

# SOLAR DISTRICT HEATING

# BALLERUP (Denmark)

*In order to replace fossil fuels and to reduce CO<sub>2</sub>-emissions, the use of thermal solar energy with common long-term storage of the heat is one of the most promising possibilities. These installations require a common storage tank that is able to provide warm water for a long period into the local district heating network. They may, depending on their dimension, provide as much as 50 to 70 % of the annual heating needs of a residential quarter. In addition to this, these systems can use innovative techniques, for example concerning their connection or feeding into a heat network and offer large energy saving potentials in comparison with single installations. In Ballerup, a municipality close to Copenhagen, solar district heating is covering parts of the heat demand in a living area with 100 apartments. This, combined with other initiatives, has caused a remarkable decrease in the heat bill paid by the tenants. The project inspired a large number of similar projects with global, low energy, building designs, both in Denmark and in other European countries.*

## GENERAL ASPECTS

Ballerup is situated 15 kilometres from the capital of Denmark, København, straddling the border between greater København and the countryside. The municipality of Ballerup is the home for approximately 45,000 inhabitants. Ballerup is a modern municipal authority with an active contingent of residents, a lively cultural scene and an attractive business community.

### Climatic data:

Degree days (Basis 17 °C): 3400  
Hours of sun per year : 1750  
Annual Mean Temperature: 7.8 °C



## CONTEXT

Since the early eighties, the Municipality in Ballerup has been in the frontline regarding environmental issues. In the "Agenda 21 action plan" from August 1999, the municipality stresses that use of collective heat supply and renewable energies should be implemented. Solar heating is a large part of this. The municipality is host for a large living area called Egebjerggård, which includes a large number of different projects ranging from focusing on architecture aims to savings of energy. One project is particularly interesting with a renewable energy point of view. Skotteparken is a living area containing approximately 100 apartments supplied partly with solar district heating and partly by gas-fired combined heat and power. In addition, the municipality of Ballerup is involved in other projects regarding energy savings and implementation of renewable energy. This includes studies in how to promote solar energy, feasibility studies on implementation of renewable energy in general, projects on specific energy savings in schools, and a new, locally based energy agency. All these projects have been funded partly by the European Union. (Like "Thermie", "Altener" and "SAVE 2").

# EXPERIENCE OF BALLERUP

The apartments in Skotteparken were already built in 1992, housing 100 families. It has been shown there how it is possible to decrease the heat demand for hot tap water and space heating by almost 50% compared to conventional housing. In addition, the consumption of electricity and water has decreased as well. These gains have been achieved by means of an extra investment of 8% compared to normal housing plus grants from the European Union, the Danish Energy Agency, and the Danish ministry of housing. The project in Skotteparken includes partly solar heat based, district heating with a special "pulse operated" controlling system, decreasing the heat loss in the pipes dramatically. These results were gained by a wide range of different approaches to the basic problem – how do we save energy ?

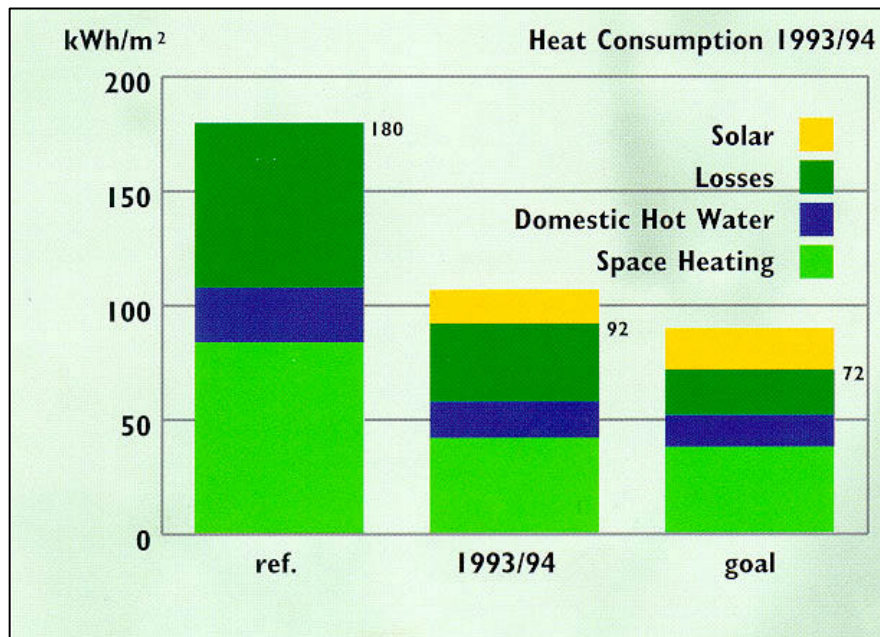
The most innovative aspect are the six, solar heating systems with approximately 100 m<sup>2</sup> of solar collector each, both for hot water and space heating. This equals 6 m<sup>2</sup> solar panels per apartment. An energy management system (EMS) is used to control the operation of the district heating network in such a way that it is only in operation when one out of six local solar/buffer storage tanks (5 m<sup>3</sup>) calls for heat. After the pulse, the district heating network is filled with cold return water from the tanks (30 - 35 °C). This means that the pipes only are subject to heat losses when a pulse is going on. This saves a lot of energy – especially in the summertime. The method is known as the pulse operation. Its advantage is less heat loss from the distribution pipes than would occur if hot water were in constant circulation as in conventional district heating systems. In sunny periods the distribution system stops completely, thus preventing considerable heat losses. The gains from the pulse operation system equal more than half of the total energy savings.



