



Lundeberg (Denmark)

Thermal performance ratio: 1,15 per cent

Payback period: 7-8 years

**PV production matches electricity use for ventilation
First architectural competition with PV in Denmark**

Project data

Location, address:	Lundeberg Skovlunde
Region:	Copenhagen
Surroundings:	Part of Ballerup plan, concrete housing block area
Climate:	Mild and humid;
Heating degree days:	2906
Year of construction and renovation:	1960's (constructed); 2000 (renovation)
Typology:	Apartment;
No of dwellings:	27
Total floor area:	2.160 m ²
Owner:	Housing Association FSB. Now owned by Almenbo housing association.
Architect and Builder:	Suensons Tegnestue; FSB; Cenergia Energy Consultants
Costs of energy saving measures:	€ 5.330 per house (incl.. VAT)
Renovation financed by:	EU and Danish Energy Agency



Fig. 1: PV cells fitted into chimney, facade and gable.

Objectives and Results

The objective of this project was to develop low-energy heat recovery DC ventilation systems, which were supplied with electricity from PV modules integrated in the building facade and roof.

As a result, the project has shown the possibility of decreasing the electricity use to only 25-40 W per dwelling for ventilation systems with heat recovery. Hereby, there have been great energy savings on ventilation.

Renovation concept

Key renovation features

- PV-Vent
- New facade covering
- Sky lighting
- Development and test of PV-Vent prototype systems
- Development of PV modules
- Ventilation chimneys on roof
- Low energy ventilation with heat recovery

State-of-the-art

Before renovation	After renovation
<p>Constructions [U-values: $W/m^2 K$]</p> <ul style="list-style-type: none"> 	<p>Constructions [U-values: $W/m^2 K$]</p> <ul style="list-style-type: none"> New windows [1,8]
<ul style="list-style-type: none"> Natural ventilation 	<p>Installations</p> <ul style="list-style-type: none"> PV-Vent Heat recovery ventilation PV system

Energy saving and monitoring

Calculations show that with PV-Vent systems it is possible to have an electric to thermal performance ratio of 1.15 (electricity use in relation to heat savings), a pay back period of 7 years and a saving of primary energy per dwelling of about 4.000 kWh/year.

The PV fans used less energy than expected according to the calculations. The consumption for the ventilation was measured to approx. 35 W per apartment. Heat exchangers have a measured efficiency of approx. 80-90 %.

Additional information

- The PV-Vent system is a low-energy ventilation concept, which can be used in both new and renovated buildings for improving the indoor air quality. The ventilation fans will use electricity generated by solar cells and the air for the ventilation system is preheated behind the solar cells, thereby also cooling these.
- The PV-Vent system consists in addition to PV panels of a low-energy ventilation system with counter flow heat recovery. In the system there is a ventilation air heat exchanger with a high efficiency, an electrical switch box for using PV electricity directly for ventilation fans, and the air for the ventilation system is preheated behind the PV panels and is cooling the panels for improved efficiency.
- By using the electricity from the solar cells directly for the DC ventilation fans, the losses from converting the electricity from DC to AC are avoided or reduced.
- A very important part of this project has been the integration of the PV panels in the gables, facades and roofs of buildings in an architectural acceptable and interesting way.
- Payback period for heat recovery system: 4-5 years and for the PV driven solutions: 7-8 years.

Lessons learned and conclusions

- This project showed that energy savings on ventilation is possible and efficient
- An efficiency of 80-85% was reached on the heat recovery
- Good experiences using pro-active builders for a research and development project
- Total cost could be lowered to 3.100 – 3.300 Euros (from 5.330 Euros) with further experiences with the different solutions
- Good way of introducing the PV- Vent system that may be utilised by others in future projects
- Different ways of integrating PV-VENT systems in the buildings envelope have been successfully tested and developed

References

- [1] www.ecobuilding.dk
 [2] Solcelledreven ventilation til Lundebjerg-bebyggelsen i Skovlunde, Cenergia Energy Consultants, April 2003