

SOLAR HEAT

NECKARSULM (Germany)

Since the beginning of the 1990s, the solar heat market in urban areas has been constantly growing thanks mostly to the large improvement in the quality and efficiency of the equipment available as well as to the support policies that many countries are copying from Greece, Germany, and Austria. Subsequently, in the city of Neckarsulm (Baden-Württemberg), a new concept in heat procurement, based on distribution networks powered by solar energy, has been developed for the residential neighbourhood Amorbach.

THE CITY

Situated along the banks of the Neckar river, among forest and vineyards, the city of Neckarsulm is the main city in Baden-Württemberg's Heilbronn district, with 27,000 inhabitants. The arrival of the railway (1866) and the creation of a river port (1867) developed industrial activities (spinning, shipyards, production of pistons and two-wheelers) and economic growth in the city during the 20th century. Along with world-renowned industries such as Audi and Kolbenschmidt many small and middle-sized companies were set up, employing more than 20,000 people.

Climatic data:

Average annual temperature:

Annual duration of sunshine: kWh/m²a



CONTEXT

Convinced that it is impossible to reach holistic goals (such as reducing CO₂ emissions) without a strong commitment by the various players on a local level, at the end of the 1980s Neckarsulm Town Hall committed to a widespread campaign to promote and raise awareness of solar energy.

Since July 1996, Neckarsulm has been offering financing to individuals who wish to invest in photovoltaic and solar heat facilities. This aid programme was extended in February 2000 and now supports all measures aiming to improve energy efficiency in buildings (installing insulation and double glazing as well as heat pumps or biomass boilers).

Note also: since September 1999, owners of electric vehicles can recharge their batteries for free at the first solar public service station in Germany. 8 photovoltaic panels produce the electricity, which also powers the *Stadtwerke* buildings outside charging periods (2 to 3 hours per vehicle). The municipality and the *Stadtwerke* financed the 20,450-€ investment for 50% each.

THE NECKARSULM EXPERIENCE

In 1992, faced with a growing demand for housing, the municipality decided to enlarge the Amorbach district with a 51 hectare housing development, which would eventually house an extra 4,000 people in single-family homes or apartment blocks. Apart from the efforts made with respect to urban ecology, the new quarter was to provide the ideal site for experimenting and demonstrating a new concept in energy supply based on heating networks powered by solar energy.

Project Chronology:

The Neckarsulm project began in 1992 with the construction of 600 low-energy consumption homes (less than 75 kWh/m²a). 250 of them were connected to a heating network powered by a **gas cogeneration plant** (220 kW_{th} /100 kW_e) and a 400 kW gas/oil fired boiler. The other 350 houses were connected to a second heating network powered by a 1,440 kW condensing gas furnace. **760 m² of solar collectors** built into the roof of the two apartment blocks are used to preheat the water before it arrives in the conventional boiler. The solar energy, which is stored for a short time in a 20m³ tank, covers a total of 12% of the housing development's requirements in heating and domestic hot water. The operation cost 1.84 million €, with 153,400 € in subsidies granted by the Baden-Württemberg *Länd*. After a few months of operation, the facility's profitability as well as the quantity of heat provided by the solar heating equipment exceeded the amount expected.



With this first positive experience, in 1996 the municipality decided to build a third heating network in 1996 (Amorbach II). This third network was to provide heating for the equivalent of 1,300 homes, i.e. 105,000 m² of usable area, for an annual heat requirement of about 10,500 MWh. Solar energy was to reduce the need for fossil fuels by at least 50%. The new energy concept developed for this project is founded upon four basic factors:

- **Low-energy housing:**

Combining **passive solar architecture** with a modular building principle which will allow later installation of solar collectors. The project managers are contractually committed with the municipality to provide only buildings with heating requirements of less than 50 kWh/(m²a). This value is 25% below current German thermal regulations.

- **Ventralized heat production, distributed by interconnected networks:**

The heat production system is composed of 3 gas condensing furnaces with a unit power of 1,750 kW. Coupling the three heating networks in Amorbach provides optimal management of resources according to needs.

- **Wide area solar collectors:**

Amorbach II plans on installing 15,000 m² of flat-plate solar collectors. Using collectors built into the roof as well as pre-manufactured tailored solar elements (combining framework and collectors) will help reduce depreciation costs.

