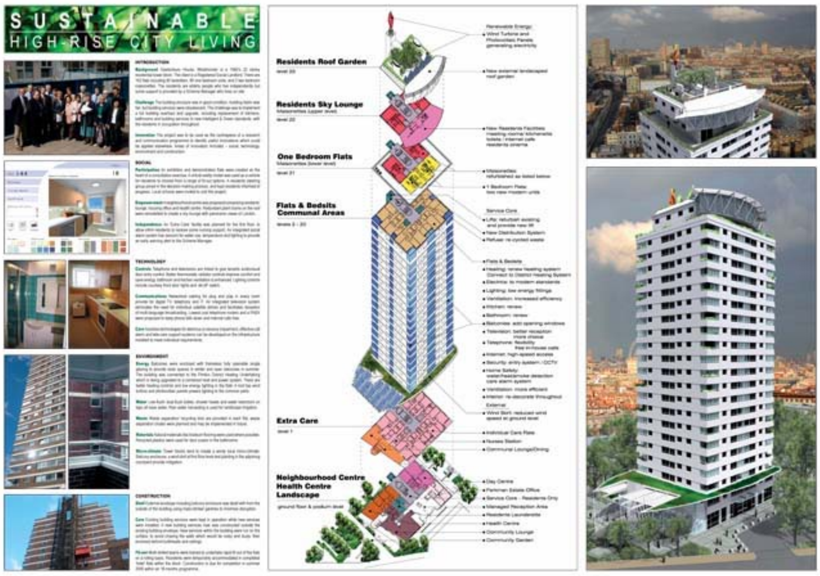
process and history

In January 2001, Westminster City Council, a partner in INTEGER (an action research network in the UK), asked INTEGER to investigate options for the intelligent and green refurbishment of housing in general, and specifically residential tower blocks. 50% energy savings and 40% water savings were targeted. A key part of the project was the development of a virtual reality model to ensure that residents were able to have a clear understanding of what the project would achieve and were able to participate fully.

The strategy for the refurbishment was devised around the requirement for innovation in seven key areas related to social housing: management; social; design; construction; technology; environment; finance. Participation was particularly important, and consultation with residents continued throughout the demonstration phase. Residents remained in their own homes for as long a s possible during the refurbishment, as the prospect of moving was a major anxiety for many people; this meant that the programme had to be devised so that as much work as possible could be carried out from the outside, and residents were moved out for as short a period as possible.

Glastonbury House

Front elevation



Brochure taken from http://www.colethompson.co.uk/w_glast_sust.html

process and history

This ground-breaking refurbishment project is to set new technical quality standards:

- A showcase for environmentally friendly systems
- Intelligent Home Control (IHC)
- Integrated Reception System (IRS)
- Networked cabling infrastructure for DTV and broadband to every flat
- Potential 'free' telephone system throughout the block for calls between flats
- Resident involvement throughout the development process
- New neighbourhood centre and on-site management office to provide care and support for residents
- Waste segregation
- Target 50% reduction in energy consumption and carbon emissions
- More efficient heating and lighting
- Photovoltaics
- Wind turbine
- Target 40% water savings
- Rainwater harvesting
- Dual-flush toilets and low energy lighting
- Roof top residents' 'Sky Lounge'

Existing service infrastructures such as lifts and building service risers were maintained while replacement infrastructures such as external intelligent lifts and new, modern building services were installed, so that residents suffered as little disruption as possible. Multi-skilled teams were developed and trained to carry out rapid fit-out of flats on a rolling basis, to minimise disruption and to reduce the amount of time for which residents were required to vacate their flats.

Control systems for heating, lighting and security systems within the block were upgraded to ensure efficient use of resources and reduce wastage. At the same time, the systems were set up to provide passive and unobtrusive monitoring of residents to check that regular habits are kept to, and hence pick up any unusual behaviour which might be a sign of distress.

Best value was addressed throughout the project - through use of innovative procurement routes, two stage tendering, partnering, early involvement of suppliers and off-site fabrication to drive unit costs down.

description of special project features

The refurbishment project was broken down into four key stages:

- Feasibility study (completed November 2001) - To identify ways in which Westminster's housing policy objectives can be applied to the refurbishment of a tower block, using Glastonbury House in Pimlico as a vehicle for a study of generic solutions which may be applied throughout Westminster
- Demonstration Project (December 2001 - July 2003) - To propose and demonstrate ways in which possible refurbishment solutions may be trialled in a small scale demonstration project. For this purpose, Westminster City Council allocated two bedsit flats on the 19th floor, along with an exhibition space on the ground floor. The refurbished areas opened in September 2002, and will stay open until July 2003, during which period extensive consultation and ideas development will take place involving the City Council, residents, suppliers and other stakeholders.

- Pilot Project (Commence July 2002) - To consider how the ideas, processes and technologies used in the demonstration phase may be implemented on a major refurbishment of Glastonbury House or another similar tower block, and to begin the pilot refurbishment project in July 2003.
- Policy, procedure and guidelines (ongoing) - INTEGER is an action reseach network, and effective communication of research outputs is especially important. This occurs through written literature, seminars, workshop sessions and also through the INTEGER Education Programme. This initiative aims to bring the pilot project into the lives of the whole local community, and particularly into the school lives of the local children. To date, INTEGER has helped to develop around forty lessions linking into key areas of the National Curriculum such as physics, chemistry, design and citizenship. INTEGER will work with schools in the Pimlico area to involve them in the pilot project.

funding

NA

results

- Energy - 50% energy savings and a 50% reduction in carbon emissions through more efficient heating and lighting systems, improved building insulation and use of renewable energies such as solar water heaters, photovoltaics and wind turbines
- Water - 40% water savings by efficiency measures including rainwater harvesting, use of spray taps and grey water recycling
- Waste - reduce waste in construction by closer management and off-site fabrication. Introduce pre-contract specifications for re-cycling. Reduce waste in use by considering waste separation, compaction and other technologies
- The micro-climate around the base of the building was improved through intelligent landscaping and the introduction of wind-deflectors. The balconies of the flats were made more habitable through enclosure.
- Life cycle costs were addressed - investing for the longer term in the housing stock. A 10% saving in year on year costs was targeted (compared to a traditional refurbishment benchmarked against savings of 9% identified in the feasibility study).

contacts:

sources:

- http://www.wates.co.uk/living_space/living_space_projects/glastonbury/
- http://www.ukswedensustainability.org/projects/glastonburyhouse.jsp
- http://www.integerproject.co.uk/westminster_team.html
- http://www.greenstreet.org.uk/index.php?ct=1&filters=f16&loadDocumentID=518
- http://www.colethompson.co.uk/w_glast_sust.html

Flagship Home

location on map (image from Wikipedia: http://en.wikipedia.org/wiki/Knightsbridge)

Front entrance

location: City of Westminster, UK
dates: 2005
type: Renovation of a five storey Victorian terraced house from the 19th century.
use: Residential
size:
people: 36
actors: The Royal Borough of Kensington and Chelsea Council, City of Westminster Council, Eaga Partnership Ltd, ECD Architects, EDF Energy, Energy Saving Trust (EST), English Heritage, S E Land and Estates plc, Beechwood Property Renovations Ltd

goals:
- "The aim of the project is to show that this type of house can make a positive contribution to a low carbon economy while maintaining the traditional character of the building and adhering to planning constraints."
- maximise energy efficiency and reduce emissions of CO_2

energy use	KWh/m^2
total energy demand, goal	
total energy demand, achieved	

systems	
district heating	
combined heat & power	
solar panels	x
solar cells	
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	x
non-renewable energy	x
individual metering	x

construction

amenities

special project features
- Renovation and preservation
- Information, education and inspiration through active involvement of different actors and a web-site explaining the project

site ecology

process and history

The Flagship Home in 36 Beaufort Gardens, Knightsbridge, was a five storey Victorian terrace house comprising of bedsits and one self-contained flat. It is classified as a House in Multiple Occupation so the Council looks after its regulations. By this refurbishment the Council wanted to provide an example to other landlords in the Borough - to encourage greater awareness and take-up of energy efficiency.

As an old building structure, it is a typical representative of a large proportion of the housing stock in the Royal Borough, Westminster and other British cities. It is in a conservation area but is not a listed building.

The Flagship Home is owned by SE Land and Estates plc, which owns residential and commercial property across the UK.

Flagship Home

Front elevation

Two communal 26kW condensing boilers provide heating to the whole building

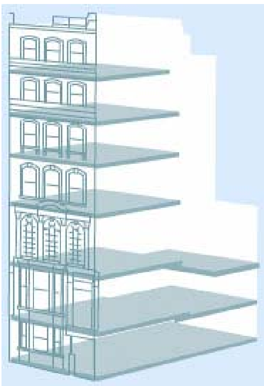
process and history

The objectives of the project were:

- To demonstrate and promote practicable, cost effective, energy efficiency measures to private landlords.
- To target older, solid walled properties in conservation areas that have been ignored by national and regional campaigns.
- To demonstrate how older properties can make a positive contribution to a low carbon economy through the use of innovative methods used in conjunction with traditional sustainable green materials.
- To encourage a close working relationship and a better understanding between statutory bodies and building preservation organisations.
- To tackle issues such as fuel poverty that may be alleviated through more energy efficient housing.
- To provide Royal Borough of Kensington and Chelsea and Westminster City Council with the opportunity to explore new innovative measures, identify new ways of working and promote sustainable housing.
- To use the property as an exhibition home to promote innovative energy solutions to our target audience.

description of special project features

Energy improvements involve:



Throughout the Flagship Home, light fittings have been installed which will only take energy efficient lightbulbs. As the Flagship Home was constructed in the 1800s, some of its units have very high ceilings, requiring the landlord to send out maintenance staff simply to replace lightbulbs. The use of energy efficient lighting – which has a much longer lifetime – means that the costs of maintenance are significantly reduced.

