Projektinfo **04**/2015

Detailed information on energy research

Local heating links new-build with existing district

High energy building standards and network expansion in the existing building stock save primary energy and costs

BINE Information Service

By means of a district energy concept, researchers in Ludwigsburg are combining the advantages of ambitious building concepts and refurbishment measures with energy efficient heat supply. The heat required for the Sonnenberg development area is generated in winter using a brine/water heat pump in combination with a combined heat and power plant. The local heating network and its extension into the adjacent existing district of Grünbühl provide the post-war housing estate, which is in need of refurbishment, with not just greater living comfort but also energy efficiency benefits and cost savings. The central heating network in Sonnenberg has now been installed and brought into operation by the municipal utility company

How can an area with a low heating density be supplied with district or local heating? Is it worth expanding the network for existing building stock? And how can renewable energies be sensibly integrated? These questions were posed by researchers at Stuttgart University of Applied Sciences and by planners at the Ludwigsburg-Kornwestheim municipal utility company (SWLB) and the town of Ludwigsburg when developing an energy concept for the Grünbühl and Sonnenberg housing estates. For this purpose they developed solutions for a new local heating system and for implementing the low-exergy approach for new-build schemes and refurbished existing buildings. The basis for this was provided by the integrated "Opportunities for Ludwigsburg" urban development concept with its guiding principles and goals in eleven thematic areas – including "energy". It has been implemented since 2006 in many individual projects at the urban district level – accompanied by the "Sustainable Urban Development" unit as the coordinating body for the municipality.

This research project is funded by the

Federal Ministry for Economic Affairs and Energy (BMWi)

Fig. 1 *Heat requirement simulation for the existing Grünbühl district using a 3D urban model.*

Fig. 2 *The new-build schemes in the Sonnenberg urban district consist of a variety of different building types. The photo shows multi-family townhouses to the KfW Energy Efficiency House 70 standard.*

Fig. 3 *In addition to dense high-rise buildings, building blocks in need of rehabilitation are typical for the Grünbühl district.*

Local heating system uses geothermal energy

The central pillar of the integrated energy concept is to expand the local heating network in Sonnenberg with the aim of significantly increasing the proportion of renewable energy in the heat supply. The basic heat load is ensured by a brine/water heat pump with a heat output of 200 kW and a CHP plant with 236 kW_{th}. The main energy source is a borehole heat exchanger array that extends to about 5,800 metres. In the first construction phase, it is intended to achieve about 20 per cent of the annual heat output using geothermal heat. It is also planned to integrate additional heat sources. A gas boiler covers the peak loads. SWLB is the operator of the new heat supply system. For new-build schemes, a mandatory connection to the local heating network will be stipulated in the land purchase contracts.

Passive house residential estate with LowEX heating network

It is planned to build an energy-plus housing estate in the Sonnenberg-Southwest area. For the construction, the aim is to achieve a standard similar to the passive house benchmark for apartment buildings and detached and semi-detached homes. In addition to the low energy requirement, the low development density will make it difficult to expand the local heating network economically. The researchers have therefore investigated several network connection options, ranging from standard expansion via a low-temperature connection into the network return to using a cold local heating system with decentralised heat pumps. In the latter variant, the main network return in the smaller network for Sonnenberg-Southwest is reduced to about 25 °C using a return admixture. This ensures minimal heat loss but requires decentralised heat pumps to provide the space and domestic hot water heating. The analysis of all the network variants showed that it is possible to connect Sonnenberg-Southwest to the return of the main network with a flow temperature of about 45 °C and a return temperature of about 25 °C. The low network temperature will require electrical backup heating for the domestic hot water. However, as this only has to increase the hot water temperature by a few degrees Kelvin, the electrical energy consumption will remain low.

Grid expansion in the existing district

Until now Grünbühl has only been supplied with decentralised heat. The restructuring involves larger-scale demolition and remodelling work together with successive building redevelopment with highly energy efficient buildings to the west and south of the district. This is because the poor condition of the existing building fabric does not permit economic modernisation. To determine a solution for the future local heating network the municipal utility company has assessed five installation variants with respective estimates of the heat generation costs. One possible solution is to compile together load groups: instead of the traditionally used provision with transfer stations in each building, a single terminal is installed for each row of terraces. This minimises not only the pipe lengths but also the investment costs. In terms of the energy efficiency, the significantly reduced heating requirements of the new buildings are causing higher localised network losses. Considering the area as a whole, however, enables these losses to be better “distributed”: the network-linked, energy-efficient heat supply in the dense existing housing stock offsets the disadvantages in the new building schemes – not only in terms of the primary energy but also the costs. Solar thermal feed-in seems at best to make economic sense in the summer months. This is because it has hydraulically and thermally negative impacts on the operation of the cogeneration plant:

