PHOTOVOLTAIC | *AMERSFOORT (The Netherlands)*

Photovoltaic energy is not really a very new technology. Although its principle is known for many years now, quite a lot of obstacles hinder its full market penetration. One of the possible remedies (besides new developments making the technology cheaper) can be either large-scale fabrication of solar panels or innovative policies on urban level, trying to make this technology achievable for many more people than before. The City of Amersfoort and the Dutch energy supplier REMU used the opportunity of the building of a completely new quarter to experiment with photovoltaic energy. They did not only concentrate on technical aspects, but also on availability of the technique.

GENERAL ASPECTS

Amersfoort is a municipality situated in the central part of the Netherlands, about 50 km from Amsterdam and 20 km from Utrecht, having excellent railway connections.

Amersfoort has about 122,000 inhabitants, but expects further population growth. This makes it necessary to change the city's energy policy if the goal of reducing CO_2-emissions is to be obtained.

Climatic data:

Hours of sun per year : 1477 h/a
Annual Mean Temperature: 10 °C

CONTEXT

The City of Amersfoort decided that in its new quarter Nieuwland which comprises about 5,000 homes and about 70 ha for industrial purposes the buildings should serve to experiment both new environmental techniques and owner structures for them in order to achieve a high grade of sustainable living.
In order to achieve these goals, the local authority has appointed an environmental supervisor being charged to assess all subsidiary plans on the basis of the environmental objectives, to inform and encourage the parties involved.
For this purpose, the so-called DCBA method has been used. For each environmental aspect, a base line situation (D) and an optimum situation (A) were defined. They provide a standard against which each design can be checked. It has been agreed with planners and builders that the target level must at least be 'C', i.e. on all fronts at least one step better than normal. In the case of the solar energy project, it has been convened to go even further: level 'B' and in some situations even 'A'.
The planning for this new development started in 1995 and should be finished by 1999. Nieuwland comprises of four different quarters that have been build in different phases of the development, each of them having its own characteristics.

EXPERIENCE OF AMERSFOORT

The City of Amersfoort, REMU (N.V. Regionale Energiemaatschappij Utrecht – the Utrecht Electricity Corporation), the builders and developers implied seek to demonstrate that the use of solar energy can result in architecturally sound design. They also wish to gain experience in the use of solar energy in various situations: in rented housing, owner-occupied housing and non-residential buildings. A special importance is therefore laid on aspects of financing and owner structures in this case study. Five different projects using solar energy have been undertaken by REMU in co-operation with many other partners:

Three low-energy primary schools

As REMU is aware of the fact that schools are a place where next generations are educated and that they are a meeting point for the residents of a district, it also paid attention to the three primary schools to be built in Nieuwland. In two of them, provisions were made to integrate solar panels, the first one already being finished in 1995, thus too late to integrate solar panels into its roof.
In 1995, SRO, a local building company and REMU signed an agreement covering the installation of solar panels. SRO granted REMU a right of superficies as they installed the solar panels and receive the electricity generated. In exchange, REMU paid part of the extra cost resulting from other energy-saving measures applied in the schools. Subsidies were granted by NOVEM and the EU.
One of these schools was fitted with 192 solar panels and completed in 1996, the other one having a roof with 124 so-called 'AC modules' and completed in 1997. These modules have a small inverter on the back, which means that each panel provides alternating current to the grid. Both installations together can generate about 8,000 kWh annually. To visualise energy consumption and production, the schools have displays showing current and cumulative data and comparisons with target figures. They are hung up in central points in the schools, visible for anyone to actively illustrate the performance of the installations.

MW photovoltaics project

After a first exploration of possibilities, it was decided to aim for an installed capacity of 1 MW. Based on an average of twenty square meters of solar panels per house and a peak capacity of 100 W per m^2, a specification has been made in 1994 to build about 500 houses. The urban development was structured to allow (optimum) installation of solar panels on as many houses as possible. It was also specified that all designers and developers involved should co-operate in the implementation of the solar project. It comprises altogether eight sectors on which nine developers are working. Construction of the first sector started in 1997 and should be finished before 2000. REMU applied two different methods when selling these houses. One half of the solar panels will remain the property of REMU with similar conditions for using the roof space, except that the house-owners are remunerated by REMU for the use of their roofs. For twenty percent of the electricity generated on their roof, they will receive a sum equal to the normal domestic consumer tariff. The other half of the installations is to be sold to the residents. The current generated will be fed into the REMU

grid with the residents receiving the normal domestic user tariff for the whole electricity produced.

