SOLAR DISTRICT HEATING (SDH): TECHNOLOGIES USED IN LARGE SCALE SDH PLANTS IN GRAZ – OPERATIONAL EXPERIENCES AND FURTHER DEVELOPMENTS

M. Schubert[1], C. Holter[1] and R. Soell[1]

[1] S.O.L.I.D. Solarinstallationen und Design GmbH, Puchstr. 85, A-8020 Graz, m.schubert@solid.at

Abstract

S.O.L.I.D. installed three large scale solar plants for feeding into the city's district heating in Graz in recent years. These three solar plants have an annual heat production of 13,5 PJ, the city's grid delivers 2990 PJ per year. Therefore the integration of solar thermal in a technical and economical feasible way has to meet the requirements of Graz' existing district heating grid, which is one of the largest in Austria.

The first plant, at stadium Graz-Liebenau with 1.420 m², has been for seven years in reliable operations, with very good power output data.

AEVG Graz, the largest plant in Graz at 4.960 m², feeds into the gas power station (maximum power of 250 MW) and from there the heat is distributed through the district heating grid.

The latest plant, at Wasserwerk Andritz with currently 3.860 m², has a buffer storage of 60 m³ and the planning for installation of a heat pump is completed. The plant feeds into the district heating grid and supports the room heating of a large office building.

This paper presents operational experiences about three different ways for feeding solar thermal energy into a large city's district heating grid. Recent developments like buffer management for combined district heating and room heating and integration of a heat pump are outlined.

1. Introduction

For reasons of energy security and environmental protection, the European Union has set a target of 1 % solar fraction in district heating in 2020 and of 5 % in 2050 [1].

Solar thermal technology is widespread in the single family house sector in most European countries. Mainly for domestic hot water preparation (DHW), but also for room heating (RH).

In multi-family houses and for heating grids, there are not yet as many solar thermal plants and the market begins to develop.

First solar thermal plants for district heating were built in the 1970's in Sweden. Since then, various plants have been built mainly in Austria, Denmark, Germany and Sweden.

Most of these solar plants feed into rather small heating grids or sub-grids with an annual heat delivery below 50 GWh_{th}(180 TJ). In Denmark, this market was growing rapidly in recent years and is now bigger than the market for small-scale solar systems for single-family houses.

In Graz, Austria, solar thermal plants feed into a large scale heating grid with an annual heat delivery of 830 GWh_{th}(2,99 PJ) and a maximum power of 382 MW_{th}. Technical parameters and operation strategies in large scale heating grids are different to those in small scale grids and solar thermal technology has to adopt to these circumstances.

Three solar thermal plants in Graz are presented and the way they are integrated into the city's heating grid.

2. SDH plant designs in Graz

2.1. Feeding directly into the district heating grid – plant at stadium Graz-Liebenau

This plant is located on the roof of an ice-skating hall next to the city's football stadium.
The return medium of the heating grid is heated up and transferred to the flow (Fig. 1) [2]. The adaption of solar thermal technology for the temperature and pressure levels of the district heating grid were challenging. This project was realized with standard large scale collectors (1420 m² collector area) of the Austrian manufacturer Oekotech and temperature levels in the district heating flow of above 70°C have to be reached dependant on the ambient temperature. Solar plant Stadion Liebenau has no buffer storage, which results in lower invest and higher solar yield. In winter, solar energy is mainly used for room heating of buildings in the stadium complex and for a fitness center, in summertime main use is district heating.
During first operation years, detailed monitoring was done on the plant's performance. Dependant on climate condition, the annual yield of the plant was between 521 MWh/a and 569 MWh/a. This corresponds to a specific yield of 370 – 404 kWh/a per square meter collector area. Also the return temperature of the heating grid is of great importance for the performance of the solar plant.