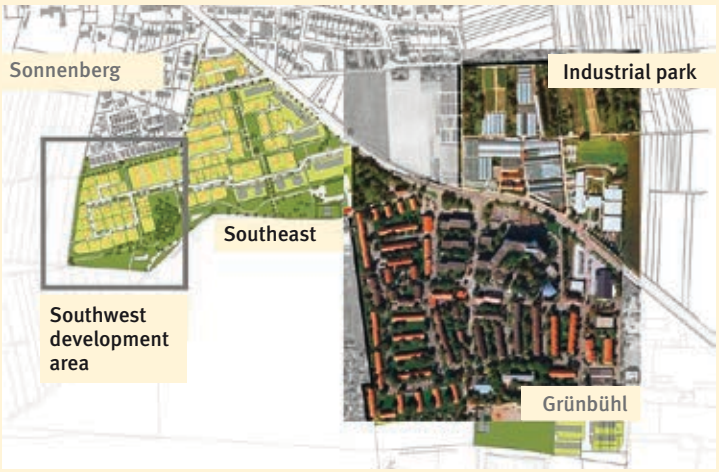

Fig. 4 *Overview of the "E+ district Grünbühl/Sonnenberg" project area. The urban framework plan developed in 2008 provides the basis for the restructuring.*

Fig. 5 *Installation of borehole heat exchangers beneath an open space in the Sonnenberg-Southwest area.*

it reduces the service life of the CHP plant and thus its electricity generation and economic feasibility.

Framework plan ensures structural and social mix

The districts of Grünbühl and Sonnenberg are situated on the south-eastern edge of Ludwigsburg. The development area covers nearly 40 hectares. Grünbühl exemplifies the structural and energy-based refurbishment requirements typical of buildings from the 1950s to the 1970s. Sonnenberg was built in the post-war period as a residential development for officers from the US armed forces. It was abandoned by the US Army in 1991 and then mainly used as social housing. In 2006, both districts were included in the "Social City" programme.

In order to improve the poor living conditions and one-sided building structure, Ludwigsburg town council created an urban master plan for both districts in 2008. It seeks to restructure the areas with different building types that are also intended to ensure a social mix. The underlying urban design concept for redeveloping Sonnenberg is based on a green "garden city" with many recreational spaces and play areas. The central area is complemented by stand-alone point blocks to the east and by terraced, semi-detached and linked housing types to the west. To the southwest of the district, a looser building structure is envisaged with detached, semi-detached, terraced and townhouses provided as energy-plus buildings, whereby the new-build schemes in Sonnenberg-Southeast shall meet a minimum energy efficiency standard equivalent to the KfW Energy Efficiency House 70 benchmark. Today, the existing buildings in Grünbühl have low energy standards and in most cases are in urgent need of refurbishment. The youth and community centre is situated between the two districts. Next to it the town council has constructed a children and family centre as a multi-generational centre. Together the two facilities form the communal and social heart of both neighbourhoods.

Conversion from Federal Real Estate

To the west of Grünbühl there are 320 homes in need of renovation with significant deficiencies in regards to their building fabric and with obsolete sizes and floor plans. Previously owned by the Institute for Federal Real Estate (BImA), Ludwigsburg town council acquired them at the end of 2012 after lengthy negotiations. The housing blocks from the 1950s and 1960s cover around 6 hectares, which is almost a quarter of the total area of Grünbühl. Their future development plays a central role in enhancing the overall district. According to a thermal diagnosis by a specially developed 3D urban model, the heating requirement of the BImA buildings is usually more than 200 kWh/m² p.a.

It is planned to create a model district in the northern part of the area. This will include combined photovoltaic and electricity storage systems with intelligent load management for apartment buildings. The area provides the starting point for expanding the local heating network from Sonnenberg to Grünbühl. Particularly efficient transfer stations and building services components are designed to provide very low return temperatures in the network. In order to develop a socially acceptable approach, a residents' survey was initiated. A "competing planning process" is currently being prepared. The aim is to update the urban master plan from 2008 and realise a pilot project by Wohnungsbau Ludwigsburg GmbH (WBL) for affordable rental housing. The plans for the future development structure are expected to be presented by June 2015.

State of the implementation

Ludwigsburg Energy Agency (LEA) has conducted a solar optimisation of the urban planning framework. This already enabled the first new development plan, Sonnenberg-Southeast, to specifically consider the position of the buildings and the placement of trees. The municipal utilities have meanwhile fully installed the local heating network in the Sonnenberg development core. The heating plant already commenced operation at the beginning of the 2011 heating season.

