

## **ØKOhuset (the Ecohouse) – an architectural designed ecological standard low-energy house.**

Until 1999 the energy specialist company Cenergia has in cooperation with the company EBO Consult acted as coordinator for the EU-Thermie target demonstration project "the European Housing Ecology Network", where 11 different solar energy/low-energy housing projects have been built in 7 different EU-countries.

Through a two-years period of time until 1999 Cenergia has at the same time in cooperation with the firm of architectural company Thure Nielsen & Rubow and together with future tenants made an extensive development and design work in connection with the ecological housing project Munkesøgård, which at the moment is being built near Trekroner in Roskilde.

To ensure a practical use of the obtained knowledge about ecological and energy friendly low-energy building, an initiative has been taken to develop and market a new ecological standard house based on a wood construction and a heavy core, after almost the same model as the one suggested for the Munkesøgård-project. In 1998 funding was obtained from the EU-Altener programme to work with the solar energy design of the proposed ecohousing concept and in the spring of 1999 the partners Cenergia, Thure Nielsen & Rubow and EBO Consult made a private company "ØKOhuset" or "The Ecohouse" with the aim to realise housing projects with architect designed ecological low-energy standard houses.

In a dialogue with the local authorities in the municipality of Ballerup a new housing project with 21 "Ecohouses" and a common house was designed for a new urban development area "Østerhøj Syd" in Måløv and by the end of January 2000 a marketing campaign concerning the house has taken place, which also includes a special homepage on the Internet with illustrations and descriptions ([www.okohuset.dk](http://www.okohuset.dk)) and several information meetings have taken place at the local Østerhøj school.

The Ecohouse project in Østerhøj Syd consists of 21 houses and a common house.

The new urban area Østerhøj Syd is situated as neighbour to the Østerhøj Nature Park and the existing nature of the ground is kept wherever possible. The existing plantation, hill tops and small lakes are included as character-forming distinctive features in the area.

21 Ecohouses will here be facing a small curved street, which follows the ground and creates variation and treat when you go through the area. A square and a common area with e.g. a playground and a common house will also be made.

The price for one of the 21 Ecohouses is only a little bit higher than for other standard houses. And if the lower operation costs are taken into account the total costs for a house owner will be less than in normal standard houses.

The price for a 132 m<sup>2</sup> house is DKK 1.5 million and for a 148 m<sup>2</sup> house it is DKK 1.67 million. To this will be added the price of land and connection charges that dependent of the size of the site and other circumstances, this will be between 0.55 million DKK and 0.8 million DKK at Østerhøj.

In connection to the housing project at Østerhøj Syd at least one of the housing units will be equipped with improved energy savings and a possibility of testing alternative low temperature heating designs with funding from the EU-Thermie, European Green Cities project.

The ecological concept of the Ecohouse is based on the following 10 fundamental principles:

1. The compact design in two stories (minimum surface of covered area).  
Small houses will however only be single-storey.
2. Wood as a general building material and emphasis on healthy building materials (healthy indoor climate).
3. Use of active and passive solar heating (solar collector and a possibility of PV-modules) and a heavy built core as heat storage.
4. Good insulation and low-energy windows (minimum heat loss).
5. Climatic zones = living room with constant heating, bedrooms with light materials (varying heating).
6. Ventilation with electricity efficient counter-flow heat recovery (in winter).
7. Natural ventilation (in summer).
8. Flexible arrangement of the rooms
  - = Multi-use
  - = Different family sizes
  - + Possibility of integration, housing/business
  - = Long life-span
9. Gradual increase: The house can grow larger
  - + Winter garden
  - + Carport and shed
  - + (Bed)room
  - + Bay
  - + Covered terrace
10. Many sizes and variable linking possibilities
  - 82 – 157 m<sup>2</sup> in one or two stories
  - Detached houses
  - Semi-detached houses
  - Terrace houses

On the basis of these 10 fundamental principles an individual house for each family can be designed within an ecological built-up area, which with a view to the social cooperation also includes the mentioned common house.

The Ecohouse can in generalæ be built as part of a common built-up area with 20-30 houses and a common house. The site for each house could be relatively small, e.g. 400-600 m<sup>2</sup> and with a relatively small site width, partly to save space, road length, etc., and partly to obtain a private environment with good possibilities of social contact.

ØKOhuset ApS is responsible for sale and construction of the houses. The building activities will not begin until the houses have been sold and each house has been designed. This means that the houses can be sold at the price based on the actual expenses and without additional risk charge/margin on both the site and the house (the same principle as for construction of public financed (housing society) dwellings).

At the same time it is the idea that the owners are going to be involved in the design of the common area and the common house.

This process of formation for owner-occupied dwellings is something quite new in Denmark. The purpose is to build the best possible ecological house within the "usual" house budget.