The existing building had no fixed heating appliances. Typically the landlord would install an electric heater where needed. These were expensive to run and emitted a lot of carbon dioxide. As part of the feasibility study a number of options were reviewed and the conclusion was made that a central gas fired heating system was the most cost effective solution.

Two communal condensing gas boilers were installed supplying radiators in each bedsit and two hot water cylinders. Each bedsit has a programmable thermostat so the occupant can set the temperature and operating times. This is an important feature particularly to those working long hours or shift workers.

The hot water cylinders are powered by a combination of solar power and gas. On hot days in the summer the solar power can provide all the building's hot water requirements.

Because the building was located in a conservation area a planning permission to add external wall insulation, for example stone cladding, to the front was not possible to get. There were also difficulties with the rear elevation so the only viable option was to use insulated drylining (this involves adding a layer of plaster board with insulation attached to it to the inside of an external wall).

All of the external walls were dry-lined with a 35mm thick insulated dry-lining achieving a U-value of 0.6W/m^2K (space limitations restricted the thickness that could be applied). This insulation will reduce heat losses through the walls by up to 65 per cent. In addition, to reduce thermal bridging or cold spots, the insulated dry-lining was continued along the party walls for one metre.

To ensure that the building is free from problems caused by condensation and mould growth a new ventilation system was introduced. This provides a constant supply of pre-warmed, dry air and extracts stale, moist air which results from washing, cooking and such like. The ventilation system allows for efficient heat recovery – this means the warm air that is being extracted from the building partly heats up the incoming cold air.

The building's windows were in a poor state of repair. But as the property was located in a conservation area it was not possible to get planning permission to replace the front windows with double-glazed ones. However, the rear windows were replaced. The front windows were refurbished and secondary glazing was added to prevent heat loss. The rear windows were replaced with new wooden double glazed ones, the glazing includes a low emissivity coating and the gap between the double-glazing is filled with argon rather than air to help reduce heat losses.

The Royal Borough's standards require that all bedsits have a small refrigerator, all refrigerators in the Flagship Home will be 'A' rated. The toilets have a "low-flush" option - flushing uses either two or four litres of water (a typical toilet uses six litres).

With 36 residents living in small, well-insulated individual units, the building has a high demand for hot water compared to its demand for space heating. As the back of the building faces south-west, it provided an ideal location for solar panels which are used to help heat the building's water. A solar water heating system has been installed which will provide on average 60 per cent of the tenants' hot water needs. The system includes two 500 litre hot water cylinders. Solar panels were incorporated into the new roof design to ensure they were would not be visible from the street.

funding

The landlord paid most of the project costs. The additional capital costs of the energy efficiency measures were supported by funding from the Royal Borough of Kensington and Chelsea, the Energy Saving Trust and London Energy. The Royal Borough of Kensington and Chelsea has contributed £140,000 to the Flagship Home project, while the Westminster City Council has contributed £1,500.

The Energy Saving Trust's Innovation programme provided a grant of £90,000 towards a feasibility study and project management and marketing costs.

London Energy has contributed to the costs of insulation and white goods through its Energy Efficiency Commitment programme.

The improvement done on this house can be measured by "NHER" stands for National Home Energy Rating, which is a UK wide scheme that provides a reliable method for measuring the energy performance of a home. It runs from one to ten, ten being the most efficient. As a result of this project, the Flagship Home will leap from three to nine!

results

- Energy costs have fakllen by 67 per cent from approximately £3,400 to £1,100.
- CO_2 emissions have been cut by 63 per cent from a level of 25.74 tonnes per year to 9.58 tonnes

Lessons learned:

The breadth of the partnership involved in the Flagship Home project necessitated clear communication between all the partners.

Local authorities and other housing providers are particularly interested in solutions for 'hard-to-treat' properties, where common energy efficiency measures cannot be installed.

Having successfully demonstrated how the installation of energy saving measures can significantly improve performance in an older building, the project team believes others can benefit from the adoption of some, if not all, of the measures in their own projects.

It is difficult to engage private landlords on energy efficiency. The immediate benefits of improvements (increased comfort, reduced fuel bills) accrue to the tenant, so there is often no obvious incentive to the landlord. However, the response to the project, particularly at London Landlords Day, has been promising and a database of interested landlords has been established for future marketing activities.

contacts: Project manager: Jean Roberts, tel: 020 7341 5673, jean.roberts@rbkc.gov.uk
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sources:

- Most information was attained from the projects web-page http://www.rbkc.gov.uk/flagshiphome/general/default.asp
- Making private rented housing energy efficient – the Flagship Home, case study, CE192 © Energy Saving Trust January 2006. E&OE All technical information for the brochure was produced by BRE on behalf of the Energy Saving Trust

NEW CITY AREAS

New city areas in this guide are considered to be areas which have not been previously occupied by another activity. Cities are expanding both by occupying free city land within existing city limits and by extending the city borders. However, while doing so, there are not so many that have sustainability targets integrated into their planning programmes.

In Hamburg, an opportunity was taken when a new housing area was built as one of the two first major projects in Germany which involved solar municipal heating with long-term heat storage in a new residential area. This is a relatively old project, initiated only in 1996. Nevertheless, it can still serve as a guide and as a success story that other can follow. Even in the mid 1990s it was evident that **CO_2 emissions should be reduced**, **climate protected, and water conserved**. **Public participation** was an important part of the project. A downside of the project is low density and which can be questioned when talking about sustainability of a project and possibility to multiply it on a wider scale.

Beyond the North Sea Region borders there are a number of good examples that should be mentioned as a reference to building new city areas. One of them is the ecological experimental area of Viikki in Helsinki, Finland, and the other one is a new housing area in Amersfoort in Nieuwland, The Netherlands, where 1MW of PV cells were integrated into the new buildings.

Special attention should be given to the Viikki project in Helsinki. The development was driven by a **set of criteria** PIMWAG which was developed for this project. The project was successful and good experiences are now being used for other developments in the region. Recently, Viikki project has won the award for Best Sustainable City Development Practice in the North Sea and Baltic Region, which was given out at the Sustainable City Development Conference 2007 in Malmö, in September 2007. The award was given by the City of Malmö together with IVL Swedish Environmental Research Institute.

Kronsberg in Hannover also deserves mention due to its remarkable success in achieving the goals that were set for the development.

On following pages you can read more about the projects and their specifics.

Braamwisch Ecological Settlement

Location of Braamwisch Ecological Settlement

location:	Hamburg-Bramfeld, Germany
dates:	1996-2000
type:	Residential area, 40 housing units (WE) in five town house rows and two duplex houses
use:	Residential
size:	1.2 hectares, each terraced house with approx. 125 m2 living quarters and approx. 300 m2 land (hereof approx. 100 m2 community area, e.g. vegetation-based sewage treatment plant, sidewalks)
people:	143
actors:	Hamburger Gaswerke, City of Hamburg, citizens
goals:	Supplying an entire area with solar heating, climate protection and CO_2 reduction, significant reduction of drinking water consumption.

energy use	KWh/m^2
heating&electricity, goal	100
heating&electricity,achieved	90
heating&electricity,best	NA

construction

Low-energy house, partially solid brick construction, partially wood frame construction

amenities

Existing amenities (not belonging to settlement): kindergarten, primary school, shops, health care facilities, access to public transport.

systems	
district heating	X
combined heat & power	
solar panels	X
solar cells	X
biomass and refuse	
wind power	
natural ventilation	X
forced vent.w/heat recovery	X
non-renewable energy	X
individual metering	X*

special projects

Resident participation
Car sharing
Planted roofs (sheds) and house fronts
Ecological building material
Composting toilets
Rainwater toilets
Shared use of open space

site ecology

Rain water collection
Waste separation
Plant-based sewage treatment system (grey water)

* Individual metering for heating, electricity, and water in each house. Overheads e.g. for parking lot lighting, sewage plant operations.

process and history

In 1996 the Karlshöhe Solar Settlement was created as a pilot project by Hamburg Gas Works, the company responsible for the city's power supply at that time, with support from the Free and Hanseatic City of Hamburg and the federal government. It was one of the two first major projects in Germany involving solar municipal heating with long-term heat storage in a new residential area. 40 terraced houses in this settlement belong to the Braamwisch Ecological Settlement. It is the product of committed citizens who have realised in practice, through this project, their vision of ecological building and living.

Low-energy houses were built, using ecological building materials, equipped with composting toilets and connected to their own plant-based sewage treatment system.
In the planning of the Braamwisch Ecological Settlement, climate protection and the reduction of carbon dioxide emissions were not the only considerations.

Braamwisch Ecological Settlement

process and history, continued

The developers also had other aspects of sustainable construction in mind.

- Efficiency (= raising the degree of effectiveness), e.g. by providing houses with good insulation and so reducing power consumption
- Consistency (= connecting with natural cycles), e.g. through an alternative waste water solution involving composting toilets and an on-site plant-based sewage treatment system
- Substitution (= replacement of toxic substances with environmentally friendly substances presenting no hazards to health), e.g. through the use of resource-saving and regenerative raw materials and sources of energy
- Sufficiency (= adequacy), e.g. through the shared use of open spaces and car sharing.

description of special project features

To supply an entire residential area with solar heating – in 1996 this was something that had never been done in Germany before. The Hamburg pilot system was designed to give the idea a first trial. A total of 124 single family terraced houses have been connected to solar collection surfaces measuring 3000 square metres in all. The water that is heated up in the solar collectors is fed into a subterranean hot water tank measuring 4500 cubic metres (see photo below), and should cover about 50 percent of what is needed in the way of heating and domestic hot water. Two low-temperature gas-fuelled condensing boilers at the settlement‘s central heating unit supply the missing heat energy in winter.