Solar energy on fifty rented dwellings

Within one project of the "Woningcorporatie N.V. SCW", the Amersfoort housing corporation has completed a project comprising 114 rented houses with 50 of them using combined solar power. Thereby, REMU gains experience concerning its implementation and management in social housing. The construction was started in 1994 and completed in June 1996.
5.6 m^2 of solar collectors are on the roof of each house, situated next to the ridge. Immediately below them are the solar cells – 22.5 m^2 per house. A row of windows below the solar cells provides direct solar radiation into the houses and forms a separation between the energy roof and the tile roof lower down. There have been many tests on impermeability to water, wind load, thermal shock and durability. The current gained from the solar cells – about 82,500 kWh per year altogether is supplied to the mains while the hot water is used in the houses themselves. A solar/ gas combination unit with a capacity of 15 kW each has been installed in each house.

The housing corporation made the roofs available for the use of solar power. Between REMU and SCW, an agreement on management and ownership has been made. The solar-power roof is the property of REMU, including supplementary provisions regarding access to the roof and the installations. The solar collectors and the solar/ gas combination units are the property of Gasrent Stegas B.V. and are rented by SCW.

Nineteen owner occupied homes with solar power

On 19 luxury owner-occupied houses in one of Nieuwland's districts, REMU has installed solar roofs. Preparations started in 1995 with the last houses being completed in 1998. REMU wanted to investigate the possibilities of furthering solar energy in the private property sector. The houses are private property while the solar panels belong to REMU. The relationship between both parties has been set out in agreements with the building company and the individual occupant. For them, the solar panels act as a waterproof roof covering. They pay nothing for construction and maintenance of this structure. In return, the owner must prevent the panels from being overshadowed and may not make any changes to the roof. In case the owner wants to replace the solar panels, there are special agreements. REMU can access the roofs in the events of faults occurring and is responsible for any leakage.
The partners also wanted to investigate whether it was possible to prefabricate the entire roof structure in a workshop - tested on one of the houses first. But this revealed two predominant objections: First, the fragility of the different parts during transport and secondly, the elements did not fit together accurately enough for the aluminium sections to match correctly. The necessary additional work during assembly cancelled thus out the logistical advantage of prefabrication. For the other eighteen houses, only the timber roof was prefabricated, after which the profile sections and the solar panels were installed on site.

Two semi-detached "balanced energy houses" ®

A unit consisting of two semi-detached houses has been built in Amersfoort whose annual energy consumption is fully covered by solar energy. It was constructed in 1997/8, one half being used for dwelling purposes, the other serving as an Information Centre for Sustainable Energy open for the public. Besides many other features aimed at reducing the house's energy consumption, the solar roof plays an important role in the design of the house. Many different systems have been incorporated: solar collectors, 'normal' solar panels, double-glazed transparent panels, single-glazed transparent panels, ordinary double glazing and sunblinds. Despite this combination with various thicknesses, an even roof surface has been achieved. The whole panel surface is about 90 m^2, providing on average approximately 7,500 kWh of electricity per house annually, while the 14 m^2 of solar collectors provide three water tanks for different (storage) needs: domestic hot water, heating and a ground water layer at a depth of 12 m for long term storage. An electric heat pump satisfies the rest of the heating requirement. The heat pump as well as a supplementary tap-water heater in the kitchen are fed by the solar panels.

Evaluation and Perspectives

In mid-1999, four of the projects have already been completed. The 1 MW project is still being implemented and should be completed in 1999. Approximately 1,150 homes in Nieuwland will then have been equipped with solar collectors. About 570 homes will have twenty or more m^2 of solar panels and nearly 400 homes will have one to five solar panels.

For further information

REMU
Electricity Supply Company
Mr. Pasma
PO BOX 3053
NL - 3760 DB SOEST
Tel: +31 35 60 944 11
Fax: +31 35 60 944 22
E-mail: *@Remu.nl
http://www.Remu.nl

Informatiecentrum voor Duursame Energie
Ms. Wieta Schäfer
Nieuwlandseweg 42
NL – 3824 AMERSFORT
Tel : +31 33 46 25 843

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