The main results for the project in Skotteparken can be summarised as follows:

- The normal amount of energy used for heating and hot water of 180 kWh/m<sup>2</sup> (normal housing) has been reduced to 92 kWh/m<sup>2</sup> in 1993, to 82 kWh/m<sup>2</sup> in 1994, reaching 77 kWh/m<sup>2</sup> in 1995.
- 65 % savings of district heating network losses was obtained from the low temperature pulse operation.
- Solar system yields 274 kWh/m<sup>2</sup> (which corresponds to 382 kWh/m<sup>2</sup> when including saved network losses).
- Heating bills only 4.42 Euro/m<sup>2</sup> which equals approximately 40 % of a "normal" heat bill.
- A good economic saving for the tenants based on an extra investment of approximately 8% compared to normal housing and grants from external sources.

Next to this text the yearly energy use in kWh per square metre housing area for heating and domestic hot water in Skotteparken is shown. The total heat consumption is divided into: (Solar) – solar heating supply, (Losses) – heat and hot water distribution heat losses, (Domestic Hot Water) – domestic hot water consumption and (Space heating) – room heating consumption. Be



Be aware that the solar heating does not consume energy. The yellow part just represents the amount of solar energy. A comparison is made between reference houses to the left, monitored energy use from May 1993 to May 1994 in the middle, and to the right the savings goal. As it can be seen, the largest contributor to the savings is the earlier loss part; this is due to the one pulse system.

Apart from the solar supported heating network, there are a wide range of other energy savings features implemented in Skotteparken. These features are as follows:

- Extra insulation, which is mostly added in the ceilings with a total thickness of 375 mm. The apartments are aimed airtight making the natural air change as low as 0.1 times per hour.
- Thermo glazing is used everywhere with two layer windows with an air gap of 15 mm. The windows have a U-value of approximately 1.4 W/m²K.
- Ventilation system with counter-flow, heat recovery is utilised as shared systems for 4-5 apartments. The system recovers approximately 80 % of the energy in the out flowing air. Special ventilators with an electricity use of only 35 -50 W are used.

- Electricity savings have been directed forward things like outdoor lighting. The "in-house" electricity consuming devices are the tenants own business, but individual electricity bills based on meters installed in every single apartment have been implemented to stimulate individual savings.



# EVALUATION AND PERSPECTIVES

A close co-operation with "green" minded cities like Ballerup and the Danish capital Copenhagen has been developed in order to change norms for sustainable building practice.

The interesting results with the Skotteparken project lead, in 1992, to an initiative by Cenergia together with the Danish housing association, KAB, to form a network co-operation with energy and environmental concerned housing associations in Europe. And, in November 1992, the European Housing Ecology Network, EHEN, was established as a co-operation at a workshop in Copenhagen. In 1993, Cenergia took responsibility to present a target project proposal in the building sector from EHEN to the EU-Thermie programme, and this was funded later that year with 11 solar, low-energy building projects build in 7 different EU-countries.



In 1994, Skotteparken received the international housing award "the World Habitat Award". This, because Skotteparken was seen as one of the first examples of a thorough fitting-in of urban ecology in the building sector as regards combined energy and water consumption. It is foreseen, that Skotteparken can serve as a model for other similar building projects – not only in the industrialised world but also in less developed countries.

## FOR FURTHER INFORMATION

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