The houses do not have either boilers or chimneys, only a heat transfer station at which the district heating supply arrives, at a temperature of 60°C. It is then transferred to the house‘s internal heating circulation or to domestic hot water for the bath and kitchen, with the amount of heat that has been tapped being registered. The residents allow the south-pointing surfaces of their roofs to be used for the installation of solar collectors, and pay a one-off connection charge of 6000 euros. This is notably cheaper than the construction of an individual solar collection system, which comes to around 9000 euros minus subsidies.

Since 2002 the low-energy approach to construction has become established standard in Hamburg in connection with new buildings – that is to say, the heat energy needs (without hot water) must not exceed more than 70 kWh per square metre per year. The houses of the Braamwisch Ecological Settlement are still well below this limit: in a mid-terraced house, consumption levels are around 59 kWh per square metre per year, including hot water supply. This amounts to about a third of the consumption level in an average German household (197 kWh per square metre per year). These sparing consumption levels have been achieved in Hamburg‘s Ecological Settlement by the use of double walls with perlite cavity wall insulation and ecological insulating materials such as isofloc, cork or coconut fibres.

In the steamy rooms (bathroom and kitchen), a ventilator extracts air at all times. Air valves in the wall or in the window frames allow this to be replaced by a flow of fresh incoming air. If the outgoing air is directed by way of a heat exchanger that can transfer up to 70% of its heat to the cold fresh air. This will result in further energy savings.

In some houses of the Ecological Settlement cob walls have been used.

On two rows of houses a total of 65 square metres of photovoltaic modules were installed to generate electricity. The annual yield is around 5100 kWh, which is fed into the public grid.

In the Braamwisch Ecological Settlement each house is connected to a grey water treatment system, which purifies waste water from the bath and kitchen (not from the toilet). The purified water flows into the closest available stream.

Braamwisch Ecological Settlement

The area of the settlement includes three reedbed sewage treatment systems, measuring 250 square metres in all. Each dwelling unit contributed some 8000 euros to the construction of the facility. The sewage systems are common property, the residents are responsible for maintaining them.
A consistent extrapolation of the principle of viewing water as a resource to be handled with care was the installation of composting toilets as opposed to traditional flushing toilets in the houses of the settlement. Various different systems were adopted: 17 houses have a BioLet composting toilet, 9 have a Terra Nova model and 7 a Clivus Multrum. Seven houses in the Braamwisch Ecological Settlement have rainwater toilets.
Braamwisch is not a completely carfree settlement. But all residents agreed that the areas directly adjoining the houses should not be used as a car park but should be made available as a green play area for children. A car-sharing vehicle is available for use on the settlement car park.

funding

For the local solar heating project the overall costs of the Hamburg pilot project came to around 3.4 million euros. Finance was provided by the Federal Ministry of Science, Research and Technology (1.5 million euros), the City of Hamburg (0.5 million euros), Hamburg Gas Works as the operating company (0.7 million euros) and the project developers with around 6000 euros per dwelling unit (0.7 million euros).

results

In comparison with a standard terraced house, the construction costs of a house in the Braamwisch Ecological Settlement will be about 10-15 percent higher. This is balanced out against annual savings of 1200 euros. That corresponds to a payback period of around 20 years – without taking into account rising energy prices and waste water charges. The benefits of healthy construction materials for the resident cannot be directly measured in monetary terms, but they play an important role, too.
The environment, too, is a significant gainer from the construction of ecohouses. An example of a carbon dioxide balance of a house in the settlement (only taking into account power consumption for heating, hot water and electricity) shows that at 0.31 tons of carbon dioxide, an individual in the illustrative household of the Braamwisch Ecological Settlement produces less than one sixth of the amount generated by a person in the average German household (2.05 tons).

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Project information assembled by Silvia Schubert and Franziska Mannke.
sources: Nachhaltiger Wohnen. Erfahrungen aus 10 Jahren Ökologische Siedlung Braamwisch, 2007.
LifeSTYLE: www.lifestyle-project.eu **GER:** leal@tutech.de

Viikki

Location on map of Helsinki

Areal view to the Viikki development

location: Helsinki, Finland
dates: 1989 – 2000 first phase, final phases by 2010
type: New construction in greenfield area

use: Mostly residential, some services, including University expansion
size: First phase 23 hectare
people: 7000 residents in 2007
by 2015 the target is to have more than 15000 residents, 7000-8000 work places and 6000 students in the area

actors: Eco-Community Project, City of Helsinki (established by Ministry of the Environment and the Finnish Association of Architects (SAFA)),
National Technology Agency of Finland (Tekes), Helsinki City Planning Department, architect Petri Laaksonen (who won the competition for the area according to which the detailed plan was made)

goals:
- reduce consumption of natural resources in both building construction and maintenance
- reduce heating, electricity, and water consumption among residents by a considerable percentage compared to the typical average residential use in Helsinki
- replace fossil fuel use with renewables natural resources

energy use	KWh/m^2
heating&electricity, goal *(33% less than a conventional Helsinki residential building consumes)*	105
heating&electricity,achieved	120
heating&electricity,best	45
household energy,achieved	45

construction
- low-rise mostly wood construction
- elimination of thermal bridges
- use of conservatories for passive solar
- low-energy house construction
- use of non-toxic and certified material

amenities
- daycare and community playfields
- community clubhouse
- shared saunas and laundries
- pedestrian streets
- garden cultivation centre
- allotment gardens
- church
- health services

systems	
district heating	x
combined heat & power	
solar panels	x
solar cells	x
biomass and refuse	
wind power	
natural ventilation	x
forced vent.w/heat recovery	x
non-renewable energy	x
individual metering	x

special projects
- district solar heating
- adaptable multi-storey wooden housing
- resident participation

site ecology
- storm water retention and collection
- land for food-growing
- inclusion of bio-diversity within plan

process and history

The Eco-Community Project was a collaborative project established in 1993 by the Ministry of the Environment and the Finnish Association of Architects (SAFA) with the intention of testing "ecological principles in practical design and building."
An inquiry throughout Finland for interest in providing a testing ground for the project led to 16 proposals for new projects. The area of Viikki, 7km north and east of Helsinki's city center and bounded by a nature conservation area and the University of Helsinki's School of Agriculture and Forestry, was chosen as the site. Preliminary plans to settle Viikki had already begun in 1989.


PV cells in roof-top


Timber bridge


Experimental area for timber construction

process and history, continued

The starting point of the local plan was to extend the university area, specialising in bio-sciences and bio- technology, and to construct an extensive new residential area connected to the Science Park, whilst preserving the natural and cultural values of the area. The City of Helsinki and the Eco-Community Project organized competitions that were held throughout the entire planning and building development process, which generated a huge amount of interest. The final plan for this project, which was to support 1700 people and contain daycares, a school, and a shop, was selected from 91 proposals. The winning proposal oriented the majority of the buildings facades to the south to maximize solar exposure, dealt with wind abatement through gradated building massing and vegetative wind breaks, and included 'green fingers' of land between the buildings to provide areas for planting and allotment gardens, the managing of stormwater runoff, and habitat for birds.
The competition structure allowed Viikki to be a testing ground for both actual building solutions and, as importantly, the collaboration between people with different areas of expertise that is required in creating new ecological solutions. In the competition for building solutions, proposals had to be the result of a collaborative workgroup that included the architects, the developer, a structural engineer, and an expert in ecology. In this way, there could be some guarantee that the schemes were buildable and would be able to achieve the level of ecological performance proposed, all within a realistic economic framework.
The main parts of Viikki are the Viikki Science Park and Latokartano housing area.
Eco-Viikki is the southernmost section of Latokartano housing area. In this ecological experimental area the target has been to find housing solutions for improving the ecological quality of high-density housing construction through design competitions and pilot projects.

description of special project features

Viikki's ecological planning was steered by a set of ecological criteria called PIMWAG. A competition was held for its creation. The PIMWAG criteria (an acronym for the names of the groups members) was selected. While it was decided that no specific requirements would be made of the buildings in terms of their construction, the PIMWAG ecological criteria would establish a high standard for the baseline performance that the proposals for the buildings competition would have to achieve. Proposals that achieved this baseline would be considered and solutions that went beyond the minimum criteria and were feasible would have a better chance of selection and becoming realized. The 5 main factors addressed by the criteria were:

- pollution: CO_2 emissions, water consumption, building material waste, household waste, environmental labelling
- natural resources: primary energy, heating energy, electrical energy, and spatial adaptability
- health: internal climate, moisture risks, noise, wind, and sun issues, and organization of floor plans
- bio-diversity: plant selection, stormwater management
- nutrition: cultivation of useful and edible plants

A PIMWAG notification including calculations and explanations were included in the building permit documents, and would also be signed by the developer; this would show that the project "fulfilled the obligatory demands of the criteria."

results

Besides high targets for energy consumption, water consumption in Viikki was targeted to 22% (125 lit/person,day) less than normal. The average daily achieved is 126 lit/inhabitant, but the consumption varies depending on the house type, form of ownership, and presence of sauna.

