Summary
In Denmark, and most other European countries, renovation of housing only includes slightly improvement of insulation and use of low energy glazing.

Cenergia has been technical co-ordinator of a number of European funded low energy renovation projects which, however, until now have not influenced the market much.

Compared to new built it has proved to be much more difficult to introduce a low energy practice in the area of renovation of social housing.

The main reason is that the financiation systems are very conservative, that the tenants do not want to pay extra in rent even though they will save on the energy bill, and also that consultants are against it.

In the area of new built housing a number of projects according to the new energy rules in Denmark have been realised including use of the new low energy classes 2 and 1 which are 25% and 50% better than the minimum demands.

Also a passive housing design has been realised with good results.

1. New Build Housing Projects

Cenergia has been involved in more than 25 solar low energy demonstration projects in Denmark since 1984, in most cases with EU support as an important incentive.

In 1992 the Skotteparken solar low demonstration project was realised with 200 housing units. This project won the “World Habitat Award” in 1994 by its impressive strategy to document savings on heating, electricity and water.

Based on the good results with the Skotteparken project the EC in 1993 supported a proposed targeted project with demonstration projects in 7 different EU countries from the new established European Housing Ecology Network housing association co-operation.

In Skotteparken an aimed at 60% saving on heating and DHW use was obtained (from 180 kWh/m², year to 72 kWh/m², year) with a very good total economy for the users.

Based on this total economy assessment was introduced as basis of social housing investments in Denmark, so extra investments could be accepted when you could show that extra energy savings can lead to a benefit for the tenants.


From all the mentioned projects it was clear that it was very important to introduce savings on the ventilation loss by using heat recovery ventilation (HRV), and at the same time keep the electricity use for ventilation low.

Best energy performance was around 50 kWh/m², year for heating and DHW.

In Farum an electricity use for individually balanced HRV ventilation units were monitored as low as 20 W per housing unit. And with a noise level at only 20 dBA.

In 2001 the Munkesøgård project was realised as the first large scale ecological housing project in Denmark with 100 housing units.
This project, together with a sustainable building effort by the municipalities of Roskilde and Glostrup, was supported in the Green Solar Regions Project connected to the European Green Cities cooperation. (See www.europeangreencities.com).

And in Glostrup the so-called Green Build system with a check list using energy and environmental points was used with good results demanding a certain minimum energy standard when filling in the check list in connection to sales of land by the municipality.

In 2003 the Dalgasparken housing project in Herning was realised using PV panels to obtain CO2 neutral balanced HRV ventilation in combination with a very good and documented airtightness. The local energy company documented a 50% saving on the heating bills leading to a very good economy for the tenants. Blowerdoor tests were here performed in 3 rounds.

1. At the time the first housing unit was closed
2. Based on registered failures in (1) when failures had been removed / mended
3. At the finalisation of the project.

As basis of developing a basis of a cost effective “passive house” design in Denmark a CO2 neutral test house was developed in 2003 using PV panels to match yearly electricity use for operation.

Here an only 22 cm thick low cost heat recovery ventilation (HRV) unit from the Danish company EcoVent was developed and used with success.

In the prefabricated housing project, Solengen in Hillerød (2005), built by Scandibyg and Nielsen & Rubow Architects, the EcoVent HRV unit has been introduced at a total installed cost, including ducting and heating elements, of only 2.000 Euro, equal to only 1.100 Euro in extra costs for the builder.

At the same time, in 2006, Cenergia had been using the same technology for the first passive housing project in Denmark, Rønnebækhave in Næstved, where PV panels is used to match electricity use for operation of an energy efficient shared ground coupled heat pump system.

### 2. Retrofit housing projects

The Østerbro – solar low energy retrofit housing scheme with 80 apartments was realised in 1994. Here was used solar heating for DHW, solar walls, facade insulation, low energy windows and individual HRV systems. A 51% saving of district heating was documented. The project was selected as a finalist for the World Habitat Award in 1995.

In 1995 the European Green Cities co-operation (EGC) was established in co-operation with Green City Denmark. And in 1996 support was obtained from the EC for a targeted project in the building sector with 11 projects in 9 EU countries.

The Danish EGC demonstration was realised in the Hedebygade housing block with 3 different demonstration projects as part of the largest urban ecology project in Denmark (1998 – 2001).

In connection to the Lundebjerggaard housing block renovation in 1999/2000, several types of HRV ventilation designs were tested in combination with PV panels as part of a PV-VENT design where PV is used to match electricity use for ventilation. This was realised in connection to the EU Joule R&D project PV-VENT.

At Lineagaarden and Trekanten, Frederiksberg in Copenhagen, solar low energy ventilation towers were introduced for nearly 200 apartments to hide ventilation ducts and produce solar energy at the same time. Here shared HRV systems were used with individual user control. But when the HRV units are placed in a cold loft room after heating of the inlet air proved to be necessary.

At Lauritz Sørensens Gaard experience with PV assisted HRV ventilation has been obtained as well as in Havremarken, both at Frederiksberg in Copenhagen.

