APT building in Engelsby, DK

PROJECT SUMMARY
Renovation including adding insulation of facade/roof, new heating system and new water installations. The energy demand before renovation was 123 kWh/m² a. Measured demand after renovation was 46 kWh/m²/year (space heating and domestic hot water).

SPECIAL FEATURES
Solar panels for domestic hot water, improved daylighting, demand controlled moisture regulated ventilation, glazed balconies.

ARCHITECT
Creo A/S, DK (former Stærmose & Isager)

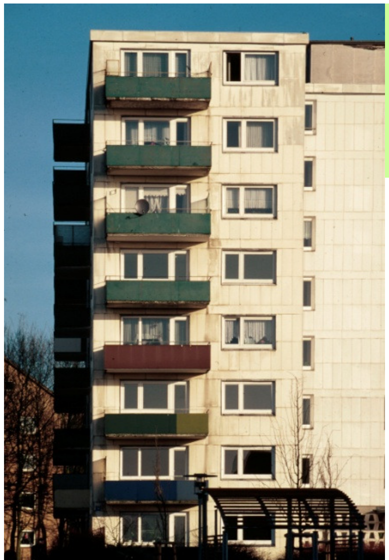
ENERGY CONSULTANT:
Esbensen Consulting Engineers A/S, DK

OWNER
Housing company DAIG, GE

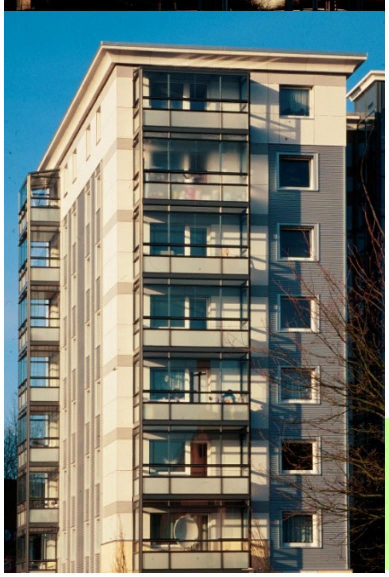
Photo: Stærmose & Isager Architects

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

IEA – SHC Task 37
Advanced Housing Renovation with Solar & Conservation



Before



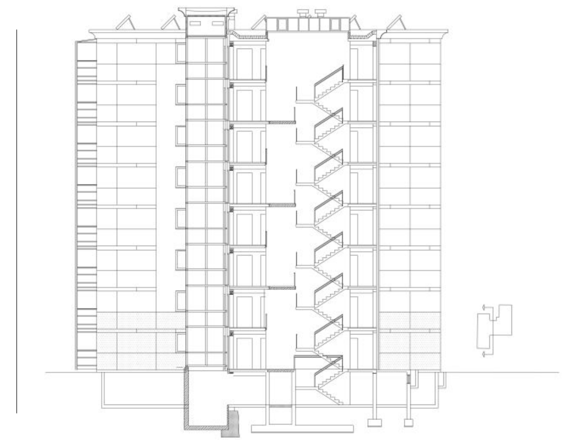
After

BACKGROUND

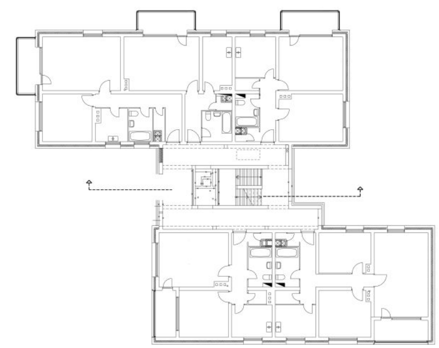
Degradation of the building envelope and urban renewal necessitated the renovation of these two old multi-storey buildings. The renovation was very successful: work was completed within the time schedule and budget. The expected energy savings of 60% was achieved and thermal and visual indoor climate were significantly improved. The occupants were very satisfied with their new homes and the housing company now has people on a waiting list verses the app. 30% vacancy rate before the renovation.