In addition higher targets than normal were set for the utilization of the soil dug from plots, amount of waste produced by an inhabitant (160kg/per,year=20%less than normal), max level of CO_2 emission by each building (3200kg/m^2 = 20% less than normal, achieved 9% more than target), max amount of building waste (18kg/m^2= 10% less than normal, achieved 5-15kg/m^2). Social aspects of sustainability are also included in the project and the results are monitored by the University of Helsinki Department of Social Policy. The best features of the area are the 'green fingers' which link the plots and their allotment gardens.

The solutions that characterise the area are various, from promotion of more ecologically responsive construction to utilization of various technologies for energy production and savings.

Utilization of solar energy was tested the most, while other solutions such as improved intermediate floor solution with respect to moisture and sound insulation properties, HPAC equipment solutions, special spatial configurations and technical systems, use of low-emission materials and others were also present.

With respect to solar energy utilization applied systems include passive and active strategies. Passive strategies involve building orientation, green houses and glazed balconies, while active strategies involve solar-generated heating or electricity systems. With respect to the later, an integration of photovoltaic cells was tested on a multi family building, where 200m^2 of photovoltaic cells were incorporated into balcony railings, producing 15-20 per cent of property's needs. Being connected to the grid allows export of sufficient electricity in the summer times and import of needed energy during the darker winter days. The system generates approximately 80-100 kWh/m^2 and has the capacity of 24kWp. An important part of the project includes information and management systems of the applied photovoltaic cells.

Solar heating systems are another exploitation of the solar energy in Eco Viikki. Nine properties have solar heating systems installed, mostly focusing on the integration of various solar energy collectors in roof construction and canopies. The energy is utilized mostly for the heating of domestic hot water, and at some locations for sub-floor heating of wet spaces. More than 1200 m^2 of solar collectors were installed so far for 368 apartments.

Out of the nine properties, a special project called SUNH (Solar Urban New Housing) has tested solar instalment of 157m^2 of solar collectors and 18m^3 of energy storage cells. The area has 44 apartments with 4505 m^2 floor area. Solar heating is used for domestic hot water as well as a supplement of the indoor heating.

funding

National Technology Agency of Finland through the KEKO programme supported the development with the objective to test and apply the principles of sustainable development and eco-construction to housing production. The Housing Fund of Finland subsidized the housing production within this new district. Expense of building foundations on difficult clay soil was compensated for with a reduction in the land rents by the City of Helsinki. 4 million Euros were granted to the project through the EU, and were primarily devoted to research and project development within the TEKES Programme for Building.
"Instead of an experimental building subsidies system...it was agreed to channel the economic support through research and product-development funding. This was then developed by the Ministry of the Environment and TEKES and implemented between 1989 and 2000." This funding went into such projects as researching building materials and methods, environmental management, waste management, and organizing the building site waste.

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sources:

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NEW BUILDINGS WITH SPECIAL FOCUS ON ENERGY PERFORMANCE OF BUILDINGS

With the increasing concern for the rising energy dependency in Europe, rising consumption and therefore rising impact to the environment, many activities in the building sector are being carried out in order to improve the energy performances of buildings.

Passive house principle is considered to be today's leading building principle for houses with low energy consumption. A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems (Adamson 1987 and Feist 1988). The technical definition applies for climate conditions between 40 and 60 degrees latitude in the Northern Hemisphere. The house heats and cools itself, hence "passive". For European passive construction, prerequisite to this capability is an annual heating requirement that is less than 15 kWh/(m²a) (4755 Btu/ft²/yr), not to be attained at the cost of an increase in use of energy for other purposes (e.g., electricity). Furthermore, the combined primary energy consumption of living area of a European passive house may not exceed 120 kWh/(m²a) (38039 Btu/ft²/yr) for heat, hot water and household electricity.[3]

In Sweden, a modified version of passive house principle is developed due to the big difference in climate conditions from the southern part to the far north. For instance, in the southern Swedish climate zone the specific power need should not exceed 10W/m^2 while in the northern zone it should not exceed 14 W/m^2.[4]

There are however a number of other codes and principles around Europe that are successfully used and specified as low energy building codes. In Italy, in the Autonomous Province of South Tyrol a certification system called **KlimaHaus/CasaClima**[5] was introduced in 2002. In Switzerland and Liechtenstein, a similar principal to Passive house concept has been developed called **Minergie** ® with **Minergie-P**® and **Minergie-Eco**®[6] versions. The UK Government has set a target for 0 Carbon homes by 2016 – all new homes should be 0 CO_2 emission. Recently, a new code has emerged called **Code for Sustainable Homes**. It is an environmental assessment method for new homes based upon BRE's Ecohomes (British Research Establishment – BRE).

Here we present two examples of passive houses in Sweden and one example of low energy house neighbourhood in Germany. It should be noted that the focus was on housing neighbourhoods rather than single family houses. Remarkably, in Landskrona, for instance, no special subsidies were given for the project, which makes it very attractive for future developments.

During 2006 and 2007 many new case studies have emerged across the North Sea region and the surroundings, but results are not available. They will however be carefully followed and included in the guide at a later stage.

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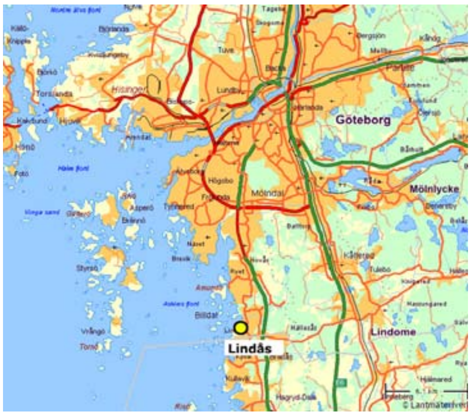
[3] http://www.passiv.de/
[4] http://www.energieffektivabyggnader.se/
[5] http://www.klimahausagentur.it/en/casaclima/klimahauscasaclima.html
[6] http://www.minergie.com/index2.php?basics

Houses without heating systems, Lindås



location on map

location: Lindås, Göteborg, Sweden
dates: 2001
type: New construction in passive house technology
use: Residential
size: 20 apartments
people:
actors: EFEM arketektkontor, Chalmers University of Technology, Swedish Council for Building Research, Lund University, Swedish National Testing and Research Institute
goals:
- provide a pleasant indoor environment with minimum energy use
- highlight the practicality of passive house approach, and its replicability elsewhere

energy use	KWh/m^2
total energy demand, achieved	76,9
2006 regulations for new building (BBR), goal	110

construction
- External wall U-value of 0.1W/m^{2}K (framed timber construction with 43cm insulation)
- Roof U-value of 0.08W/m^{2}K (masonite beams with 48cm insulation)
- Floor U-value of 0.09W/m^{2}K (concrete slab laid on 25cm insulation)
- Windows U-value of 0.85W/m^{2}K (three pane windows with two metallic coats and krypton fill)
- External door U-value of 0.80W/m^{2}K

amenities

systems	
district heating	
combined heat & power	
solar panels	x
solar cells	
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	x
non-renewable energy	
individual metering	x

special project features
-

site ecology

process and history

In Lindås Park, 20 km south of Gothenburg, twenty terrace houses stood ready in spring 2001. The houses were designed to use as little energy for heating as possible, and were therefore more insulated than normal.

The houses are the result of a research project extending over a period of years and aim to highlight the practicality of taking this kind of approach, and its replicability elsewhere. The study was carried out in cooperation with Chalmers University of Technology, the Swedish Council for Building Research (Formas), Lund University, and the Swedish National Testing and Research Institute. The houses were designed by the architectural practice EFEM arkitektkontor.

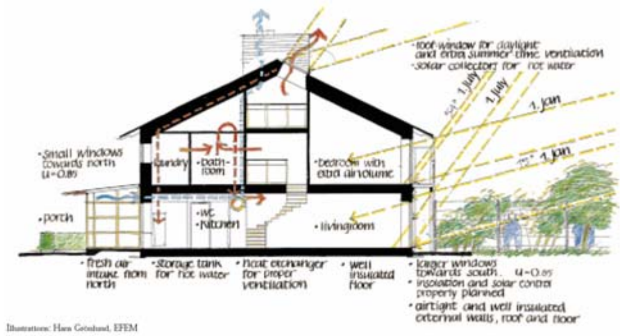
Houses without heating systems, Lindås

Workers at the site

Picture from site

Layout of a typical house

description of special project features



The courtyard facade towards the south has large windows to make full use of solar heat. Balconies and projecting eaves provide protection against excessive solar radiation during the summer. Owing to the terrace construction with houses of 11 m depth, there are few external walls, and these are exceptionally well insulated and airtight. The roof window above the staircase gives light in the middle of the house, and is also used for effective ventilation in the summer. Cross section of the typical house is on the picture to the right.

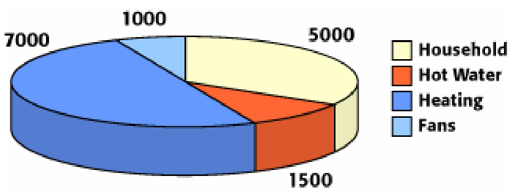
The houses are equipped with solar collectors on the roof and all windows installed were modern energy efficient windows. Solar collectors of 5 m^2 per house are estimated to provide the energy for half the hot water requirement. The 500 l storage tank is equipped with an electric immersion heater to cover the rest of the requirement. An efficient heat exchanger was installed, which reuses the heat of the ventilated air. There is no traditional heating system, but the ventilation system is equipped with an electric heater of 900 W, which is possible needed during cold winter days.