For the Gyldenrisparken housing project at Amager in Copenhagen thin EcoVent HRV units will be introduced at an installed cost of 2.000 – 2.500 Euro per apartment in combination with airtightness measures to obtain a combined improvement of indoor air climate and a reduction of the tenants’ heating bills. This pilot project is realised in connection to the EU-Demohouse project.

Condense from exhaust air will here as always be lead to drains to reduce the moisture level in apartments. Besides the idea has been to focus on energy quality control, (e.g. by energy signatures for follow-up), and
introduction of an energy renovation quality stamp like the Green Diploma system. (see: www.demohouse.net).

During the summer 2005 the so-called Soltag prefabricated CO2 neutral rooftop apartment was developed and exhibited at Ørestad Nord in Copenhagen.

It has been developed in a co-operation between Cenergia and the Velux Group, Urban Renewal Copenhagen and Nielsen & Rubow Architects (which are ISO 14001 certified). Homepage : www.soltag.net.

The prototype Soltag housing unit was a great success. It received the Danish Energy Saving Price in 2005 as well as the national Energy Globe Award in 2006. It has now been moved to the headquarter of Velux north of Copenhagen, now aimed to utilise the developed principles of the CO2 neutral rooftop apartment for several rooftop extension projects both in Denmark and Sweden.

The here mentioned activities are supporting the ongoing Solar City Copenhagen initiative which are aiming at high CO2 reductions for cities in combination with use of energy savings and solar energy. (See also www.solarcitycopenhagen.dk). In connection to this it has e.g. also been possible to realise the first PV-Coop in the world, Copenhagen PV-Coop, (see www.solcellelauget.dk).

3. Aims for the future

It is expected that the EU-Energy Performance Directive for Buildings and the new energy rules in Denmark which have been introduced with a 25-30% energy saving from April 2006 will change the situation for cost effective solar low energy building so it will become more like a standard solution in the future. This is also supported by the introduction in Denmark of two low energy standards, 1 and 2, with a further 25% and 50% energy saving compared to the new minimum standard. This is introduced by the Government as the expected level of revised energy standards for year 2010 and 2015 in Denmark.

Besides there is also introduced an energy certification procedure by energy consultants in connection to all new and retrofit building projects, but primarily based on an evaluation of calculations for the projects.

A barrier here is if it is not possible to document aimed at energy savings in practice. Like in the Västra Hamnen BO-01 project with 11 low energy housing projects in Malmö, Sweden. (Partner in Solar City Copenhagen). Here was seen a 40-60% higher energy use in practice compared to calculations.

To obtain a better practice it is suggested to introduce “energy quality control” as a common practice in new building and retrofit building projects.

Here e.g. blowerdoor tests, thermo photography and use of energy characteristics / energy signatures should be used during the final year of operation, so possible failures can be identified and corrected in connection to the “First Year Commissary” together with the building contractor.

The idea for this was presented by Cenergia already in January 2003 in connection to the EU-Save project, Green Catalogue (www.greencatalogue.com) which includes suggestions for performance requirements for 32 best practice technologies in the building sector.

In Denmark an initiative has been made to form a network of cities who will involve themselves in a “sustainable cities campaign” where means to obtain sustainable and energy efficient building will be developed and introduced in practice. This is in connection to the Danish Association of Sustainable Cities and Buildings, (FBBB), see www.fbbb.dk), and it will also be supporting the “EU-Thematic Strategy for the City Environment” (KOM(2004)6039, where the following policy was stated:

“In the EU countries only very few buildings are build or renovated in a sustainable way, even though there exist documented solutions for this. The main barrier is a lack of interest from the contractors and investors who believe that sustainable buildings are expensive and further they are suspicious of new technologies. The long term benefits from sustainable building, like lower maintenance and operation costs, improved durability and a higher value for the building are not visible in the short term and in relation to the original purchase. Due to this it is needed to make a special effort to focus on such benefits, so investors, banks and mortgage banks will be able to spot the difference between buildings realised by normal solutions and sustainable buildings”.

A good example is the city of Stenløse near Copenhagen. Here minimum demands for sustainable building have been introduced in connection to sales of land for 700 housing units.

Here there was requirements for :

1. Reuse of rainwater for flushing of toilets
2. Avoidance of PVC and pressure impregnated wood
3. Use of low energy design which is 35% below the new minimum energy demands from January 2006.

And there was no problems of selling the land at the aimed at prices. At present it has been possible to obtain EU-Concerto funding both for the activities in Stenløse to reach a low energy class 2 level and for Valby in Copenhagen as support to the large scale PV implementation plan for Valby where the long term plan is to have installed 300,000 m² of PV-modules in year 2025 to supply 15% of he total electricity use.

Figure 1 - Photos from Solengen low energy housing project in Hillerød with balanced heat recovery ventilation and airtightness to reduce energy use for heating and DHW by 50%. Besides PV-modules are used to support low consumption ventilation fans.

Figure 2 - Photos of Soltag prefabricated CO2 neutral housing unit.

Figure 3 - Photos of PV-modules on roof of Valby School in Copenhagen.