The Hedebygade block

In 1993 Cenergia and the urban renewal company SBS started a cooperation about solar/low-energy rehabilitation based on the positive results from an EU-Thermie funded solar low-energy retrofit housing project at Østerbro in Copenhagen.

As a start Cenergia made a feasibility study for SBS about urban renewal and solar low-energy rehabilitation of an old housing block in Hedebygade at Vesterbro. It was the aim to show the effect of advanced energy saving measures with a high saving goal for 4 schemes with 80 apartments.

Calculations showed that the annual consumption for room heating and domestic hot water could be reduced by more than 50% and combined with electricity and water savings by using the following energy saving measures:

- New super low-energy windows.
- New ventilation systems with counterflow heat recovery and if possible air heating.
- Facade insulation and solar walls, including use of PV-modules.
- New types of low temperature installations for heating and domestic hot water, e.g. with centrally placed radiator installations and domestic hot water heat exchangers.
- Improved light conditions with glazed balconies.

Based on the feasibility study, support was achieved from the Danish Energy Agency and the EU-Thermie programme for solar low-energy retrofit of 3 housing schemes with 62 apartments. And a PV-demonstration project was at the same time realised for an old commercial building. In all the demonstration projects building integrated PV-modules are used as a building element with an aim to utilise preheating of ventilation air in the PV-modules as something new. Details concerning this have been developed by the architect Klaus Boyer Rasmussen from the SolarVent company in cooperation with Cenergia Energy Consultants

Tøndergade 3-3A

The solar low-energy rehabilitation includes 21 apartments. The following energy saving measures are included here:

- Additional insulation and low-energy windows.
- Central placing of the radiators.
- Central heat recovery systems.
- Two central heat recovery units, placed in the attic, covering 10 apartments each. Heat surfaces that give extra heat to the ventilation air.
- Building integrated amorphous PV-modules from Fortum in the facade.
- The living rooms facing the courtyard have a 6 m² heated glazed patio each. The window parapets are covered with 60 m² amorphous PV-modules from the Finish company Fortum. The PV-modules are utilised in a hybrid solution where the ventilation air is preheated behind the PV-modules, which also has the effect that the cooled PV-modules get a higher yield.

Figure 3. Building integrated amorphous PV-modules in Tøndergade 3, 3A, which are used to preheat the ventilation air. Architect is Jørgen Rosenkilde.

Sundevedsgade 26-28

This solar low-energy rehabilitation includes 21 apartments. The following energy saving measures is included:

- PV-modules. 60 m² mains connected crystalline PV-modules from Gaia Solar have been mounted on the two original stair turrets. Preheating of the air in the stair turrets cools the back of the PV-modules and in this way the transmission loss between the stairs and the apartments is reduced.
- Solar heating system. On the roof there is a solar heating system from Batec Solar Heating that heats the domestic hot water. The total area is 35 m².
- Heat recovery. In the attic there are two high efficient counterflow heat recovery units from TermoVex Denmark, which covers 10 apartments each.
- Central placing of radiators gives saving on investment costs.
- Double windows with hard covering.
- Solar energy optimised sunspaces with overheating protection

Figure 4. Sundevedsgade 26-28. Facade facing the courtyard. Here is seen the attached sunrooms with solar protection and the PV-modules on the stair turrets. Architect is the Architect group Copenhagen.

In connection with this project an assessment of how the sizing of the centralised radiator system can take the ventilation with heat recovery and use of low-energy windows into account has been made in cooperation with the engineering company Erik K. Jørgensen.

In addition to this the initial costs of a traditional radiator system with riser pipes on the facade are compared with a radiator with riser pipes and radiators placed centrally in the apartments.

The sizing of the radiator system also takes the heat recovery in the ventilation unit into account.

Heat recovery of the ventilation air has in this way reduced the heat loss of approx. 20 kW; equal to approx. 20 W per m² heated area.

The expenses of a radiator system with centrally placed riser pipes are calculated on the basis of the results from the call for tenders from April 1998 for Hedebygade 3, 3A and Sundevedsgade 26-28. The average price is 292 DKK pr m² heated area.

Proportionally, the price of a traditional radiator system is approx. 374 DKK per m² heated area. This amount is based on an average of three results of calls for tender from 1995, 1996 and 1998 and they are indexed to the level in April 1998, which is the time of quoting prices for Sundevedsgade 26-28 and Hedebygade 3, 3A.

As you can see above 82 DKK/m² has been saved by use of this solution. In a 70 m² apartment this is equal to a total saving of the investments of 5,700 DKK, which are primary coming from the use of centrally place riser pipes.

The saving due to the heat recovery is not fully included in connection with the sizing. When more basic experiences have been obtained an even higher total saving can be expected.

Sundevedsgade 14/Tøndergade 1

This project is described in detail in the following. The project is also a part of the Projekt Renovation programme and is made in a cooperation between Cenergia, C.F. Møller architects and SBS urban renewal.