Each house has one air inlet, where fresh air is passed through a heat-exchanger to warm it; it is then circulated around the house. Each house has three chimneys, one providing an outlet from the heat exchanger, the other two providing outlets for sewage and kitchen air, which are kept separate from incoming air. Overall 85 percent of exit heat is recovered via the heat exchanger. Besides the heat from the heat exchanger, the rest of the heat requirement is covered by heat from the occupants, appliances and lighting. The heat from occupants is equal to an energy increment of ca 1200 kWh/year. Heat gains from lighting, fridge, freezer, cooker and other appliances come to about 2900 kWh/year, provided that the most energy efficient appliances available in the market are used. A part of this is useful to heat the building.

Comparison between Lindås and traditional houses

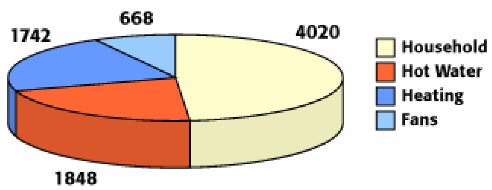
Traditionally built house - Total 1500 kWh/year

Newly built terrace house with exhaust-air heat pump



Lindås project - Total 8279 kWh/year

Typical performance



funding

The extra cost of the implemented windows (as against those normally required by Swedish building standards) was around 15,000-20,000 SEK (some £1,200-1,500).
Other additional costs included the heat exchanger (some 10,000 SEK), the extra insulation (15-20,000 SEK), producing a total additional cost (as against required Swedish building standards) of some 40-50,000 SEK (roughly £3,000-3,800). This was offset by the fact that no heating system had been installed, making the buildings no more expensive to construct than conventional equivalents.

Houses without heating systems, Lindås

results

The energy performance of the buildings are as calculated. The average energy consumption is higher than the calculated according to user habits (higher indoor temperature, more TV-sets, home computers, stand by appliances). The variation in energy use for the house units is large. The total delivered energy demand varies between 45 and 97 kWh/m²a for different households. Savings compared to houses built according to the national building code and practice is 50 – 75%.

Heating of space and ventilation air: 14.3 kWh/m² (electricity)

Domestic hot water (electricity): 15.2 kWh/m²

Fans and pumps: 6.7 kWh/m²

Lighting and appliances: 31.8 kWh/m²

Delivered energy demand: 68.0 kWh/m²

Domestic hot water (solar energy): 8.9 kWh/m²

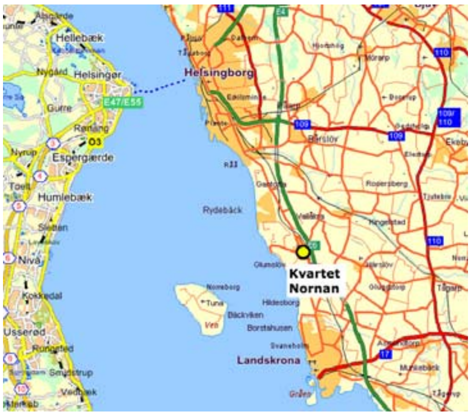
Total monitored energy demand: 76.9 kWh/m²

contacts: Hans Eek, hans.eek@goteborgenergi.se, Maria Wall, maria.wall@ebd.lth.se

sources:

- Lindås, Göteborg, case studies presented on the Joint UK-Sweden Initiative on Sustainable Construction web page http://www.ukswedensustainability.org/projects/lindas.jsp
- Window aspects of low energy housing – the Lindås case, a paer by Anna Werner, Mari-Louise Persson, Arne Roos, and Maria Wall. Paper downloaded from: www.teknik.uu.se/ftf/staff/mari-louise/dokument/windowasp.doc
- Göteborg, Sweden, A Demonstration House Brochure from the IEA – SCH Task 28 / ECBCS Annex 38: Sustainable Solar Housing, available at: http://www.iea-shc.org/task28/final_reps/Sweden_LindasGoteborg.pdf
- http://www.ebd.lth.se click "Research"
- http://www.goteborg2050.nu

Kvarteret Nornan, Passive houses



location on map

location: Landskrona, Sweden
dates: 1999 design competition, constructed in 2003-2004
type: New construction in passive house technology, rental apartments
use: Residential
size: 35 apartments
people:
actors: Client: AB Landskronahem (municipal housing company); Contractor: Skanska, Project leader: Prime Project AB, Architect: Mernsten Arkitektkontor AB. Tenants
goals:
- to get a rental cost for the apartments of maximum 100 €/m² usable floor area during the operation period to use highly thermal performance of constructions in order to exclude conventional heating i.e. radiators or floor heating systems
- to secure moisture proof buildings
- sustainability e.g. special solution for achieving good air tightness, choice of materials.

energy use	KWh/m^2
total energy demand, goal	50-60
space heating demand	0-5
domestic hot water demand	25-30
household electricity	20-25
heating & electric, achieved	
heating & electric, best	
2006 regulations for new building (BBR), goal	110

construction

- floor construction: 10cm concrete, 35cm polystyrene insulation, 20cm macadam (U value= 0,10 W/(m2K))
- external wall construction: framework from wooden studs and aluminium profiles with 45cm polystyrene and mineral wool insulation, in 4 layers, internally gypsum board (U value= 0,10 W/(m2K))
- roof: lightweight roof trusses filled with 55cm mineral wool insulation (U value= 0,08 W/(m2K))
- windows: triple glazed with low emission coating (U value= between 0,09 and1,0 W/(m2K))

amenities

systems	
district heating	
combined heat & power	
solar panels	
solar cells	
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	x
non-renewable energy	
individual metering	x

special project features

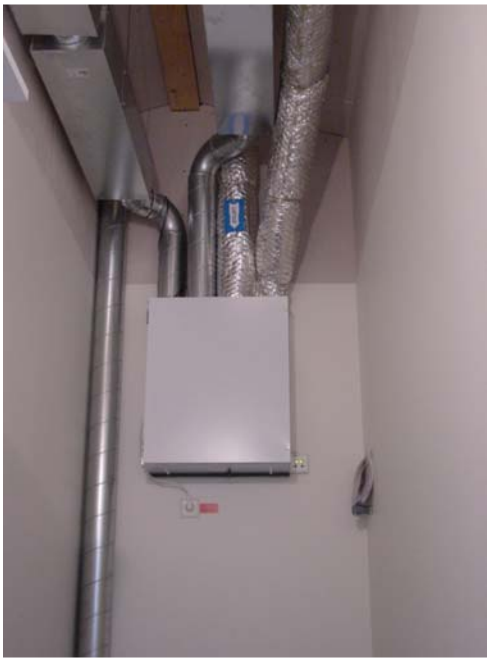
- Energy efficiency
- No heating system
- Energy efficient household appliances
- Moisture control
- Dehydration issues

site ecology

process and history

In Glumslöv, outside Lansdskrona, the Landskronahem housing company has decide to build rental houses in passive house technology. As a result of a competition in 1999, 35 houses were designed and built using passive house principles.

Kvarteret Nornan, Passive houses



process and history, continued

It was a project without financial support, so the focus was on building affordable energy efficient houses for rent. The houses cost not more than conventional building, where savings for the heating costs were used for improvement of energy performances of the building shell (wall and roof insulation as well as types of windows).
One of the goals was to have low rental costs, which was achieved by reducing operational costs by approx 25% through minimal space heating demand. The achieved costs were about 100€/(m^2 year) compared to the rental costs of apartments built at the same time which were approx. 130€/(m^2 year)
A project team was formed and it consisted of: project leader from the municipal housing company, an external project leader, an architect, a building physicist, a structural engineer, a technical engineer, an electric engineer, a landscape architect, a contractor and two tenants.

description of special project features

Each apartment has a supply and exhaust air ventilation system with heat recovery (air-to-air heat exchanger). The efficiency is approx. 85% depending on the outdoor temperature. The very limited space heating demand is covered by electric resistance heating, 700 W, in the supply air. The air flow rate is according to the Swedish Building Code and corresponds to approx. 0,5 ach, depending on the size of the apartment. Household appliances, e.g. refrigerator and freezer, as well as the hot water boiler are energy efficient. The domestic hot water is heated by electricity.
In order to control the heat gains through windows, the apartments were equipped with windows with low g-value and large roof overhang, 1m.
Besides energy efficiency, the project has considered moisture and dehydration issues. The construction has during the design phase been examined and improved concerning moisture prevention. The goal has been to dehydrate the concrete constructions to 85% relative humidity and wooden constructions to a moisture content by mass below 18%. Measurements and mechanical dehydration have also been made during the construction phase. Regarding air tightness of buildings, besides special attention during design phase, two carpenters were specially engaged to explicitly work with the plastic sheet making the apartments air tight. A blower door test was carried out after the plastic sheet was fixed. The air tightness was measured as 0,1 litre/(m^2·s) at 50 Pa differential pressure.
The indoor temperature and space heating demand were calculated with the computer program IDA Indoor Climate and Energy 3.0 (Equa, 2003).

funding

No special subsidies were received

contacts: Kontakt person: Werner Strolz. Tel: 046 418 100 40. werner.strolz@primeproject.se
sources: Landskrona, Sweden, A Demonstration House Brochure from the IEA – SCH Task 28 / ECBCS Annex 38: Sustainable Solar Housing, available at: http://www.iea-shc.org/task28/final_reps/Sweden_Landskrona.pdf

