

## Urban Development and the Passive House Standard – Heidelberg's new *Bahnstadt* District is Growing Dynamically

### 1 Introduction

Bahnstadt, a new district, is arising on the area of the former freight and switch yard in Heidelberg. It will be the first quarter consisting entirely of buildings constructed to the passive house standard. With its 116 hectares, it is one of the largest urban development projects in Germany and, as far as we know, it will be the largest area of passive houses in the world. It is developing dynamically, significantly faster than projected and with the highest quality standards. The ground-breaking ceremony took place in 2010, starting the construction of a building supplies store. By now, 57,000 square metres of useable surface have been completed – including residential buildings, day-care centres, retail outlets, offices and laboratories. A further 120,000 square metres are under construction or waiting for a building permit and the main part of it will be occupied in 2013 – further residential buildings and offices, halls of residence for students and a hotel.

Practical experience has shown that the passive house standard is ready for broad implementation. The energy strategy does not only involve technical standards but also obligations of planning law and contracts, energy consulting, quality management, public relations and financial incentives. Thanks to its district heating and electricity supply based on combined heat and energy production from a wood cogeneration plant, Bahnstadt is a zero-emission district.

### 2 Sustainable Urban Development

The Heidelberg Development Company (*EGH*) was established in order to develop and market *Bahnstadt*. Its stockholders are *Sparkasse Heidelberg*, the Heidelberg Housing and Real Estate Company (*GGH*), and *Landesbank Baden-Württemberg*.

The course for the sustainable development of *Bahnstadt* was set by integral environmental and energy concepts. By reusing the freight and switch yard, closed in 1997, this urban development saves a lot of space. Transportation is minimized by the central location of the district which allows for a high percentage of non-motorized traffic. The new district has direct access to Heidelberg's central railway station, attractive walking and cycle paths inside and outside the district as well as a good connection to



local traffic by tram. The spatial proximity of life and work, attractive open spaces, local supply and cultural offers keep motorized traffic low.

Two thirds of *Bahnstadt*'s roofs will be vegetated to foster nature conservancy, microclimate and rainwater retention. Rainwater from roofs is drained and retained. Hence, discharging into channels is minimized.

### 3 The Energy Concept

Sustainable urban development contributes significantly to climate protection – with regards to transportation, due to energy-efficient building standards, and due to an efficient and renewable energy supply. The tasks included in the energy concept are the following: minimizing the required thermal heat, efficient water supply, the development of adequate strategies for implementation, estimating the required electricity as well as the potential solar energy of roof areas. The engineering office *ebök*, which specializes in energy consultancy, building services, and ecological concepts, was assigned to develop the corresponding concept and presented its final report in November 2007 [ebök 2007].

Heidelberg's energy conception is the basis for the energy concept of *Bahnstadt*. It defines high energy standards for municipal buildings, the management of estates, and urban development. In 2010, the energy conception was updated with a focus on the passive house standard [Stadt Heidelberg 2010].

#### Area-wide Passive House Standard in *Bahnstadt*

*ebök* used the existing urban *master plan* in order to calculate examples of the construction cost and the profitability of different energy standards for selected building plots in *Bahnstadt*. For the calculation of profitability a period of 40 years was investigated, which is a realistic assumption as serviceable lifetime until the first fundamental reconstruction becomes necessary. Regarding such life time cycles is one precondition for sustainable investment decisions. The passive house standard could be attained with conventional insulation for all buildings – it even showed to be more profitable than building according to the legal standard of the regulation for energy saving (*Energieeinsparverordnung [EnEV]*).

Further arguments in favour of the passive house standard were the following: considerable practical experience with various types of buildings, the evaluations and documentation of realised passive houses at hand, offers of skill enhancement for architects and engineers, the *Energy Balance and Passive House Planning Tool [PHPP]* as a realistic instrument, and existing concepts for quality management and certification.

Due to *ebök*'s survey and these criteria relevant for the implementation, an area-wide construction of passive houses was defined as obligatory.

## Supply with “Green District Heating” from Renewable Energies

According to the calculations regarding profitability and emissions of carbon dioxide of different types of heat supply, district heating proved to be the most efficient solution due to the urban density – despite the passive house construction.