- **Inter-seasonal heat storage using a U-wave battery:**

Extra heat taken in during summer months is stored in the earth (clay and schist) via a network of tubular exchangers buried 30 m deep and 2 m apart. The capacity of this natural reservoir, keystone of the entire project, will eventually reach 140,000 m³.

Even though this storage technique depends on the geological nature of the earth and requires a more important regulation system, the investment costs are 40% less than a traditional concrete storage reservoir tank (18,4 €/m³).

The different phases of the project are detailed in the table below.

	Phase I	Phase II	Final Phase
Schedule	1995-1999	2000-2003	~2010
Housing connected	115 including one school, a shopping centre, and a retirement home	231	739
Power installed	930 kW	1,890 kW	4,830 kW
Heat requirement	977 MWh/a	2,847 MWh/a	8,754 MWh/a
Collector size	2,637 m ²	6,337 m ²	15,000 m ²
Storage volume	20,200 m ³	63,200 m ²	140,000 m ³

The cost of the global project is estimated at 12.53 million €. There is 4.83 million € (i.e. 20,900 €/housing and 162 €/m²_{heated surface}) in investment fees (excluding VAT and planning costs) for phases I and II which include buying solar collectors, the storage unit, boilers, the heating network and the sub-stations.

The federal research and education ministry has subsidized Phase I to 50% within the framework of the "Solarthermie 200" programme. It also granted 950,000 € for Phase II. The remaining 50% was financed by the *Stadtwerke Neckarsulm* as well as contributions from the project managers in order to connect their buildings to the network. The European Union also awarded a grant of 308,000 €.

An original and innovative means of financing has made it possible for the municipality to cover part of the costs engendered by Phase II of the project. A call for subscriptions for 2,000 m² of solar collectors, divided into 100 20 m² shares, was launched in August 2000. The shares are fixed at 1,943 € for anyone wishing to rent them from the *Stadtwerke Neckarsulm* which runs and maintains the installation. The solar energy collected is published every year and serves as a basis for owners' remuneration. This co-ownership status has two main advantages:

- > The possibility of involving the local population in the project (and hence gaining their support) while providing financial benefits,
- > Motivating other municipalities to find innovative and attractive ways of promoting renewable energies.

Partnership:

The municipality's partners are:

- > *Landesentwicklungsgesellschaft Baden-Württemberg* for project management,
- > An architect office in Esslingen for planning,
- > *Steinbeis-Transfertzentrums* for technical design as well as for its experience in energy efficiency,
- > the *Stadtwerke Neckarsulm* for operating and monitoring the facility.
- > *Institut für Thermodynamik und Wärmetechnik Uni-Stuttgart* for coordination and scientific monitoring.

Public Relations:

To coordinate their efforts and offer an efficient service in promoting solar energy, the Neckarsulm municipality, as well as other towns, associations, and companies in the region, have combined to create a cooperative society called "Solar- und Energieinitiative e.G".



Considered as a technological showcase for ecological building and innovation, the Amorbach district has received two awards given by the Federal government: "Solarpreis 1998" and "Umweltpreis 1999".

EVALUATION AND OUTLOOK

The city of Neckarsulm has committed itself to promote solar heat and has contributed, at its level, to the development of solar technology on the German market. In 10 years, this has grown from an experimental procedure to a mature, competitive technology. Heating networks powered by solar energy can be profitable for daily storage. Experts estimate that, for inter-seasonal storage, the cost of heat provided by solar collectors (excluding subsidies) is less than twice the price of heat produced by conventional equipment.

Even though it means taking certain risks, being innovative and setting the example has been and still is the main motivation behind the municipality's policy. If Neckarsulm hopes to provoke a healthy competitive spirit in the region through the town's actions, the message is to encourage private initiative.

Solar heating systems enjoy a privileged position on the renewable energy market and the growth of this market (+18% in Europe) shows the growing involvement of consumers. The procedure used in Neckarsulm (demonstration projects, technical development of the field, aid programmes, education for and financial contributions from the population), should set an example to countries where the solar heating market is poorly developed. This is the price for achieving its goals that is defined in the White Paper for 2010.

FOR MORE INFORMATION

Mr. Andreas Bracht
Rathaus – Marktstrasse 18
Tel: +49 (0)7132 350

Neckarsulm Press Office
D-74172 Neckarsulm
e-mail: info-stadt@neckarsulm.de

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