### **The Ecohouse as a solar energy/low-energy house**

The Ecohouse has been designed with a considerably reduced energy consumption for heating and hot water compared to usual single-family houses. According to a so-called BV-95 calculation the annual heat demand in an Ecohouse is 43% of the demand in new single-family houses of the same size, which have been built according to the Danish building regulations.

The total energy savings on heating and hot water in the Ecohouse are as mentioned 57% compared to a normal one-family house of the same size. At the same time the usual water consumption will be reduced by approx. 35% (and if a rainwater system is installed the reduction will be up to 59%) and it is also the aim to reduce the electricity consumption. E.g. it is intended to offer an organisation of a collective purchase of A-marked electric equipment.

According to the calculations the expenses for heating will be reduced by approx. DKK 6000 and the expenses for water will be reduced by approx. DKK 1200 for each household. The total economy assessments that have been made show that the energy and water saving measures in the Ecohouse are a financial benefit for the owners on a long view.

The reason for the low heat demand is the use of a combination of improved insulation, optimised low-energy windows, passive solar heating and

mechanical ventilation with counter-flow heat recovery and a low electricity use. At the same time the domestic hot water is heated by solar heating and as the windows area is considerably larger than normal there is also a good daylight utilisation.

In the Ecohouse the heating system can be smaller than in other houses due to the low heat demand. Furthermore a woodburning stove is an important part of the design of the house. The woodburning stove is directly ventilated with fresh air and it is the idea that it can be made with a storage function for the heat, equal to a mass furnace.

Compared to standard single-family houses the necessary installed heating capacity in an Ecohouse is only approx. half of what is needed in a usual single-family house. The annual heat consumption in a 148 m<sup>2</sup> house is approx. 6000 kWh, incl. hot water.

The Østerhøj area will be supplied with natural gas. And in the Ecohouse-project a common natural gas fired heat station will be located by the common house. The heat from this will be distributed to the houses by means of a low-temperature district heating network, which will be stopped during the summer, where individual solar heating systems, situated in the houses, will cover 90-95% of the heat demand, while an electricity supplement will cover the remaining 5-10%.

The houses are usually built rather tight even though they are individual houses. This means that it is a question of short piping for the supply of the district heating and furthermore the network will be with reduced dimensions due to the low demand.

The heating system in the Ecohouse will be made with both floor heating and radiators, to meet the wish to make a low temperature heating system with maximum comfort. There is floor heating in the ground floor, while radiators situated on the heating core will heat the first floor. All technical installations are located centrally in the so-called heating core. In this way a cheap possibility of easy maintenance is obtained.

A 3.5 m<sup>2</sup> solar collector will be integrated on the top of the sun lounge of the Ecohouse and will be connected to a hot-water tank ready for solar heating, which is located in the core with technical installations. It is at the same time the idea that the pump of the solar heating system is going to be powered by a PV-module, which is integrated on the side of the ventilation chimney on the Ecohouse.

Cenergia has together with the companies TermoVex and SolarVent developed a new concept for ventilation with heat recovery focussing on:

1. Use of a newly developed efficient counter-flow heat recovery unit with a low-pressure loss.
2. Use of DC ventilators with low electricity consumption.
3. Low sound level.
4. Easy installation.
5. Possibility of additional savings from 1-3 m<sup>2</sup> PV-modules.

An efficiency of 80-90% can be obtained by use of the new counter-flow heat recovery unit, this means that 80-90% of the heat in the extract air will be recovered. At the same time much work has been done to keep the electricity consumption on a minimum.

Therefore ventilators with an output of only 35 W have been chosen (both exhaust and air supply) equal to a total electricity consumption of approx. 200 kWh/ year. This can be compared to the requirements in the Danish building regulations with a maximum electricity consumption for mechanical ventilation, which are 87 W by the required ventilation (126 m<sup>3</sup>/h). At the same time it is the aim to get a low sound level of below 25 dB, which can hardly be heard.

It is the aim that the electrothermal relation between electricity use and heat savings for this type of ventilation system with counter-flow heat recovery have to be more than 1:8. And if the used DC ventilators are supplied with supplemental power from PV-modules calculations show that this value can be increased to almost 1:15.

For the time being other "Ecohouse" building projects are being prepared in e.g. Glostrup and Roskilde. In Glostrup 25 Ecohouses will be built with funding from the EU-Thermie project "Green Solar Regions". In connection to this project a further development of a cost effective global solar low-energy design for the Ecohouses will be made.

The idea is here to utilise the reduced effect demand in the houses to obtain savings on the heating system costs. Besides the project will be realised in connection to a new approach with green urban management in the municipality of Glostrup also using a new developed energy and environmental point system.

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