



APELDOORN (The Netherlands)

Energy savings: 25% of gas and 75% of electricity

Total living expenses after renovation lower

Innovative roof renovation: fill-in PV roofing of 20 m²; air heat pump boiler

Project data

Location, address:	Residential areas De Mheen and Sluisoord
Region:	Gelderland
Surroundings:	Central part of the country, low hilly landscape covered by forests
Climate:	Mild and humid
Heating degree days:	2765 (KWA Bedrijfsadviseurs, www.kwa.nl)
Year of construction and renovation:	1970 (constructed); 2001 - 2003 (renovated)
Typology:	Row family houses
No of dwellings:	364 dwellings
Total floor area:	Approximately 36,400 m ² (100 m ² per dwelling)
Owner:	De Woonmensen (housing association)
Architect and Builder:	Dakmeester Van der Linde; Lafarge Dakproducten, Sun Factory
Costs of energy saving measures:	€ 33.132 per dwelling (total costs of renovation)
Renovation financed by:	The owner; EU and governmental subsidies, Nuon (total: € 5.5 million)



Figur 1: Renovated family houses in Apeldoorn (courtesy of Lafarge S.A.)

Objectives and Results

In the year 2003, when the renovation has been finished, the project has been the largest project in the world in which the roof fill-in PV panels have been used. The project is a best practice example for other housing associations, but the necessary governmental support for follow-up projects is missing at present. The project let see that it is possible to realise complete roof and heating system renovation, while answering the objectives of the project: high energy saving, use of renewable energy sources, living comfort increase, creation of healthy indoor environment and extension of the exploitation period. The exterior of houses has got an aesthetic upgrade and a futuristic look.

The city council of Apeldoorn has supported the project. It fits in the plans of the city to become energy neutral in 2020. The project has won the European environmental price the Climate Star 2005 and was been nominated for the National Energy Future Trophy (Nationale Energie Toekomst Trofee) in 2005.

Renovation concept

Key renovation features

- Insulation of roof
- Photovoltaic panels
- High efficiency boiler
- Mechanical ventilation
- Heat pump boiler based on ventilation air, heat used for DHW heating

State-of-the-art

Before renovation

Constructions [U-values: W/m^2K]

- Non-insulated roof

Installations

- Individual boiler with conventional efficiency
- Natural ventilation

After renovation

Constructions [U-values: W/m^2K]

- New Insulated roof
- New attic window (insulation glazing)

Installations

- High efficiency boiler
- Heat pump boiler based on ventilation air, heat used for DHW heating
- Mechanical ventilation
- Photovoltaic panels (20 m² each house)

Energy saving and monitoring

Energy consumption before renovation:

KWh/m²: unknown
Energy Index¹: unknown

Energy consumption after renovation:

KWh/m²: unknown
Energy index: unknown
Percentage saving²: 25% gas and 75% electricity
PV systems installed on the 364 renovated houses produce about 750.000 kWh electricity a year.



Figures 2 and 3: installation of PV tiles on roofs
(Courtesy of Lafarge S.A.)

Additional information

- The photovoltaic roofing tiles (Blue Sky PV 80) are a special product of the Lafarge company. The PV tiles are installed directly on the tile laths, it means no special facilities are necessary for the installation.
- The excess produced energy is sold to the energy supply company.
- To keep an even look, all roofs have been equipped with the same amount of PV tiles, even though parts of a number of roofs have been shaded by trees. Orientation of PV equipped roofs is east, south or west.
- The original roof has been removed and new insulated roof elements placed.
- The heat pump boiler based on (mechanical) ventilation air produces heat for DHW pre-heating.
- Asbestos pipes for natural ventilation have been replaced and mechanical ventilation system installed.
- There have been four test houses renovated as show cases for tenants. Tenants have been thoroughly informed about plans and the project progress.
- The nuisance during the renovation has been minimised to 2.5 days per house. Tenants got detailed instructions at which time the individual tasks will be carried out, and at which time it is necessary to be at home. Blankets have been distributed to cover the property on the attic.

Lessons learned and conclusions

- Due to good communication and persuading advantages for tenants, nearly 100% of tenants have agreed to participate in the renovation. If the housing association will carry out a renovation project, 70% of tenants have to agree with the rent increase and given measures.
- The renovation has been realised according to a so-called National Agreement on Housing (Nationaal Akkoord Wonen), which is formulated by Aedes, the national representative of housing associations. The starting point is that the total living costs after the renovation cannot increase, it means that energy saving is high enough to cover the increased rent. The project has proved that this is possible.

References

- [1] www.iea-pvps.org; Summary of major projects, demonstration and field tests programmes in the Netherlands
- [2] www.apeldoorn.nl; "Apeldoorn werkt aan duurzaamheid; Woningrenovatie Mheen & Sluisoord
- [3] Megadakrenovatie met Dakmeester als hoofdaannemer; DAKmeester magazine; May 2003
- [4] www.newnrg.nl; Huurwoningen comfortabeler en zuiniger; 11 April 2005
- [5] www.nationalerenovatieprijjs.nl; De Mheen & Sluisoord, Apeldoorn
- [6] www.dakweb.nl

¹ Calculated by EPA - Energy performance Advice programme
² Compared to the situation before renovation