Introduction

The Engelsby project demonstrates an exemplar implementation of new and innovative solar based techniques in the renovation of three eight-storey tower blocks. The energy demands for heating, ventilation and production of domestic hot water, are expected to be reduced by 60%. Furthermore, significant improvements of the thermal comfort and the air quality are expected. Two of the tower blocks are part of an ongoing THERMIE project "SHINE". The results from the design, construction and monitoring phases were amongst others reported at the EuroSun 98 conference in Slovenia and at the EuroSun 2000 conference in Copenhagen, DK.

The results from the project show that it is possible to carry out an ambitious building renovation based on utilisation of solar energy. However, it is important to be aware that a successful result with respect to the implementation of solar measures still often depends on external subsidies.

Therefore, further development and demonstration projects are still necessary to develop and improve solar-based concepts for building renovation.

S.H.I.N.E. (Solar Housing through Innovation for the Natural Environment) is a European Commission Thermie project to reduce energy and improve comfort and environment. In involves different housing renovation project it is demonstrating new and innovative solutions to energy and efficiency.

Proposer Team	*BIG Heimbau AG*
Architects	*Stærmose & Isager K/S*
SHINE Co-ordinator	*Serge Jauré, ArchiMEDES*
Consultants	*Esbensen Consultants*
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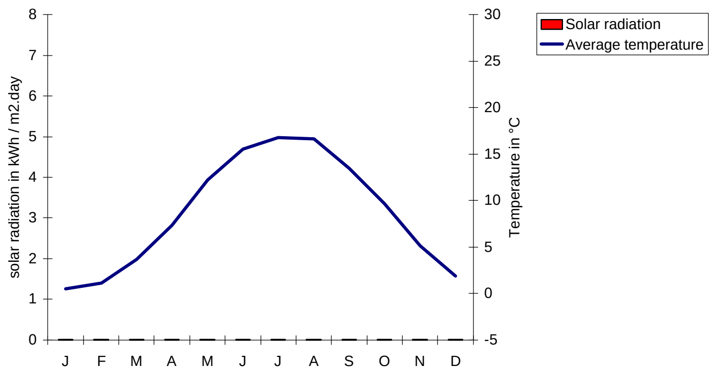
Regional and Urban Context



climate

Type of climate	*mild, sea climate*
Altitude (m)	*sealevel*
Latitude	*54.5º NB*
Longitude	*9.3º WL*
Average ambient temp	
January	*-0.6°C*
July	*16.4 °C*
Degree days (base 18°C)	*3,102°C Days*
Global irradiation (kWh/m²days)	*0.472(Jan), 5.071(July)*
Sunshine hours (h)	
Total	*1518*
During heating season	*625*

The buildings are of a size and form, which is typical for a lot of European housing areas from the 60's and 70's. A special problem for these kinds of areas is their image. The buildings are in great need of renovation due to a high-energy demand for space heating as well as a very poor indoor climate (Sick Building Syndrome). Thus, the building owner (the housing company BIG HEIMBAU), the Municipality of Flensburg and the local government have decided to help to try to improve the local area.

A competition focussing on providing a "face-lift" to a larger area was won by the design team (Stærmose & Isager architects K/S , Birch & Krogboe Consulting Engineersand Esbensen Consulting Engineers). The project programme includes renovation of facades in the three eight-storey tower blocks with 112 apartments. A noticeable change of the project is that it has been changed also to include a number of apartments suited for the elderly people. An important element in the design process has been to work with the different innovative technical measures at a very early stage of the planning process to make these elements fully integrated in the building design.

The tower blocks in this case study are constructed in 1966. External walls consist of 24-cm sand-lime brick with an exterior facade cladding of eternite plates and an internal surface of gypsum boards. Only the two lower floors of the buildings are insulated (50 mm). This insulation however, has collapsed.

Green building aspects

Domestic hot water
The electrical water heaters are removed and a central domestic hot water system is installed. In one of the two tower blocks this system will be supported by roof mounted solar collectors for domestic hot water. Because of complex structural problems and for financial reasons, it was not possible to make roof integrated collectors, even though the roof was also renovated and insulated. The solar collectors are expected to reduce the energy demand for domestic hot water by approximately 25,000 kWh corresponding to 30%.

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Glazed staircases
Large parts of the staircases are provided with highly insulating glazing (U =1.1 W/m²K) in order also to improve the thermal and visual comfort in the staircases to help to improve the social life in the tower blocks. Furthermore, new roof lights have been added to the staircases.

Glazed Balconies
Numerous studies of various ways of glazing and insulating the balconies have been made. The studies have especially focussed on the risk of introducing an increase of the energy demand as the tenants might heat the balconies. These studies have shown that it is of high importance to design glazed balconies that are sturdy against unintended use such as heating by electrical heaters or similar equipment. The studies have been made for various heating scenarios and the tendency is similar but of course less significant if the balconies are only heated in shorter periods.