Brachvogelweg

Location of Brachvogelweg development

Areal view

location: Hamburg-Lurup, Germany
dates: 1998-2002
type: new residential area
use: residential
size: 1,0 hectares, 45 dwellings
people: 125 inhabitants
actors: Bau- und Wohngenossenschaft Brachvogel eG
goals:
- low-energy standard and passive-house standard
- use of sustainable building materials
- additional use of solar energy

energy use	KWh/m^2
heating, goal	33
heating,achieved	33
heating,best	10

construction

low-energy standard and passive-house standard with brick casing
air tight buildings with elimination of thermal bridges
water saving fixtures
energy saving appliances
sustainable materials

amenities

primary school, children's day-care centre, public trans-portation, shops in walking distance

systems	
district heating	x
combined heat & power	
solar panels	
solar cells	x
biomass and refuse	
wind power	
natural ventilation	
forced vent.w/heat recovery	x
non-renewable energy	x
individual metering	

special projects

solar cells
partly barrier free for elderly people
public meeting areas
resident participation

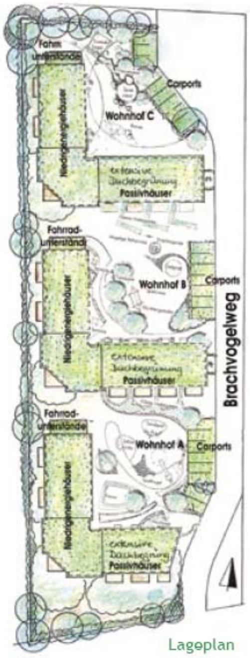
site ecology

rain water collection
waste separation
green roofs
partly green facades

process and history

In 1998 the "Brachvogel" cooperative was able to acquire a property in the west of Hamburg and started to bring together people who were interested in developing and inhabiting a new residential area which should be built according to high ecological and energetic standards. Within four years a group of about 60 persons organized monthly meetings and developed a concept together with the architect and the energetic planer which included 11 passive town houses and 3 apartment buildings grouped around three green courts. Different workgroups were installed to deal with the diverse tasks from financing to technical planning.
This ensured on the one hand that the future inhabitants could bring their own ideas to the planning process and helped on the other hand to develop a good resident community. The method "planning for real" was applied to ensure that the various views and opinions could be brought together to obtain decisions in a good consensus. After the assignment of one main contractor the construction works started in 2001. The first inhabitants could move into the finished buildings at the end of 2002.

Brachvogelweg



description of special project features

From the beginning of the planning it was the agreement between the participants to realize the project according to a high energetic and ecological standard.
The 11 town houses were built as passive-houses, while the apartment houses comply with the low-energy standard. Every dwelling is equipped with a forced ventilation system of which the ones in the passive-houses are provided with heat recovery systems. The buildings have green roofs and partly green facades. The balconies to the south are shaded by roofs which carry solar cells. The rain water is collected to be used for the garden watering, water saving showers and toilets have been installed and the use of energy saving appliances has been promoted.
Only non toxic and recyclable construction materials with a low energy input have been chosen in order to construct the buildings in a very sustainable way.
A quality control has been accomplished during the planning and construction phase. A certificate stating the accordance of the planned and achieved energetic standards has been issued for each building.

funding

The project was partly funded by the “Wohnungsbaukreditanstalt” Hamburg as a residential development scheme.

results

The planning and decision process worked out well and during the four years of preparation a good consensus between all the participants could be achieved. It resulted in a strong identification of the inhabitants with the project.
The quality control throughout the whole planning and building process had assured that the promoted energetic and ecological goals have been reached.
The project “Brachvogelweg” can serve as an example for further similar residential development activities, concerning as well the resident participation as the sustainable way of building.

contacts: **Bau- und Wohngenossenschaft Brachvogel eG**, Brachvogelweg 5, D-22547 Hamburg

sources: **Wohnprojekt Brachvogelweg**, Bau- und Wohngenossenschaft Brachvogel eG, Arbeitsgemeinschaft für zeitgemässes Bauen, Gedruckt von Kaufmann und Meinberg KG, Hamburg Mai 2005
www.brachvogel-eg.de
Project information assembled by Prof. Dr.-Ing. habil. H.-J. Holle, Dr.-Ing. D.Scherz, Institute for Applied Building Technology, Technical University Hamburg-Harburg.

OTHER TYPES OF DEVELOPMENTS

When looking at the type of developments, housing developments are mostly pioneering in sustainability especially energy efficiency, having strong support from the authorities and being involved in different demonstration EU projects. To a large extend it is the size of developments and the possibility to have a wide spreading effect that makes housing interesting for demonstration projects.

However, educational buildings are also often used for testing different state of the art solutions. It is often the universities that drive the new solutions and in many cases university personnel are involved in different progressive projects, if not in the development then in analysis.

On the following pages you can read about two examples of university buildings designed to be energy efficient, both in UK. The first one is the Computer Faculty at the University of Cambridge, where low energy solution coupled with flexible layout solution were the main goals. The building is expected to consume approximately half of the energy of many contemporary buildings, less than 100 kW/m^2. The other building (ZICER) belongs to the University of East Anglia where an effective energy management policy was created. A new construction Termodeck was tested for the first time in UK on an educational/office building.

Finally, two more examples of buildings with an educational character are presented. First is an environmental educational facility called Discovery Centre where one of the activities of the centre is to provide environmental education to the community. The design of the centre incorporates a number of innovative ideas to reduce energy consumption, recycle waste products and minimise environmental degradation, having whole life cycle approach. The second project is the SmartLife Centre in Cambridge, where main actors in the project were actually LifeStyle project partners. A specific of the project is the smart-metering policy, where current energy status can be monitored online.

There are many other good examples in the North Sea Region and its surrounding which will be analysed and included in this guide at a later stage.

William Gates Building

Location map

location: University of Cambridge, West Cambridge Campus
dates: Design commenced in 1998, and construction in February 2000. The building was completed in June 2001, and occupied from August 2001.
type: University and research Building, Computer Faculty
use: It provides new accommodation for the Computer Faculty - the university's fastest-growing department.
size: The total building is 10,100m^2
people: 300 students
actors: Architect, Structural Engineer and Building Services: RMJM London Ltd
Main Contractor: Shepherd Construction Ltd
Quantity Surveyor: Gardiner and Theobald
goals:
- low-energy solution,
- accommodate highly specialist computer equipment in the building and yet ensure that it was flexible enough to adapt to possible long-term changes in use

energy use	KWh/m^2
heating&electricity, goal	
heating&electricity,achieved	100
heating&electricity,best	

construction

Natural materials
Timber roof structure

amenities

systems	
district heating	
combined heat & power	
solar panels	
solar cells	
biomass and refuse	
wind power	
natural ventilation	x
forced vent.w/heat recovery	
non-renewable energy	
individual metering	

special projects

site ecology

The area around the building is planted with indigenous trees which also give shade in the summer.

The Computer Laboratory close to completion on 26th September 2001. The front, showing the covered cycle racks.

process and history

The William Gates building is the result of an architectural competition held in 1998. A two-stage procurement route encouraged a creative dialogue between RMJM and the construction team, and RMJM say that a number of initiatives emerged which helped them to develop the design concept both in cost and environmental terms.

William Gates Building

Image credit: School of Architecture, Planning and Landscape, University of Newcastle
http://www.cabe.org.uk/CaseStudies.aspx?csid=1192&imgid=9

The Computer Laboratory close to completion on 26th September 2001.

Inside the Computer Laboratory, March 2002. Photo: Alex Labeur

description of special project features

The building has a super-insulated building envelope, within which artificial heating and cooling systems are minimised. This gave the design team the opportunity to omit the heating system serving research offices, relying instead upon the heat emitted from occupants, computer equipment and lighting to warm the building in winter. The benefit in summer is that heat can be kept out, so the cooling provided by chilled beams is kept to a minimum and free cooling is utilised for much of the season. The building is expected to consume about half the consumption of many contemporary buildings, a point noted by the judges who gave it an RIBA Award in 2001. Indeed, although not needed with the current ventilation strategy, opening windows are provided to allow future use of simple natural ventilation.
The different zones of the building have different massing and materiality. The street is a three-storey airy space with rich detailing in solid hardwood and steel. At each end of the 'street' there is a three-storey glazed facade, in to which the café extends. Terracotta clad seminar rooms have panels peeled away to provide diffused light to the computer users. The lecture theatres are modest in scale, and are expressed as a cedar panelled box which extends beyond the bounds of the building envelope, close to the tall, slender columns which support the over-sailing roof.
The three-storey building includes research, teaching, library and catering facilities for three hundred undergraduate and graduate students. Research accommodation is arranged around two courtyards with the teaching areas separated from the research space by a three-storey 'street' with connecting galleries and bridges. The circulation space is to promote meetings and discussions.
The building is expected to consume approximately half of the energy of many contemporary buildings, less than 100 kW per meter squared.
Buildings containing computer equipment can minimise energy demand through using high levels of insulation and allowing the electronic equipment to act as a source of heat.The building incorporates windows designed to achieve good day lighting to reduce the need for artificial light.

funding

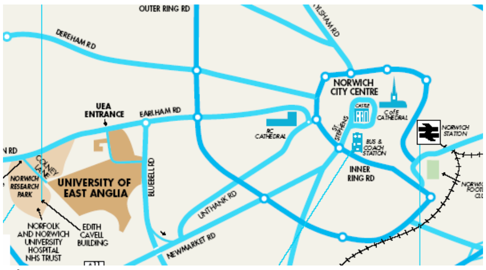
The building can be said to represent very good value within a relatively tight budget of £20m. It was partly funded by the William Gates III Foundation, by University of Cambridge and various smaller donations.

results

The brief called for a building sensitive to its energy use and sustainability, and it has achieved this. Natural materials, the timber roof structure and its dramatic tented cover to the cycle parking accurately reflect the nature of the world the computer faculty occupies.