SUMMARY OF THE RENOVATION

- •Insulation (120 mm wall, 180 mm roof)
- •New heating plant
- •New water installations
- •New kitchens and new bathrooms
- •New and improved glazed staircases
- •Solar collectors for domestic hot water
- •Advanced glazed balconies
- •Ventilated solar walls
- •Improved daylighting conditions
- •Demand controlled moisture regulated ventilation



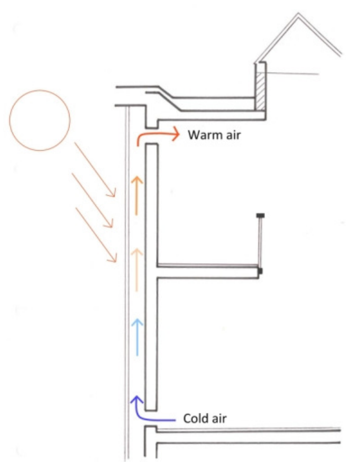
Vertical cross section.



Horizontal cross section.

Photos and drawings Stærmose & Isager Architects

Principle of solar wall. *Illustration: Esbensen*



User satisfaction – Trombe /solar wall

The old staircase was completely changed: fefore it was closed and dark, now it is open and bright. The combination of the glazed staircase and the ventilated solar wall ensures a very good indoor climate. Occupants perceive the building entrances as friendly and safe. The staircase is brighter and warmer and free of drafts from cold surfaces. Because of the staircase the social life in the building has improved, tenants now stay in the staircase for longer periods, meet and talk.

Trombe wall – ventilated solar wall

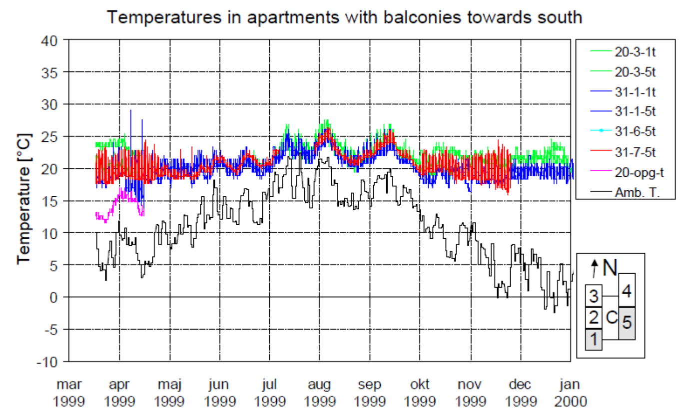
Cold air enters the bottom of the Trombe wall and heated by the black absorber. Two stories higher up the heated air enters the stair case. As the staircase is very open and as there is an open two-storey “room” behind the window of the staircase, good distribution of the solar heated air is ensured.

Temperature

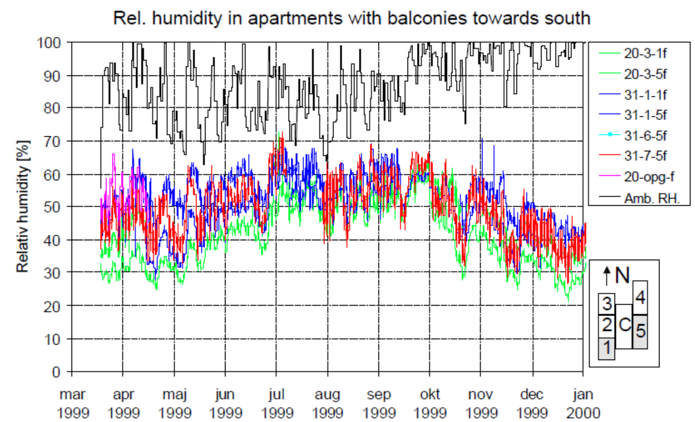
The graph above at the right shows measured apartment and ambient temperatures. The indoor temperatures are quite stable around 20ºC for the whole period without any overheating problems. The indoor temperature is often around 5ºC higher than the ambient temperature in the summer.

Relative Humidity

The graph to the right shows measured relative humidity in the apartment with south-facing balconies. The ambient temperature is also shown. Normally the indoor relative humidity is low in winter, increasing in spring, peaking in summer and diminshing in autumn. This pattern is observed in the monitored apartments and runs counter to the trend for the ambient humidity, namely: low during summer and high during winter.