Solar Walls
Ventilated
One of the glazed staircases is provided with ventilated solar walls for preheating the fresh air to the staircase. Since, the air temperature in the staircases has increased, especially during spring and autumn, the staircases are now considered much more attractive as common areas by the tenants.

Unventilated
Unventilated solar mass walls with various types of Transparent Insulation was investigated but turned out to be too expensive compared to the possible energy-savings.

Demand Controlled Ventilation
To improve the indoor climate, a mechanical moisture controlled ventilation system has been analysed and implemented. The most significant benefits by using a moisture controlled ventilation system compared to a conventional exhaust air system or a ventilation system with heat recovery are:

- Moisture controlled ventilation will improve the indoor air quality much faster than a ventilation system with heat recovery as the polluted air is removed immediately.
- Running costs will be reduced significantly as the ventilation rate and thus the use of electricity will be decreased significantly whenever the moisture content is low.
- Installation costs are much lower than for a ventilation system with heat recovery.
- Large annual energy savings are possible using moisture controlled ventilation in combination with preheating ventilation air in solar walls or glazed balconies.

Daylight Windows
In the dark and deep west facing rooms which have been provided with a glazed balcony towards east, also new high performance windows have been added to increase the daylight level.

Project Data	**Project case**		**Old situation**	
(re)construction	*December 1998*		*1966*	
Construction costs (€) excl. project management, planning, monitoring, etc.	*4,162,000 (incl. 300,000 EU support)*			
Urban plan				
Area (ha)				
Floor Area (m^2 gross floor area)	*5700 m^2 - 2 buildings (external insulation)*		*5150 m^2 - 2 buildings*	
Floor Area Ratio (m^2 gross floor area)				
Transport				
Distance to car park	*< 100 m*		*< 200 m (only for a few cars)*	
Distance to public transport	*< 300 m*		*< 300 m*	
Frequency of public transport	*several buses per hour*		*several buses per hour*	
Bicycle storage				
Waste separation				
Construction and demolition waste				
Household waste				
Design for deconstruction				
Building Materials				
Construction				
Facades	*sand lime stone/concrete/alu/eternit, 12 cm insulation*		*sand lime stone , poor insulation*	
Roof	*20 cm insulation (mineral wool)*		*5 cm insulation*	
Window frames	*alu/ alu-wood, plastic*		*plastic*	
Internal walls	*bricks*		*bricks*	
Recycled materials				
Interior paint	*water based*			
Insulation	**area (m^2)**	**U-value (W/m^2K)**	**area (m^2)**	**U-value (W/m^2K)**
Ground floor area (m^2/bldg)	*356*	*2.6*	*345*	*2.6*
Roof area (m^2/bldg)	*356*	*0.15*	*345*	*0.6*
External wall area (m^2/bldg)	*1,581*	*0.3*	*1,592*	*1.35*
Window area total (m^2/bldg	*107 / 155 / 219*	*1.1 / 2.5 / 3.1*	*470*	*3.1*
South (m^2/bldg)	*54 / 51 / 51*	*1.1 / 2.5 / 3.1*		*3.1*
Ventilation system	*demand controlled moisture regulated*		*small ineffective dampers*	
Infiltration	*preheated in glazed balconies and facade integrated solar walls*			
Exhaust	*exhaust from kitchen and bathroom*		*small ineffective dampers in bathrooms*	
Heat recovery	*no*		*-*	
Air exchange rate, heating season	*average of 0.4 h^{-1}*		*from very small to very large*	
Back-up systems	**system**	**energy source**	**system**	**energy source**
Space heating	*waterbased district heating*	*coal*	*waterbased district heating*	*coal*
Domestic hot water	*central solar based*	*solar collector*	*individual heaters*	*electricity*
Cooling	*none*	*-*	*none*	*-*
Electricity production	*CHP*	*coal*	*CHP*	*coal*
Ventilation	*opening of windows*	*-*	*ventilator in window*	
Energy data	**(kWh/m^2)**		**(kWh/m^2)**	
Space heating	*42*		*134*	
Space cooling	*0*		*0*	
Domestic hot water	*20*		*33*	
Electricity (total)	*-*		*-*	
Lighting	*-*		*-*	
Fans + pumps	*-*		*-*	
Small power	*-*			
Solar systems				
Passive	*solar facade, glazed balconies, extra daylight windows in dark west facing rooms*		*-*	
Active	*solar collector*		*-*	
PV	*planned but left out for financial reasons*		*-*	
Water				
Supply:				
Toilet system (4, 6, 9 litres)	*adjustable flush*		*large flush*	
Shower	*water saving heads*		*old*	
Bath	*water saving taps*		*old*	
Sewage				
Rainwater collection	*rain water bassin in garden*			
Grey water system				