The so-called “*Mininetze*” (mini-grids) are an innovative and detailed concept and were developed together with *ebök*: Each plot is supplied by one indirect transfer point for heat. The secondary mini-grid can be driven at low temperatures which minimizes distribution losses. As many consumers use the grid together instead of each building having its own supply, the requirements of heat output are reduced. Hence, each consumer has to pay less for its provision of heat.

Another important argument in favour of district heating is the fact that the grid can be used as infrastructure for a gradual increase of the share of renewable energies for the heat supply. The first step towards “green district heating” is the construction, by Heidelberg's municipal energy supplier (*Stadtwerke Heidelberg*) of a co-generation power station using wood next to *Bahnstadt*. It enables the city to use the renewable, but only limited energy source (wood) efficiently for cogeneration. Completely natural wood is used to cover the entire demand of heat and energy of *Bahnstadt*. Furthermore, the basic load of Heidelberg's district heating can be covered in summer. The combination of the passive house standard and “green district heating” makes *Bahnstadt* a zero-emission-district with regards to its buildings' energy demand.

## 4 Political Decision and Planning Acts

Heidelberg's City Council resolved upon an energy concept for *Bahnstadt* including the following commitments:

1. The heat supply of *Bahnstadt* will be provided by district heating using the optimized model of mini-grids ... in the medium-term with 100% of renewable energy ...
2. The construction of *Bahnstadt* will be carried out in the passive house standard. Exceptions are possible when the standard is not technically appropriate nor economically justifiable. In these cases, a comparable environmental balance has to be achieved due to specific energy efficiency concepts.

The energy concept is part of the urban contract with EGH. EGH passes on the demands, especially the duty to build according to passive house standard, to the building promoter through appropriate acts of sale. Each building project has to be permitted within the limits of the “*Entwicklungsmaßnahme Bahnstadt*” (urban development measure), which is also based on this energy concept. A third instrument to ensure the concept is land development plans incorporating intentions for the construction.

## 5 Implementation – Development of an Image, Specialist Counselling, and Quality Management

When developing the image for *Bahnstadt*, the City of Heidelberg and EGH emphasised the criteria of sustainability and the energy concept for their public relations work. A leaflet was created for *Bahnstadt*’s energy concept and the passive house standard. The district’s construction signs include a reference to the world’s biggest development of passive houses. Also the private building promoters used the passive house standard for their own marketing. In a representative survey of Heidelberg’s citizens in 2012, *Bahnstadt*’s energy concept had by far the highest awareness level of all programmes for climate protection. And the most important: The passive house standard is in demand! *Sparkasse Heidelberg Immobilien* (estates division of the provident bank), which merchandises most of the residential buildings, explained that customers named the energy standard as one of the most important reasons for buying.

The City offers individual dates for specialist counselling to building promoters and assigned production engineers as soon as possible and hence significantly fosters the acceptance of its requirements. These dates also mark the introduction of the quality management process, which is bound tightly to the process of approbation and the municipal support programmes. The quality management was developed on the basis of the certification of passive houses. The regional energy agency *KliBA* is assigned to checking the calculations of *PHPP* before building approval is given as well as during the process of planning. Further steps of quality management are appointments at the building yards, Blower-Door-Tests, final acceptance, and a concluding update of the *PHPP*. A formal certification is not required, but in some cases the building promoters ordered them voluntarily. The process of quality management is described in more detail in a lecture of my colleague Robert Persch. The municipal support programme sponsors passive houses with a subsidy of 50 € per square metre up to a maximum of 5,000 € for each flat. The offers for energy consulting are completed with *Bahnstadt*’s energy saving concept, which includes individual concepts for the sectors living, offices, retailers, and laboratories [Stadt Heidelberg 2012].