contacts:	Architect/Designer: RMJM Architects http://www.rmjm.com/
sources:	The William Gates Building http://www-building.arct.cam.ac.uk/westc/cl/cl.html http://www.cabe.org.uk/default.aspx?contentitemid=1192&field=btstr&term=Universities%20and%20colleges&type=1

ZICER building



site map

location: University of East Anglia, Norwich
dates: 2003
type: New construction
use: The Zuckerman Institute for Connective Environmental Research (ZICER) is a University building on campus- Educational facility
size: 2,860m2 divided across 5 floors
people:
actors: Whitbybird - responsible for the structural engineering of the building as well as the PV outline design and integration into the naturally ventilated top floor space using CFD modelling;
RMJM – architect; Northcroft - the quantity surveyor; and Willmott Dixon - the contractor
goals:
- Implement technical means of low-energy building design, installing renewable energy sources, good energy management and raise awareness
- Test 'termodeck' construction principle
- Demonstrate potential of PVs: both on vertical and gently sloped roof surfaces
- Lower the CO_2 emissions (CO_2 emissions are designed to be 70% lower than mid-1990s best-practice buildings, with carbon index is in excess of 10.0)

energy use	KWh/m^2
heating&electricity, goal	<100
heating&electricity,achieved	
heating&electricity,best	

construction

- 'Termodeck' construction principle (concrete slabs for heating and cooling)
- blockwork walls
- Construction materials included recycled aggregates and timber from managed sources
- Triple-glazed timber windows with lowemissivity coatings and louvres

amenities

systems	
district heating	
combined heat & power	x
solar panels	
solar cells	x
biomass and refuse	
wind power	
natural ventilation	x
forced vent.w/heat recovery	
non-renewable energy	
individual metering	

special projects

- Combined heat and power plant
- Electricity produced is used locally
- Atrium for demonstrating the potential of PVs
- Independent heating and lighting control systems

site ecology

process and history

The University of East Anglia (UEA) was established in 1963 on a campus approximately 4 km west of the city of Norwich. It currently has over 13 000 students and over 2200 employees, of whom 465 are academic staff. The initial phase of campus development centred around buildings constructed in the mid to late 1960s, many of which represent the energy-wasteful approaches to building design that were prevalent at the time.
Many of these are now Grade II listed buildings and the scope for significant improvements in their thermal performance is thus limited.

Left and below: The ZICER building emphasised low energy consumption from the start.

Photos: Cambridge Architectural Research

process and history, continued

Since 1990, university policy for most new buildings has been for construction to standards well in excess of the then and likely future building standards. The buildings fall into two broad types: low-energy highly efficient student residences dating from the early 1990s and four (shortly to be five) education/office buildings employing the 'Termodeck' method of construction.

The ZICER building is a new research venture designed to address the environmental challenges facing us through much closer and more effective connections with business, policy makers and wider society. The Institute is also the first physical symbol of recognition commemorating Lord Zuckerman, the Government's first Chief Scientific Adviser and one of the founding fathers of the School of Environmental Sciences.

description of special project features

The lower four floors (including the basement) were Termodeck construction (an exhibition area on the top floor, designed to demonstrate the use of PV cells, is outside the Termodeck envelope).

The UEA was a pioneer in the UK in constructing educational/office buildings to the 'Termodeck' principle. The construction uses lightweight hollow-core ceiling slabs through which both incoming and exhaust air can circulate. The system provides high insulation standards, good air tightness and a highly efficient heat recovery system. There is provision for individuals to open windows, although this facility is seldom used. Nevertheless, it is important that such provision is available as user acceptability of working environments is important.

In winter heat gains from occupants and office equipment are absorbed by the exposed concrete during the day and reradiated at night. In summer the absorbed heat is rejected outside the building by running the fans at night, so enabling the concrete to give the impression of radiating cooling energy the next day. There are extremely high levels of insulation and airtightness. The blockwork walls have 190mm of expanded polystyrene insulation. Triple-glazed timber windows with lowemissivity coatings and louvres between the panes give excellent thermal performance. These windows open, to give occupants a degree of control over their environment.

The ZICER building also uses high quality ductwork and variable-speed fans. It has independent heating controls for each floor, some automatic lighting controls, and efficient 'T5' lighting. An air pressure test achieved an impressive 2.8 air changes/hour @50 Pa. This significantly undercuts the airtightness of the Elizabeth Fry building. Like that building, ZICER has a very efficient heat recovery system – reckoned to recover most of the energy from air leaving the building. However, due to the large amount of glazing, the top floor of the building uses almost the same amount of energy as the other four floors. Since commissioning, the heating strategies have been modified, which approximately halved the heating load. The changes included re-circulating air on the top floor, maintaining the floor at 15ºC unless it is occupied, and installing sensors to bring the temperature up to 20ºC when it is being used. The heating energy requirements are now slightly higher than the Elizabeth Fry building, but electricity use is lower.

It is one of the most energy-efficient buildings in Europe, incorporating high thermal-mass Termodeck concrete slabs for heating and cooling in the majority of the building, with triple-glazed windows and insulation rates far in excess of current UK standards.

UEA also has a combined heat and power plant, which uses the waste heat produced from electricity generation to heat buildings. UEA estimates that this saves about 8,600 tonnes of CO_2 per year, or more than 30% of the University's CO_2 emissions.

A 34 kW PV array on the facade of the top floor and the roof of the building.

Electricity generated by this building is used in the ZICER Institute, or exported to other buildings on the UEA campus.

It is better to use as much of the electricity locally like this in order to reduce transmission losses through cables.

The glass/glass PV is fitted to the 'atrium' like arrangement on the top floor, which was designed to maximise the potential for demonstrating PV: both on vertical and gently sloped roof surfaces. Glass/glass laminates were selected to

give semi transparent glazing that also included PV. This area is naturally ventilated, with air entering at low level, passing over the PV panels to remove heat, and leaving again through louvres at high level. The roof shape was designed to draw warm air up over the PV panels in the roof, and away from the occupied area.
Detailed life-cycle cost and impact analysis for the construction, fittings and furniture was undertaken.

funding

The building integrated PV cells part of the project was supported by the funding from DTI Major PV Demonstration Programme and the EU Framework 5
Total value of the project was 5 million pounds

results

Adverse effects of global warming and climate change is a critical issue. For the past 15 years the University of East Anglia has been addressing these concerns through a multi-pronged approach using technical means of low-energy building design, installing renewable energy sources, good energy management and raising awareness. Through good energy management, the university has been able to reduce the energy consumption of already low-energy buildings by as much as 50%. A large-scale building-integrated photovoltaic (PV) array has been installed along with on-site generation of heating, cooling and electricity via a 3MWcombined heat and power (CHP) plant and, recently, an adsorption chiller.

The PV system has been providing monitoring data since January 2005. During the first year of generation a total of 22,650 kWh was provided to the building, slightly below the predicted output of 28,400 kWh. As expected, the roof-mounted array performed better than the vertical façade, generating 730 kWh/kWp. Generated output from the façade was only 415 kWh/kWp.

CO_2 emissions are 70% lower than mid-1990s best-practice buildings, and the carbon index is in excess of 10.0.

The ZICER Building has an effective energy management policy. Heating consumption was reduced by a further 57% by careful record keeping, management techniques and adaptive approach to building control.

Leasons learnt:

Installing the glass/glass laminates was problematic as the contractor, Wilmot Dixon, found it difficult to find a glazing/façade company to take on the work. Potential contractors saw the PV installation as different and complicated.

No special or bespoke components were required to integrate the PV laminates. Standard Schuco curtain walling was adapted to accommodate the PV cabling. The PV array influenced the design of the building's atrium. A passive ventilation strategy makes use of the heat building up behind the PV array to drive a "stack effect", with warm, stale air ejected at high level through opening louvers. However, the ventilation louvers increased the noise and dust entering the atrium. The lamination on 11 of the roof-mounted modules was peeling away due to a manufacturing problem. This has now been rectified and BP Solar is replacing all the roof modules with Romag glass-glass laminates.

The University encountered a number of problems with the PV monitoring system, including incorrect wiring and calibration of some of the sensors. Nevertheless, since the problems were rectified the PV system has been providing reliable performance data.

The PV contractor was not involved right at the end of the project when the building was handed over to UEA. If UEA's Estates staff had been present when the PV work was completed there may have been fewer problems later.

Energy summary results:
Total PV system output 22,650 kWh/year
Power used in building 249,760 kWh/year
Power imported into building 227,500 kWh/year
Power exported to grid 390 kWh/year

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sources: www.dti.gov.uk/energy/renewables

Discovery Centre

location: Great Notley, Braintree, UK
dates: Groundworks started in 1999, opened in June 2001
type: New Construction
use: Environmental Education Facility and Country Park

size: 159m2, the surrounding park is 110 acres
people:
actors: Braintree District Council, Countryside Properties
goals: To provide a sustainable social community resource as a centre for sports, environmental education and recreation

energy use	KWh/m^2
heating&electricity, goal	
heating&electricity,achieved	
heating&electricity,best	

construction
- concrete floors with termodec flooring
- double glazed windows
- special choice of building materials

amenities
- Country park
- Open air sport facilities
- Conference facilities
- Education facility
- Shop
- Café

systems	
district heating	
combined heat & power	
solar panels	x
solar cells	
biomass and refuse	
wind power	x
natural ventilation	x
forced vent.w/heat recovery	
under floor heating system	x
individual metering	

special projects
- Rainwater Collection & wetland treatment system

site ecology
- Wider site supports a wide variety of wildlife

process and history
The Discovery Centre evolved from a Planning Obligation between Braintree District Council and Countryside Properties, to provide a community centre for sports, environmental education and a social community resource. Architects Penoyre & Prasad designed the building to maximise its sustainable credentials. The site, formerly farmland, was selected for its close proximity to the Great Notley Garden Village residential development.
The design of the centre incorporates a number of innovative ideas to reduce energy consumption, recycle waste products and minimise environmental degradation. Forward planning has also been included in its design, as the Discovery Centre will cause minimal impact on the environment when it comes to the end of its life. Nearly all of the materials used can be recycled and the landscape can be easily recreated thanks to shallow foundations.

description of special project features
It is estimated that the 2 renewable energy systems provide 1/3 of the total energy requirements of the building. A future planned extension will integrate a smart metering system and a biomass burner.
Passive Solar Gain
The Discovery Centre has a bank of double glazed windows on the south elevation including an area of central glazing to maximise internal illumination. The north elevation contains only small windows primarily for ventilation.
Wind Turbine
A Proven 6KW wind provides approximately 1/3 of the centre's electricity demand.
Solar Panels
The south elevation holds a tier of solar thermal panels distributing hot water throughout the building.