Measurement of Temperatures. *Model: Esbensen*



Measurement of Relative Humidity. *Model: Esbensen*

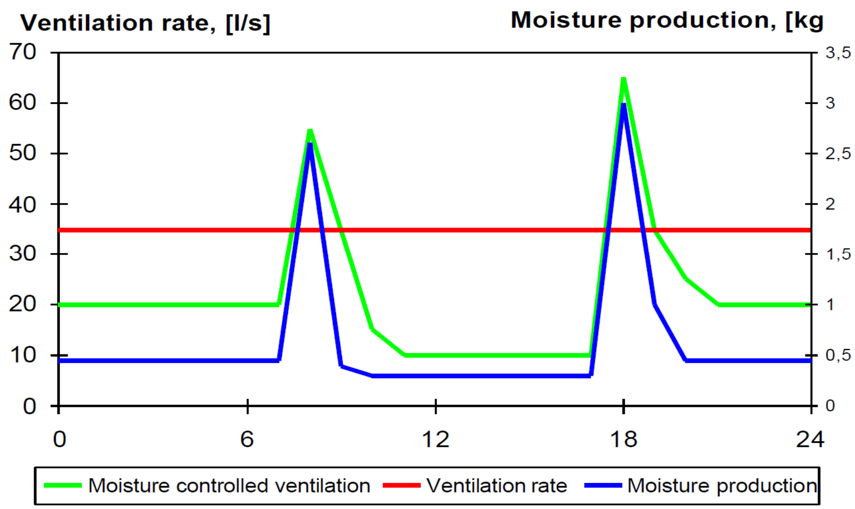
Demand controlled moisture regulated ventilation

Demand controlled ventilation is an advanced way of ventilating in apartments. The figure to the right compares moisture production by a traditional constant ventilation system and a demand controlled moisture regulated ventilation system.

Mornings, when people shower the ventilation rate increases 2.5 times. During the day when people are not at home the ventilation rate falls to a low level, 6 times lower than during peak loads. At dinner time cooking increases the humidity level and the ventilation rate is increased again.

Evenings the ventilation level again falls to a low level. A traditional constant ventilation system ventilates too much, when it is not needed and often too little when the moisture production is high. For a 24 hour period, the moisture controlled ventilation typically ventilates approximately 60% of the air compared to a traditional ventilation system. However, the indoor climate is improved.

One of the advantages by using demand controlled ventilation is that high indoor air humidity is avoided, minimizing risks of mould and dust mites. Another advantage is that the energy loss (heat and electricity) due to ventilation is markedly reduced. Calculated and measured saving are up 58% compared to a traditional ventilation.

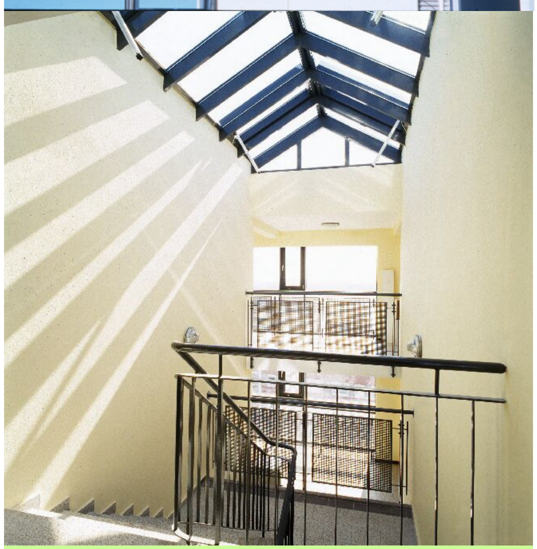


Source:
SBi: 2008:08 Moisture controlled housing ventilation. Measurements and evaluation

Others references regarding ventilation

"Behovsstyret mekanisk ventilation – Fugt som reguleringsparameter – et pilotprojekt" " Demand Controlled Mechanical Ventilation – Moisture as regulation parameter a pilot project". BUR-report, June 1992. Danfoss Research Center, Esbensen Consulting Engineers A/S, The Danish Building Research Institute.

"FLEXREN - Flexible Facade System for Energy Conscious Renovation of European Homes - SOLAR RENOVATION PROJECT ØSTERBO, VEJLE, DENMARK". EU contract No: BU/0204/98/DK/DE. July 2002. Esbensen Consulting Engineers A/S.



Very good insulating glass makes the climate in the staircase warmer in winter. In summer, to avoid overheating sky lights may be opened automatically.