The project includes the rehabilitation of 20 apartments. The following energy saving measures is included in the project:

- Air solar collector. A 19 m² air solar collector has been mounted on the roof, and heats a central storage tank in the basement, which is also connected to the district heating system.
- A new solar wall design with an integrated heat recovery unit that is also connected to the district heating system is used for 12 apartments. The only 25 cm thick counter flow solar wall has been built with frosted glass and PV-modules as covering coat. The heat recovery unit has been placed inside the solar wall. This innovative unit developed by TermoVex Denmark in cooperation with the company SolarVent, contains both the counterflow heat recovery unit, sound absorber and ventilation fans. The complete heat recovery system is high efficient and has a very low electricity consumption. These systems form part of the EU/Joule project PV-VENT together with the PV-modules. A built-in damper in the solar wall secures against too high temperatures.
- Ventilation with heat recovery for eight apartments. The corner apartments cannot be connected to a solar wall and individual counter flow heat recovery units from TermoVex Denmark with 85% efficiency have therefore been placed here also as individual systems. The ventilation systems in these apartments have been made as real air heating systems by means of heating surfaces that are heated by district heating. There is also a traditional but centrally placed radiator system to cover peak loads.
- PV-modules. The PV-modules form part of the solar wall and the produced electricity is used directly in the heat recovery unit by help of a so-called PV-mixer which can give second priority to grid-based electricity as a supplement, see also www.solarvent.dk on this. There is approx. 1 m² PV-modules per apartment.
- Water heat exchangers. The heating is supplied from the central storage tank in the basement, which is partly supplied with district heating and partly with heat from the air solar collector. The heat is in this way supplied to the apartments for both room heating and domestic hot water via only one duct, which reduces the heat loss. The heating of the water takes place via individual domestic hot water heat exchangers that also secure against problems with bacteria.
- South oriented sun-protected sunspaces for each apartment and improved daylight function.

Solar wall with heat recovery and PV-operated ventilation

Figure 5a+b. shows a photo with built-in, specially developed only 25 cm thin counterflow heat recovery systems from TermoVex Denmark before installation of PV-modules to operate the ventilation fans and the temperature dampers to avoid overheating. To the right the recovery unit can bee seen from the inside, where it can be reached from the patio, e.g. to change filter.

Figure 5a. The solar wall with built-in thin counterflow heat recovery units in the corner block in Tøndergade 1, Sundevedsgade 14 is here shown after the

installation of the PV-modules to operate the ventilation unit and the air damper.

Figure 5b. A counter flow only 25 cm thick heat recovery ventilation unit with built-in heat exchanger, sound absorber and ventilation fans fit into the solar wall in connection with urban renewal of the building in Sundevedsgade 14, Tøndergade 1.

Figure 6. Solar wall with PV-operated build-in counterflow heat recovery ventilation unit in the housing block in Sundevedsgade 14, Tøndergade 1 after the rehabilitation.

The idea of this part of the project was to develop a solar wall solution, which at the same time has a built-in possibility of heat recovery on the ventilation air. The company TermoVex Denmark has in this connection developed a new type of building integrated counterflow heat recovery unit, which can be used with a varying number of exchanger plates dependent on the purpose. This way it can be made relatively thin and at the same time it was going to have a reduced air resistance and thus a smaller electricity consumption and higher efficiency than existing solutions. By this it was also the aim to cover the electricity consumption of the ventilation fans when the sun is shining with an acceptable economy.

Within the present range of possibilities the heat recovery unit can, however, not be made thinner than 230 mm if the ventilation fans are going to be placed in connection with the unit in one element.

Cenergia and TermoVex Denmark have therefore made the design of the solar wall on this assumption. This way a thin ventilation unit with heat recovery has been achieved, which is 230 mm deep, 920 mm wide and 1800 mm long and which can be placed behind a transparent solar wall covering with frosted glass and with both built-in ventilation fans, filters and sound absorbers.

The suggested design cause that the wall behind the solar wall does also receive solar energy and is heated. Experiences from previous solar wall projects show that in this way a considerable equalisation of the solar energy contribution can be achieved. So the ventilation air can be preheated in the solar wall even at night. Due to the rather compact design of the ventilation unit the heat loss from this will furthermore be very limited. In addition to this there is a temperature controlled damper in connection with the solar wall to protect against overheating.

The first tests of the new type of heat recovery unit show that it has been possible to obtain a very limited air resistance of less than one third of the previous resistance, also the extent of recovery has been improved. The electricity consumption can therefore, probably be kept at 30-40 W per unit, where the requirement in the building regulations is 87W. The relation between electricity consumption and heat saving will then be favourable.

Air heating and ventilation in the remaining eight apartments

In the remaining eight apartments there are individual ventilation systems with heat recovery, which have been mounted in connection with false ceilings in the apartments. As something new air heating devices from the ventilation systems has been used here. These can supply up to 45° warm air into the apartments by means of a built-in heating surface. The demand to the size of the radiator system has then been reduced. The size can also be smaller due to the reduced power demand as a result of the good windows and the heat recovery.

Originally the sun could not shine through the ordinary apartments and the windows facing the courtyard were very small. The apartments have now got heated glazed patios, which are an integrated part of these. The glazed area facing the courtyard has then become many times larger. The apartments have also been opened so the daylight shines through these

Figure 7. Visualisation of the daylighting function of an apartment, January 3 p.m. with a cloudless sky. Calculated by Cenergia with Lumen Micro 7.2. The effect of the direct insolation is shown.