

# SOLAR DISTRICT HEATING

# FRIEDRICHS-HFN (Germany)

*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 Friedrichshafen, a housing development with almost 600 residences has been supplied by a small-scale solar district-heating system since 1996.*

## GENERAL ASPECTS

Friedrichshafen lies on the shores of Lake Constance [Bodensee], in south-western Germany. It has 53,000 inhabitants, and is known both as a tourist attraction, and as the town where the zeppelins were built and tested.

Today, Friedrichshafen is home to automobile, aerospace, and other high-tech companies.

### Climatic Data:

Degree Days (Basis 17 °C):	3,726
Annual mean temperature:	9.7 °C



## CONTEXT

In Friedrichshafen, the town of trade fairs and zeppelins, climate protection and saving energy are becoming more and more the focus of energy policy. Together with the citizens of the town, concepts for implementing the Local Agenda 21 are drawn up and adopted. All interested parties receive important tips and suggestions for optimum energy use in their domestic or commercial facilities in the Town of Friedrichshafen's Bureau of Conservation and Environmental Protection, in the energy-advice offices of the municipal utility, the Technische Werke Friedrichshafen GmbH, and from many other partners in the "Campaign for Climate Protection by Saving Energy in Bodensee County" Among the renewable sources of energy, solar thermal energy receives especially high priority in Friedrichshafen. The Wiggenhausen-Süd (4,300 m<sup>2</sup> when completed), Markdorf-Lichtenberg (230 m<sup>2</sup>) and Friedrichstraße (70 m<sup>2</sup>) plants, built and operated by the municipal utility, have provided important findings for the construction of other solar-assisted small-scale district-heating systems in Germany. Several years' practical operating experience have demonstrated the limitations and perspectives of this technology.

# EXPERIENCE OF FRIEDRICHSHAFEN

## The town planning concept

In a fundamental decision by the town council in August 1994, it was resolved to incorporate a solar-assisted district-heating scheme with long-term storage as a major component of the overall planning concept for the Friedrichshafen development "South Wiggenshausen", and to provide the groups doing the building with environmentally oriented guidelines for the planning and design of the individual quarters. At that time, it was thought that the medium-term demand for housing would best be met by blocks of flats built as complete or interrupted peripheral coverage. The overall South Wiggenshausen project is divided into



three sections. The first two sections are part of the solar-energy project, while the third section will be connected to the district-heating supply, but will not be fitted with solar collectors. The town planning aspects are supervised by the Friedrichshafen Municipal Planning Bureau. 250 residences were planned for the four quarters of the first section. But upon completion of the first section in 1996, a total of 280 residences were handed over to the clients. A

kindergarten was added to the residential area afterwards, and also connected to the district-heating supply. The thermal insulation levels of the buildings erected go far beyond the requirements of the 1995 Thermal Insulation Regulations [*Wärmeschutzverordnung* (WschVO 95)], so that the values are about 20% less than the prescribed standards.

1st section	Building 1 StWB	Building 2 LEG	Building 3 KBG	Building 4 SW	Building 5 KiGa	Total for Buildings 1-4
Number of residences	72	63	83	62	-	280
Living spaced	5,372 m <sup>2</sup>	4,761 m <sup>2</sup>	5,600 m <sup>2</sup>	5,652 m <sup>2</sup>	1,552 m <sup>2</sup>	21,385 m <sup>2</sup>
Heating demand	193 kW	200 kW	239 kW	290 kW	50 kW	922 kW
Provision of hot water	110 kW	135 kW	157 kW	115 kW	20 kW	517 kW
Heat consumption 1997	532 MWh	518 MWh	650 MWh	423 MWh	0 MWh	2,123 MWh
Heat consumption 1998	499 MWh	471 MWh	590 MWh	501 MWh	70 MWh	2,061 MWh

Table 1: South Wiggenshausen, building data for the first section

## The financing concept

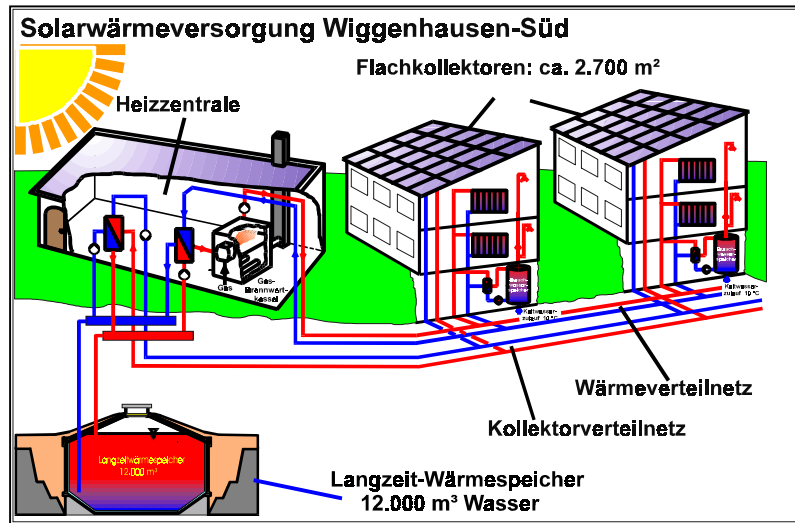
The Federal government ("Solarthermie 2000" research programme) subsidized the construction of the long-term storage and the district-heating system with a total of 53% of total costs. Other important supporters are the clients, with construction-cost subsidies of 24% of the total costs for connecting up to the district heating system and the solar-energy facility. The solar collectors of the first section were subsidized by the State of Baden-Württemberg with 9% of the total costs. The Technische Werke Friedrichshafen GmbH are the owners and operators of the entire solar-powered district-heating system and long-term storage facility, and have also assumed the builder's and operator's risk, including compensation in case of cost overruns.