CONSTRUCTION

Wall	*U-value: 0.29 W/(m²·K)*
(inside out)	
Sand lime stone	240 mm
Insulation	120 mm
Ventilated building envelope	45 mm
Total	405 mm

Roof	*U-value: 0.21 W/(m²·K)*
(inside out)	
Concrete	230 mm
Insulation (Polystyrol)	180 mm
Total	410 mm

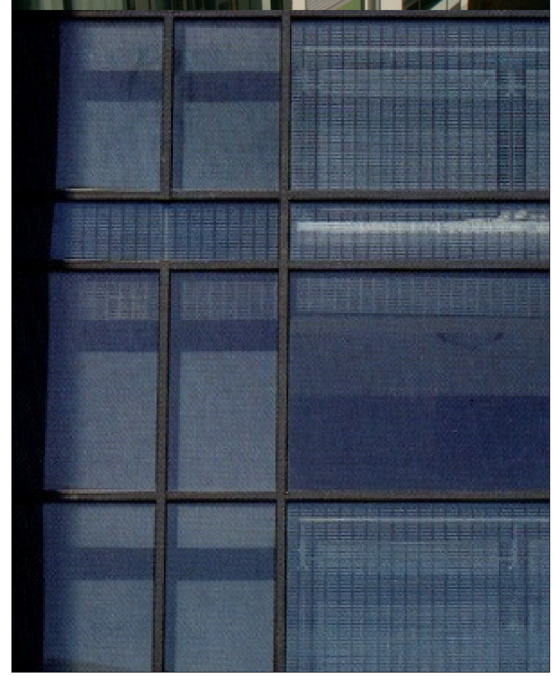
DEVELOPMENT PROJECT

The project is a development project illustrating different technical solutions for renovating apartments in one project. Therefore, the applied solutions are not necessarily the most cost-effective e.g. balconies used for preheating the ventilation air instead of using an increased amount of insulation.

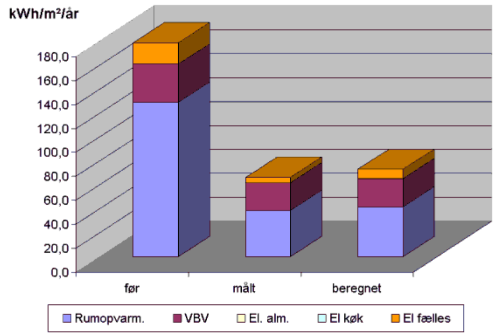
AWARDED PROJECT

In 1999, the project was awarded a first prize for exemplar building integrated solar energy projects in a German competition for implementation of solar energy in building renovation (Messepreis Solar '99).

Photos: Stærmose & Isager Architects



Top photo: Solar collectors for domestic water on the roof.
Bottom photo: Solar walls integrated in the facade



Model: Esbensen

Summary of U-values W/(m²·K)

	Before	After
Roof	4.40	0.21
Walls	3.14	0.29
Floor	1.6	1.6
Windows *	2.7	1.4 - 2.7*
Glazed balconies*	-	1.4 – 5.6**

**Not all the windows were replaced as part of the renovation*
***Some of the balconies has only single-layer glass*

BUILDING SERVICES

Demand controlled, moisture regulated ventilation is implemented: The air change rate increases when necessary and reduces to a base level when less ventilation is needed. For a 24 hour period, 60% less air is exchanged than is the case for a traditional exhaust air system.

20 solar collectors with a total area of 80 m² supply energy for heating domestic hot water, meeting approx. 30% of the demand.

Photo: Stærmose & Isager Architects

RENEWABLE ENERGY USE

Roof and facade integrated solar heating systems preheat domestic hot water and ventilation air and reduce heat losses through facades.

ENERGY PERFORMANCE

Space + water heating (primary energy)*
Before: 123 kWh/m² a
After: 46 kWh/m² a
Reduction: 63 %

The area used in the calculation is the total heated floor area (net m²).

*The conversion factor for district heating is assumed, as Stadtwerke Flensburg does not publish their energy sources. Assumed therefore to be: 70% CHP-coal cond. and 30% oil, and factor 0.77 is used.

INFORMATION SOURCES

Final report: Solar renovation project BU/1051/96 (SHINE - Solar Housing through Innovation for Natural environment)
Creo architechts www.creo.dk
Esbensen Consulting Engineers www.esbensen.dk

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