## 6 Dynamic Development of *Bahnstadt*

### Passive House Solutions for Non-Residential Buildings

The first building project being realised in *Bahnstadt* was a building supplies store in 2010. It has a heated floor space of 12,000 square metres. At first, the passive house standard seemed to be a distant goal due to the inevitable opening of doors and gates and the cost structure of the standardized, industrial construction technique. But precisely because of the large ceiling heights of the store and the numerous door-openings make measures reducing the loss of air infiltration heat especially important. Hence, a concept for an air-tight attachment of iron sheet components and for the reduction of air exchange at the doorways for customers as well as for suppliers was developed. The latter goal was achieved by installing windscreens, air curtains, and fast-closing sliding doors and gates. The light-bands in the roof were created with air-tight connections in cooperation with the firm *Lamilux*. The project planning of the passive houses showed that it is not vital to meet the conventional heat transfer coefficients for windows (*U-Wert*) between 0.15 W/m<sup>2</sup>K and 0.85 W/m<sup>2</sup>K in such a large building. Therefore, effective solutions could be found without significant changes to standardized methods of industrial construction. As the hall has an air capacity of more than 100,000 cubic metres, it was not easy to find a provider offering a Blower Door test.

The second business project realised was *SkyLabs*, a building consisting of offices and laboratories. It has a floor space of 22,000 square metres and thus required individual solutions for its energy concept. The laboratory equipment has immense weight and the technical standards for laboratories demand an air change about eightfold that of normal buildings. Hence, the parameters for passive houses generally cannot be met. Furthermore, only heat exchangers with closed loops could be used for ventilating the laboratories in order to eliminate the possibility of contaminating the incoming air. The outer level of the buildings was constructed in passive house quality. The confirmation for passive houses was achieved by layout and operating methods for the ventilation system common for offices. The *SkyLabs* were finished at the end of 2012 and the first tenant, a private international university, has already moved in. The façade of the building is formed by curtains which integrate foldable elements creating shadow.

The first day-care centre started its work in autumn of 2012. It was the first building in *Bahnstadt* being constructed under lightweight construction methods using wood.

At the moment there is a hotel with 12,000 square metres space under construction. The passive house project work showed that the installation of a ventilation system with heat recovery is not necessary because of unavoidable internal weights due to the hot water

supply. Additional plots are being planned, for example a retailer's centre including a discount house, department store, a chemist's shop, a car dealer, a big cinema, and a plot for public buildings such as a school, a second day-care centre and a community centre.

## Living in *Bahnstadt*

The demand for residential building is developing rapidly. 2,000 to 2,500 flats are planned from which 226 with a living space of 22,500 square metres have been completed. Two plots are already inhabited. Further 80,000 square metres of living space are under construction at the moment and are planned to become mainly inhabited in 2013. Comparable large areas are currently in various states of planning, from preliminary design to the planning permission application.

Next to flats for families along the green corridor "Promenade", halls of residence for students are being built. There is also space for various smaller trade units and retailers on the ground floors.

A system for monitoring the energy consumption is currently being prepared in cooperation with Heidelberg's municipal energy supplier and the Passive House Institute (*Passivhaus Institut*). The energy supplier equips *Bahnstadt* area-wide with "Smartmeters".

## 7 Conclusion

The factor of success for the district *Heidelberg-Bahnstadt* with its passive houses and zero-emission buildings is the total package of a coherent energy concept, binding planning acts and contractual guidelines, the development of a positive image, specialist counselling in terms of energy, financial support, and sophisticated quality management. The experience is positive: *Bahnstadt* is attractive to customers and investors and in addition planners accept their task in a dedicated way.

### Literature

- [Bermich 2011] „Passivhaus als Standard der Stadtentwicklung – Null-Emissions-Stadtteil Heidelberg-Bahnstadt in Heidelberg“, Ralf Bermich, Vortrag auf der 15. Internationalen Passivhaustagung, Innsbruck, Mai 2011.
- [ebök 2007] „Baugebiet Bahnstadt in Heidelberg – Städtebauliches Energie- und Wärmeversorgungskonzept“, Ingenieurbüro für Energieberatung, Haustechnik und ökologische Konzepte ebök, Tübingen, November 2007.
- [Stadt Heidelberg 2010] „Energiekonzeption der Stadt Heidelberg“, Stadt Heidelberg, Amt für Umweltschutz, Gewerbeaufsicht und Energie, Beschluss des Gemeinderates Mai 2010.
- [Stadt Heidelberg 2012] „Stromsparkonzept Bahnstadt“, Fachliche Erarbeitung ebök, Tübingen, Herausgeber Stadt Heidelberg, Amt für Umweltschutz, Gewerbeaufsicht und Energie, Heidelberg 2012.