Ludwigsburg town council is also currently re-designating the Sonnenberg-Southwest area with a new development plan process. As the future owner of the sites, the WBL is planning among other things to build around 60 new apartments there with high construction standards. However, some of the local community have organised a citizens' action group to oppose it. The action group and the municipal council are currently discussing different planning alternatives that will be decided in March 2015. The development plan process could then be completed.

Success factors for district energy concepts

District-based energy planning requires an integrated design approach, whereby as many players and stakeholders as possible should be involved in the planning and implementation of the measures. The goal therefore always represents a balance of interests. Local authorities need to coordinate these processes, anchor them in terms of policy and provide the resources. A major rethink is also required here. Local authorities need to further professionalise in order to become competent business partners, as these days investors are demanding sustainable framework conditions from them, including in the energy field. Urban development, climate protection and district energy concepts provide excellent references in this regard. They offer clear goals, planning security and binding measures for all stakeholders. For years it has been shown in Ludwigsburg that the town administration is accepted as a controlling player and that public debate provides a key factor for success.

By means of district energy concepts, planners develop in ideal cases socially acceptable and cost-effective energy efficient solutions. Although the ambitious use of technology is a highlight, it is not in itself sufficient, as communication and cooperation also play a crucial role in conveying and implementing such concepts. This involves, in addition to local partnerships with public utilities and housing companies, public participation schemes, motivation campaigns and the networking of players. This is because an increase in energy efficiency does not necessarily lead to a reduction in the energy consumption. Rebound effects and user influence are not only key aspects here but also required research fields. The early involvement of owners, tenants and users in the planning process is now also a prerequisite for funding district energy efficiency concepts. An initial evaluation of the projects in the EnEff:Stadt research initiative shows that the greater the projects' complexity, the more their success at the district level depends on structural and communicative processes. This begins with the development of the project idea, continues with the internal project management and stakeholder participation, and extends as far as the success monitoring and consolidation.

Project participants

- **Project management:** Stuttgart University of Applied Sciences, Centre for Sustainable Energy Technology (zafh.net) and the Centre for Sustainable Urban Development, Germany, Dr Dirk Pietruschka, dirk.pietruschka@hft-stuttgart.de, www.hft-stuttgart.de
- **Project partners:** Ludwigsburg Town Council, Germany, Referat Nachhaltige Stadtentwicklung (Sustainable Urban Development Unit), Sandra Bühler-Kölmel, s.buehler-koelmel@ludwigsburg.de, Fachbereich Stadtplanung und Vermessung, Avni Veselaj and Albrecht Burkhardt, www.ludwigsburg.de/stadtentwicklung
  Stadtwerke Ludwigsburg-Kornwestheim GmbH, Germany, Gerold Kohler, gerold.kohler@swlb.de, Martin Klein, martin.klein@swlb.de, www.swlb.de

Links and literature

- www.ludwigsburg.de/stadtentwicklung
- www.eneff-stadt.info/en

More from BINE Information Service

- Making district heating renewable. BINE-Projektinfo brochure 13/2014
- Energy from waste water supplies urban district. BINE Projektinfo brochure 09/2014
- Science and business park grows efficiently. BINE-Projektinfo brochure 14/2013
- On route to a low-energy urban district. BINE-Projektinfo brochure 15/2012
- Integrated energy concept for a residential neighbourhood. BINE-Projektinfo brochure 01/2010
- This Projektinfo brochure is available as an online document at www.bine.info under Publications/Projektinfos.

BINE Information Service reports on energy research projects in its brochure series and newsletter. You can subscribe to these free of charge at www.bine.info/abo

Imprint

Project organisation
Federal Ministry for Economic Affairs and Energy (BMWi)
11019 Berlin
Germany

Project Management Jülich
Forschungszentrum Jülich GmbH
Doris Laase
52425 Jülich
Germany

Project number
0327400T

ISSN
0937-8367

Publisher
FIZ Karlsruhe · Leibniz Institute for Information Infrastructure GmbH
Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen
Germany

Author
Uwe Friedrich

Contact · Info

Questions regarding this Projektinfo brochure? We will be pleased to help you:

+49 228 92379-44
kontakt@bine.info

BINE Information Service
Energy research for application
A service from FIZ Karlsruhe

Kaiserstraße 185-197
53113 Bonn, Germany
www.bine.info

Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

Concept and design: iserundschmidt GmbH, Bonn – Berlin, Germany · Layout: KERSTIN CONRADI · Mediengestaltung, Berlin, Germany