Discovery Centre

description of special project features

Termodeck Flooring

The concrete floors throughout the Discovery Centre have hollow cores running through them. These hollow cores have many outlets in the floors of the Discovery Centre. There is a large air inlet at the front of the Discovery Centre. The air that comes into the building from the inlet is then blown around the building to regulate the air temperature, this keeps the building cool in summer. In winter the air is blown through the boiler, which heats the air and keeps the Discovery Centre warm in the colder months.

Rainwater Collection & wetland treatment system

A rainwater harvesting system collects and filters rainwater, which is used to flush the toilets. Sewage is flushed into a settlement tank before flowing into a reed bed and slowly filtering into the pond as clean water over a period of about 90 days.

Materials

Materials used have been selected with an awareness of their embodied energy, their recyclability, sustainability of their sources and their potential toxicity. Desks, worktops and shelves are made of recycled plastics. The exterior cladding is Douglas Fir selected for its longevity and sustainability. The lignacite and breeze blocks used internally and externally contain a high level of recycled material including cardboard and wood. Procedures as detailed as purchasing copper piping from sources that use Hydro Electric Power for smelting has been included in the construction. Nearly all of the materials used can be recycled and the landscape can be easily recreated thanks to shallow foundations.

contacts:
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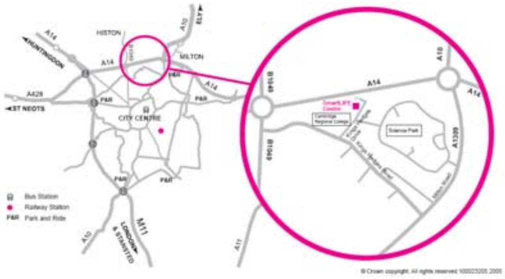
sources:

SmartLife Centre



Location on map

location: Cambridge, UK

dates: Ground works on site began April 2005 and construction was started May 2005. The centre took approximately 10 months to build and was completed March 2006.

type: New Construction

use: Business and Training Centre

size: The building footprint is 1500 m2

people:

actors: Cambridgeshire County Council; City of Malmo; Tu-Tech Innovation; Cambridge Regional College

goals:

- The building should encompass sustainability the life-cycle is to be carefully assessed throughout the duration of the project and beyond.
- The building needs to incorporate energy and carbon efficient design.
- The building design should minimise energy and resource consumption, incorporate effective insulation, low-values, efficient heating and cooling systems and appliances.
- The building should meet a BREEAM rating of ‘very good’.

energy use	KWh/m^2
heating&electricity, goal	
heating&electricity,achieved	
heating&electricity,best	

construction

- Insulation: recycled newspaper
- Roof fabric: from PVC coated cotton
- Wall clad with aluminum sheets
- laminated Gluam timber frame supporting
- timber-based internal floors, external walls and roofs
- roofing insulation is CFC free polyurethane foam
- windows and doors are made from FSC-certified timber

ammenities

- classrooms
- practical workshops
- reception/foyer area
- canteen
- staff offices
- car parking

systems	
wind power	x
passive solar gain,	x
Solar shading	x
solar panel heating system.	x
photo-voltaic (PV) modules	
reversible ground source heat pump	x
naturally ventilated	x
passive solar gain	x
Solar shading	x

special project features

- Energy efficiency measures
- rainwater collection tanks
- water reduction technology
- waste management

site ecology

process and history

There are large variations across Europe in tenure rates, the UK for example has a culture for home ownership and the aspiration to purchase a home remains strong. Over the past 30 years, the European average real house price growth has been approximately 1.1%, In the UK it was 2.4%. The shortage of housing is most severe in UK, it is estimated by Government that up to 140,000 extra homes a year need to be built if supply is to keep up with demand. According to estimates there are between 220,000 and 230,000 new households being formed annually, yet there were only 165,000 homes being built annually. In the Cambridge region, the annual shortfall of affordable housing is estimated to be 5020 units, nearly 12 times the current level of supply to be delivered.

SmartLife Centre

process and history, continued

A plot of land was located on the Science Park Campus of Cambridge Regional College (CRC) and was selected for the UK SmartLIFE business and training centre. This site was chosen as it benefited from the existing facilities provided by CRC and was in a good central location. The College is a well-established further education college, with relatively new buildings (phase 1 opened in 1993). It has on-site amenities and facilities already in place which are typical of an establishment of this nature, for example classrooms, practical workshops, canteen, staff offices, reception/foyer area and car parking. The College is also part of the Centres of Vocational Excellence (CoVE). As SmartLIFE was looking to develop courses in MMC it was a perfect match to be situated on the same site as the further education college that already teaches construction. The high demand for places on the colleges existing construction course's means they were also looking to develop courses further and increase their capacity. The goal of the project was to train around 1,300 people over three years in modern, sustainable methods of house building. The site also benefits from good infrastructure, with effective road, rail and bus networks.

description of special project features

The building was designed to incorporate as many sustainable features and materials as possible. As noted the main structural elements, of structural frame, walls, floors and roofs are all timber-based. This wood was responsibly sourced and is FSC or PEFC certified. Timber frame has the lowest CO2 cost of any commercially available building material and at the end of its life it can easily be recycled. Strength for strength, concrete uses 5 times and steel uses 6 times more energy to produce than timber. For every cubic meter of wood used instead of other building materials, 0.8 tone of CO_2 is saved from the atmosphere. The energy used in extraction and production of a material or product is called "embodied energy". In general terms the higher the embodied energy, then the higher the CO2 emissions. Wood compared to other materials such as steel, concrete, plastic and aluminum has low embodied energy. Even if these materials are recycled the process can involve high amounts of energy.

Building Description

The design of the centre incorporates many of the modern methods it hopes to promote.
The building can be split in to 3 sections:

The Practical Training Centre:

The Practical space, within which the students will construct two-storey houses using MMC techniques is covered with a large fabric roof manufactured from a recyclable PVC. Of its type it is the largest in Country. It is supported by four large steel masts; one at each corner and covers an area approx 24mx24m.
The walls are extend up to 12m high and constructed from a FSC certified timber frame using 356 deep engineered timber studs up to 12m long. The walls are clad with aluminium sheets which is preferred to steel on environmental

and sustainability grounds. Windows and doors are made from FSC accredited timber.

The visitor centre, conference room and office space:

These sections were constructed with a laminated Glulam timber frame supporting timber based external floors, external walls and roofs. The pre-finished pitched roofing panels are from Milbank. They are 8m long structurally insulated panels (SIP's) spanning across the Glulam frame. The pitched roofing insulation is CFC free polyurethane foam. It has been finished off with aluminium sheeting.

The majority of the external wall finishes are untreated Western Red Ceder cladding from FSC certified sources. The 150mm thick insulation for these external walls is warmcel recycled newsprint (cellulose insulation), which was sprayed in to the walls. Windows and doors are made from FSC accredited timber.

The Classroom block and student areas:

This was constructed with pre-fabricated structural wall, floor and roof panels made from solid laminated timber panels (Lenotech system). They arrived on site as complete walls, floor and roof sections.

These areas require no insulation and are clad in a light-weight mineral spun fibre wall panel. Windows and doors are made from FSC accredited timber.

funding

The centre cost approximately £2.5m to construct. Funding came from the European Union (Interreg IIIB funding stream) (£0.5m) and from the Department for Communities and Local Government's (£2m).

results

In the UK centre it has been estimated that the 3 renewable energy systems working at minimum efficiency in the SmartLIFE Centre will contribute 38% of the buildings energy requirements. This figure is an estimate. SmartLIFE is also implementing a smart-metering policy. This gives real time figures on a live website that show how much at any one time the renewables are contributing to the energy usage within the building. The website http://smartlife.sentec.co.uk/status.php shows the current energy status, energy balance (for hour, day, week, month, year, at the moment of observing and from a selected staring time).

At the web-site CO2 emission savings are also calculated and compared to UK emissions per person and 2010 target for emissions per person.

contacts: Further information is also available from www.smartlife-project.net

sources: http://www.smartlife-project.net/smartlife/DisplayArticle.asp?ID=7817

More about the project: http://www.ukswedensustainability.org/se/projects/smartlife_details.jsp

Smart monitor: http://smartlife.sentec.co.uk/status.php

The Guide to Sustainable Construction in the North Sea Region and its Surroundings was prepared for the **EU Interreg IIIB North Sea Region**-funded project called '**LifeSTYLE**' Sustainable Technologies for Your Local Environment by

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