## The heat supply concept of the South Wiggenshausen solar-energy settlement

On the roofs of the multi-storey buildings of the first and second section, about 4,300 m<sup>2</sup> of solar collectors will be installed. The solar heat generated in summer will be fed into the storage recharging loop of the long-term storage unit in the heating plant via a separate solar-heat distribution network (solar network) and a heat exchanger.

The long-term heat storage unit is heated by the solar network to temperatures ranging from 40°C to 90°C when the sun is shining. This heat is discharged into the district-heating distribution network (heat network) via another heat exchanger. The amounts of heat needed for heating and hot water in the individual quarters are, in turn, separated off via a heat exchanger in heat transfer stations.

The goal of the South Wiggenshausen pilot project is to cover almost half the total heat demand for space heating and hot water supply of the 570 flats with solar energy. The other half will be covered from gas-fired condensing boilers.

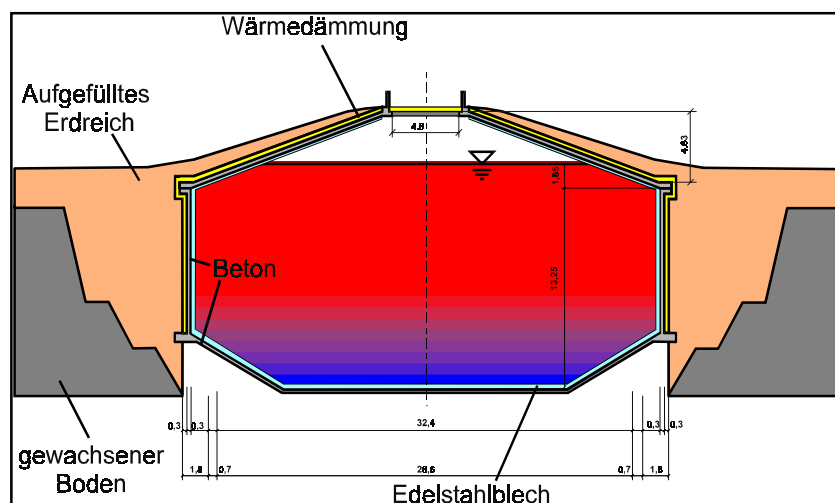


### The solar collectors

The main component are the flat solar collectors, with a surface area of 2,700 m<sup>2</sup>. The aperture of the individual modules ranges from 7.5 m<sup>2</sup> to 12.5 m<sup>2</sup>, depending on the manufacturer. Some of the collectors are on elevated mountings on the roof, while others are integrated into the roof. The costs, including final assembly of the collector arrays, range from about 180 Eur to 240 Eur per square metre, depending on the model of collector.

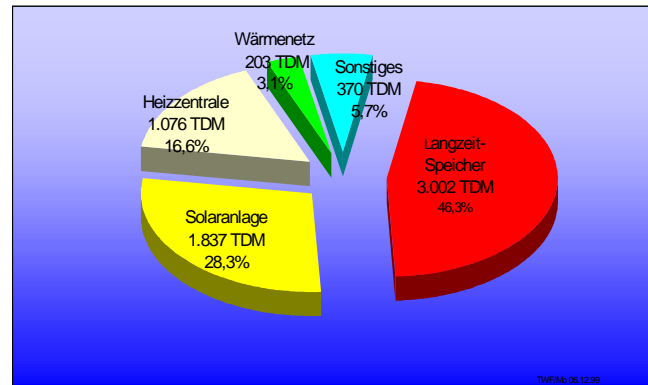
### The long-term heat storage unit

The long-term heat storage unit was designed as a cylindrical reinforced-concrete tank with a top and bottom having the form of truncated cones. This shape, with its optimum ratio of volume to surface area, enabled the construction costs of the long-term heat storage unit to be reduced considerably. The top and side wall of the cylindrical tank were lagged with 20 to 30 cm of rock-wool. The tank was lined with stainless-steel sheeting (1.25 mm) as protection against vapour diffusion. The long-term heat storage unit is entirely buried in soil.



### Capital costs & commercial viability

The capital costs for the first section of the solar-district-heating system amounted to about 3,317,000 Eur. For 280 completed flats, this means an outlay of 8,600 Eur per flat. Total annual costs of 90,000 Eur and an annual heat output of 1,980 MWh result in a heat price of about 45 Eur per MWh.



## EVALUATION AND PERSPECTIVES

The "Solarstadt Wiggenshausen-Süd" has become known far beyond the borders as Germany's largest solar-powered installation. The first section was implemented to the extent planned, and documents that the concept works in principle. However, the predicted amounts of solar heat and the ability to store them were not always fully realized. Nor were the planned return-leg temperatures of 25°C to 30°C in the heat network achieved. High return temperatures equal higher storage losses, and a reduction of the storage capacity of the long-term heat storage unit and of the solar yield. The energy accounting of the first two years of operation shows that, in particular, the expected 100% coverage of heat supply from the solar-energy facility during the summer and early autumn months is not achieved.

The experience gathered is already contributing to the building of the second section, whose planning aspects have also been reworked. The residential density of the first section is being supplemented by more scattered construction, in the form of single-family houses, blocks of flats with fewer storeys, and types of town houses. Site preparation for the second section will be in the spring of 2000.

## FOR FURTHER INFORMATION

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