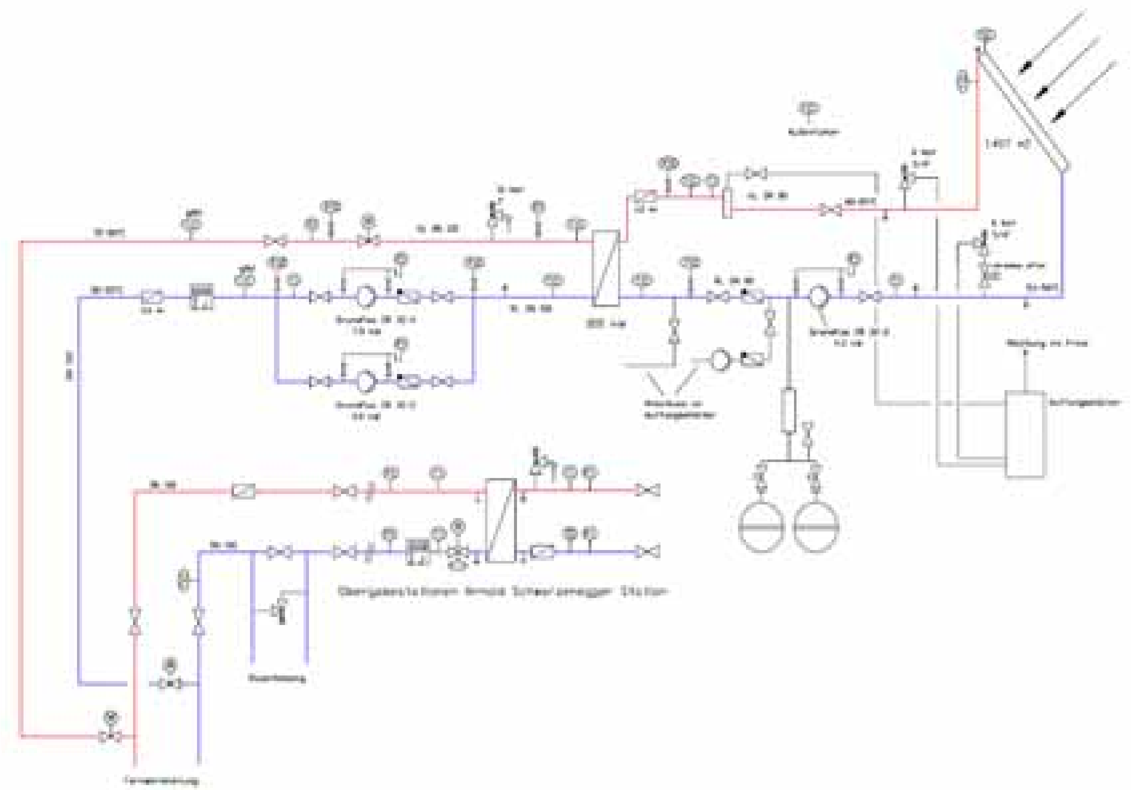

Fig. 1: hydraulic scheme of solar feed-in at Stadion Liebenau

2.2. SDH connected to a large scale fossil fuel fired station – plant AEVG Graz

This is the largest solar thermal plant in Austria and it is installed on four different buildings of the local collection and recycling station (Fig. 2). For both solar plants AEVG and Wasserwerk Andritz high temperature collectors gluatmugl from Oekotech are used.
From the solar plant, a pipe, which is partly aboveground and underground, goes to the equipment container with solar pumps and expansion vessels. This container is situated in the nearby gas heating plant. In the heating plant is the interface between solar plant and district heating grid.

Fig. 2: solar plant AEVG Graz

Situated next to the central gas-fired heating plant, pressure parameters are favourable for feed-in. At the central heating plant, the pressure in the heating grid's return is lower than in the solar thermal plant. This low pressure level is very favourable for pump dimensioning and electricity consumption.

2.3. SDH for combined room heating and district heating with buffer and heat pump – plant Wasserwerk Andritz

As solar thermal systems can't always generate the high temperatures as required for the district heating grid, other applications were found for temperature levels below 75 °C (Fig. 3).

Solar heat at low temperature level is stored into a 60 m³ buffer tank and later used for room heating of an office building (low temperature floor heating). The buffer is also fed by district heating and thus decreases the required connected load of the office building. The lower fixed price for connected load is an essential part of the ESCo financing model.

Collector yields at temperature levels which are too low for floor heating, especially at the evening, in shoulder seasons and in winter can be raised by a heat pump. The installation is planned for the end of 2010. COPs above 4 are expected, i.e. when flow from the collectors of 26 °C is heated up to 55°C for room heating. As the combination of solar thermal and heat pumps has been researched so far only for small scale systems, implementation and optimization of the heat pump at Wasserwerk Andritz will be done in the course of a research project.

Fig. 3: solar thermal plant Wasserwerk Andritz

Acknowledgement

This work is supported by the EU in the project "SDHtake-off" (IEE - Intelligent Energy Europe).

References

[1] ongoing EU-funded project "SDHtake-off"

[2] Bucar, G., Schweyer, K., Fink, Ch., Riva, R., Neuhäuser, M., Meissner, E., Streicher, W., Halmdienst, Ch. (2005), FEEt – Bestehende fossile oder teilfossile Fernwärmenetze – Einbindung von dezentraler Energie aus Erneuerbaren Energieträgern – Chancen und Hemmnisse, Endbericht zu „Energie der Zukunft" Forschungsprojekt No 807718 im Auftrag des BMVIT, publisher: Grazer Energieagentur Ges.m.b.h.